Universidad del País Vasco

Euskal Herriko Unibertsitatea

DOCTORAL THESIS

Memory Retrieval: representations and processes involved during sentence comprehension. Evidence from Spanish

---

Author:
Nerea EGUSQUIZA

Supervisor:
Dr. A. ZAWISZEWSKI

Department of Linguistics and Basque Studies

2019

Resumen

Nerea EGUSQUIZA

Memory Retrieval: representations and processes involved during sentence comprehension. Evidence from Spanish

Comprender el lenguaje humano es un proceso psicológico que requiere un sistema cognitivo capaz de codificar, mantener y combinar la información contenida en cada palabra del aporte lingüístico tan pronto como la percibamos en tiempo real para que podamos generar una representación estructural que nos permita asignar significado a una oración que, de otra manera, constituiría una secuencia lineal de palabras que proporcionan información semántica individualmente (véase Sturt y Crocker, 1995). Sin embargo, la cantidad de información lingüística que podemos procesar activamente en la memoria de trabajo es muy limitada (Miller, 1956; Baddeley y Hitch, 1974; Shiffrin, 1976; Crowder, 1993; Cowan, 2001; 2005; 2010; Chen y Cowan, 2005). Cualquier teoría sobre el procesamiento oracional humano, por lo tanto, debe tener como objetivo explicar las propiedades de dicho sistema; cómo se almacena la información en tiempo real y cómo se recupera de la memoria cuando se necesita acceso a representaciones lingüísticas previas para interpretar la relación sintáctica entre dos palabras no adyacentes y que se encuentran a menudo a larga distancia. En esta tesis nos hemos centrado particularmente en la resolución pronominal (correferencia), en la concordancia sujeto-verbo y en la interpretación de las dependencias de pronombre clítico en español con el objeto dislocado a la izquierda con el fin de investigar cómo afectan la información léxica, la estructura lingüística y las restricciones gramaticales a la recuperación de las propiedades del antecedente almacenadas en la memoria. El español nos permite analizar el contraste gramatical entre los sintagmas nominales con sujetos y objetos animados así como el impacto de la información léxica de género durante la comprensión oracional, ya que ambas pistas informativas se codifican morfológicamente. Adoptamos un modelo de

procesamiento oracional basado en la activación en el que un único conjunto de principios generales memorísticos y de mecanismos cognitivos rige la recuperación de información y donde se accede en paralelo a los elementos en la memoria reciente según las características de su contenido (véase, por ejemplo, Lewis y Vasishth, 2005; Engelmann et al., 2016).

Una predicción central de los modelos de procesamiento oracional que asumen que el acceso a la información depende del contenido de los elementos en la memoria es la aparición de efectos de interferencia cuando un elemento sintácticamente ilícito cumple de manera parcial o total con los requisitos característicos de la dependencia; es decir, cuando cumple de alguna manera con sus pistas de recuperación (*retrieval cues*). Los indicios obtenidos en varios tipos de dependencias lingüísticas apoyan la idea de que un mecanismo de acceso basado en características o pistas (*cue-based*) subyace la comprensión oracional, por ejemplo, durante la concordancia entre sujeto y verbo y las dependencias tipo "filler-gap" (Jaeger et al., 2017; Ness y Meltzer-Asscher, 2017). La suposición general es que un único mecanismo de recuperación, uniforme, propenso a las interferencias y basado en pistas es el encargado de procesar todas las dependencias lingüísticas (Van Dyke y McElree, 2011; Martin y McElree, 2008; Lewis y Vasishth, 2005; Lewis, Vasishth y Van Dyke, 2006; McElree, 2000; McElree, 2006). Esta visión, sin embargo, ha sido cuestionada. Algunos investigadores sugieren que un mecanismo de acceso estructurado es el responsable de recuperar el antecedente según su posición sintáctica dentro de la oración (Phillips, Wagers y Lau, 2011; Dillon, 2011; Dillon et al, 2013; Dillon, 2014), mientras que otros proponen que tanto la información estructural como la no estructural se ven involucradas en el instante de la recuperación (*retrieval site*), aunque el mecanismo de procesamiento conceda preferentemente un mayor peso a la primera (Cunnings y Sturt, 2014; Parker y Phillips, 2017).

Esta diferencia es clave para los modelos de memoria cognitivo-generales y de contenido accesible (*content-addressable*). El modelo basado en la estructura sugiere que un mecanismo de recuperación cualitativamente diferente subyace ciertas dependencias sintácticas (por ejemplo, el licenciamiento de los pronombres reflexivos en inglés) y no otras, como la concordancia entre sujeto y verbo. Sin embargo, el modelo de ponderación de pistas o señales (*cue-weighting model*) defiende la idea de que un mecanismo de recuperación regido por pistas informativas y con distintos patrones de sensibilidad para

cada una de ellas opera en todas las dependencias lingüísticas durante la comprensión oracional. El primer modelo implica que el mapeo entre restricciones gramaticales y pistas de recuperación varía según el tipo de dependencia lingüística en juego. Crucialmente, predice que las pistas de recuperación de una dependencia no se pueden inferir directamente de sus restricciones gramaticales, morfológicas y semánticas y , por lo tanto, plantea el problema de "cómo consiguen converger los hablantes en la estrategia de recuperación a implementar para cada dependencia" (Parker y Phillips, 2017).

Además, al otorgar prioridad a la información sintáctica durante el procesamiento de ciertas dependencias, el modelo de acceso estructurado respalda las teorías modulares sobre el lenguaje, donde el sistema lingüístico funciona en gran medida independientemente de otros sistemas cognitivos y en los que la información sintáctica, semántica, fonológica y ortográfica se aborda de manera individual dentro de módulos mentales separados a los que se suele acceder en serie y en los que la sintaxis va primero (Forster, 1979; Ferreira y Clifton Jr., 1986; Frazier, 1987; 1990; Frazier et al., 1996; Crocker, 1992).

En esta tesis apoyamos empíricamente la visión de que todas las dependencias lingüísticas, independientemente de la gramaticalidad oracional, se procesan a través de un mecanismo de acceso cognitivo general, no específico del lenguaje, direccionable por contenido y basado en pistas o señales (*cues*) en el que las pistas de recuperación sintácticas pesan más que las no sintácticas y donde la información morfológica de número destaca cognitivamente sobre la de género cuando se trata del procesamiento de las características de concordancia.

El cuerpo de esta tesis se compone de tres capítulos en los que se investiga la naturaleza de las representaciones así como la de los procesos implicados en la recuperación en tiempo real de la información previa almacenada en la memoria, necesaria para la comprensión de dependencias sintácticas en español.

El capítulo 2 examina el contenido de las representaciones del antecedente que el sistema cognitivo recupera durante la resolución pronominal anafórica en español en contraste con el acceso léxico repetido al sintagma nominal del antecedente. Los capítulos 3 y 4 se ocupan de la naturaleza de los mecanismos de procesamiento que subyacen bajo las operaciones de concordancia y correferencia durante la interpretación de dependencias sintácticas a distancia en español.

En la primera parte (capítulo 2), aprovechamos el fenómeno psicológico de "efecto de frecuencia léxica", donde las palabras de uso más frecuente son más fácilmente accesibles en la memoria que las poco frecuentes, para explorar el contenido de las representaciones del antecedente que los lectores recuperan de la memoria durante la resolución pronominal anafórica en español. Nuestra hipótesis se basa en la sugerencia de Meyer y Bock (1999) de que los hablantes podrían tener acceso a representaciones del antecedente cualitativamente diferentes según el tipo de información necesaria que medie la correferencia en sus respectivas lenguas. Reportamos dos tareas de lectura auto-administrada y un experimento de seguimiento visual que muestran que el procesamiento pronominal en español difiere del acceso léxico a otros estímulos. Concretamente, mientras que el efecto de frecuencia léxica en la región del antecedente se replica en la condición de control a pesar de repetirse el antecedente por segunda vez, este efecto desaparece durante la resolución del pronombre anafórico en español. Interpretamos nuestros datos como indicios sugerentes de un modelo de acceso léxico anafórico. A diferencia del acceso léxico a otros estímulos, el mecanismo de procesamiento en el caso de elementos anafóricos accedería de forma escalonada a la información del antecedente para recuperar únicamente la sintáctica y semántica, es decir, su lemma, dejando fuera la información ortográfica-fonológica (el lexema, véase Simner y Smyth, 1998). Este modelo se basa fundamentalmente en los resultados obtenidos en experimentos con pares de homófonos de alta y baja frecuencia y que llevaron a Jescheniak y Levelt (1994) a concluir que la información de frecuencia léxica se almacena en el nivel del lexema. Nuestros resultados coinciden con los hallazgos en inglés (Simner y Smyth, 1999; Lago, 2014; cf. Van Gompel y Majid, 2004) y contradice los estudios llevados a cabo en alemán (Heine et al., 2006a; 2006b).

En la segunda parte de esta tesis (capítulos 3 y 4) investigamos la naturaleza de las pistas lingüísticas y de los mecanismos de procesamiento involucrados durante la resolución de la concordancia sujeto-verbo y de la correferencia con pronombres clíticos en español en dependencias sintácticas a distancia. El capítulo 3 presenta dos experimentos de lectura auto-administrada en el que nos servimos de la interferencia basada en la atracción con el objetivo de analizar el efecto de la prominencia del atractor sobre el procesamiento de la información de número durante el establecimiento de la concordancia sujeto-verbo en español. Los resultados muestran que el papel gramatical del atractor modula los efectos de interferencia de número en oraciones gramaticales en español. Este descubrimiento apoya la inserción del principio de

prominencia de Engelmann et al. (2016) al modelo de procesamiento oracional de Lewis y Vasishth (2005) al mismo tiempo que contradice la hipótesis que postula que el mecanismo de recuperación memorística de la información a través de pistas se dispara únicamente como un mecanismo de último recurso para reparar errores en el marcaje de número del verbo durante la concordancia sujeto-verbo (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; c.f. Nicenboim et al., 2018). El modelo extendido (Engelmann et al., 2016) explica nuestros datos así como los resultados inconsistentes en la literatura previa con la predicción de interferencia inhibitoria asociada al modelo de Lewis y Vasishth (véase Jaeger et al., 2017). En conjunto, interpretamos que la evidencia empírica apoya la idea de que un mecanismo de recuperación memorística de la información basado en el uso de pistas subyace el procesamiento de la concordancia sujeto-verbo en español independientemente de la gramaticalidad de la oración (cf. Lago et al., 2015).

En el capítulo 4, investigamos la interferencia durante la recuperación memorística de la información del antecedente durante la resolución de la coreferencia con pronombres clíticos en español, en un contexto en el que éstos exhiben un comportamiento mixto entre inflexional y pronominal y en el que son sintácticamente predecibles además de estar ligados a un constituyente previo dentro de la misma cláusula, como ocurre en las oraciones con pronombres reflexivos en inglés. El objetivo era examinar cómo se implican y combinan diferentes conjuntos de pistas informativas entre sí durante la búsqueda del antecedente después de que Dillon (2011) y Phillips et al. (2011) sugirieran que distintas dependencias lingüísticas podrían desplegar mecanismos de recuperación cualitativamente diferentes entre sí (véase Dillon et al., 2013).

La investigación sobre la implementación en tiempo real de las restricciones de ligamiento sintáctico se ha centrado en el procesamiento pronominal y en el licenciamiento de los pronombres reflexivos en inglés. En esta tesis, sin embargo, analizamos una dependencia lingüística en la que argumentamos que las expectativas de arriba a abajo durante la comprensión oracional en tiempo real no eliminan la necesidad de recuperación memorística en nuestro estudio. Mostramos que la resolución de los pronombres clíticos en dependencias de objeto dislocado a la izquierda son susceptibles a efectos de interferencia basados en la atracción y que el papel sintáctico del atractor modula dichos efectos en las oraciones gramaticales, coherente con el modelo de recuperación memorística durante el procesamiento oracional de Engelmann et al. (2016).

Además de esto, comparamos el procesamiento de la información de género y

número entre experimentos y descubrimos que el acceso a las pistas de número es más rápido que a las de género, presumiblemente, porque el número sea una característica cognitivamente más relevante y destacable según la hipótesis de jerarquía de características (Greenberg, 1963; Carminati, 2005). Interpretamos nuestros resultados como evidencia a favor de un mecanismo de recuperación memorística de la información que principalmente concede mayor peso a la información sintáctica sobre la no sintáctica y a la pista informativa de número sobre la de género en lo referente a las características de concordancia.

En su conjunto, las pruebas empíricas presentadas en la segunda parte de esta tesis se unen a la creciente cantidad de indicios provenientes del procesamiento de la concordancia sujeto-verbo y de otros tipo de expresiones lingüísticas que apoyan la idea de que un único mecanismo cognitivo general de recuperación memorística de la información basado en pistas y con distintos patrones de sensibilidad para cada una de ellas opera en todas las dependencias lingüísticas.

Abstract

Nerea EGUSQUIZA

Memory Retrieval: representations and processes involved during sentence comprehension. Evidence from Spanish

This dissertation investigates the nature of the representations and processes involved in memory retrieval during sentence comprehension through examining the resolution of syntactic dependencies in Spanish. We adopt Lewis and Vasishth's (2005) content-addressable, activation-based memory model of sentence processing and explore the predictions of the extended version by Engelmann et al. (2016). Both accounts are built within the Adaptive Control of Thought-Rational cognitive architecture (ACT-R; see Anderson et al., 2004; Anderson, 2005) and assume that a single set of general memory principles and cognitive mechanisms governs memory retrieval during sentence comprehension. In the first part of this dissertation, we use Spanish to investigate what kind of antecedent representation is retrieved during anaphoric pronoun resolution. Our results show that pronoun processing in Spanish differs from lexical access to nouns even when these nouns are repeated. In the second part of this dissertation, we explore the nature of the processing mechanisms underlying agreement and coreference in non-adjacent dependencies in Spanish. We analyze (i) how a syntactically illicit noun matching the antecedent in agreement features and grammatical role affects retrieval interference and (ii) how different sets of cues (i.e. number and gender) are involved and combined during object-clitic pronoun resolution. Our results indicate that the grammatical role of the interloper noun is a factor which modulates retrieval interference in grammatical sentences during subject-verb number agreement and object-clitic pronoun resolution, consistent with Engelmann et al.'s (2016) retrieval-based model. Likewise, we demonstrate that the memory access mechanism underlying object-clitic pronoun processing primarily relies on syntactic constraints during memory retrieval while prioritizing number information over gender cues. Dependency predictability did not

affect susceptibility to interference effects (cf. Parker and Phillips, 2017). Taken together, our results add to the increasing amount of evidence supporting the view that a cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues underlies all linguistic dependencies.

Acknowledgements

I am extremely grateful to my advisor, Adam Zawiszewski, for his patience, guidance, dedication, trust, constant encouragement and support as well as for the careful feedback, constructive comments and valuable discussions. To Itziar Laka, for her trust, care, encouragement, support, insightful discussions, comments and advice. I am also indebted to Kepa Erdocia, who supported me at the beginning of this project, and to Mikel Santesteban, for his suggestions, encouragement and support.

This thesis has greatly benefited from a pre-doctoral research funding grant awarded by the Basque Government Department of Education, Universities and Research (BFI-2012-219), a sponsored research grant from the Spanish Ministry of Economy and Competitiveness to the project *Prediction and agreement: Mechanisms of language processing* (FFI2014-55733-P), led by Mikel Santesteban, and a three-month visiting research internship at the University of Maryland Linguistics Department in College Park. I take this opportunity to thank them warmly for their support and contribution to my professional development.

Completing this work would have been much more difficult were it not for the unfailing support, help and assistance provided by my friends, colleagues and staff members from the lab. I am especially grateful to Idoia Ros. Her bright intelligence, fearlessness, broad knowledge, generosity, creativity, patience and strong work ethic unknowingly turn her into an incredible mentor for her colleagues, a challenger of ideas and awesome collaborator. To Luis Pastor and Sergio López-Sancio, for their role as members of a friendly, caring, generous and supportive team, but also for more concrete actions like proof-reading earlier parts of this thesis, providing constructive feedback, valuable advice and suggestions on my work. To all of you, thank you very much for helping me keep things in perspective during the ups and downs of my research.

Finally, I would like to thank my parents, brother, grandmother, my aunt Carmen, Keturrah Betts and her family, who are also part of mine, Grandpa John and my friends for their unconditional love, trust and support. This thesis is dedicated to them.

Contents

List of Figures

List of Tables

1 Introduction

Understanding human language is a psychological process which requires a cognitive system capable of encoding, maintaining and combining the information contained in each word of the linguistic input as soon as we perceive them in real-time, so that we can generate a structural representation which will assign sentence meaning to, otherwise, a linear sequence of words providing individual semantic information (see Sturt and Crocker, 1995). The amount of linguistic input we can actively process in working memory is very limited though (Miller, 1956; Baddeley and Hitch, 1974; Shiffrin, 1976; Crowder, 1993; Cowan, 2001, 2005, 2010; Chen and Cowan, 2005). Any theory of human sentence processing, therefore, should aim to explain the properties of such system; how information is stored on-line and retrieved from memory when access to old linguistic representations is needed to interpret the grammatical relationship between two non-adjacent, often long-distant words in a sentence. In this dissertation, we aim to investigate the nature of the linguistic representations and working memory processes involved during the construction and interpretation of long-distance dependencies. We particularly focus on coreference (pronoun resolution), subject-verb agreement and object-clitic pronoun dependencies in Spanish in order to examine how lexical information, linguistic structure and grammatical constraints affect memory retrieval. Spanish allows us to test for the grammatical contrast between animate subject and object noun phrases as well as for the impact of gender information during sentence comprehension, because both cues are morphologically codified. We adopt an activation-based model of sentence processing where a single set of general memory principles and cognitive mechanisms governs memory retrieval and where memory items are directly accessed in parallel based on their feature content (see content-addressable models by Lewis and Vasishth, 2005; Lewis et al., 2006; Engelmann et al., 2016).

A central prediction of content-addressable models of sentence processing is the emergence of interference effects when a syntactically illicit item partially or fully matches the feature requirements of the dependency (i.e its retrieval

cues). Evidence from various kinds of linguistic dependencies supports a feature-based (cue-based) access mechanism underlying sentence comprehension, for instance, in subject-verb agreement and filler-gap dependencies (Jäger et al., 2017; Ness and Meltzer-Asscher, 2017). The general assumption is that a single, uniform, interference prone, cue-based retrieval mechanism subserves the computation of all linguistic dependencies (Van Dyke and McElree, 2011; Martin and McElree, 2008; Lewis and Vasishth, 2005; Lewis et al., 2006; McElree, 2000, 2006). However, this view has been challenged by some researchers. Some suggest that a structured access mechanism is responsible for retrieving the antecedent based on its syntactic position (Phillips et al., 2011; Dillon, 2011; Dillon et al., 2013; Dillon, 2014), whereas others propose that structural and non-structural information is deployed at retrieval site, but that the former is preferentially weighted over the latter (Cunnings and Sturt, 2014; Parker and Phillips, 2017).

This difference is key for general-cognitive, content-addressable memory models. The structured-based account (Phillips et al., 2011; Dillon, 2011) suggests that a qualitatively different retrieval mechanism underlies certain syntactic dependencies (e.g. reflexive licensing) and not others (e.g. subject-verb agreement); whereas the cue-weighting model (Cunnings and Sturt, 2014; Parker and Phillips, 2017) defends that a cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues operates on all linguistic dependencies during sentence comprehension. The first model implies that the mapping from grammatical constraints to retrieval cues varies according to the type of linguistic dependency at play. Critically, it predicts that the retrieval cues of a linguistic dependency cannot be directly inferred from its grammatical, morphological and semantic constraints and, therefore, raises the problem of how learners manage to "converge on a retrieval strategy to deploy for each dependency" (Parker and Phillips, 2017).

Additionally, by giving priority to syntactic information for processing certain dependencies, the structured-based account is endorsing modular accounts of language, where the language system is largely independent from other cognitive systems while syntactic, semantic and phonological-orthographic information is individually tackled in separate mental modules which are frequently accessed in a serial fashion, being syntax first in line (Forster, 1979; Ferreira and Clifton Jr, 1986; Frazier, 1987, 1990; Frazier and Clifton, 1996; Crocker, 1992).

In the present dissertation, we provide empirical support to the view that all

linguistic dependencies, regardless of sentence grammaticality, are processed through a general-cognitive, general-purpose, content-addressable, cue-based access mechanism which preferentially weights syntactic retrieval cues over non-structural constraints and number over gender information when it comes to agreement features.

The body of this thesis is composed of three chapters. Chapter 2 is concerned with the nature of the antecedent representations involved in memory retrieval during anaphoric pronoun resolution in Spanish, whereas chapters 3 and 4 concern the nature of the online processing mechanisms underlying the computation of non-adjacent, syntactic dependencies in Spanish.

In the second chapter, we take advantage of the psychological phenomenon of word-frequency effect in order to investigate what kind of antecedent representation is retrieved from memory during anaphoric pronoun resolution in Spanish. Our question is based on Meyer and Bock's (1999) suggestion that speakers might be accessing qualitatively different antecedent representations depending on the kind of information needed to mediate co-reference in their respective languages. We ran two self-paced reading tasks and an eye-tracking experiment showing that whereas the word-frequency effect at the antecedent region was replicated in the control condition, such an effect was absent during pronoun resolution in Spanish. These results were interpreted as suggestive of a lexical access model specific for anaphoric pronoun resolution in which the processing mechanism only targets the syntactic and semantic properties of the antecedent, i.e. its lemma, leaving orthographic-phonological information out (the lexeme; see Simner and Smyth (1998) on anaphoric lexical access in comprehension). Crucially, this account assumes that lexical frequency information is stored at the lexeme level based on findings with high and low-frequency homophone pairs in Jescheniak and Levelt (1994). Our results extend Simner and Smyth's (1999) and Lago's (2014) conclusion in English to Spanish and contradict findings reported in English and German by Van Gompel and Majid (2004); Heine et al. (2006a) and Heine et al. (2006b), respectively. Further research should aim to provide data from a larger number of participants and languages as well as data from other methodologies such as EEG before drawing any strong conclusions about the kind of antecedent representations accessed cross-linguistically during pronoun resolution.

In the third and fourth chapters, we focus on the nature of the working memory mechanisms underlying agreement and object-clitic pronoun resolution

in non-adjacent dependencies in Spanish. Chapter 3 presents two self-paced reading task experiments on subject-verb agreement attraction which were designed to understand in which way the prominence of a syntactically illicit noun matching the antecedent in agreement features can affect retrieval interference in sentence comprehension (see Engelmann et al., 2016). Evidence shows that the grammatical role of the interloper noun is a factor which can explain why previous results in grammatical sentences in subject-verb number agreement dependencies consistently contradicted the prediction of inhibitory interference posited in Lewis and Vasishth's retrieval-based model. We interpreted our data as evidence for a content-addressable, cue-based retrieval mechanism underlying subject-verb number agreement processing in Spanish regardless of sentence grammaticality (Nicenboim et al., 2018, cf. Wagers et al., 2009, Dillon et al., 2013, Lago et al., 2015).

In Chapter 4, we analyze clitic pronoun processing in left-dislocation structures in Spanish in order to tease apart structure-based accounts of anaphor processing (Nicol and Swinney, 1989; Sturt, 2003; Kennison and Trofe, 2003; Phillips et al., 2011; Dillon et al., 2013; Dillon, 2014) from content-addressable models of memory retrieval which use structural and non structural features as retrieval cues (Lewis and Vasishth, 2005; Lewis et al., 2006; Engelmann et al., 2016). We investigate how different sets of cues are involved and combined during antecedent search. Just like English reflexives, clitic pronouns in left-dislocated configurations in Spanish must be bound by an antecedent within their local syntactic domain. Likewise, similarly to subject-verb agreement, they can be syntactically predicted provided that the antecedent is an animate object. Three self-paced reading task experiments show that the presence of a syntactically illicit noun matching the grammatical role and agreement cues of the clitic pronoun affects memory retrieval.

Finally, the last chapter (Chapter 5) provides a summary and interpretation of the findings reported in the present dissertation. We conclude that a general-cognitive, content-addressable, cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues underlies the computation of all linguistic dependencies.

2 Coreference and antecedent frequency effects in Spanish[1]

2.1 Outline

In this chapter, we explore the nature of the antecedent representations involved during anaphoric pronoun resolution in Spanish. We assume a serial, anaphoric lexical access account derived from the speech production model of Jescheniak and Levelt (1994); Levelt et al. (1999) and use word-frequency effects in order to investigate whether Spanish native speakers retrieve qualitatively different antecedent representations than English and German native speakers in previous studies. Likewise, we analyze the impact of syntactic prominence on the word-frequency effect and sentence processing in general. We report and discuss the results from two self-paced reading tasks and an eye-tracking while reading experiment in light of the current hypotheses.

2.2 Background

Sentence comprehension requires immediate access to the mental lexicon, where conceptual, grammatical and lexical information is stored. We say that speakers understand a sentence, a text or a discourse when they have an accurate mental representation of it. Needless to say, the longer the text or the speech, the more likely will be to find expressions referring to previous entities in the discourse. Anaphoric pronouns belong to this class of referential expressions which depend on the lexical properties of their referent or *antecedent* for interpretation. Evidence from agreement studies in Spanish, Italian, French and German shows that anaphoric pronoun resolution involves retrieving grammatical gender information from its antecedent representation in memory (Garnham et al., 1995; Di Domenico and De Vicenzi, 1995; Cacciari et al.,

[1] Part of this chapter has been published as Egusquiza et al. (2016).

1997; Irmen and Knoll, 1999; Arnold et al., 2000; Rigalleau et al., 2004; Hammer et al., 2007). Nevertheless, as suggested by Meyer and Bock (1999), antecedent representations could, in principle, differ qualitatively across languages based on the kind of information needed to mediate coreference. It might be the case that in languages like English, for instance, discourse/conceptual information will suffice to interpret anaphoric pronouns (Hankamer and Sag, 1976; Sag and Hankamer, 1984; Cloitrew and Bever, 1988; Lucas et al., 1990). Hence, it is unclear what kind of antecedent representation is retrieved during anaphoric pronoun resolution and whether it is language specific or not.

Here, we adopt a serial, two-stage, activation-based, lexical access model derived from the speech production model of Jescheniak and Levelt (1994); Levelt et al. (1999), which suggests that lexical entries store information at two separate levels: grammatical and semantic information at the lemma level and orthographic and phonological information at the lexeme level. Evidence for a separate access to each informational layer during processing comes from a translation latency task where Jescheniak and Levelt (1994) found that homophones (words that only share the lexeme) inherited the lexical frequency of their control pairs –a word frequency effect which suggests that the locus of the effect lies at the lexeme level (see also Laubstein, 1999, Laubstein, 2002. For a dissenting view, see Bonin and Fayol, 2002; Finocchiaro and Caramazza, 2006; Navarrete et al., 2006).

In order to investigate what kind of antecedent representation is retrieved during pronoun processing in Spanish, we use the *word-frequency effect*, which is one of the most robust phenomena in experimental psycholinguistics. It refers to the fact that frequently used words are processed faster and more accurately than infrequent ones. High-frequency words yield faster responses in reading (Rayner and Duffy, 1986), lexical decision (Schilling et al., 1998) and picture naming tasks (Oldfield and Wingfield, 1965; Almeida et al., 2007). Furthermore, data from brain damaged patients suggest that high-frequency words are preserved more often than low-frequency words (Dell, 1990; Colangelo et al., 2004; Knobel et al., 2008) and that speakers experience less tip-of-the-tongue states with high-frequency words (Brown, 2012; Gianico, 2010; Vitevitch and Sommers, 2003). Although all these observations suggest a processing advantage for high-frequency words compared to low-frequency words during lexical access, it remains an open question whether anaphoric pronoun resolution depends on the lexical frequency of the antecedent. In addition to this, we address the role of structural prominence during pronoun

processing in this context.

2.2.1 Hypotheses

In order to account for the results found in previous literature, three hypotheses have been proposed: the *full re-access account*, the *lemma re-access hypothesis* and the *saliency account*.

The *full reaccess account* states that pronoun comprehension is similar to lexical access for non-anaphoric words: readers will retrieve the same information from the antecedent as when they first accessed to it. Hence, it predicts that the lexical frequency of the antecedent should be transferred to the anaphoric pronoun. This effect has been observed in language production tasks. Navarrete et al. (2006), for instance, reported faster naming latencies for sentences containing a pronoun with a high-frequency antecedent noun than with a low-frequency antecedent noun. Similarly, participants tested by Finocchiaro and Caramazza (2006) elicited faster pronominal clitic production latencies when the replaced noun was highly frequent.

The *lemma-reaccess account*, however, assumes that pronoun processing differs from non-anaphoric lexical access in that there is only partial re-access to the antecedent representation in memory; more specifically, to its lemma, where grammatical and semantic information is stored (Simner and Smyth, 1998). Based on evidence from speech production showing that the word frequency effect lies at the lexeme (Jescheniak and Levelt, 1994), the lemma reaccess account predicts that pronouns referring to low-frequency nouns should not be harder or easier to process than those linked to high-frequency nouns (Simner and Smyth, 1999). In a series of experiments carried out by Simner and Smyth (1999), participants read English sentences containing a pronoun whose antecedent had been previously presented in picture form. The lexical frequency of the depicted noun was either high or low. Simner and Smyth found that reading times for sentences containing a pronoun were unaffected by the lexical frequency of the antecedent. Further evidence supporting this account comes from Lago (2014), where she manipulated the lexical frequency of English common and proper noun antecedents in two eye-tracking experiments and concluded that low-frequency antecedents had no additional cost compared to high-frequency antecedents during pronoun resolution.

The *saliency account* challenges any null antecedent frequency effect. Van Gompel and Majid (2004), for instance, ran an eye-tracking study in which participants read sentence pairs in English containing a pronoun referring to a high or low-frequency antecedent. Pronouns with low-frequency antecedents elicited shorter reading times at the post-anaphoric region in first-fixation, first-pass and total reading times measures. The authors explained their reverse word-frequency effect in terms of saliency (Pynte and Colonna, 2000): infrequent words tend to have rather unusual –salient– features and their processing is thus more costly compared to that of high-frequency words, as evidenced by the word-frequency effect in nouns. The investment of additional attentional resources on infrequent words increases their probability of being better encoded in long-term memory (Garnham et al., 1996; Malmberg and Nelson, 2003; Foraker and McElree, 2007) and, consequently, low-frequency words are recognized more quickly than high-frequency words (O'Brien and Myers, 1985; Glanzer and Adams, 1990; Shiffrin and Steyvers, 1997; Garnham, 2001; Malmberg and Nelson, 2003; Nicol and Swinney, 2003). The *saliency account* predicts that word saliency determines faster processing when pronouns refer to low-frequency antecedent nouns. Further evidence supporting this account comes from the EEG study in Heine et al. (2006b), where pronouns referring to high-frequency antecedents elicited a larger P300 component than those referring to low-frequency antecedents in German, suggesting a higher processing cost for the former (see also Heine et al., 2006a).

The three accounts described above make different predictions. The *full reaccess account* predicts the same effects in nouns as in pronouns, i.e. faster reaction times with pronouns referring to high-frequency words than with pronouns referring to low-frequency words. The *lemma-reaccess account* predicts no frequency effects, whereas the *saliency account* predicts a reverse frequency effect, with faster processing for pronouns referring to low-frequency words.

2.2.2 The present study

The aim of the present study is to examine the nature of the antecedent representations involved during anaphoric pronoun resolution in Spanish by manipulating the word frequency of the antecedent noun in two self-paced reading tasks and an eye-tracking experiment. Two factors were crossed: lexical frequency of the antecedent (high vs. low) and anaphor type (pronoun vs. repeated noun). *Repeated noun* refers to the noun phrase control condition

where the antecedent was repeated in order to pre-empt a null frequency effect across conditions. Based on Rayner et al. (1995), frequency effects should persist at repeated noun phrases. We considered three hypotheses in our study: (i) faster reaction times and shorter fixation duration for pronouns referring to high-frequency antecedents (*full reaccess account*); (ii) no antecedent frequency effects for pronouns (*lemma-reaccess account*); (iii) faster reaction times and shorter fixation duration for pronouns referring to low-frequency words (*saliency account*).

In addition to this, we investigate the influence of syntactic position during pronoun processing between the self-paced reading tasks. Some studies have reported faster reading times for anaphors when the antecedent was a subject than when it was an object (Purkiss, 1978, as cited in Sanford and Garrod, 1981; Brennan et al., 1987; Crawley et al., 1990; Gordon et al., 1993; Grosz et al., 1995; see Järvikivi et al., 2005, for a review). To this respect, we hypothesized that, given the highly prominent status of the subject, anaphors referring to subject antecedents will be processed faster than those referring to object antecedents (Arnold, 1998; Falk, 2006). Three outcomes can be expected: (i) a larger frequency effect in anaphor resolution when the antecedent is a subject than when it is an object due to the fact that subjects are more prominent in working memory than objects; (ii) a larger antecedent frequency effect when the antecedent is an object and (iii), a similar frequency effect both in the subject and object antecedent contexts, suggesting that lexical frequency of the antecedent plays a similar role during anaphoric pronoun resolution, independently of the syntactic status of the co-referring element (subject or object).

In Experiment 1, we test how the lexical frequency of the subject antecedent modulates subject pronoun resolution; while in Experiment 2, we analyze to what extent pronoun resolution can be influenced by the lexical frequency of an antecedent in object position. In Experiment 3, we adapt the materials from Experiment 2 and look into the same question in an eye-tracking-while-reading study, in case the previous methodology had not been sensitive enough to detect any antecedent frequency effect at the pronoun condition.

2.3 Experiment 1: Anaphor processing in subject position

Previous studies exploring word frequency effects during anaphor resolution placed the antecedent noun in object position. In this experiment, we examine antecedent frequency effects during pronoun resolution when the antecedent was in subject position. Participants were presented with sentence pairs. Antecedents were either high-frequency or low-frequency Spanish noun phrases (e.g. *ministro* or *senador*, 'minister' or 'senator' in English, respectively).

2.3.1 Method

Participants

Thirty-two native speakers of Spanish (eighteen women), aged 18-46 years (Mean = 23.7), were recruited from the University of the Basque Country (Vitoria-Gasteiz campus).

Materials and Design

40 sentence pairs of the form shown in **Table 2.1** were constructed and arranged in a 2 x 2 counterbalanced design with frequency of the antecedent (high frequency vs. low frequency) and anaphor type (repeated noun phrase vs. pronoun) as factors. The anaphor of interest was either a subject noun phrase or pronoun which coreferred with the subject of the preceding sentence. 40 high-frequency (mean = 67.62 occurrences per million; range = 689.82 – 18.93) and 40 low-frequency nouns (mean = 1.72 occurrences per million; range = 0.18 – 12.86) were selected as antecedents from the B-Pal Spanish standard database (Davis and Perea, 2005) in such a way that every high-frequency word matched in number of syllables with its low-frequency counterpart.

The 160 sentence pairs were distributed across four lists in a Latin Square design and combined with 80 filler sentences of similar length, structure and complexity. Subject and object nouns in filler sentences matched or mismatched in gender and number with the experimental sentence pairs. 40

TABLE 2.1: Sample of the materials used in Experiment 1.

		EXPERIMENT 1
Repeated noun phrase	01.	**[Un ministro]** criticó a la reina durante el discurso de ayer. [A minister] criticized the queen during the speech of yesterday.
	HF	**[El ministro]** censuró la monarquía. [The minister] disapproved the monarchy. *Meaning: A minister criticized the queen during yesterday's speech. The minister disapproved the monarchy.*
	02.	**[Un senador]** criticó a la reina durante el discurso de ayer. [A senator] criticized the queen during the speech of yesterday.
	LF	**[El senador]** censuró la monarquía. [The senator] disapproved the monarchy. *Meaning: A senator criticized the queen during yesterday's speech. The minister disapproved the monarchy.*
Pronoun	03.	**[Un ministro]** criticó a la reina durante el discurso de ayer. [A minister] criticized the queen during the speech of yesterday.
	HF	**[Él]** censuró la monarquía. [He] disapproved the monarchy. *Meaning: A minister criticized the queen during yesterday's speech. He disapproved the monarchy.*
	04.	**[Un senador]** criticó a la reina durante el discurso de ayer. [A senator] criticized the queen during the speech of yesterday.
	LF	**[Él]** censuró la monarquía. [He] disapproved the monarchy. *Meaning: A senator criticized the queen during yesterday's speech. He disapproved the monarchy.*

yes/no comprehension questions were built and half of them targeted the stimuli items.

Procedure

Participants were tested individually and assigned one of the four lists of stimuli randomly. They sat in front of a 19-inch screen and a keyboard connected to a PC in a quiet, lit up booth and read the instructions on the screen. The experiment was a self-paced reading task controlled by the Linger software (Rohde, 2001). Each session consisted of a practice of 3 sentences followed by 120 sentence pairs. Participants were told to read carefully at his or her normal rate. They were first presented with an array of preview dashes: each dash corresponded to a word in the current sentence pair. Every time the reader pressed the space bar, a constituent of the sentence appeared, replacing the corresponding dashes. Sentences were unmasked one constituent at a time, keeping the previous and following parts of the sentence hidden. A space-bar hit automatically served readers an incoming sentence pair and

allowed them to proceed with the task. 40 yes/no comprehension questions were added to the task. Two optional breaks every 40 sentences were also included to prevent participants from fatigue. The entire experimental session lasted about 15 minutes.

2.3.2 Analysis

Reaction times below 100 ms or above 2500 ms and those above 3 standard deviations from the participant's mean were excluded from the analyses (affecting a 2 % of the data). Two within-subject factors, frequency (high frequency vs. low frequency) and anaphor type (repeated noun phrase vs. pronoun), and their interaction, were included in the analysis. Separate analyses were carried out treating participants and items as random factors, yielding F1 and F2 statistics respectively. Analyses were performed on the antecedent, anaphor and post-anaphor regions. The antecedent region consisted of the subject noun phrase in the first sentence of every sentence pair. The anaphor region consisted of the pronoun or repeated noun phrase in the second sentence, whereas the post-anaphor region was the verb immediately following the anaphor. We report anaphor type effects even though they were probably due to length and lexical differences between nouns and pronouns. In order to directly compare antecedent lexical frequency effects, paired t-test analyses were carried out whenever appropriate.

2.3.3 Results

Antecedent region.

The main effect of frequency was significant (F_1 (1, 31) = 14.67, p < .01; F_2 (1, 39) = 13.08, p < .01): infrequent antecedents took longer to read than frequent antecedents (648.11 vs. 594.29 ms). The effect of anaphor type was not significant (F_s < 1). There was no interaction between these two factors (t_s < 1).

Anaphor region.

The main effect of frequency was significant in the analysis by participants and marginally significant in the analysis by items (F_1 (1, 31) = 5.27, p < .03; F_2 (1, 39) = 3.21, p = .08). The main effect of anaphor type was significant (F_1 (1, 31) = 69.56, p < .001; F_2 (1, 39) = 95.01, p < .001). The interaction between these two

factors was significant in the analysis by subject and marginally significant in the analysis by item (F_1 (1, 31) = 5.77, p < .02; F_2 (1, 39) = 2.83, p = .1). Paired t-tests revealed that the interaction was due to the frequency effect observed in the repeated noun phrase condition (t_1 (31) = -2.87, p < .01; t_2 (39) = -2.26, p < .02), but not in the pronoun condition (F_s < 1). Low-frequency repeated nouns were read slower than high-frequency nouns (569.58 vs. 534.18 ms).

Post-anaphor region.

The main effect of frequency yielded no significance (F_1 (1, 31) = 1.96, p > .17; F_2 (1, 39) < 1), but the main effect of anaphor was significant (F_1 (1, 31) = 15.85, p < .001; F_2 (1, 39) = 27.65, p < .001). The interaction between both factors was not significant (F_s < 1).

Results in the antecedent region showed a word frequency effect, with high-frequency nouns eliciting shorter reading times than low-frequency nouns, replicating thus previous studies (Forster and Chambers, 1973; Rayner and Duffy, 1986; Besner and McCann, 1987; Schilling et al., 1998). At the anaphor region in the control condition, high-frequency nouns were read faster than low-frequency nouns, suggesting the high reliability of the effect (for an overview, see Ellis, 2002). Critical for our purposes, there was no antecedent frequency effect in the anaphor region and no interaction in the post-anaphor region either in the pronoun condition. Before drawing conclusions from these results, in the next experiment, the lexical frequency effect was explored when the antecedent was in object position, because the syntactic prominence of the subject might have obscured an antecedent frequency effect.

2.4 Experiment 2: Anaphor processing in object position

The same materials and procedure as in Experiment 1 were used here with the only difference that sentences were modified in order to place both the antecedent and the anaphor at the object syntactic position. In order to allow the comparison between the two experiments, the distance in the total number of words between the antecedent and the anaphoric pronoun in Experiment 2 was the same as in Experiment 1.

2.4.1 Method

Participants

A new set of thirty-two native speakers of Spanish (twenty-four women), aged 18-34 years (Mean = 20.34), were recruited from the University of the Basque Country (Vitoria-Gasteiz campus).

Materials, Design and Procedure

The materials of Experiment 1 were adapted so that both the antecedent and the anaphor regions were in non-prominent syntactic positions. Same design and procedure as in Experiment 1.

TABLE 2.2: Sample of the materials used in Experiment 2.

		EXPERIMENT 2
Repeated noun phrase	HF	01. La reina criticó **[a un ministro]** durante el discurso de ayer. The queen criticized [a minister] during the speech of yesterday Posteriormente arremetió **[contra el ministro]** en el parlamento. Later attacked [against the minister] at the parliament. *Meaning: The queen criticized a minister during yesterday's speech.* *Later on, she attacked the minister at the Parliament.*
	LF	02. La reina criticó **[a un senador]** durante el discurso de ayer. The queen criticized [a senator] during the speech of yesterday. Posteriormente arremetió **[contra el senador]** en el parlamento. Later attacked [against the senator] at the parliament. *Meaning: The queen criticized a senator during yesterday's speech.* *Later on, she attacked the senator at the Parliament.*
Pronoun	HF	03. La reina criticó **[a un ministro]** durante el discurso de ayer. The queen criticized [a minister] during the speech of yesterday. Posteriormente arremetió **[contra él]** en el parlamento. Later attacked [against him] at the parliament. *Meaning: The queen criticized a minister during yesterday's speech.* *Later on, she attacked him at the Parliament.*
	LF	04. La reina criticó **[a un senador]** durante el discurso de ayer. The queen criticized [a senator] during the speech of yesterday. Posteriormente arremetió **[contra él]** en el parlamento. Later attacked [against him] at the parliament. *Meaning: The queen criticized a senator during yesterday's speech.* *Later on, she attacked him at the Parliament.*

2.4.2 Analysis

Following the same criteria as in Experiment 1, 2% of the data points were discarded from the analysis.

2.4.3 Results

Antecedent region

The main effect of frequency was marginally significant in both analyses ((F_1 (1, 31) = 3.7, p = .06; F_2 (1, 39) = 2.91, p = .09). No other effects were found at this region (F_s <1).

Anaphor region

The main effect of frequency was significant in the analysis by participants and marginally significant in the analysis by items ((F_1 (1, 31) = 4.99, p < .04; F_2 (1, 39) = 3.33, p = .07). The main effect of anaphor type turned out to be statistically significant as well ((F_1 (1,31) = 83.44, p < .001; F_2 (1,39) = 209.5, p < .001). The interaction between these two factors was significant ((F_1 (1, 31) = 5.21, p < .03; F_2 (1, 39) = 3.90, p = .05). Paired t-tests revealed that the interaction was due to the frequency effect observed in the repeated noun phrase condition (t_1 (31) = -2.52, p < .02; t_2 (39) = -2.09, p < .05), but not in the pronoun condition (t_s < 1).

Post-anaphor region

The only significant effect was the main effect of anaphor type ((F_1 (1, 31) = 5.28, p < .03; F_2 (1, 39) = 4.33, p < .05). No other effects yielded statistical significance at this region (F_s < 1).

TABLE 2.3: Mean reading times by participants (in milliseconds) at the anaphor region for conditions in Experiment 1 and Experiment 2. Standard deviations from the mean (in milliseconds) are shown in parentheses.

	Experiment 1 (Subject)	Experiment 2 (Object)
Repeated NP		
HF antecedent	534 (22)	687 (27)
LF antecedent	569 (21)	744 (40)
Effect size	-35	-57
Pronoun		
Pronoun-HF	463 (14)	499 (16)
Pronoun-LF	459 (16)	500 (19)
Effect size	4	-1

Results of this experiment replicated those of the Experiment 1: a word frequency effect was found in the antecedent region, with shorter reading times elicited by high-frequency nouns than by low-frequency nouns. At the anaphor region, the frequency effect was found in the repeated noun condition, with high-frequency nouns being read faster than low-frequency nouns. No effect was found in the pronoun condition. No antecedent frequency effects or interaction with anaphor type occurred in the post-anaphor region.

Cross-experiment analysis

An additional analysis was carried out comparing the anaphor region in Experiments 1 and 2 in order to further explore whether syntactic position of the antecedent plays a role in anaphoric pronoun resolution. We addressed two critical issues. First, we examined whether the syntactic position of the antecedent affects anaphor resolution by analyzing the factor Syntactic Position (Experiment 1 vs. Experiment 2). The main effect of Syntactic Position was significant (F_1 (1, 62) = 10.40, p < .01; F_2 (1, 78) = 402.86, p < .001), with faster reading times in Experiment 1 than in Experiment 2 (514 ms and 608 ms, respectively). In other words, reading anaphors was faster with antecedents in subject than in object syntactic position. The interaction between the factor Syntactic Position and Anaphor type (repeated noun vs. pronoun) was significant (F_1 (1, 62) = 22.49, p < .001; F_2 (1,789) = 17.15, p < .001). Further paired t-tests revealed that the interaction was due to the fact that the Syntactic Position effect was larger in the repeated noun condition (177 ms; t_1 (62) = -4.12, p < .001; t_2 (78) = -13.58, p < .001) than in the pronoun condition (53 ms; t_1 (62) = -1.15, p > .25; t_2 (78) = -18.99, p < .001). Nevertheless, it is known that, besides lexical frequency, the context of use of lexical items also plays a significant role during language comprehension (Gahl and Garnsey, 2006; Brown and Rivas, 2012). In order to make sure that the reported effects were due to the lexical frequency of the nouns used in the experiments rather than to the frequency they occur in a given syntactic context (subject vs. object), we performed a comparison based on GOOGLE (Ghemawat et al., 2003) where we contrasted the occurrence of the nouns in subject and object positions with the verbs used in both experiments (i.e. *un ministro criticó* 'a minister criticized' and *criticó a un ministro* 'criticized a minister'). Two variables were used to perform statistical analyses: frequency (high / low) and position (subject / object). Besides the expected frequency effect (F (1, 39) = 12.41, p = .001), no position effect (F (1, 39) = .804, p = .375) or frequency by position interaction (F (1,39) = .950, p = 0.336) were found, suggesting that the reported findings

must be due to the lexical frequency of the nouns rather than to the specific position these nouns appear within the sentences.

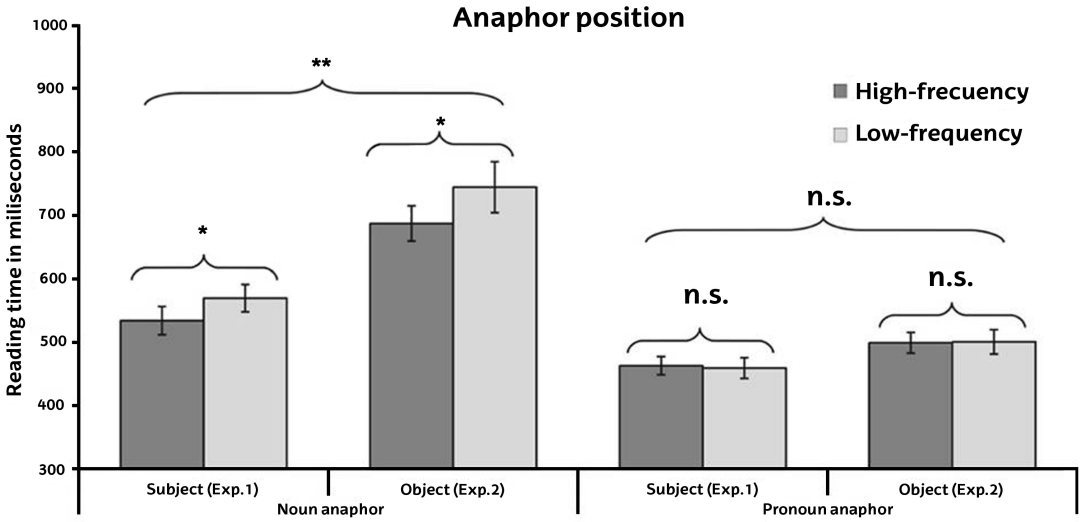

FIGURE 2.1: Mean reading times in ms. at the anaphor region in Experiment 1 and Experiment 2. $^{**}p < 0.01$; $^{*}p < 0.05$

Second, in order to investigate whether the faster reading of repeated high frequency vs. low frequency nouns was due to the repeated mention rather than due to the frequency of the noun itself, we performed additional statistical tests with full nouns, considering frequency (high / low) and mention (antecedent / anaphor) as within-subject factors and experiment (Exp. 1 / Exp. 2) as between-subject factor. The analyses revealed a significant effect of frequency (F_1 (1, 62) = 17.07, p < 0.001: F_2 (1, 78) = 13.09, p = 0.001) and mention (F_1 (1, 62) = 21.93, p < 0.001; F_2 (1, 78) = 17.43, p < 0.001); that is, faster reading times for high frequency (649 ms, SDE = 20.85) than low frequency items (704 ms, SDE = 25.85) and faster reaction times in anaphoric contexts (560 ms, SDE = 14.59) than in the antecedent contexts (712 ms, SDE = 25.53).

2.5 Experiment 3:Anaphor processing with object antecedents

The preceding self-paced reading experiments showed that pronoun resolution was unaffected by antecedent lexical frequency in Spanish, in support of the lemma-reaccess account. The reliability of our results was evidenced by the fact that the frequency manipulation was strong enough to replicate

the word-frequency effect in the antecedent and the repeated-noun regions. Alternatively, self-paced reading might not have been sensitive enough to detect antecedent frequency effects during pronoun processing. In the following experiment, we opted for eye-tracking, a methodology with a higher temporal resolution and which makes reading more natural than self-paced.

The underlying initial assumption in eye-tracking studies is that eye movements are strongly linked to cognitive processing (Just and Carpenter, 1980; cf. Anderson et al., 2004). Reading times are interpreted as an index of language processing effort; with longer reading times (and more fixations) revealing processing difficulty compared to faster reading times (and less fixations), much as in self-paced reading tasks. Eye-movement data, however, offer a more detailed map of what happens during online sentence comprehension. Regressions (i.e. re-reading earlier parts of a text), for instance, cannot be captured in self-paced reading tasks and are interpreted as a sign of language processing difficulty at the discourse/semantic integration levels. Despite its higher temporal resolution compared to self-paced reading, eye-tracking while reading shows higher data loss rates due to word skipping and blinking (Rayner et al., 2011), among other factors. The method provides highly accurate information about where readers look, for how long they gaze and how many eye fixations they make in a region.

2.5.1 Method

Participants

A new set of twenty-two native speakers of Spanish (twelve women), ages 18-24 (SD = 1.96), who had not participated in Experiment 1 nor in Experiment 2, were recruited from the University of the Basque Country (Vitoria-Gasteiz campus). All participants had normal or corrected-to-normal vision. Two of them were excluded from further analysis because their data accuracy was below 70%.

Materials and Design

The materials were adapted from those used in Experiment 2. Two factors were crossed: frequency of the antecedent noun (high vs. low) and anaphor type (repeated noun vs. pronoun). 160 sentence pairs were distributed in four

lists (10 items per condition per list) so that each participant read only one version of the same item. 80 filler sentences were randomly intermixed with the experimental sentence pairs of each list and 40 yes/no comprehension questions (half of them about the experimental sentences) were included. Both filler and experimental sentences shared a similar structure and length.

Our materials differed from Experiment 2 in two aspects: (i) a three-word spillover region was included after the post-anaphoric one to capture any wrap-up, sentence-final effect; (ii) an additional discourse entity was inserted in the prepositional phrase following the verb in order to improve the naturalness of the materials in the repeated noun conditions. It mismatched in gender with the first element in the prepositional phrase (the retrieval target.) The subject was feminine and singular across conditions, omitted in the second sentence of each pair and it always mismatched the retrieval target in gender. **Table 2.4** contains a sample of our materials.

The discourse entities were taken from Es-Pal Spanish Lexical database (Duchon et al., 2013), and pairs in the conjoined prepositional phrase were matched for relative frequency within each item to keep the prepositional-phrase saliency level constant. The Es-Pal Spanish Lexical database showed that the frequency type of the high-frequency antecedents (mean: 93.06 per million words, range: 18.25 – 912.26) was much higher than that of the low-frequency antecedents (mean: 3.10 per million words, range: 0.08 – 5.83).

Norming study

We ran a norming study where sixteen native speakers of Spanish judged the acceptability of our materials on a 7-point Likert scale, where 7 meant perfectly acceptable and 1 was completely unacceptable. Each participant read ten experimental sentences intermixed with thirty fillers. None of them took part in the following eye-tracking experiment. Target sentences with a rate higher than 3.5 were considered for the follow-up experiment. None of them had to be excluded. The mean score value for the four lists was 5.58 (range: 5.15 – 6.09).

Procedure

Experiment 3 involved an eye-tracking reading task. Participants were tested individually in a dimed-light, sound-proof booth, and eye-movements were recorded using a remote Tobii X120 Eye Tracker interfaced with a PC. The

TABLE 2.4: Sample of the materials used in Experiment 3.

		EXPERIMENT 3
Repeated noun phrase		01. La senadora criticó **[a un ministro]** y a una parlamentaria durante el discurso de ayer. The senator$_{fem}$ criticized [a minister$_{masc}$] and a member of parliament$_{fem}$ during yesterday's speech.
	HF	Posteriormente arremetió **[contra el ministro]** en los medios nacionales y europeos. Later, (she) attacked [the minister] on the national and European media. *Meaning: The senator criticized a minister and a member of parliament during yesterday's speech. Later, (she) attacked the minister on the national and European media.*
		02. La senadora criticó **[a un banquero]** y a una alcaldesa durante el discurso de ayer. The senator$_{fem}$ criticized [a banker$_{masc}$] and a mayoress during yesterday's speech.
	LF	Posteriormente arremetió **[contra el banquero]** en los medios nacionales y europeos. Later, (she) attacked [the banker] on the national and European media. *Meaning: The senator criticized a banker and a mayoress during yesterday's speech. Later, (she) attacked the banker on the national and European media.*
Pronoun		03. La senadora criticó **[a un ministro]** y a una parlamentaria durante el discurso de ayer. The senator$_{fem}$ criticized a minister$_{masc}$ and a member of parliament$_{fem}$ during yesterday's speech.
	HF	Posteriormente arremetió **[contra él]** en los medios nacionales y europeos. Later, (she) attacked [him] on the national and European media. *Meaning: The senator criticized a minister and a member of parliament during yesterday's speech. Later, (she) attacked him on the national and European media.*
		04. La senadora criticó **[a un banquero]** y a una alcaldesa durante el discurso de ayer. The senator$_{fem}$ criticized [a banker$_{masc}$] and a mayoress during yesterday's speech.
	LF	Posteriormente arremetió **[contra él]** en los medios nacionales y europeos. Later, (she) attacked [him] on the national and European media. *Meaning: The senator criticized a banker and a mayoress during yesterday's speech. Later, (she) attacked him on the national and European media.*

sampling rate for recordings was 120 Hz. The maximum gaze angle was 36 degrees and viewing was binocular. Participants were seated 67 cm. from a 19-inch LCD screen. The forty experimental sentence pairs were randomly intermixed with the eighty fillers and displayed on a single line in 13.5 pt. fixed width Arial white font on a black screen. Each participant was randomly assigned one of the four lists of stimuli. The experiment was implemented using the **Tobii Studio 3.2** software. A calibration check was run at the beginning of each individual session. Previous to the task, participants were instructed to read carefully at their normal rate and completed a short practice session with 5 sentence pairs and their corresponding yes/no comprehension questions. A fixation cross on the left edge of the computer screen was displayed for 800

milliseconds before each item. The position of the fixation cross coincided with the beginning of every sentence to prevent participants from random looking and to make sure that the starting point of every sentence was the same for all conditions and items. Forty yes/no comprehension questions were included to ensure participants were attending to the stimuli. The entire experimental session lasted approximately 45 minutes and six optional breaks were included along the task. All participants had at least one break.

2.5.2 Analysis

Only subjects whose data accuracy was 70% or above were taken into consideration for further analysis. Two subjects did not meet this criterion and thus, were excluded. Skips of a region in any particular measure were treated as missing data points. Following Van Gompel and Majid (2004), three regions of analysis were delimited: the antecedent region, the anaphor region and the post-anaphor region. The antecedent region was the first prepositional phrase in the conjoined object position (e.g. *a un ministro* 'to a minister'). The anaphor region was the prepositional phrase immediately after the verb in the second sentence (e.g. *contra el ministro/contra él* 'against the minister/against him'). The post-anaphor region consisted of the three-word prepositional phrase after the anaphor region. We report three eye-tracking measures: first-fixation duration, fixation duration and total fixation duration. *First-fixation duration* is the duration of the reader's first fixation in a region. *Fixation duration* corresponds to the sum of all fixations on a critical region before the reader leaves it for the first time (only first-pass reading is taken into account; no regressions). *Total fixation duration* is the sum of all fixation durations in a region (possible regressions included). During the recordings, Tobii Studio 3.2 software's *IV-T Fixation Filter* (Olsen, 2012) was set on: adjacent fixations were automatically merged provided the fixation was shorter than 75 ms (see Salojärvi et al., 2005) and the maximum angle between both fixations was 0.5 degrees - to filter out micro-saccades (Komogortsev et al., 2010), which usually have an amplitude of 0.5 or less (Yarbus, 1967). Fixations shorter than 120 ms or longer than 890 ms were deleted (for similar approaches, see Drieghe et al., 2010; Folk and Morris, 2003; Johnson et al., 2007; Lowder et al., 2013; Rayner et al., 2010; Van Gompel and Majid, 2004). The remaining data points that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 1.6% of the data in first-fixation duration, 2.99% in fixation duration and 1.84% in

total fixation duration. Two ANOVAs were conducted for each eye-tracking measure and region, one with participants (F_1) and one with items (F_2) as the random factors, with Frequency (High Frequency / Low Frequency) and Anaphor type (Noun Phrase / Pronoun) as within-participants and within-items factors. Only frequency effects and its interaction with anaphor type will be reported. In order to directly compare frequency effects, paired T-test analyses were carried out whenever appropriate.

2.5.3 Results

TABLE 2.5: Means (in milliseconds) for conditions in Experiment 3 for first-fixation, fixation and total fixation times. Standard error by participants is shown in parentheses.

	Antecedent	Anaphor	Post-anaphor
First-Fixation times			
Repeated NP-HF	237 (9)	269 (16)	248 (13)
Repeated NP-LF	275 (15)	303 (20)	255 (10)
Pronoun-HF	247 (13)	252 (14)	284 (17)
Pronoun-LF	279 (14)	242 (11)	280 (17)
Fixation times			
Repeated NP-HF	241 (9)	255 (14)	248 (13)
Repeated NP-LF	269 (14)	286 (17)	270 (10)
Pronoun-HF	245 (9)	254 (16)	268 (16)
Pronoun-LF	274 (13)	241 (11)	276 (12)
Total Fixation times			
Repeated NP-HF	507 (51)	449 (37)	589 (48)
Repeated NP-LF	559 (50)	513 (44)	620 (51)
Pronoun-HF	550 (56)	384 (34)	817 (65)
Pronoun-LF	529 (39)	334 (27)	725 (49)

Antecedent region

Low-frequency antecedents took longer to read than high-frequency antecedents in all measures but total fixation duration (first fixation: F_1 (1, 19) = 8.11, p = .01; F_2 (1, 39) = 7.01; p = .01; fixation duration: F_1 (1, 19) = 6.03; p = .02; F_2 (1, 39) = 3.99; p = .05; total fixation duration: F_1 (1, 19) = .27; p = .61; F_2 (1, 39) = .49; p = .48).

Anaphor region

In first-fixation duration, no frequency effect (F_1 (1, 19) = .7; p = .41; F_2 (1, 39) = .01; p =.91) or interaction with anaphor type (F_1 (1, 19) = 2.53; p = .13; F_2 (1, 39) = 3.89; p =.56) was found. However, in fixation duration, there was an interaction between both factors (F_1 (1, 19) = 4.94; p =.04; F_2 (1, 39) = 11.65; p = .002). Paired T-tests showed that repeated low-frequency nouns took longer to read than repeated high-frequency nouns ((t_1 (19) = -2.31; p =.03; t_2 (39) = -2.89; p = .006), but pronoun conditions did not elicit any significant difference ((t_1 (19) = 1; p =.32; t_2 (39) = 1.54; p = .13) In total fixation duration, the interaction between frequency and type of anaphor turned out to be statistically significant (F_1 (1, 19) = 7.33; p = .01; F_2 (1, 39) = 6.58; p = .01). Pronouns referring to low-frequency antecedents were read faster than those referring to high-frequency ones in the analysis by subjects ((t_1 (19) = 2.47; p = .02; 334.49 ms. vs. 384.80 ms.); but not by items (t_2 (39) = 1.34; p = .18; 343.44 ms. vs. 394.79 ms.) Regarding the control condition, the opposite pattern was observed: repeated high-frequency nouns were read faster than repeated low-frequency nouns in the analysis by items (t_2 (39) = -2.31; p = .02; 449 ms vs. 522.48 ms.), but not by subjects (Repeated HF NP vs. Repeated LF NP: (t_1 (19) = -1.67; p = .11; 449.39 ms. vs. 513.27 ms.)

Post-anaphor region

No frequency effects or interaction with anaphor type occurred in this region in any measure (first-fixation duration: (F_1 (1, 19) = 0; p = .93; F_2 (1, 39) = .09; p = .76); fixation duration: (F_1 (1, 19) = .31; p = .58; F_2 (1, 39) = .77; p = .38) and total fixation duration: (F_1 (1, 19) = 2.24; p = .15; F_2 (1, 39) = 2.94; p = .09).

The aim of this eye-tracking-while-reading study was to determine how the lexical frequency of the antecedent affects anaphoric pronoun resolution.

Similarly to the eye-tracking results obtained by Van Gompel and Majid (2004) and Lago (2014), we found a lexical frequency effect at the antecedent region in first-fixation and fixation duration; however, we do not observe any in total fixation duration. This difference suggests that high and low-frequency antecedents in our materials elicited a similar amount of regressions.

In the anaphor region, there was an interaction between frequency and anaphor type in fixation duration and total fixation duration, such as repeated noun phrases referring to high-frequency antecedents were read faster than those linked to low-frequency nouns. Nevertheless, this frequency effect was fully significant in fixation duration only.

Results elicited in total fixation duration should be interpreted with caution since they are partially significant: pronouns linked to low-frequency antecedents were read faster than the same pronouns referring to high-frequency nouns, but this saliency effect was only significant in the analysis by subjects[2]. The fact that there was no effect in fixation duration for pronouns compared to repeated noun phrases suggests that the saliency effect in total fixation duration was caused by readers looking back to the anaphor region. Similarly to Van Gompel and Majid (2004) and Lago (2014), the pronoun was a short word at the edge of the region, so we expected participants' eyes to move onto the next without having fully processed it. However, there were no spill-over effects of antecedent lexical frequency at the post-anaphor region (cf. Van Gompel and Majid, 2004; Lago, 2014), which led us to think that the saliency effect detected in the previous region could be a Type I error.

2.6 Discussion

Two self-paced reading tasks and an eye-tracking experiment were performed in order to investigate how the lexical frequency and syntactic position of the antecedent affect anaphoric pronoun processing in Spanish.

Three alternative hypotheses were considered in our study: (i) faster reaction times and shorter fixation duration for pronouns referring to high-frequency antecedents (*full reaccess account*); (ii) no differences in reaction times nor in fixation duration between pronouns with high and low-frequency antecedents (*lemma-reaccess account*); (iii) faster reaction times and shorter fixation duration for pronouns referring to low-frequency antecedents (*saliency account*.)

Previous comprehension research studies provide mixed results. Simner and Smyth (1999) and Lago (2014)[3] found no antecedent frequency effects during pronoun resolution in English (*lemma-reaccess account*), whereas Van Gompel

[2]Despite the fact that we ran a norming study to evaluate the grammatical acceptability of our materials, a plausibility effect might be responsible for the lack of significance in the analysis by items. It is likely that high-frequency words fitted better in the context than low-frequency words.

[3]In Experiment 4, Lago (2014) did not observe any antecedent frequency effects in the pronoun conditions. However, she found them in the post-anaphor region of a subsequent experiment in first-fixation duration only and, therefore, concluded that "pronouns with infrequent antecedents do not cause processing cost during reading, in that they are not read more slowly than pronouns with frequent antecedents [...] Comprehenders do not show evidence of reaccessing a lexical representation of a pronoun's antecedent during coreference in English." (p. 107)

and Majid (2004) in English and Heine et al. (2006a,b) in German observed a higher processing cost for pronouns referring to high-frequency nouns, i.e. a saliency effect (saliency account).

In Experiment 1, native speakers of Spanish were tested while reading sentence pairs containing either a high-frequency or a low-frequency subject antecedent in the first clause, and a subject, repeated noun phrase or anaphoric pronoun in the second. Whereas high-frequency noun phrases were read faster than low-frequency ones in the antecedent and anaphor regions (Forster and Chambers, 1973; Rayner and Duffy, 1986; Besner and McCann, 1987; Schilling et al., 1998), pronouns were unaffected by the lexical frequency of the antecedent.

In Experiment 2, we replicated the pattern of results obtained in Experiment 1, but in this case the antecedent and the anaphor were in object position. High-frequency noun phrases were read faster than low-frequency ones in the antecedent and anaphor regions, but no antecedent frequency effects emerged during pronoun processing. Crucially, the distance between the anaphoric expression and its antecedent was identical in both experiments. We ran a cross-experiment analysis and found that the frequency effect was larger when the noun occupied an object (57 ms) rather than a subject syntactic position (35 ms). This effect must be attributed to structural differences between the antecedent positions (subject vs. object) rather than to other factors (e.g. working memory load) –although the possibility that stronger priming might have occurred when the nouns had the same syntactic role (subject) compared to the contexts where the antecedent was a direct object and the anaphor was a prepositional object cannot be discarded. Thus, in light of these data, syntactically prominent arguments such as subjects were easier to refer to than less prominent arguments (i.e. objects), consistent with previous research (Kennison and Gordon, 1997; Arnold, 1998; Falk, 2006). These findings are in line with other experimental results showing that subject-relative clauses are easier to process than object-relative clauses (e.g. Traxler et al., 2002; cf. Carreiras et al., 2010; Mak et al., 2008). On the other hand, the fact that participants were faster in processing anaphors referring to subjects compared to those referring to objects may be related to the order of mention effect, that is, the advantage in reaccessing first-mentioned characters within a clause. It does not depend on linguistic factors and occurs even if the first participant is not the initial word in the sentence, because initial elements are considered the foundations of discourse understanding (Gernsbacher and Hargreaves,

1988; Gernsbacher, 1991).

In Experiment 3, we used the eye-tracking while reading method in order to test our hypothesis and found that high-frequency noun phrases were read faster than low frequency ones in first-fixation and fixation duration in the antecedent and anaphor regions. However, no reliable antecedent frequency effect was observed during pronoun resolution in any of the three eye-tracking measures.

2.7 Conclusion

The aim of this study was to investigate the nature of the antecedent representations involved during anaphoric pronoun resolution in Spanish after Meyer and Bock (1999) suggested that pronoun processing could, in principle, differ across languages based on the kind of information needed to mediate coreference. Whereas we replicated the word-frequency effect in the case of repeated nouns in the control condition, no reliable effect was found for pronouns: infrequent antecedents did not cause any processing cost during pronoun comprehension. We interpret this finding as evidence in favor of the lemma-reaccess account by Simner and Smyth (1998, 1999), which postulates that anaphoric pronoun resolution involves lemma retrieval (i.e. retrieval of the syntactic and semantic properties of the antecedent) whereas lexical (re)access to nouns additionally requires orthographic or phonological information. Simner and Smyth (1999) based their proposal on the serial, two-stage, activation-based speech production model proposed by Jescheniak and Levelt (1994), which locates the word-frequency effect at the lexeme level. The fact that this effect was elicited at the antecedent region as well as with repeated nouns in the control condition suggests thus that the lexeme must have been retrieved during sentence comprehension. Therefore, we argue that the absence of antecedent frequency effects during anaphoric pronoun resolution is a reliable null effect indeed rather than evidence for a difference between the production and comprehension systems. The current research extends Simner and Smyth and Lago's conclusion in English to Spanish and to the syntactic context where the anaphor occupies a subject position. Likewise, it contradicts the results reported in English and German by Van Gompel and Majid (2004) and Heine et al. (2006a,b), respectively, in support of the saliency account: i.e. the idea that since infrequent words require more attention and effort during language processing, they are better encoded in memory

and, therefore, reaccessed faster than frequent antecedents during anaphoric pronoun resolution. Van Gompel and Majid (2004) suggests that their results can be accommodated within the lemma re-access account by positing two processing stages: one where the memory access mechanism finds the antecedent and retrieves the infrequent word faster, and a second stage where the processor re-accesses the lemma information of the antecedent only. The question which follows then is if discourse information would be enough to target and retrieve the antecedent during stage one of pronoun resolution when the grammatical properties of the antecedent are not yet available and there is not enough context.

Given our results, further research on pronoun processing and lexical access in general needs to be carried out in order to provide data from a larger pool of participants and typologically different languages before drawing any strong conclusions on the nature of the antecedent representations retrieved across languages.

2.8 Summary

Chapter 2 provides empirical evidence in favor of a lexical access model where nouns and pronouns retrieve qualitatively different antecedent representations from memory, in support of a theory of anaphoric lexical access in comprehension (Simner and Smyth, 1998, 1999). We show that coreference resolution in Spanish only involves lemma retrieval – i.e. retrieval of the syntactic and semantic properties of the antecedent –, whereas lexical access to nouns and repeated nouns additionally targets orthographic-phonological information.

3 Agreement processing in Spanish

3.1 Outline

In this chapter, we approach the nature of the mechanisms underlying agreement computation in non-adjacent dependencies. In line with Chapter 2, we aim to contribute to the current knowledge on memory retrieval, what kind of information is used and how it is accessed in this context. We use the so-called attraction effects in order to investigate in which way attractor prominence affects number interference during subject-verb agreement in Spanish; i.e. what kind of information is accessed on-line. This chapter is organized as follows: First, we review the literature on subject-verb number agreement attraction and introduce current models explaining agreement attraction effects. Next, we describe in more detail the original cue-based retrieval model by Lewis and Vasishth (2005), the theoretical framework which provides the most compelling explanation regarding the pattern of results found in agreement attraction studies in comprehension so far. Subsequently, we introduce the extended cue-based retrieval model (Engelmann et al., 2016), which adds a correction for attractor prominence to Lewis and Vasisth's model. Finally, we report and discuss the data obtained from two self-paced reading experiments in Spanish in light of the proposed models.

3.2 Background

The fact that grammatical agreement errors are common in natural speech and even persist in proofread texts has sparked a great deal of psycholinguistic research aiming to learn more about the type of linguistic cues involved in agreement and the nature of the mechanisms underlying agreement computation, grammatical encoding and non-adjacent dependencies in general

(Tanner et al., 2014). Most experimental studies have focused on number attraction errors in subject-verb agreement dependencies such as (1), where the verb erroneously agrees with the embedded noun phrase *cabinets* instead of with the head of the subject key. We will further call such an intrusive element "attractor."

1. *The key to the cabinets were rusty* (Bock and Miller, 1991).

Research in language production has shown that plural attractors induce more number-attraction errors than singular ones. Singular heads followed by a plural attractor also elicit larger error rates than plural heads followed by a singular attractor in the same context (Bock and Miller, 1991, et seq.). This mismatch asymmetry is usually explained in terms of plural markedness (Bock and Eberhard, 1993; Eberhard, 1997): plurals are considered the marked number value in English compared to the singular default (cf. Franck et al., 2002, 2004, 2006, for a discussion on its cross-linguistic validity). Because of that, they are assumed to be more prominent and, therefore, more likely to interfere with the singular head of a subject noun phrase in working memory than a singular attractor (Bock et al., 2001; Haskell and MacDonald, 2003).

Although agreement attraction was initially interpreted as a case of local coherence effects, where the verb simply agreed with the linearly closest noun (Francis, 1986; Quirk et al., 1972), later studies proved that attraction effects arise independently of the adjacency of the attractor to the verb (Bock and Miller, 1991; Vigliocco and Nicol, 1998; Franck et al., 2006, 2010; see Clifton et al., 1999; Wagers et al., 2009; Lago et al., 2015, for comprehension data). In Vigliocco and Nicol (1998), for instance, participants made attraction errors when asked to repeat and turn a grammatical sentence such as "The helicopter for the flights is safe" into a question ("Are the helicopter for the flights safe?") In a comprehension study by Wagers et al. (2009), sentences of the form in (2), where the embedded verb agrees not with its singular antecedent but with the plural head of the relative clause, also elicited attraction; in this case, faster reading times after the critical verb compared to the singular attractor condition.

2. *The musicians who the reviewer praise so highly will probably win a Grammy* (Wagers et al., 2009).

More evidence in support of agreement attraction as a structural phenomenon –at least in production– comes from Bock and Cutting (1992) and Solomon

and Pearlmutter (2004), who reported higher agreement error rates in configurations where the subject head and the attractor were within the same clause (3) than when they were in separate clauses (4). This is known in the literature as the clause-boundedness effect (see also Franck et al., 2004, 2010; cf. Gillespie and Pearlmutter, 2013).

3. *[The editor of the history books]*

4. *The editor [who rejected the books]*

Likewise; Franck et al. (2002) found that, in subject noun-phrase preambles containing two stacked prepositional phrase modifiers, the medial prepositional phrase elicited a higher rate of attraction errors in (5) than the most deeply embedded one in (6). In sum, the structurally closer the attractor is to the subject head, the more often agreement attraction errors occur.

5. *The computer with the programs of the experiment*

6. *The computer with the program of the experiments*

Another factor which seems to affect agreement by influencing the timing of structural planning processes in production is semantic integration, the degree to which phrases are connected at the conceptual level. Solomon and Pearlmutter (2004) found larger error rates for more semantically integrated phrases (7) compared to less or non-integrated ones (8) and argued for a parallel-activation processing mechanism underlying agreement in language production, where multiple representations would be held simultaneously in memory. Solomon and Pearlmutter (2004) hypothesized that phrases like (7) would be processed together, inducing higher interference in working memory and, thus, more errors compared to (8).

7. *The pizza with the yummy toppings; The drawing of the flowers*

8. *The pizza with the tasty beverages; The drawing with the flowers*

Agreement attraction errors have been experimentally attested across multiple languages, such as in English (Bock and Miller, 1991; Bock and Cutting, 1992; Bock and Eberhard, 1993), German and Dutch (Hartsuiker et al., 2001, 2003), Italian (Vigliocco et al., 1995; Garraffa and Di Domenico, 2016), Spanish (Anton-Mendez, 1996; Vigliocco et al., 1996; Foote and Bock, 2012), French (Fayol et al., 1994; Vigliocco, 1996; Franck et al., 2002, 2006, 2010), in Russian (Lorimor et al., 2008, 2015) and Slovene (Harrison, 2009), among others.

Recent research has demonstrated an analog effect in language comprehension: in subject-verb agreement, plural versus singular attractors significantly decreased the sensibility to grammatical violations in acceptability judgment, reading time and EEG studies: Nicol et al., 1997; Pearlmutter et al., 1999; Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014, in English; Tucker et al., 2015, in Arabic; Ros et al., 2016, in Basque; Kaan, 2002, in Dutch; Lago et al., 2015, in Spanish. The attraction effect manifests itself in ungrammatical sentences with a plural attractor being considered more acceptable and read faster than those with a singular attractor, whereas the P600 effect in EEG studies –associated with processing syntactic violations and anomalies (for a review, see Gouvea et al., 2010) – is smaller in the same condition. These effects at memory retrieval are interpreted as evidence that the sentence was considered grammatical on a first-pass reading and are thus known as *illusions of grammaticality* (Phillips et al., 2011).

3.2.1 Accounting for attraction effects: theoretical proposals

Different kinds of models have been proposed to explain why number attraction effects arise: models belonging to the *representational account* hold that attraction errors occur due to a faulty representation of the number specification of the subject noun phrase (Eberhard et al., 2005; Franck et al., 2002; Nicol et al., 1997; Staub, 2009, 2010; Vigliocco and Nicol, 1998). In a sentence preamble like *The key to the cabinets*, the plural number feature of the attractor would either *percolate* (migrate) upwards (Feature Percolation: Bock and Eberhard, 1993; Vigliocco et al., 1995; Eberhard, 1997; Franck et al., 2002) or spread via activation throughout the syntactic structure to the root node of the subject phrase (Marking and Morphing: Eberhard et al., 2005; Hartsuiker et al., 2001), overwriting thus its number specification. As a result, verb number is assigned to an incorrect representation and an agreement error follows. These structure-based models were suggested to account for agreement attraction data in language production[1].

Alternately, *retrieval-based accounts* (Solomon and Pearlmutter, 2004; Lewis and Vasishth, 2005; McElree, 2006; Badecker and Lewis, 2007; Badecker and

[1] A couple of comprehension studies on subject-verb number agreement attraction in English suggest that a process similar to feature percolation (head overwriting) underlies agreement computation in comprehension (Nicol et al., 1997; Pearlmutter et al., 1999). Nevertheless, Wagers et al. (2009) pointed out that, since the attractor and the verb were linearly adjacent in the stimuli, a spillover of the plural markedness effect onto the verb cannot be disentangled from the attraction effect.

Kuminiak, 2007; Wagers et al., 2009; Martin et al., 2014; Dillon et al., 2013; Lorimor et al., 2015) presume that the amount of information we can maintain in working memory is very limited (Cowan, 2001; McElree, 2006) and, therefore, processing non-adjacent dependencies will require reactivation of previous information from immediate memory via cue-based retrieval. Based on evidence from memory studies on interference effects (Gordon et al., 2001, 2006; McElree et al., 2003; Van Dyke and Lewis, 2003; Van Dyke and McElree, 2006; Van Dyke, 2007), retrieval-based accounts assume that items in memory can be directly accessed based on their features (content-addressable, cue-based mechanism: Ratcliff, 1978; Van Dyke, 2002; Anderson et al., 2004; McElree, 2006), and that a cue-based retrieval mechanism is responsible for quickly and simultaneously re-accessing or activating the items that fully or partially match the dependency requirements (cues) at retrieval while incrementally building a structural sentence representation in memory. In such a noisy and time-constrained environment, these models suppose that the human parser will sometimes fail to retrieve the intended controller and either delay retrieval or deliver an attractor to the system instead (misretrieval).

Since Lewis and Vasishth's retrieval-based theoretical framework, the *activation-based model of sentence processing*, predicts best for the pattern of results reported in the literature and provides the most compelling explanations regarding the processes underlying attraction effects up to date, we will focus on it and refer to it as the *original cue-based retrieval model* to further distinguish it from the *extended cue-based retrieval model* by Engelmann et al. (2016).

The original cue-based retrieval model is built within the *Adaptive Control of Thought-Rational* cognitive architecture (ACT-R; see Anderson et al., 2004; Anderson, 2005) and assumes that a single set of general memory principles and cognitive mechanisms governs memory retrieval during sentence comprehension. Sentence processing is discussed in terms of *activation level* of memory items and degree of *association strength* between a cue and the retrieval target at the time of retrieval. Crucially, activation level is subject to time decay.

Under the original cue-based retrieval model, in grammatical agreement processing, partially cue-matching items (or attractors) compete against the fully-matching controller for the limited amount of activation available in working memory, reducing thus controller's distinctiveness (*association strength*) among memory items. The item with the highest activation boost and the strongest association level is the most likely to be retrieved, but partially-matching items hinder its retrieval. This phenomenon, known as *similarity-based interference*

or *fan effect*, arises at the time of retrieval and results in longer reaction times in the cue-matching attractor condition (*inhibitory interference effect*).

In ungrammatical sentences, however, neither the controller nor the attractor fully match the retrieval cues of the dependency. The activation level between them is similar, which can lead to shorter reading times when the cue-matching attractor is misretrieved (a *facilitatory interference effect* due to the illusion of grammaticality effect).

In order to illustrate these predictions, we will focus on subject-verb agreement comprehension. It requires at least two relevant cues for processing: local subject of the main clause and verb number. The former is a structural cue used to distinguish the retrieval target from the attractor. The latter is a non-structural cue and is manipulated between conditions in order to test for interference effects from the attractor. A plus or a minus on **Figure 3.1** indicates matching or mismatching with the retrieval cues, respectively.

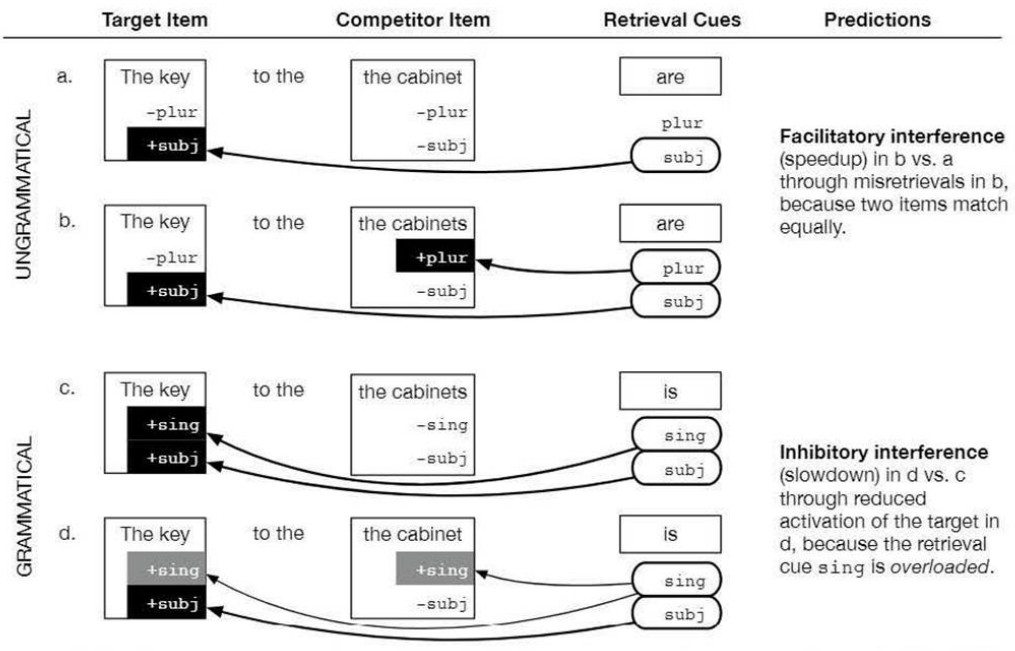

FIGURE 3.1: Schematic representation adopted from Nicenboim et al. (2018) of the predictions of the cue-based retrieval model of Lewis and Vasishth (2005) for the ungrammatical and grammatical agreement attraction configurations.

In the grammatical conditions, the retrieval target fully matches the dependency cues, whereas –in the ungrammatical conditions– it only matches the structural cue. The similarity-based interference mechanism is expected to elicit inhibitory interference effects in the grammatical cue-matching attractor condition, whereas misretrievals are assumed to cause facilitatory interference effects in the ungrammatical cue-matching attractor condition.

Subject-verb number agreement attraction studies in comprehension consistently show facilitation in ungrammatical sentences across languages and experimental methodologies, supporting thus the prediction of the model. Effects in grammatical sentences, however, contradict the model's prediction of inhibitory interference: effects are either facilitatory (in English: Nicol et al., 1997, Exp. 4; Pearlmutter et al., 1999; Pearlmutter, 2000; Wagers et al., 2009; in Arabic: Tucker et al., 2015; in Spanish: Acuña-Fariña et al., 2014; Lago et al., 2015, Exp. 3A; cf. Franck et al., 2015, in French relative clauses, for an inhibitory effect) or null at the time of retrieval (in English: Nicol et al., 1997, Exp. 5; Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; in French: Franck et al., 2015; in Spanish: Lago et al., 2015; in Dutch: Kaan, 2002). Interestingly, this contradiction does not occur in subject-verb agreement studies investigating other cues than number (Van Dyke and Lewis, 2003; Van Dyke, 2007).

To the best of our knowledge, four hypotheses have been proposed to explain this pattern of results (H1-H4):

Wagers et al. (2009) argue for plural complexity –the additional processing cost of plural items relative to singular ones- as a very likely contributor to the facilitatory effects found in grammatical sentences with a singular verb. Most subject-verb number agreement attraction studies in comprehension follow the 'classic' design from production where a prepositional phrase containing the attractor modifies the subject head noun (e.g. 'The key to the cabinets was/*were rusty'). When the attractor is no longer linearly adjacent to the verb, grammatical attraction effects disappear in relative clause configurations with *proactive* and *retroactive interference*[2] designs[3]. Wagers and colleagues

[2]Retroactive and proactive interference refer each to the linear order of the attractor with respect to the retrieval target. In a retroactive interference design, the attractor follows the retrieval target, whereas, in a proactive design, it precedes the target.

[3]To the best of our knowledge, only two self-paced reading experiments elicited grammatical attraction effects from a relative clause configuration (Lago et al. (2015, Exp. 3A), in a proactive design; Tucker et al. (2015) in a retroactive design). The authors, however, argue against this facilitatory interference effect in grammatical conditions, in the presence of illusions of grammaticality, for considering it unreliable.

claim that a cue-based retrieval mechanism could still account for this *grammatical asymmetry* (i.e. null effects in grammatical sentences and facilitation in ungrammatical ones): (H1) either cue-based retrieval underlies agreement processing and misretrievals are extremely rare when the retrieval target perfectly matches the verbal cues or (H2) the mechanism is only triggered by a number-marking error at the verb (*error-driven mechanism*) and reanalysis after error detection causes attraction sometimes when the bottom-up features of the verb mismatch the top-down prediction and the parser misretrieves the attractor during that reanalysis stage.

Another possibility raised by Jäger et al. (2017) is that other mechanisms than cue-based retrieval could be at play during number agreement processing (H3). Retrieval-based accounts such as the original cue-based retrieval model propose that attraction phenomena results from either delays or misretrievals when aiming at retrieving the intended item in memory. If the process goes awry, however, the representation or encoding of the relevant items is also subject to failure. This idea of misrepresentation of memory items is shared with representational accounts, which postulate that attraction errors arise due to a faulty representation of the number specification of the agreement controller. For instance, in a sentence like *The key to the cabinets is rusty*, if the plural number feature of the attractor migrates upwards throughout the syntactic structure by means of a feature percolation mechanism and overwrites the number specification of the subject noun phrase, then an illusion of ungrammaticality should arise and lead to a facilitatory effect (shorter reading times) in the grammatical singular (cue-matching) attractor condition. Both the original cue-based retrieval and the feature percolation accounts predict facilitation in ungrammatical sentences, but their expectations diverge for grammatical sentences: whereas the original cue-based retrieval model predicts inhibition (longer reading times) in the cue-matching condition, feature percolation predicts facilitation (shorter reading times). Critically, if cue-based retrieval and feature percolation mechanisms were at play during number agreement processing, the latter could be hiding or even reversing the effects caused by the former. This hypothesis could account for the pattern of results reported by Jäger et al. (2017) in their Bayesian meta-analysis of the published research on retrieval interference effects in subject-verb agreement and reflexive-/reciprocal-antecedent dependencies in language comprehension.

The authors, though, claim that the variability in effect sizes, null effects and results that contradict the predictions of the original cue-based retrieval model

could be related to systematic differences in attractor prominence, language studied and the type of dependency and interference type (retro- vs. proactive) among studies (H4).

3.2.2 The present study

The aim of the present series of experiments is to investigate the nature of the mechanisms underlying agreement computation in subject-verb dependencies in a language other than English, where most studies up to date have been carried out (see Jäger et al., 2017). More precisely, we explore how number interference is affected by attractor prominence (understood as a function of its syntactic position and discourse saliency) in Spanish. To this end, attractor prominence and number were manipulated in retroactive interference configurations with relative clauses in two self-paced reading experiments (Experiment 4 and 5) by taking advantage of the fact that the subject-object grammatical contrast is morphologically codified for animate noun phrases in Spanish.

3.3 Experiment 4: Agreement with a subject attractor

Based on previous research on subject-verb number agreement attraction in comprehension, we hypothesize that, overall, grammatical sentences will be read faster than ungrammatical ones (a main effect of grammaticality) and that ungrammatical sentences with singular subject heads and plural attractors will elicit significantly shorter reading times at the post-critical region than those with singular attractors (an *illusion of grammaticality*).

As for grammatical sentences, we predict a null interference effect. The attractor in this experiment is a subject within a relative clause, in a retroactive configuration and, therefore, highly prominent (accessible/activated). However, since it is in a different clause than the retrieval target and the verb, attractor prominence probably will not be high enough to outcompete the activation level of the subject in the main clause (see clause-boundedness effect: Franck et al., 2004, 2010, cf. Gillespie and Pearlmutter, 2013). Hence, we expect readers to retrieve the target in most trials.

3.3.1 Method

Participants

Forty-four native speakers of Spanish (thirty-five women), aged 18-30, were recruited among the students of the University of the Basque Country (Vitoria-Gasteiz campus). Participants gave written informed consent and were paid €4 for the session, which lasted around 30 min.

Materials and Design

40 sentences were created and two alternative constructions were tested in two separate norming studies, because object relative clauses involving human entities can sometimes, but not necessarily, be preceded by the accusative marker *a* in Spanish. The main reason for testing them separately was that speeded acceptability judgment tasks require a sustained involvement of attention, because reading time for word/sentence processing is fast and constrained there. As a result, these kinds of tasks are cognitively highly demanding and stressful. Running both norming studies together would have probably discouraged volunteers from completing the task. The purpose was finding a grammatical, acceptable instance of an object-gap relative clause in a subject-verb agreement dependency so that the attractors were highly prominent and strongly interfered with the controller (the subject) at memory retrieval. We wanted to make sure that the participants in our real experiment would not be distracted by the type of structure and its frequency of use.

Norming Study 1

We tested first the construction where the accusative case marker for the [+human] object-gap relative clause was absent. The 40 experimental sentences from the grammatical singular attractor condition were mixed with 120 fillers, a third of them ungrammatical. We run them on a speeded acceptability judgment task using the Ibex Farm web-based platform (Drummond, 2013). Sentences were randomly presented word-by-word in the center of the screen in a timely manner, with a 100 millisecond lapse, and each word disappeared after 500 milliseconds. Twenty-nine native speakers of Spanish judged the acceptability of the sentences on a 5-point Likert scale, where 5 meant perfectly acceptable and 1 was completely unacceptable. Each participant read

ten experimental sentences plus thirty fillers and completed the task in about 15 minutes. The results are shown in **Table 2.5**.

Norming Study 2

We tested the construction where the accusative case marker for [+human] nouns preceded the object relative clause, removing thus any temporal structural ambiguity compared to the construction used in Norming study 1, where ambiguity was resolved at the post-verbal region. The design and procedure were the same as in Norming Study 1. A new set of twenty-four native speakers of Spanish judged the acceptability of the sentences. The results are presented below:

	Mean value
Norming study 1	3.17 (.03)
Norming study 2	4.26 (.02)

TABLE 3.1: Mean acceptability judgments and standard errors by participants. Values are on a 5-point Likert scale, where 5 means perfectly acceptable and 1 is completely unacceptable.

Participants preferred the structurally unambiguous object relative clauses preceded by the accusative case marker. Therefore, our materials had the form shown in **Table 3.2**:

The stimuli were arranged in a 2 x 2 counterbalanced design with grammaticality (grammatical/ungrammatical) and attractor number (singular/plural) as factors. The auxiliary verb (*ha*, '(he) has') was the retrieval site and agreed in the grammatical conditions with the subject of the matrix sentence (the retrieval target), which was animate, masculine and singular across conditions. An object-gap, relative clause with an animate, masculine subject (the attractor), which could match or not in number with the target and the auxiliary, intervened between them and modified the retrieval target. Since the embedded subject and verb of an object-gap relative clause need to agree with each other, there was an additional number cue (-n, marking plurality) in the plural conditions. Based on Eberhard (1997), Wagers et al. (2009) argued that plural complexity in English could incur an additional processing cost in grammatical sentences. Plural is also marked in Spanish compared to the

TABLE 3.2: Sample of materials used in Experiment 4.

Grammatical - Interference (SG)	El reportero al que saluda ese ministro diariamente **ha** aparecido esta madrugada en el Congreso.[a]
Grammatical - No interference (PL)	El reportero al que saludan esos ministros diariamente **ha** aparecido esta madrugada en el Congreso.[b]
Ungrammatical - No interference (SG)	El reportero al que saluda ese ministro diariamente ***han** aparecido esta madrugada en el Congreso.[c]
Ungrammatical - Interference (PL)	El reportero al que saludan esos ministros diariamente ***han** aparecido esta madrugada en el Congreso.[d]

[a]The reporter who that minister greets daily **has** come this early morning to the Congress.
[b]The reporter who those ministers greet daily **has** come this early morning to the Congress.
[c]The reporter who that minister greets daily ***have** come this early morning to the Congress.
[d]The reporter who those ministers greet daily ***have** come this early morning to the Congress.

default singular form. In order to control for spillover effects from the plural attractor into the critical region, an adverb was placed between the attractor and the retrieval site (see Wagers et al., 2009). The verb inside the relative clause was in third person, present simple tense and perfective aspect (e.g. *salud-a*, 'greet.3sg'; *salud-an*, 'greet.3pl'), agreeing with the embedded subject, whereas the main clause verb phrase was in third person, present perfect tense and perfective aspect (e.g. *ha/-n contrat-ado*, 'aux.3sg/pl - hire.pprt.') and referred to the subject of the matrix in the grammatical conditions. Grammaticality was manipulated by switching the number of the auxiliary verb from singular to plural after less marked verb forms in Spanish were found to be more susceptible to attractor interference in a subject-verb agreement study comparing auxiliary and main verbs (see Alcocer and Phillips, 2009). The use of a verb in the present perfect tense also allowed us to examine two points of retrieval: the first one, at the auxiliary verb, where an agreement check is needed, and a second one we hypothesized, located at the main verb, in order to check verb phrase agreement.

The 40 sentences were distributed across four lists in a Latin Square design and combined with 96 filler sentences of a similar length. 20% of the total items were ungrammatical. Every sentence was followed by a yes/no

comprehension question; none of them targeted the agreement dependency.

3.3.2 Procedure

Participants were tested individually in a quiet, lit-up booth and assigned one of the four lists of stimuli randomly. Items were presented on a 19-inch LCD screen connected to a PC running the Linger software (Rohde, 2001) in a self-paced word-by-word moving window reading paradigm (Just et al., 1982). The task consisted of 3 grammatical sentences for practice and 144 sentences randomly intermixed by the experimental software for each participant. Each item was followed by a yes/no comprehension question, which always appeared on the screen all at once. The 'z' key was used for "yes" and the "m" key was used for "no." Participants were instructed to read at a natural pace and answer the questions as quickly and accurately as possible. They were not informed about sentences containing grammatical errors, nor were they provided any feedback. Two optional breaks were included to prevent participants from fatigue.

3.3.3 Analysis

Experimental data were analyzed in the statistical programming environment R (R Core Team, 2014). Regions consisted of a single word and only the word-by-word reaction times from correctly answered target sentences were taken into account for analysis. Extreme values less than 100 ms and greater than 3000 ms were trimmed (.18%). The remaining data points were log-transformed, and those that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 2.35% of the data. Log reading times at each region were then analyzed using the lmer4 package in R (Bates et al., 2015) in a series of linear mixed-effects models with grammaticality, attractor number and their interaction as fixed effects and by-subject and by-item random intercepts. Other factors included in each model were spillover from the plural attractor and the logarithm transformed position of the trial in the experiment. There were four regions of interest in this experiment, ranging from R9 (the critical region) to R12. Fixed effects were centered in order to avoid collinearity. We used the maximal random effect structure justified

by the data using all the models that converged and that did not contain correlations between the random effects equal to 1 or -1 (Baayen et al., 2008).

3.3.4 Results

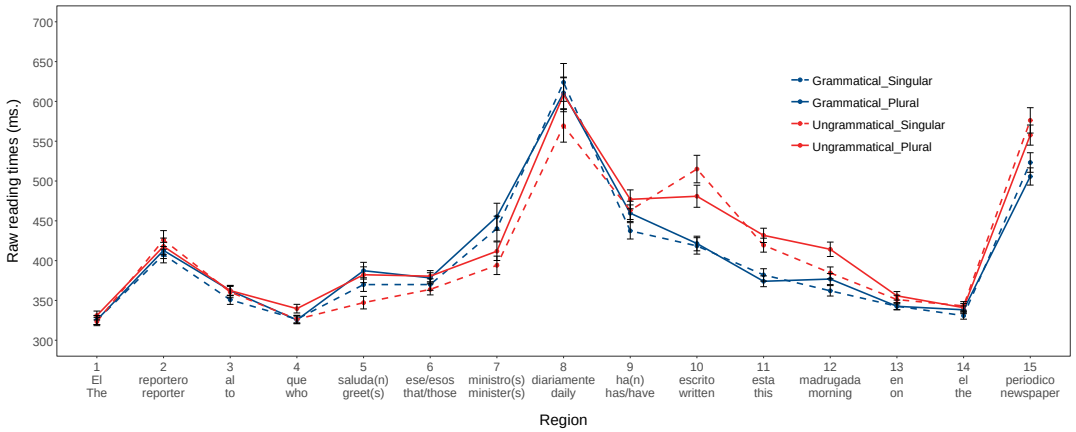

FIGURE 3.2: Region-by-region means in milliseconds in Experiment 4. Error bars indicate the standard error of the mean.

The results from this self-paced reading experiment are shown in **Figure 3.2** (see its large version in **Appendix F.1**). We plot raw reading times for easier readability, but the statistical analysis was performed on log-transformed reading times. Participants were at least 75% accurate in target sentences and, overall, 93.01% accurate in comprehension questions.

A main effect of grammaticality was found at R9, the critical word position, such as grammatical sentences were read faster than ungrammatical ones (β = -.01; SE = .008; t = -2.46, p =.01). This effect was consistent across regions and always worked in the same direction. At the post-critical region (R10), there was a main effect of grammaticality (β = -.06; SE = .008; t = -7.75, p < .01) and a significant interaction of number * grammaticality (β = .01; SE = .008; t = 1.89, p = .05). Pairwise comparisons revealed that ungrammatical sentences with a plural attractor were read faster than those with a singular attractor [grammatical plural vs. grammatical singular (425.82 ms. vs. 405.37 ms; μ = +20.45 ms.): β = .01; SE = .01; t = 1.08, p = .27; ungrammatical plural vs. ungrammatical singular (482 ms. vs. 507.03 ms.; μ = -25.03 ms.): β = -.02; SE = .01; t = -2.03, p= .04]. There was a grammaticality effect at R11 (β = -.05; SE = .006; t = -8.41, p < .01). Main effects of grammaticality and attractor number were found at R12 (β = -.03; SE = .006; t = -5.4, p < .01 for grammaticality; β = .02; SE = .006; t = 3.41, p < .01 for number). The ungrammatical conditions

were read slower than the grammatical ones. Regarding the number effect, the singular attractor conditions were read faster than the sentences with a plural attractor [grammatical plural vs. grammatical singular (376.64 ms. vs. 355.39 ms; μ = +21.25 ms.): β = .01; SE = .007; t = 1.98, p = .04; ungrammatical plural vs. ungrammatical singular (417.79 ms vs. 382.92 ms.; μ = +34.87 ms.): β = .02; SE = .009; t = 2.69, p < .01].

Results are consistent with previous findings in subject-verb number agreement attraction literature in comprehension: grammatical conditions elicited shorter reading times than ungrammatical sentences; a number attraction effect in the form of a number * grammaticality interaction was found at the post-critical region R10 and pairwise comparisons revealed that the effect was driven by ungrammatical sentences and plural attractors led to illusions of grammaticality in the ungrammatical condition.

The grammaticality effect in the critical region (R9) shows that agreement errors were immediately detected at retrieval. We found facilitation in the immediate post-critical region (R10) and the reverse effect (inhibition) in R12, on the second region after the verb phrase. In the grammatical conditions, there was no effect in R10, but one facilitatory arose in R12. We interpret the effects in R12 as evidence of a second retrieval site at the main verb. At the first critical region, where the auxiliary verb is, readers often retrieved the attractor in the ungrammatical plural attractor condition, because it matched the auxiliary verb in number. This partial cue-overlap created the fleeting illusion that the sentence was grammatical, leading to a facilitatory interference effect. As for the grammatical condition, the activation level of the attractor and the target was similar at the first critical region –they were both subjects. We argue that participants retrieved the correct item (the target) in most trials because it fully matched the retrieval cues of the auxiliary verb. Therefore, no attraction-based interference arose.

Once readers processed the auxiliary verb, we assume that the activation level of the retrieval target and the attractor decayed as a result of subject-verb agreement resolution. By the time the verbal phrase is interpreted, the prominence of the attractor relative to the target would be higher in our retroactive interference configuration and, since the item with the highest activation level is most likely to be retrieved, misretrievals in grammatical sentences and dismissal of the attractor in ungrammatical sentences would have occurred more frequently at this point.

The finding that grammatical sentences with singular attractors were read significantly faster than the grammatical, plural mismatch condition at R12 is consistent with some previous studies in subject-verb agreement comprehension: (Nicol et al., 1997; Pearlmutter et al., 1999; Wagers et al., 2009, in English; Acuña-Fariña et al., 2014; Lago et al., 2015, in Spanish; Tucker et al., 2015, in Arabic; Kwon and Sturt, 2016, in Korean). An alternative explanation for this effect in our experiment could be plurality cue overload[4] along with feature percolation from the attractor in the plural mismatch conditions, which might have induced a misrepresentation of the subject phrase as plural and, consequently, an illusion of ungrammaticality, which manifested itself in longer reading times in the grammatical plural cue mismatching condition at R12 relative to its singular cue-matching counterpart.

Wagers et al. (2009) posited two hypotheses to account for the patterns of results reported in subject-verb number agreement literature. The authors argued that a cue-based retrieval process could be (i) either always engaged after verb processing or (ii) only triggered by an agreement mismatch (i.e. ungrammaticality). We did not observe any effect in the grammatical sentences in the immediate post-critical region (R10), probably because the target was successfully retrieved in most trials. Nevertheless, a facilitatory interference effect emerged at R12, after a second retrieval. Given that previous research on subject-verb number agreement reporting effects in grammatical sentences also showed attraction in ungrammatical sentences (i.e. there are no instances of studies looking into subject-verb number agreement attraction in grammatical and ungrammatical sentences simultaneously and finding effects in the former case only), we think that our results support the idea that a cue-based retrieval mechanism was always triggered whenever the verb was encountered.

On the other hand, we cannot rule out the possibility that other mechanisms, such as feature percolation, were also at play during agreement processing though. In fact, we interpret the facilitatory interference effect in grammatical sentences (i) in terms of activation differences between the target and the attractor at retrieval site (a cue-based retrieval explanation based on the extended model) and (ii) in terms of a feature percolation mechanism causing misrepresentation of the subject phrase as plural, leading to longer reading times than in the singular attractor condition. In principle, both mechanisms

[4]Object relative clause verbs agreed with the subject attractor of the clause. Therefore, there was an additional plurality cue in the plural conditions.

could have underlain agreement computation in our experiment. They are not necessarily mutually exclusive: retrieval-based accounts postulate that attraction phenomena arise due to memory-based processing mechanisms, but they acknowledge that, if memory retrieval goes awry, misrepresentation or wrong encoding of memory items can also occur.

We believe, though, that the facilitatory effect in grammatical sentences was most likely due to activation differences between the target and the attractor at retrieval site; in other words, we assume that the effect was probably due to a similarity-based interference mechanism sensitive to the activation levels (i.e. prominence) of memory items.

Conversely, on a feature percolation account, a relative clause configuration should be less prone to attraction effects. Evidence from subject-verb agreement production studies shows that the structurally closer the attractor was to the subject head, the more often agreement attraction errors occurred. Likewise, attraction error rates were higher in configurations where the subject head and the attractor were within the same clause rather than in separate clauses (Bock and Cutting, 1992; Solomon and Pearlmutter, 2004; Staub, 2009; Franck et al., 2002, 2004, 2010; cf. Gillespie and Pearlmutter, 2013). Since our attractors were deeply embedded in the structure and in a different clause than the target, we believe it is unlikely that a feature percolation mechanism were at play in our comprehension study. We thus tentatively conclude that a cue-based retrieval mechanism sensitive to attractor prominence underlies agreement processing in this experiment (Engelmann et al., 2016).

3.4 Experiment 5: Agreement with an object attractor

The aim of the present study was to investigate the nature of the processing mechanisms underlying subject-verb agreement dependencies in Spanish. We focused on the effect attractor prominence might have on number interference and designed Experiment 4 in order to test the impact of subject attractors within a relative clause in a retroactive interference configuration.

In the follow-up experiment, however, we placed the attractor in object position. According to the extended cue-based retrieval account, when the activation level of the attractor remains lower than the activation level of the

target, attractor prominence does not affect retrieval and, therefore, effects should comply with the predictions of the original cue-based retrieval model. If so, we expect to find an attractor number effect at the post-critical region so that plural attractors in grammatical and ungrammatical sentences will induce shorter reading times at retrieval than singular attractor nouns.

However, if feature percolation along with cue-based retrieval mechanisms were at play during number agreement processing, then we should find either longer reading times in the grammatical plural-mismatch condition due to an illusion of ungrammaticality or no differences at all, because both mechanisms make opposite predictions for grammatical sentences and the effects could be thus counteracting each other.

Finally, based on previous research, we also expect to find a main effect of grammaticality such as grammatical sentences will be read faster than ungrammatical ones.

3.4.1 Method

Participants

Thirty-six native speakers of Spanish (twenty-nine women), aged 18-29 (Mean = 21.43), were recruited among the students of the University of the Basque Country (Vitoria-Gasteiz campus). Participants gave written informed consent and were paid €4 for the session, which lasted around 35 min.

Materials and Design

40 sentences of the form shown in **Table 3.3** were adapted from Experiment 4 and 8 more were added to the materials. They were arranged in a 2 x 2 counterbalanced design with grammaticality (grammatical/ungrammatical) and attractor number (singular/plural) as factors. As in Experiment 4, the auxiliary verb (*ha*, '(he) has') was the retrieval site and agreed in the grammatical conditions with the subject of the matrix sentence (the *retrieval target*), which was animate, masculine and singular across conditions. The design was similar to Experiment 4, but a subject-gap relative clause was used instead. The attractor was thus in object position. It was animate, masculine and could match or not in number with the target, but it always mismatched in the structural cue of being the local subject of the main clause. Since the

object was [+human], it was preceded by the accusative marker "a". The verb inside the relative clause was always in third person, singular, present simple tense and perfective aspect (e.g. *salud-a*, 'greet.3sg), agreeing with the retrieval target. The main clause verb phrase was in third person, present perfect tense and perfective aspect (e.g. *ha-n contrat-ado*, 'aux.3pl - hire.pprt.') and referred to the subject of the matrix in the grammatical conditions. Grammaticality was manipulated by switching the number of the auxiliary verb from singular to plural after less marked verb forms in Spanish were found to be more susceptible to attractor interference in a subject-verb agreement study comparing auxiliary and main verbs (see Alcocer and Phillips, 2009). In order to control for spillover effects from the plural attractor into the critical region, an adverb was placed between the attractor and the retrieval site (see Wagers et al., 2009).

TABLE 3.3: Sample of materials used in Experiment 5.

Grammatical - Interference (SG)	El reportero que saluda a ese ministro diariamente **ha** aparecido esta madrugada en el Congreso.[a]
Grammatical - No interference (PL)	El reportero que saluda a esos ministros diariamente **ha** aparecido esta madrugada en el Congreso.[b]
Ungrammatical - No interference (SG)	El reportero que saluda a ese ministro diariamente ***han** aparecido esta madrugada en el Congreso.[c]
Ungrammatical - Interference (PL)	El reportero que saluda a esos ministros diariamente ***han** aparecido esta madrugada en el Congreso.[d]

[a] The reporter who greets that minister daily **has** come this early morning to the Congress.
[b] The reporter who greets those ministers daily **has** come this early morning to the Congress.
[c] The reporter who greets that minister daily ***have** come this early morning to the Congress.
[d] The reporter who greets those ministers daily ***have** come this early morning to the Congress.

The 48 sentences were distributed across four lists in a Latin Square design and combined with 96 filler sentences of a similar length. This resulted in a filler-to-item ratio of 3:1, with 20% of the total items being ungrammatical. Every sentence was followed by a yes/no comprehension question. None of them targeted the agreement dependency.

3.4.2 Procedure

Same as in Experiment 4.

3.4.3 Analysis

Same as in Experiment 4.

Only the word-by-word reaction times from correctly answered target sentences were considered for analysis and extreme values less than 100 ms and greater than 3000 ms were trimmed (.34%). The remaining data points were log-transformed and those that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 2.29% of data.

3.4.4 Results

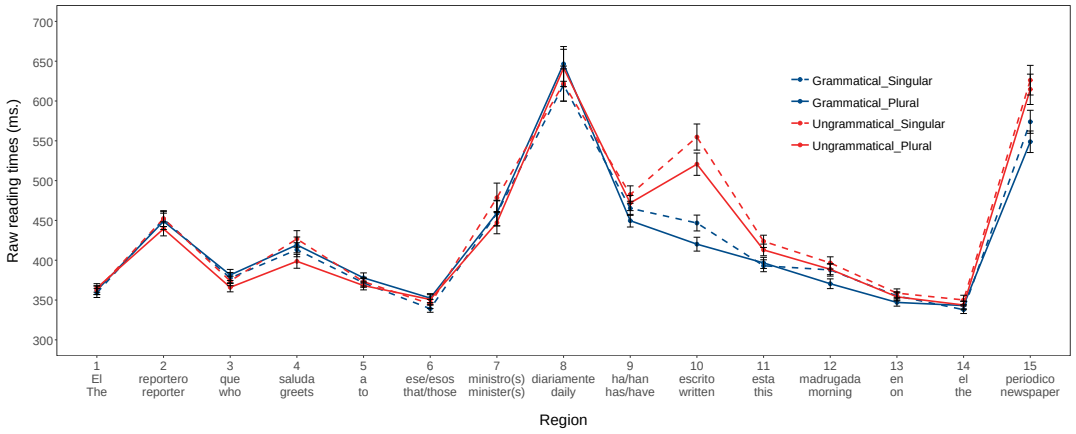

FIGURE 3.3: Region-by-region means in milliseconds in Experiment 5. Error bars indicate the standard error of the mean.

The results from this self-paced reading experiment are shown in **Figure 3.3** (see its large version in **Appendix F.2**). We plot raw reading times for easier readability, but the statistical analysis was performed on log-transformed reading times. Overall, participants were 92.14% accurate on comprehension questions.

A main effect of grammaticality was found at R9, the critical word position, such as grammatical sentences were read faster than ungrammatical ones (β = -.01, SE =.007, t = -1.98, p = .04). At the post-critical region (R10), there

was a main effect of grammaticality (β = -.08, SE = .008, t = -9.51, p < .001) and a main effect of attractor number (β = -.02, SE = .008, t = -2.92, p < .01). The grammatical conditions elicited shorter reaction times than the ungrammatical ones. As for the attractor number effect, the plural attractor conditions were read faster than the singular attractor ones [grammatical plural vs. grammatical singular (420.52 ms. vs. 453.33 ms.; μ = -32.81 ms.): β = -.02, SE = .01, t = -2.93, p < .01; ungrammatical plural vs. ungrammatical singular (525.95 ms. vs. 559.59 ms.; μ = -33.64 ms.): β = -.02, SE = .01, t = -1.67, p = .09]. The main effect of number disappeared at R11 (β = -.003, SE = .006, t = -.59, p = .55), the region immediately after the verb phrase, and only the grammaticality effect remained at that region (β = -.02, SE = .006, t = -3.76, p < .001) and spilled over R12 (β = -.01, SE = .005, t = -3.22, p < .01).

Results are consistent with the previous findings in subject-verb number agreement attraction literature in comprehension in that grammatical sentences elicited shorter reading times than ungrammatical sentences, and the ungrammatical plural (cue-matching) attractor condition was read faster at the immediate post-critical region (R10) than its singular attractor counterpart.

Crucially, when the attractor was in a less structurally prominent position, such as object of a relative clause, similarity-based interference mechanisms caused longer reaction times in grammatical sentences with singular (cue-matching) attractors than in those with plural attractors, as predicted by both the original and the extended cue-based retrieval models. Since this effect was inhibitory, we can rule out the possibility of a feature percolation mechanism underlying agreement processing.

Therefore, we conclude that a cue-based retrieval mechanism sensitive to attractor prominence was at play during subject-verb agreement processing.

3.5 Discussion

The key difference between both subject-verb number agreement experiments here is structural: in Experiment 4, the subject attractor was within an object-gap relative clause, whereas in Experiment 5, the object attractor was included in a subject-gap relative clause. We manipulated attractor number (singular vs. plural) and attractor prominence (understood as a function of syntactic position and discourse saliency). As proposed by the extended cue-based retrieval model, we assumed that subject attractors would cause

higher attraction-based interference at retrieval than object attractors based on evidence showing that subjects are accessed faster and maintained more actively in memory than objects (Ariel, 1990; Brennan, 1995; Grosz et al., 1995; Keenan and Comrie, 1977; Chafe and Li, 1976). We expected differences in memory activation between the target and the attractor at retrieval site to affect the size and direction of the effects.

On one hand, when the attractor was a subject (Experiment 4), it was in a highly prominent context and strongly competed for activation against the retrieval target. An illusion of grammaticality occurred at the region following the critical word position, as confirmed by the grammaticality * number interaction. No effects were found in grammatical sentences in this region. Previous research has shown that these effects tend to be smaller in a grammatical context and, therefore, harder to detect (Jäger et al., 2017). Following the extended cue-based retrieval model, we suggested, though, that it was due to participants retrieving the correct, fully-matching item in most trials when the activation level of the retrieval candidates was similar at retrieval site. This null interference effect in the grammatical condition became facilitatory at a later stage, after verbal phrase processing. This result is in line with previous studies in subject-verb number agreement attraction that report facilitatory interference effects in grammatical and ungrammatical sentences, whereas it contradicts the prediction of inhibitory interference effects for grammatical sentences associated with the original cue-based retrieval model (Lewis and Vasishth, 2005; Lewis et al., 2006). We argued that the effects in Experiment 4 result from differences in the activation level of the retrieval candidates at retrieval site. Furthermore, we assumed that the activation level of the retrieval target and the attractor decayed as a result of agreement resolution at the auxiliary verb, and interpreted the effects at a later region as evidence of a second retrieval site at the main verb. This could explain our results at the first post-critical region as well as at a later stage where we found inhibitory interference effects in ungrammatical sentences in the presence of facilitation in the grammatical condition. Since the retrieval candidate with the highest activation level is most likely to be retrieved, misretrievals in grammatical sentences and dismissal of the attractor in ungrammatical sentences would have occurred more frequently at this point, where the prominence of the attractor relative to the target was higher in our retroactive interference configuration.

On the other hand, when the attractor was an object within a relative clause

(Experiment 5), i.e. when it was in a less prominent context, plural attractor conditions were read faster than singular attractor conditions, as revealed by the main effect of number. An inhibitory effect was observed then in the grammatical singular attractor condition, consistent with the prediction of similarity-based interference advocated by the original cue-based retrieval model and other memory-based language processing accounts (Lewis, 1993, 1996; Gordon et al., 2001, 2002; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis et al., 2006). Grammatical sentences containing a singular attractor were read slower than those with a plural attractor when the verb was also singular, whereas the plural attractor condition in ungrammatical sentences elicited faster reading times when the verb was plural. In sum, cue-matching attractor conditions affected grammatical and ungrammatical sentences differently, as predicted by the original and the extended cue-based retrieval models. We acknowledge the possibility that the accusative marker a preceding the attractor in object position could have increased the attractor's distinctiveness relative to the retrieval target; however, it seems that the activation level of the attractor remained lower than the activation level of the target, because attractor prominence –as postulated in the extended cue-based retrieval model– did not affect retrieval and, consequently, the effects complied with the predictions of the original cue-based retrieval model.

Taking into account both experiments on subject-verb agreement, our results suggest that number attraction effects in subject-verb agreement were modulated by attractor prominence. When both the retrieval target and the attractor were subjects, attraction-based interference effects were facilitatory in the ungrammatical condition and facilitatory and inhibitory in grammatical and ungrammatical sentences, respectively, at a later stage. When the attractor was an object preceded by a case marker, however, the results complied with the predictions of the original cue-based retrieval model and no effects arose at a later region, probably because of attractor prominence being lower relative to Experiment 4.

Given our results, one could argue that the contribution of attractor prominence to attraction-based interference effects remains an open question here. In our study, attractor prominence was necessarily confounded with the structure of a relative clause in subject-verb agreement in Spanish; that is, subject attractors were embedded within object relative clauses and object attractors were embedded within subject relative clauses. Betancort et al. (2009) showed that object relative clauses are more difficult to process than subject relative

clauses in Spanish. Nevertheless, contrary to their study, the object relative clauses we used in Experiment 4 were preceded by the relativizer *al que*, which preempts a subject relative clause interpretation. In fact, in our norming study, this form scored higher than the temporarily ambiguous alternative *que* used in Betancort et al. (2009), which proves that our object relative clauses were preferred, as they were presumably easier to process. Furthermore, in their study, relative clauses were in object position, whereas ours worked as subject modifiers in order to increase the likelihood of eliciting attraction effects in subject-verb agreement dependencies. These differences across both studies might have reduced the processing gap between the two relative clause types.

Finally, we cannot rule out the possibility that structural differences between Experiment 4 and Experiment 5 contributed to the attraction effects reported here, but for the reasons stated above, we think this is unlikely.

Therefore, we conclude that a cue-based retrieval mechanism sensitive to attractor prominence, as proposed by Engelmann and colleagues, underlies subject-verb number agreement processing in Spanish, irrespective of sentence grammaticality (Nicenboim et al., 2018; cf. Wagers et al., 2009; Dillon et al., 2013; Lago et al., 2015).

3.6 Summary

Chapter 3 offers experimental evidence that cue-based retrieval is a processing mechanism sensitive to structural prominence and always engaged during syntactic dependency formation in sentence comprehension. This finding contradicts the hypothesis that cue-based retrieval is only triggered as a last-resort mechanism to repair grammatical agreement violations (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015; cf. Nicenboim et al., 2018).

4 Object-clitic pronoun licensing in Spanish

4.1 Outline

In this chapter, we further explore the nature of the processing mechanisms underlying agreement in non-adjacent dependencies. We use attraction-based interference in order to investigate how different sets of cues are involved and combined during memory retrieval (*cue combinatorics*) in clitic left dislocated configurations in Spanish, where clitic pronouns must be bound by a preceding object constituent in the same clause. First, we review reflexive attraction studies in English as a baseline for the current research and discuss the hypotheses suggested in the literature; ranging from possible ways to implement a cue-based retrieval model (Lewis and Vasishth, 2005; Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017) to the proposal that qualitatively different retrieval mechanisms might be subserving the computation of different linguistic dependencies (Dillon, 2011; Phillips et al., 2011; see also Dillon et al., 2013). Next, we introduce the present study, describe the characteristics of clitic left-dislocated configurations in Spanish as well as our experimental design and derive a set of predictions out of it. Finally, we report and discuss the results from three self-paced reading experiments in light of the proposed cue-combinatorics schemes.

4.2 Background

In the previous chapter, we analyzed the impact of subject and object attractors during subject-verb number agreement resolution in Spanish. We considered the extended cue-based retrieval model (Engelmann et al., 2016), which adds an attractor prominence correction to the activation-based model of sentence processing (Lewis and Vasishth, 2005) in order to account for the consistent

data questioning the validity of a model which had otherwise predicted best for the pattern of results reported in the literature, in addition to providing the most compelling explanations for the processes underlying attraction effects. We concluded that subject-verb number agreement processing in Spanish deploys a cue-based memory retrieval mechanism irrespective of sentence grammaticality; i.e. it is not exclusively triggered as a last-resort mechanism to repair grammatical agreement violations (Nicenboim et al., 2018; cf. Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; Lago et al., 2015). Our data supported the view that previous results contradicting the former model's prediction for a multiple cue match in grammatical sentences were due to systematic differences in attractor prominence across studies, be it in syntactic position, grammatical role, discourse saliency of the attractor or a combination thereof (Engelmann et al., 2016).

In this chapter, we further explore memory retrieval in another type of non-adjacent agreement dependency. We use agreement attraction-based interference in order to investigate how antecedent search occurs during clitic pronoun resolution in left-dislocated configurations in Spanish, where –similarly to reflexive-antecedent dependencies in English– clitic pronouns must be bound by an antecedent within the same clause (Chomsky, 1986; Pineda and Meza, 2005; Pablos, 2006). We aim to determine how different sets of cues are involved and combined during sentence processing when the element triggering the linguistic dependency exhibits pronominal and inflectional behavior alike (for a thorough discussion on the nature of clitic pronouns with a focus on Spanish, see Franco, 1993; Pineda and Meza, 2005; Ormazabal and Romero, 2006, 2013, among others). Research on agreement attraction in comprehension has shown that whereas attraction-based interference is consistently found in subject-verb agreement, this effect is harder to detect, smaller and less homogeneous in reflexive pronoun resolution despite the fact that both dependencies show superficially identical agreement constraints: they both require subject retrieval and morphological feature concord (for a review and meta-analysis of previous research, see Jäger et al., 2017). We believe that the study of clitic left-dislocated dependencies in Spanish can provide further insight into how memory retrieval processes operate when dependency predictability is controlled; i.e. when the element triggering memory retrieval is as reliably predictable as predicates in subject-verb agreement dependencies.

4.2.1 Towards a theory of cues in cue-based memory models

Cue-based theory, in principle, assumes that all retrieval cues are equally weighted during sentence comprehension (Lewis and Vasishth, 2005; Lewis et al., 2006). Nevertheless, little is known about what constitutes a cue, how cues are implemented and whether all or just a subset of cues are involved during sentence processing (see Dillon et al., 2014, for a discussion). The fact that the existing cue-based theoretical models leave cue combinatorics underspecified (Martin and McElree, 2008; Parker et al., 2017) led to several proposals on how different sets of cues are engaged and combined during memory retrieval. Some works suggest that qualitatively different retrieval mechanisms are deployed for different linguistic dependencies, such as e.g. a serial, structure-guided search mechanism for computing anaphora but a cue-based retrieval mechanism for agreement processing (Dillon, 2011; Phillips et al., 2011). Others propose that structural information would either be exclusively or primarily used during reflexive pronoun resolution in English (Dillon et al., 2013; Dillon, 2014), but that the underlying mechanism would be nonetheless cue-based. Finally, another line of research supports a cue-weighted combinatorics scheme within a cue-based theory framework, such that all sets of cues would be involved at retrieval, the main difference being in the memory access mechanism weighting structural information over non-structural cues (Van Dyke and McElree, 2011; Cunnings and Sturt, 2014; Parker and Phillips, 2017). We discuss these proposals below in relation to reflexive licensing in English.

Reflexive licensing: Primary vs. exclusive use of structural information

The evidence reported below comes from the study by Dillon et al. (2013). They ran the first comprehension study which directly compared the interference profile of subject-verb agreement and reflexive licensing in closely-matched sentences. An outline from their set of materials is portrayed below (1):

1. a. *The architect who praised the engineer so highly introduced himself to the workers.*

   b. *The architect who praised the engineers so highly introduced himself to the workers.*

c. *The architect who praised the engineer so highly introduced themselves to the workers*.

d. *The architect who praised the engineers so highly introduced themselves to the workers*.

The study replicated previous findings: faster reading times in subject-verb agreement for ungrammatical sentences in the interference condition (i.e. a facilitatory interference effect) and no attraction effects in reflexive - antecedent dependencies (Nicol and Swinney, 1989; Clifton et al., 1999; Sturt, 2003; Xiang et al., 2009; Clackson et al., 2011; cf. Badecker and Straub, 2002). Based on behavioral and computational modeling evidence, Dillon and colleagues proposed that reflexive licensing engages a structured-access processing mechanism which *prioritizes* structural information over morphological cues, such that the grammatical function of the dependency will determine the implementation of morphological constraints. They argued that, whereas the use of morphological features is well-motivated for agreement, binding in reflexive-antecedent dependencies can be established independently by applying syntactic constraints only. As a result, attractors should not be able to interfere during that early processing stage at least, because entities in structurally illicit positions would not be even considered as retrieval candidates for the reflexive pronoun (see also Clifton et al., 1999; Nicol and Swinney, 1989; Kennison and Trofe, 2003; Sturt, 2003; Xiang et al., 2009; Clackson et al., 2011; Dillon, 2011; Phillips et al., 2011; Jäger et al., 2015; Cunnings and Felser, 2013).

If the grammatical function of the dependency really determined the implementation of further constraints, then, different kinds of linguistic dependencies could involve qualitatively different retrieval mechanisms (Dillon, 2011; Phillips et al., 2011): for instance, a cue-based retrieval mechanism for agreement computation, where structural and non-structural cues combine to select an antecedent, but a serial, structure-guided search mechanism for resolving reflexive-antecedent dependencies, where morphological information would not play any role (Phillips et al., 2011; see Dillon, 2014). The absence of a uniform and transparent mapping from grammatical constraints to retrieval cues would complicate the current theories of memory access in sentence comprehension: if retrieval cues cannot be reliably predicted from the grammatical constraints associated with those linguistic dependencies, as Parker and Phillips (2017) pointed out, how will learners manage to "converge on the retrieval strategies to deploy for each dependency"? (p. 274)

What Dillon et al. (2013) proposes is that subject-verb agreement and reflexive licensing use different sets of retrieval cues to access the antecedent, but that the underlying retrieval mechanism is nonetheless "cue-based" across dependencies. They assume that, during reflexive licensing, structural information becomes available *earlier* for the parser than other kinds of cues and, for this reason, syntactic binding constraints will be diagnostic enough to retrieve the licensor. Morphological constraints would only be implemented at a later stage in comprehension (see *structured-access model:* Dillon et al., 2013).

By prioritizing access to syntactic information, we interpret that this model endorses modular accounts of language, where the language system is largely independent from other cognitive systems and linguistic information individually tackled in separate mental modules which are frequently accessed in a serial fashion, being syntax first in line (Forster, 1979; Ferreira and Clifton Jr, 1986; Frazier, 1987, 1990; Crocker, 1992; Frazier and Clifton, 1996). Therefore, we understand that the structured-access account collides with the basis of cue-based theory itself, which is grounded in a general-cognitive, general-purpose, content-addressable system where memory items are directly accessed in parallel based on their feature content.

If syntactic constraints were *primarily* used, as Dillon et al. (2013) suggest, how would the parser decide on the subset of cues relevant for processing while avoiding resorting to a structured-access mechanism?

Reflexive licensing: towards a cue-weighting memory retrieval mechanism

Cue-based memory retrieval models generally assume that a single, uniform, error-prone, memory access mechanism triggered at retrieval site underlies the computation of all non-adjacent linguistic dependencies (Lewis and Vasishth, 2005; Lewis et al., 2006; Martin and McElree, 2008; McElree et al., 2003; McElree, 2000; see McElree, 2006, for a review). Nevertheless, the above theories suggest that the processing mechanism primarily or exclusively needs structural information during reflexive licensing.

Chen et al. (2012) questioned why the parser would actively avoid using other sources of information when they are readily available; such as, for instance, in experiments with English reflexives where attractor gender is manipulated (*himself, herself*). Van Dyke (2007) and Van Dyke and McElree (2011) had indeed shown in a couple of eye-tracking studies that in subject-verb agreement structures like (2), where the attractor could be a semantically

plausible antecedent for the verb of the main clause, semantic information was also retrieved:

2. a. *[The resident] who was living [near the dangerous warehouse] was complaining about the investigation.*

   b. *[The resident] who was living [near the dangerous neighbor] was complaining about the investigation.*

   c. *[The resident] who said that [the warehouse was dangerous] was complaining about the investigation.*

   d. *[The resident] who said that [the neighbor was dangerous] was complaining about the investigation.*

The semantic interference effect was elicited in early eye-tracking measures and the grammatical role of the attractor affected its strength: reading times were longer at the verb and comprehension accuracy was lower when the antecedent and the attractor were both subjects, as in (2c) and (2d), than in (2a) and (2b).

Another possibility, thus, is that reflexive-antecedent dependencies engage a cue-based retrieval mechanism where a combination of structural and non-structural information helps retrieving a licensor while syntactic cues are weighted more highly in the process (Cunnings and Sturt, 2014).

Results in Van Dyke (2007) and Van Dyke and McElree (2011) together with the findings in Dillon et al. (2013) suggest in fact that the lack of attraction effects for reflexive licensing in Dillon and colleagues's study could probably be due to a difference in cue weighting between subject-verb agreement and reflexive-antecedent dependencies. If so, object attractors might have not been 'strong enough' to interfere during reflexive licensing.

Parker et al. (2015) and Parker and Phillips (2017) provide compelling evidence for this hypothesis. They manipulated the degree of feature-match between the reflexive pronoun and the subject retrieval target in a series of eye-tracking experiments. Under a cue-based retrieval model conceiving sentence processing in terms of activation level and degree of association strength ('feature-match') of memory items with the retrieval cues of the dependency, the item with the highest activation level and association strength will most likely be retrieved during sentence comprehension. Consequently, Parker and colleagues predicted that reflexive licensing should be more prone to attraction when the reflexive pronoun and the subject retrieval target mismatched

in multiple features. Their hypothesis was confirmed: attraction effects only emerged when the reflexive pronoun and the retrieval target mismatched in two features (in gender and number in 3b) rather than in one feature (gender in 3a):

3. a. *[The talented actor / The talented actress] mentioned that [the attractive spokesman / spokeswoman] praised himself for a great job.*

   b. *[The talented actor / The talented actress] mentioned that [the attractive spokeswomen] praised himself for a great job.*

Hence, evidence suggests that a cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues subserves the computation of all linguistic dependencies.

In support of the use of morphological cues during reflexive licensing

Several studies show that reflexive-antecedent dependencies in English are not completely immune to attraction-based interference (for a review and meta-analysis on earlier published research, see Jäger et al., 2017). Attraction effects have been found in grammatical and ungrammatical sentences, but never simultaneously in both. In the few cases where there was attraction in grammatical sentences, the effect used to be inhibitory; i.e. processing was hindered in grammatical contexts with multiple cue-matching items, in line with the prediction associated with Lewis and Vasishth's cue-based retrieval model. Most of the results in the grammatical condition were statistically inconclusive though. As for the ungrammatical condition, null, inhibitory and facilitatory interference effects have all been reported.

These inhibitory and facilitatory interference effects in reflexive attraction studies challenge Dillon et al. (2013), which argues against the reliable nature of the former type of effect in grammatical sentences. According to Dillon and colleagues, inhibition does not provide a strong argument for the use of morphological constraints in reflexive-antecedent dependencies, because the effect might be due to encoding interference: a similarity-based interference effect which can blur, degrade and even overwrite some of the features of the retrieval target during the encoding or maintenance stage of items in working memory, reducing thus its distinctiveness among competitors prior to retrieval (Nairne, 1990; Gordon et al., 2001, 2002, 2004). As a result, a slowdown would ensue when re-accessing the features of the antecedent (see

Oberauer and Kliegl, 2006). Therefore, only a facilitatory interference effect in the ungrammatical interference condition could be taken as conclusive evidence for the use of morphological information during reflexive licensing in English, because, in that context, the attractor will be the only element matching the morphological retrieval cues of the dependency.

Jäger et al. (2015), however, questions this argument. They tested encoding and retrieval interference directly against each other in an experiment with Swedish possessive and reflexive pronouns. Crucially, whereas pronominal possessives agree in gender with their antecedent, Swedish reflexives are gender-unmarked. Jäger and colleagues found that a gender match between the retrieval target and the attractor did not cause encoding interference during on-line processing of Swedish reflexive pronouns. While recommending not to interpret their results as evidence against the role of encoding interference *per se* (authors' emphasis), Jäger and colleagues concluded that "invoking encoding interference may not be a plausible way to reconcile interference effects with a structure-based account of reflexive processing" (p. 1). In fact, Villata et al. (2018) report two self-paced reading tasks showing similarity-based interference at the encoding and retrieval stages during subject-verb agreement in Italian and English object relative clauses. Therefore, taking into account the data reported so far, in the present study, we will consider either a main effect of agreement attraction or a facilitatory interference effect in ungrammatical sentences as conclusive evidence for the use of morphological retrieval cues during clitic pronoun licensing in Spanish.

4.2.2 The present study

Parker et al. (2015) and Parker and Phillips (2017) provided direct evidence that the mixed pattern of results in reflexive attraction studies was probably due to systematic differences in attractor prominence across studies: reflexive licensing was more vulnerable to attraction-based interference when the reflexive pronoun and the subject retrieval target mismatched in multiple features. Further evidence (reviewed above) suggests that a cue-based retrieval mechanism underlies both subject-verb agreement and reflexive licensing and that their contrasting interference profile in English is due to a difference in cue weighting between dependencies.

Dependency predictability is another factor which can affect sentence processing. Dillon et al. (2013) argue that, in the absence of any strong top-down

expectations about the feature content of the reflexive pronoun, memory retrieval would be the only way of accessing the retrieval target and that, consequently, comprehenders might have adopted a more conservative strategy to access the antecedent during reflexive licensing compared to subject-verb agreement. Similarly, Parker and Phillips (2017) proposes that syntactic information is prioritized in dependencies which define their antecedent in structural terms, which is the case for both dependency types, but that structural information should be weighted more strongly when the dependency is unpredictable, because a prediction error – e.g. in subject-verb agreement – would 'neutralize' the syntactic priority.

The present set of experiments directly addresses this potential issue between subject-verb agreement and reflexive licensing by balancing top-down expectations during on-line sentence processing with the need for memory retrieval within a single linguistic dependency which exhibits pronominal and inflectional behavior alike.

In the subsequent experiments, we aim to investigate cue combinatorics during anaphor resolution in Spanish. We focus on clitic pronoun resolution in left-dislocated configurations where 3rd person, singular, direct-object clitics ('lo' / 'la') agree in number, gender and person features with a preceding object argument in the same clause ('A Juan' / 'A María'; see examples 4 and 5). Just like reflexives in English, clitic pronouns in left-dislocated configurations in Spanish must be bound – i.e. c-commanded and co-indexed (Chomsky, 1986) – by an antecedent within their local syntactic domain.

4. a. *[A Juan]$_i$ que saludó [a David]$_j$ en el pasillo lo$_i$ han invitado a una fiesta.*

   b. *[A María]$_i$ que saludó [a Carmen]$_j$ en el pasillo la$_i$ han invitado a una fiesta.*

Similarly to agreement relations, clitic pronouns in left-dislocated configurations can be syntactically predicted: indirect objects and animate direct objects in Spanish share the differential object case-marking preposition 'a'; however, they crucially differ from each other in their clitic forms. Therefore, understanding sentences like (6) and (7) – where comprehenders cannot anticipate whether the antecedent will be a direct or an indirect object – will require checking the input (bottom-up) features; yet it does not necessarily involve memory retrieval if the initial prediction about the form of the clitic pronoun is confirmed during sentence comprehension:

1. a. *[A Juan]$_i$ que saludó [a David]$_j$ en el pasillo lo$_i$ han invitado a una fiesta.*

b. *[A Juan]$_i$ que saludó [a David]$_j$ en el pasillo le$_i$ han regalado un juego de mesa*.

Crucially, our participants belong to a leísta variety of Peninsular Spanish where the direct-object clitic pronoun "lo" – and the feminine "la", to a lesser extent – are syncretic with the indirect-object clitic "le" whenever the referent is animate. Interestingly, the prevalence of this characteristic is not limited to speech (see Ormazabal and Romero, 2007). We thus assume that our participants will predict the form "le" invariably after reading the left-dislocated, a-marked constituent. Consequently, when being confronted with a sentence like (6), where the standard form "lo" is used, we will expect them to update and check the features of the clitic pronoun against the memory content. Furthermore, since we intend to compare number and gender interference processing, we need the standard forms of 3rd person, direct object clitic pronouns to do so, because only they provide gender information.

We adapted the materials from our subject-verb number agreement experiments in the previous chapter and ran two self-paced reading experiments where we manipulated the prominence level of the attractor (specifically, attractor's grammatical role) and examined to which extent it affects number interference during clitic pronoun resolution in Spanish. A third experiment investigated gender interference in contexts where the retrieval target and the attractor shared the same grammatical role.

General hypotheses and predictions

Given the theoretical background, predictions made by the models and previous evidence from agreement attraction studies in other languages, here we put forward the following hypotheses regarding clitic pronoun processing in left-dislocated configurations in Spanish:

Hypothesis 1 (H1): If morphological constraints do not play any role in this type of dependency, we will expect memory retrieval to be immune to our manipulation and, therefore, no attraction effects should be found (Dillon, 2011; Phillips et al., 2011).

Hypothesis 2 (H2): If morphological information were engaged in 'syntax first' and cue-weighting models (Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017), clitic processing in left-dislocated configurations in Spanish should be more susceptible to attraction-based interference when the

activation levels of the attractor and the target strongly compete against each other at retrieval site. In other words, in configurations where the attractor linearly follows the retrieval target, object attractors will be more disruptive than subject attractors – i.e. we will expect a larger number attraction effect in the former case –, because object attractors not only fulfill the agreement retrieval cues of the dependency in the interference condition, but also match in grammatical role with the retrieval target.

Hypothesis 3 (H3): If structural and morphological cues were equally weighted and involved during clitic pronoun processing (Lewis and Vasishth, 2005; Lewis et al., 2006), agreement attraction effects should be larger than in 'syntax first' and cue-weighting models (see H2), because the implementation of syntactic binding constraints would not reduce the size of the interference effect and, therefore, even attractors mismatching the retrieval target in grammatical role would be able to elicit attraction due to their number cue match with the clitic pronoun. Object and subject attractors would elicit similar effects.

In order to test these predictions, we manipulated the properties of the attractor so that it was (a) an object in an object-clitic relationship (high interference condition; Experiment 6) and (b) a subject in an object-clitic relationship (low interference condition; Experiment 7).

Furthermore, we aim to investigate the computation of different agreement features, such as number and gender, during clitic pronoun resolution. Consequently, we ran a third experiment where we manipulated (c) gender in object attractors in an object-clitic relationship (high interference condition; Experiment 8).

According to the Feature Hierarchy Hypothesis (Greenberg, 1963; Carminati, 2005), number attraction effects should arise earlier and be larger than gender attraction effects, because number is cognitively a more prominent feature than gender (and less than person.) Therefore, it predicts earlier and larger attraction effects in Experiment 6 than in Experiment 8 (H4). Nevertheless, if gender were cognitively as prominent as number – i.e. if both agreement features were equally weighted at retrieval site – Experiment 6 and Experiment 8 should display an identical interference profile (H5).

4.3 Experiment 6: Object-clitic agreement with an object attractor

In Experiment 6, the attractor was an embedded object in a subject-relative clause modifying the left-dislocated object of the main clause. Thus, the retrieval target occupied the highest structural position of the sentence, i.e. the most prominent in the discourse. According to the extended cue-based retrieval account (Engelmann et al., 2016), when the activation level of the attractor remains lower than the activation level of the retrieval target, results must comply with the predictions of the cue-based retrieval model by Lewis and Vasishth (2005).

Hence, the specific predictions regarding this particular experiment are as follows: if clitic pronoun processing involves the use of structural and non-structural information to retrieve the target (H2 and H3), we expect to find a main effect of attractor number at the post-critical region such that plural attractors in grammatical and ungrammatical sentences will induce shorter reading times at retrieval than singular attractors. Likewise, grammatical sentences should be read faster than ungrammatical ones (a main effect of grammaticality).

If cue-based retrieval mechanism weighted structural cues over non structural cues, syntactic cues could either act as a 'hard constraint' upon retrieval (H1), and limit antecedent search to the local binding domain (i.e. they could 'gate' access), or they could just guide the retrieval process (H2: Dillon, 2014; Dillon et al., 2014; see Cunnings and Sturt, 2014, and Parker and Phillips, 2017, for a discussion).

If they gated access to the target (H1), we should observe null effects, because the embedded object attractor mismatches the locality constraint of the dependency – which states that the retrieval target must be found in the same clause as the clitic pronoun (see *structured access model:* Dillon et al., 2013). Likewise, a structure-guided search mechanism qualitatively different from cue-based retrieval would also lead to an absence of interference effects for the same reason (Dillon, 2011; Phillips et al., 2011).

Nevertheless, if syntactic cues simply guided memory retrieval operations (H2), then, we should be able to find attraction effects. These effects should be smaller compared to a model where all retrieval cues are equally weighted

(H2 vs. H3), because if structural information were heavily weighted, retrieval errors and delays should occur less frequently when resolving the clitic pronoun.

4.3.1 Method

Participants

Thirty-six native speakers of Spanish (twenty-five women), aged 18-29 years, were recruited among the students of the University of the Basque Country (Vitoria-Gasteiz campus). Each participant provided written informed consent and was paid €€4 for the session, which lasted around 35 min.

Materials and Design

48 sentences of the form shown in **Table 4.1** were adapted from Experiment 5 (subject-verb agreement with an object attractor) and arranged in a 2 x 2 counterbalanced design with grammaticality (grammatical/ungrammatical) and attractor number (singular/plural) as factors. In this study, the direct object clitic (lo, 'him') was the retrieval site and agreed in the grammatical conditions with the left-dislocated, direct object of the matrix sentence (the retrieval target), which was animate, masculine and singular across conditions. A subject-gap relative clause with an animate, masculine object (the attractor), which could match or not in number with the target, intervened between the target and the clitic and modified the former. In order to control for spillover effects from the plural attractor into the critical region, an adverb was placed between the attractor and the clitic (see Wagers et al., 2009). The verb inside the relative clause was in third person, singular, present simple tense and perfective aspect (e.g.*salud-a*, 'greet.3sg'), agreeing with the retrieval target, whereas the main clause verb phrase was in third person, plural, present perfect tense and perfective aspect (e.g. *ha-n contrat-ado*, 'aux.3pl - hire.pprt.') and referred to the null subject of the matrix. Therefore, the materials had the following structure:

Target NP_{obj}– [$RC_{Complementizer}$ – pro_1 $verb_1$ – Attractor NP_{obj} – Adv] – CLITIC – Aux – Verb + 5 spillover words.

Grammaticality was manipulated by switching the number of the object clitic. The use of a verb in the present perfect tense allowed us to keep verb

morphology constant across conditions. We assume two points of retrieval: the first one, at the clitic, and the second, at the main verb in order to check that the correct object clitic was used (a direct rather than an indirect one).

TABLE 4.1: Sample of materials used in Experiment 6.

Grammatical - Interference (SG)	Al reportero que saluda a ese ministro diariamente **lo** han contratado esta mañana en la cadena.[a]
Grammatical - No interference (PL)	Al reportero que saluda a esos ministros diariamente **lo** han contratado esta mañana en la cadena.[b]
Ungrammatical - No interference (SG)	Al reportero que saluda a ese ministro diariamente ***los** han contratado esta mañana en la cadena.[c]
Ungrammatical - Interference (PL)	Al reportero que saluda a esos ministros diariamente ***los** han contratado esta mañana en la cadena.[d]

[a] The reporter who greets that minister daily **him** has been hired this morning by the channel.
[b] The reporter who greets those ministers daily **him** has been hired this morning by the channel.
[c] The reporter who greets that minister daily ***them** has been hired this morning by the channel.
[d] The reporter who greets those ministers daily ***them** has been hired this morning by the channel.

The 48 sentences were distributed across four lists in a Latin Square design and combined with 96 filler sentences of a similar length. This resulted in a filler-to-item ratio of 3:1, with 20% of the total items being ungrammatical. Every sentence was followed by a yes/no comprehension question; none of them targeted the referential dependency. Since clitic number was responsible for rendering the sentence grammatical or ungrammatical, we counterbalanced this effect by including grammatical instances of plural clitics as well as ungrammatical sentences with singular clitics in the fillers.

Procedure

Participants were tested individually in a quiet, lit-up booth and assigned one of the four lists of stimuli randomly. Items were presented on a 19-inch LCD screen connected to a PC running the Linger software (Rohde,

2001) in a self-paced word-by-word moving window reading paradigm (Just et al., 1982). The task consisted of 3 grammatical sentences for practice and 144 sentences randomly intermixed by the experimental software for each participant. Each item was followed by a yes/no comprehension question, which always appeared on the screen all at once. The 'z' key was used for "yes" and the "m" key was used for "no." Participants were instructed to read at a natural pace and answer the questions as quickly and accurately as possible. They were not informed about sentences containing grammatical errors, nor were they provided any feedback. Two optional breaks were included to prevent participants from fatigue.

4.3.2 Analysis

Experimental data were analyzed in the statistical programming environment R. Regions consisted of a single word and only the word-by-word reaction times from correctly answered target sentences were taken into account for analysis. Extreme values less than 100 ms and greater than 3000 ms were trimmed (.24%). The remaining data points were log-transformed, and those that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 2.46% of the data. Log reading times at each region were then analyzed using the lmer4 package in R (Bates et al., 2015) in a series of linear mixed-effects models with grammaticality, attractor number and their interaction as fixed effects and by-subject and by-item random intercepts. Other factors included in each model were spillover from the plural attractor and the logarithm transformed position of the trial in the experiment. There were four regions of interest in this experiment, ranging from R9 (the critical region) to R12. Fixed effects were centered in order to avoid collinearity. We used the maximal random effect structure justified by the data using all the models that converged and that did not contain correlations between the random effects equal to 1 or -1 (Baayen et al., 2008).

The data from twelve subjects were affected by a coding error in one item in the second and fourth lists, so those two items were removed from all lists for all participants, resulting in 46 experimental sentences per subject.

4.3.3 Results

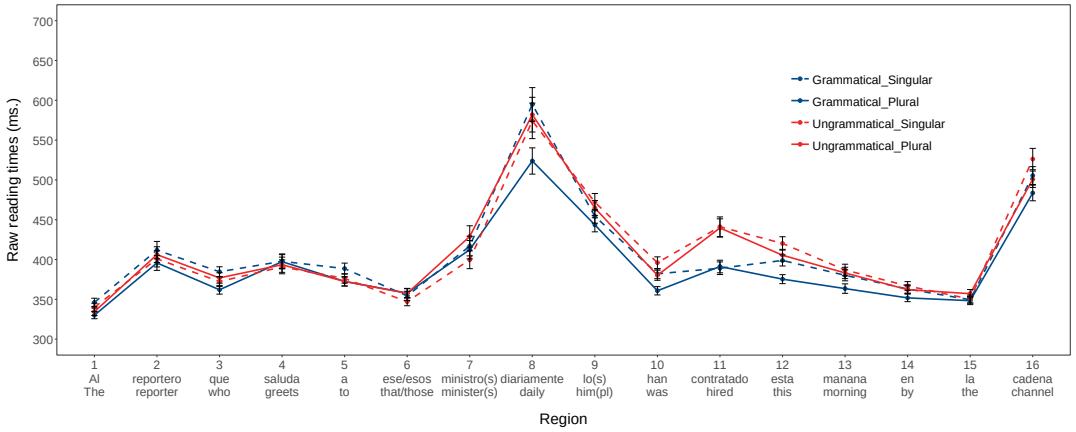

FIGURE 4.1: Region-by-region means in milliseconds in Experiment 6. Error bars indicate the standard error of the mean.

The results from this self-paced reading experiment are shown in **Figure 4.1** (see its large version in Appendix F.3). We plot raw reading times for easier readability, but the statistical analysis was performed on log-transformed reading times. Participants were at least 75% accurate in target sentences and, overall, 92.14% accurate on comprehension questions.

There was a main effect of grammaticality at R9, the critical word position: grammatical sentences elicited shorter reading times than ungrammatical ones (β = -.01; SE = .007; t = -2.03, p = .04). Main effects of grammaticality and attractor number were found at the following region (R10). Ungrammatical sentences had longer reading times than grammatical sentences (β = -.02; SE = .005; t = -3.64, p < .001). The plural attractor conditions were read faster than those with a singular noun (β = -.01; SE = .005; t = -3.27, p = .001). We carried out pairwise comparisons in order to fully account for the contribution of each attractor number condition to it and found out that the effect was mainly driven by grammatical sentences [grammatical plural vs. grammatical singular (361.82 ms. vs. 382.09 ms.; μ = -20.27 ms.): β = -.02; SE = .007; t = -3.02, p < .01; ungrammatical plural vs. ungrammatical singular (380.24 ms. vs. 396.05 ms.; μ = -15.81 ms.): β = -.01; SE = .008; t = -1.41, p = .15]. This attractor number effect disappears at R11 (β = .004; SE = .009; t = .45, p = .65; Grammaticality: β = -.04; SE = .009; t = -4.95, p < .001), the following region, only to reappear at R12, right after the verb phrase has been processed (β = -.01; SE = .005; t = -2.67, p < .01; Grammaticality: β = -.02; SE = .005; t = -4.63, p < .001). The effect was similar to that found at R10: plural attractor conditions were read significantly faster than singular attractor sentences (β

= -.01; SE = .005; t = -2.67, p < .01) and the effect was also mainly driven by the grammatical conditions [grammatical plural vs. grammatical singular (375.38 ms. vs. 398.86 ms.; μ = -23.48 ms.): β = -.02; SE = .008; t = -2.46, p = .01; ungrammatical plural vs. ungrammatical singular (407.09 ms. vs. 420.22 ms.; μ = -13.13 ms.): β = -.009; SE = .008; t = -1.12, p =.26].

Results are consistent with the similarity-based interference prediction associated with the cue-based retrieval model by Lewis and Vasishth (2005). According to this model, in grammatical conditions, attractors similar in feature content to the retrieval target can interfere with the retrieval process by competing for activation in a limited-capacity, working-memory framework prone to interference and decay, where the item with the highest activation level is the most likely to be retrieved. Since the retrieval target was singular in the experiment, similarity-based interference should cause longer reading times in the singular attractor grammatical condition than in its plural attractor grammatical counterpart. As shown in **Figure 4.1**, grammatical sentences with plural attractors were read significantly faster than those with singular attractors, supporting thus the prediction associated with the model (inhibitory interference effect.)

In addition to this, the mechanism of similarity-based interference can also erroneously retrieve the attractor and lead to faster reading times when none of the memory items constitutes a perfect match with the retrieval cues of the dependency, but the attractor matches the agreement cues (i.e. a facilitatory interference effect in ungrammatical sentences). Overall, in line with the predictions associated with the model, sentences with plural attractors were read faster than those with singular attractors. Nevertheless, a more detailed inspection showed that despite the fact that both grammatical and ungrammatical sentences headed in the same direction, the effect in ungrammatical sentences was not statistically significant (β = -.01; SE = .008; t = -1.41, p = .15).

Our results can be explained had the locality cue match effect been larger than the agreement cue match effect across conditions. To the extent the inhibitory effect in grammatical sentences truly reflects retrieval interference in sentence processing, our findings suggest that locality constraints did not limit antecedent search to the syntactic binding domain, but guided the retrieval process instead (H2). Hence, our results do not allow us to conclude that morphological retrieval cues are not involved during clitic pronoun resolution in left-dislocated configurations in Spanish.

Finally, consistent with other agreement attraction studies, we found a grammaticality effect, such that grammatical sentences were read faster than ungrammatical ones. As for the main effect of attractor number at R12, right after verb phrase processing, we think it supports our hypothesis that a second retrieval was probably triggered at the main verb in order to verify the correct use of a direct object clitic while integrating the whole syntactic unit (clitic + verbal phrase) into the on-line computation of the sentence.

4.4 Experiment 7: Object-clitic agreement with a subject attractor

In the present study, we aim to investigate cue combinatorics when the element triggering the linguistic dependency exhibits pronominal and inflectional behavior alike while being as reliably predictable as subject-verb agreement.

In Experiment 6, we found a main effect of attractor number at the immediate post-critical region, such that plural object attractor conditions were read faster – with the effect being mainly driven by grammatical sentences. Our results were compatible with a cue-based memory access mechanism with distinct patterns of sensitivity to different retrieval cues (Van Dyke and McElree, 2011; Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017). The inhibitory interference effect in grammatical sentences suggests that locality constraints guided the retrieval process rather than limiting antecedent search to the local binding domain and, therefore, it challenges any hypothesis suggesting that morphological retrieval cues are not deployed during anaphor processing (Dillon et al., 2013; Dillon, 2011; Phillips et al., 2011).

In the current experiment, the attractor was an embedded subject in an object-relative clause modifying the left-dislocated object of the main clause. This means that attractors in ungrammatical sentences additionally mismatched in grammatical role with the retrieval target compared to Experiment 6.

We predict that if a cue-based memory access mechanism with distinct patterns of sensitivity to different retrieval cues underlies clitic pronoun resolution in left-dislocated configurations in Spanish (H2), no number attraction effects will be found, because the prominence of the attractor is so low relative

to that of the retrieval target (in terms of degree of feature match) that the latter will directly be accessed in most trials (see Engelmann et al., 2016).

However, if all sets of retrieval cues were equally weighted at retrieval site (H3), a match in morphological features between the attractor and the clitic pronoun should elicit attraction-based interference. Crucially, in the ungrammatical condition, where neither the target nor the attractor constitutes a perfect match for the retrieval cues on the clitic pronoun, a facilitatory attraction effect in ungrammatical sentences would support this hypothesis.

Finally, a main effect of grammaticality – such that grammatical sentences will be read faster than ungrammatical ones – should confirm the working of the design.

4.4.1 Method

Participants

An additional set of thirty-seven native speakers of Spanish (twenty-eight women), aged 18-27, were recruited among the students of the University of the Basque Country (Vitoria-Gasteiz). Participants gave written informed consent and were paid /euro 4 for the session, which lasted around 35 min.

Materials and Design

The 48 sentences from Experiment 6 were transformed into object-gap relatives and arranged in a 2 x 2 counterbalanced design with grammaticality (grammatical/ungrammatical) and attractor number (singular/plural) as factors. The direct object clitic (lo, 'him') was the retrieval site and agreed in the grammatical conditions with the left-dislocated, direct object of the matrix sentence (the retrieval target), which was animate, masculine and singular across conditions. An object-gap relative clause with an animate, masculine subject (the attractor), which could match or not in number with the retrieval target, always intervened between the target and the clitic, modifying the former . A sample of the materials is presented in **Table 4.2**. In order to control for spillover effects from the plural attractor into the critical region, an adverb was placed between the attractor and the clitic (see Wagers et al., 2009). Since the verb inside an object relative clause must agree in number with the local subject noun –here, the attractor–, there was an additional number cue in the

plural attractor conditions (e.g. *salud-a*, 'greet.3sg' vs. *salud-an* 'greet.3pl'). The main clause verb phrase always was in third person, plural, present perfect tense and perfective aspect (e.g. *ha-n contrat-ado*, 'aux.3pl - hire.pprt.') and referred to the null subject of the matrix.

TABLE 4.2: Sample of materials used in Experiment 7.

Grammatical - Interference (SG)	Al reportero que saluda ese ministro diariamente **lo** han contratado esta mañana en la cadena.[a]
Grammatical - No interference (PL)	Al reportero que saludan esos ministros diariamente **lo** han contratado esta mañana en la cadena.[b]
Ungrammatical - No interference (SG)	Al reportero que saluda ese ministro diariamente ***los** han contratado esta mañana en la cadena.[c]
Ungrammatical - Interference (PL)	Al reportero que saludan esos ministros diariamente ***los** han contratado esta mañana en la cadena.[d]

[a] The reporter who that minister greets daily **him** has been hired this morning by the channel.

[b] The reporter who those ministers greet daily **him** has been hired this morning by the channel.

[c] The reporter who that minister greets daily ***them** has been hired this morning by the channel.

[d] The reporter who those ministers greet daily ***them** has been hired this morning by the channel.

Therefore, the materials had the following structure:

Target NP_{obj}– [$RC_{Complementizer}$ – pro_1 $verb_1$ – Attractor NP_{subj} – Adv] – CLITIC – Aux – Verb + 5 spillover words.

The 48 sentences were distributed across four lists in a Latin Square design and combined with 96 filler sentences of a similar length. This resulted in a filler-to-item ratio of 3:1, with 20% of the total items being ungrammatical. Every sentence was followed by a yes/no comprehension question; none of them targeted the referential dependency. Since the number of the direct object clitic was responsible for rendering the sentence grammatical or ungrammatical, we counterbalanced this effect by including grammatical instances of plural clitics as well as ungrammatical sentences with singular clitics in the fillers.

Procedure

Same as in Experiment 6.

4.4.2 Analysis

Same as in Experiment 6.

The data from one subject out of 36 had to be replaced because one participant scored below 75% accuracy in the target sentences. Only the word-by-word reaction times from correctly answered target sentences were taken into account for analysis and extreme values less than 100 ms and greater than 3000 ms were trimmed (.31%). The remaining data points were log-transformed and those that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 2.41% of data.

There were five regions of interest in this experiment, ranging from R8 (the critical region) to R12.

4.4.3 Results

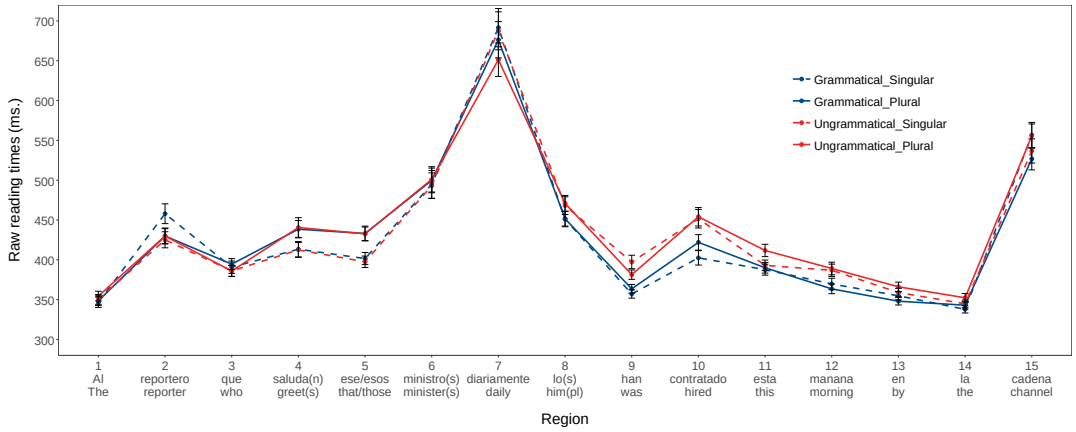

FIGURE 4.2: Region-by-region means in milliseconds in Experiment 7. Error bars indicate the standard error of the mean.

The results from this self-paced reading experiment are shown in **Figure 4.2** (see its large version in **Appendix F.4**). We plot raw reading times for

easier readability, but the statistical analysis was always performed on log-transformed reading times. Participants were at least 75% accurate in target sentences and, overall, 91.23% accurate on comprehension questions.

There was a main effect of grammaticality at R8, the critical word position, such as grammatical sentences elicited shorter reading times than ungrammatical ones (β = -.01; SE = .008; t = -2.12, p = .03). This effect remained significant at R9 (β = -.03; SE = .005; t = -5.42, p < .001), R10 (β = -.03; SE = .007; t = -4.42, p < .001) and R11 (β = -.01; SE = .006; t = -2.01, p = .04). No main effect of attractor number or interaction was observed at the regions of interest: R8 (β = .003; SE = .008; t = .41, p < 1), R9 (β = .005; SE = .005; t = .89, p < 1), R10 (β = .01; SE = .009; t = 1.33, p = .19), R11 (β = .01; SE = .008; t = 1.63, p = .11; β = -.01; SE = .006; t = -1.67, p = .09 for the interaction)

No number attraction effects were found in Experiment 7. A main effect of grammaticality at the critical (R8) and post-critical regions, though, showed that grammatical sentences were read faster than ungrammatical ones, which is consistent with previous experiments in agreement attraction. We interpret this effect as evidence that morphological constraints were used as retrieval cues in sentence comprehension.

Bearing in mind the results from Experiment 6, our results suggest that clitic pronoun processing in left-dislocated configurations in Spanish involves a cue-based retrieval mechanism where structural cues are weighted higher than morphological cues (H2). Since our clitic pronouns required a local object antecedent to be licensed, we argue that the memory access mechanism ignored subject attractors in most trials because their grammatical role did not fulfill the requirement of the dependency for an object licensor in the same clause, leading thus to null attraction effects across conditions. The absence of any effect in grammatical sentences further suggests that the inhibitory interference effect we observed in Experiment 6 was a genuine retrieval interference effect and not an effect due to encoding interference (Jäger et al., 2015; cf. Dillon et al., 2013).

4.5 Experiment 8: Object-clitic gender agreement with object attractor

Evidence from Experiment 6 and Experiment 7 suggests that clitic pronoun resolution in left-dislocated configurations in Spanish engages a cue-based retrieval mechanism where structural cues are preferentially weighted over morphological constraints. Whereas object attractors in an object-clitic relationship elicited a main effect of attractor number consistent with the predictions of the activation-based model of sentence processing (Lewis and Vasishth, 2005; Lewis et al., 2006; see also Engelmann et al., 2016), subject attractors led to null interference effects in the same context. We argued that, had all sets of cues been equally weighted at retrieval, attractors in ungrammatical sentences should have elicited a facilitatory interference effect as in subject-verb agreement attraction experiments. However, it seems that the parser relied more strongly on structural information during the retrieval process (see Cunnings and Sturt, 2014; Patil et al., 2016; Parker and Phillips, 2017, for a discussion on reflexive-antecedent dependencies in English along this same line of reasoning.)

In the current experiment, we aim to investigate the computation of gender agreement during clitic pronoun resolution in Spanish in order to test the Feature Hierarchy Hypothesis (H4; see Greenberg, 1963; Carminati, 2005), which posits that number is cognitively a more prominent feature than gender. We adapted the materials from Experiment 6, where we found a main effect of attractor number at the immediate post-critical region, and ran a self-paced reading task where the object attractor was manipulated only for gender (masculine/feminine). If H4 is correct, then number attraction effects will arise earlier and be larger than gender attraction effects. The Feature Hierarchy Hypothesis thus predicts earlier and larger attraction effects in Experiment 6 than in Experiment 8. However, if gender were cognitively as prominent as number – i.e. if both agreement features were equally weighted at retrieval site –, we should find that Experiment 6 and Experiment 8 display an identical interference profile (H5).

4.5.1 Method

Participants

A new set of thirty-six native speakers of Spanish (twenty-seven women), aged 18-27 (Mean = 20.79), were recruited among the students of the University of the Basque Country (Vitoria-Gasteiz campus). Participants gave written informed consent and were paid €4 for the session, which lasted around 35 min.

Materials and Design

TABLE 4.3: Sample of materials used in Experiment 8.

Grammatical - Interference (Match)	Al reportero que saluda a ese ministro diariamente **lo** han contratado esta mañana en la cadena.[a]
Grammatical - No interference (Mismatch)	Al reportero que saluda a esa ministra diariamente **lo** han contratado esta mañana en la cadena.[b]
Ungrammatical - No interference (Match)	Al reportero que saluda a ese ministro diariamente ***la** han contratado esta mañana en la cadena.[c]
Ungrammatical - Interference (Mismatch)	Al reportero que saluda a esa ministra diariamente ***la** han contratado esta mañana en la cadena.[d]

[a] The $reporter_{masc}$ who greets that $minister_{masc}$ daily **him** has been hired this morning by the channel.
[b] The $reporter_{masc}$ who greets that $minister_{fem}$ daily **him** has been hired this morning by the channel.
[c] The $reporter_{masc}$ who greets that $minister_{masc}$ daily ***her** has been hired this morning by the channel.
[d] The $reporter_{masc}$ who greets that $minister_{fem}$ daily ***her** has been hired this morning by the channel.

48 sentences of the form shown in **Table 4.3** were adapted from Experiment 6 and arranged in a 2 x 2 counterbalanced design with grammaticality (grammatical/ungrammatical) and gender attractor (masculine/feminine) as factors. The direct object clitic ("lo", 'him') was the retrieval site and agreed in the grammatical conditions with the left-dislocated, direct object of the matrix sentence (the retrieval target), which was masculine, singular and animate

across conditions. A subject-gap relative clause with a singular, animate object (the attractor), which could match or not in gender with the retrieval target, always intervened between them and modified the latter. In order to parallel Experiment 6, an adverb was placed between the attractor and the retrieval target (see Wagers et al., 2009).

The reason for this in number attraction experiments was the argument that plural is the marked form and could incur an additional processing cost in grammatical sentences. The adverbial region would mitigate plural spillover effects from the plural attractor into the critical region. In the case of gender, however, no experimental evidence for a default has been found in Spanish (Anton-Mendez, 1999; Igoa et al., 1999; Dominguez et al., 1999; Anton-Mendez et al., 2002; Fuchs et al., 2015).

The verb inside the relative clause was always in third person, singular, present simple tense and perfective aspect (e.g. *salud-a*, 'greet.3sg'), agreeing with the controller, whereas the main clause verb phrase was in third person, plural, present perfect tense and perfective aspect (e.g. *ha-n contrat-ado*, 'aux.3pl - hire.pprt.') and referred to the null subject of the matrix. Therefore, the materials had the following structure:

Target NP_{obj}– [$RC_{Complementizer}$ – pro_1 $verb_1$ – Attractor NP_{obj} – Adv] – CLITIC – Aux – Verb + 5 spillover words.

Similarly to Experiment 6, the 48 sentences were distributed across four lists in a Latin Square design and combined with 96 filler sentences of a similar length. This resulted in a filler-to-item ratio of 3:1, with 20% of the total items being ungrammatical. Every sentence was followed by a yes/no comprehension question. None of them targeted the referential dependency. Since the gender of the object clitic was responsible for rendering the sentence grammatical or ungrammatical, we counterbalanced this effect by including grammatical instances of feminine clitics as well as ungrammatical sentences with masculine clitics in the fillers.

Procedure

Same as in Experiment 6 and Experiment 7.

4.5.2 Analysis

Same as in experiments 4 - 7. Regions consisted of a single word and only the word-by-word reaction times from correctly answered target sentences were taken into account for analysis. Extreme values less than 100 ms and greater than 3000 ms were trimmed (.3%). The remaining data points were log-transformed, and those that exceeded a threshold of 2.5 standard deviations from the mean by region and condition were excluded from further analysis (Ratcliff, 1993). This process affected 2.24% of the data. There were four regions of interest in this experiment, ranging from R9 (the critical region) to R12.

4.5.3 Results

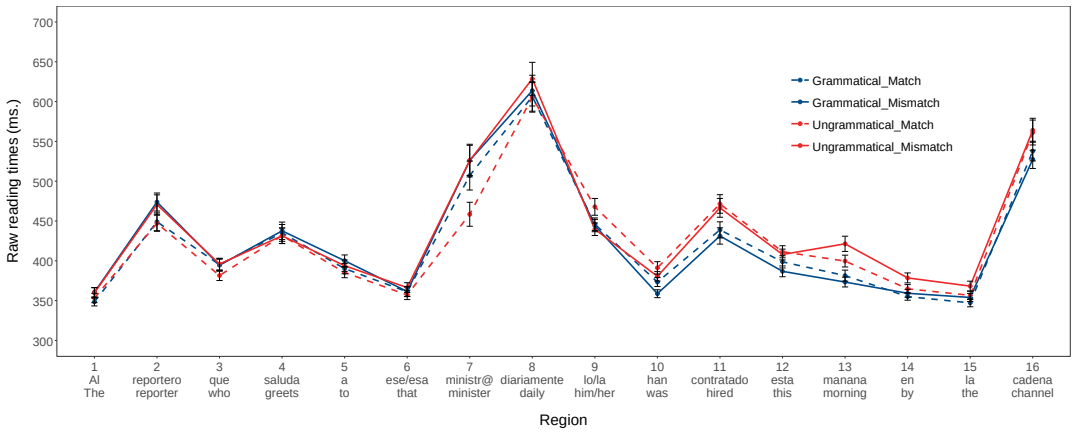

FIGURE 4.3: Region-by-region means in milliseconds in Experiment 8. Error bars indicate the standard error of the mean.

The results from this self-paced reading experiment are shown in **Figure 4.3** (see its large version in **Appendix F.5**). We plot raw reading times for easier readability, but the statistical analysis was always performed on log-transformed reading times. Participants were at least 75% accurate in target sentences and, overall, 92.39% accurate on comprehension questions.

No main effect of grammaticality or gender was elicited at R9, the critical region (β = -.001; SE = .007; t = -.19, p = .42 for grammaticality; β = .009; SE = .007; t = 1.31, p = .19 for gender). Main effects of grammaticality and attractor gender were found at the following region (R10). Grammatical sentences elicited shorter reading times than ungrammatical ones (β = -.01; SE = .005; t = -3.31, p < .001) and the feminine attractor conditions were read

faster than those with a masculine noun (β = .01; SE = .005; t = 2.2, p = .02). Pairwise comparisons for attractor gender conditions revealed that this effect was mainly driven by grammatical sentences [grammatical (target-attractor) mismatch vs. grammatical match (358.69 ms. vs. 373.36 ms.; μ = -14.67 ms.): β = .01; SE = .007; t = 2.15, p = .03; ungrammatical (target-attractor) mismatch vs. ungrammatical match (380.56 ms. vs. 391.23 ms.; μ = -10.67 ms.): β = .006; SE = .008; t = .77, p = .44]. Only a main effect of grammaticality remained at R11 (β = -.03; SE = .007; t = -4.11, p < .001 for grammaticality; β = .01; SE = .007; t = 1.47, p = .14 for gender), R12 (β = -.01; SE = .006; t = -2.88, p < .01 for grammaticality; β = .005; SE = .007; t = .65, p = .51 for gender).

The interference profile for gender was similar to the pattern of results we obtained in Experiment 6 for number, but differed from it in terms of effect size and time course of memory access. Participants processed grammatical sentences faster, presumably with a greater ease, than ungrammatical sentences (*grammaticality effect*). However, whereas number agreement errors in attraction experiments were immediately detected at retrieval site, the emergence of the grammaticality effect was delayed one region when the agreement error was in gender. As for the main effect of attractor gender, sentences with masculine retrieval targets and attractors were overall read slower than those with a feminine attractor. A between-experiment analysis revealed the main effect of grammaticality (β = -.02; SE = .004; t = -5, p < .001) and type of cue (β = .01; SE = .004; t = 3.49, p < .001) at the immediate post-critical region (R10). All other things being equal, gender processing in Experiment 8 elicited longer reading times than number processing in Experiment 6. This difference suggests that the memory retrieval mechanism accessed number information faster (earlier) than gender because, according to the Feature Hierarchy Hypothesis (Greenberg, 1963; Carminati, 2005), number is cognitively a more prominent feature than gender. We interpret these results as evidence that a cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues underlies all linguistic dependencies.

4.6 Discussion

In the present study, we used agreement attraction-based interference in order to investigate cue combinatorics during clitic pronoun resolution in left-dislocated configurations in Spanish, a linguistic dependency where a 3rd

person, direct-object clitics must be bound and agree in number, gender and person features with a preceding object argument in the same clause.

We put forward three hypotheses: (i) if syntactic binding constraints had been enough to solve the dependency, then we would have expected no agreement attraction effects (Dillon, 2011; Phillips et al., 2011); (ii) if structural cues had been preferentially weighted over non-structural cues at retrieval (Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017), object attractors should have caused a greater disruption than subject attractors and, therefore, a larger number attraction effect in the former case, because object attractors additionally match in grammatical role with the retrieval target; (iii) if all sets of retrieval cues had been equally weighted and involved during clitic pronoun processing (Lewis and Vasishth, 2005; Lewis et al., 2006), attraction effects should have been even larger, because the implementation of syntactic binding constraints would not have affected the size of the effect and, therefore, even subject attractors would have been able to elicit attraction due to their number cue match with the clitic pronoun.

We found that, similarly to subject-verb agreement attraction experiments (4 and 5) in Chapter 3, attractor prominence modulates interference effects during clitic pronoun resolution in Spanish: whereas object attractors in an object-clitic relationship elicited main attraction effects (Experiment 6, Experiment 8), subject attractors led to null number interference effects in the same context (Experiment 7) – consistent with the predictions of the extended cue-based retrieval model (Engelmann et al., 2016). Additionally, these main effects of attractor number and gender at the immediate post-critical region were mainly driven by grammatical sentences, suggesting that the memory access mechanism used a combination of structural and non-structural cues to retrieve the antecedent while relying more highly on syntactic binding constraints (Van Dyke and McElree, 2011); for a discussion with reflexive-antecedent dependencies in English, see (Cunnings and Sturt, 2014; Patil et al., 2016; Parker and Phillips, 2017). Had all sets of cues been equally weighted at retrieval site, attractors in ungrammatical sentences should have elicited a facilitatory interference effect as the one being consistently reported in subject-verb agreement attraction studies.

As for the issue of dependency predictability, Parker and Phillips (2017) posit (i) that the sentence processing mechanism prioritizes syntactic retrieval cues in dependencies which define their antecedent in structural terms and (ii)

that this kind of information will be weighted more strongly when the dependency is unpredictable (e.g. during reflexive licensing in English) compared to subject-verb agreement, where a prediction error would 'neutralize' any syntactic priority. Our results, though, suggest that the parser relied more heavily on syntactic information despite the fact that the left-dislocated clitic pronouns were as reliably predictable as predicates in subject-verb agreement dependencies.

Finally, in Experiment 8, we investigated gender agreement processing in order to test the Feature Hierarchy Hypothesis (Greenberg, 1963; Carminati, 2005), which postulates that number is cognitively a more prominent feature than gender and, therefore, more readily accessible during the retrieval process.

We found that the interference profile for gender was similar to the pattern of results obtained in Experiment 6 for number; however, both differed in terms of effect size and time course of memory access: whereas number agreement errors in attraction experiments were immediately detected at retrieval site, the emergence of the grammaticality effect was delayed one region when the agreement error was in gender. Furthermore, a between-experiment analysis revealed that gender agreement processing in Experiment 8 elicited longer reading times than number processing in Experiment 6, suggesting thus that the sentence processing mechanism accessed number information faster than gender, presumably, because of number being cognitively a more prominent feature than gender according to the Feature Hierarchy Hypothesis (Greenberg, 1963; Carminati, 2005).

Therefore, taking all evidence into account, we conclude that a cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues subserves the computation of all linguistic dependencies in a general-cognitive, general-purpose, content-addressable memory system (Van Dyke and McElree, 2011; Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017).

4.7 Summary

Chapter 4 demonstrates that clitic pronoun resolution in left-dislocated configurations in Spanish, a linguistic dependency where the clitic pronoun must be bound by an antecedent in the same clause, is susceptible to agreement

attraction effects from a structurally illicit but cue-matching object. Evidence is compared with results from reflexive attraction studies in English and, taken together, provides support for a content-addressable, cue based retrieval architecture where subject-verb agreement and left clitic pronoun processing in Spanish engage the same memory access mechanism and sets of retrieval cues, but differ from each other in cue weighting. Taken together with the results in Chapter 3, our findings add to the increasing amount of evidence supporting that linguistic dependencies are uniformly resolved through a content-addressable, cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues (Van Dyke and McElree, 2011; Dillon et al., 2013; Cunnings and Sturt, 2014; Parker and Phillips, 2017).

5 Conclusion

In this thesis, we investigated the nature of the representations and working memory mechanisms involved in the processing of syntactic dependencies in Spanish. In the first part of this dissertation (Chapter 2), we targeted the content of the antecedent representations readers retrieve from memory during pronoun resolution in Spanish after Meyer and Bock (1999) suggested that speakers of different languages might be accessing qualitatively different antecedent representations depending on the kind of information needed to establish coreference in their language(s). We presented two self-paced reading tasks and an eye-tracking experiment showing that pronoun processing in Spanish differs from lexical access to nouns even when these nouns are reaccessed. We interpreted our data as evidence for anaphoric lexical access (Simner and Smyth, 1999, 1998): pronoun resolution in Spanish only involves lemma retrieval – i.e. retrieval of the syntactic and semantic properties of the antecedent –, whereas lexical access to nouns and repeated nouns additionally targets orthographic-phonological information (see also Jescheniak and Levelt, 1994; Levelt, 1999). This finding aligns with results in English (Simner and Smyth, 1999; Lago, 2014; cf. Van Gompel and Majid, 2004) and contradicts studies carried out in German (Heine et al., 2006a,b). The second part of this dissertation (Chapters 3 and 4) aimed at examining the nature of the linguistic cues and processing mechanisms involved during subject-verb number agreement and left-dislocated clitic pronoun resolution in non-adjacent dependencies in Spanish. In Chapter 3, we used attraction-based interference in order to investigate the effect of attractor prominence on number processing during subject-verb agreement in Spanish. We showed that the grammatical role of the attractor modulates number interference effects in grammatical sentences during subject-verb agreement. This finding supports Engelmann et al.'s addition of the principle of prominence to Lewis and Vasishth's model of sentence processing and contradicts the hypothesis that cue-based retrieval is only triggered as a last-resort mechanism to repair a number-marking error at the verb (Wagers et al., 2009; Dillon et al., 2013; Tanner et al., 2014; cf. Nicenboim et al., 2018). The extended model (Engelmann et al., 2016) can

explain our data as well as previous results in the literature inconsistent with the prediction of inhibitory interference associated with Lewis and Vasishth's model (see Jäger et al., 2017). Taken together, we interpret the experimental evidence in favor of a cue-based retrieval mechanism underlying subject-verb number agreement processing in Spanish regardless of sentence grammaticality (cf. Lago et al., 2015). In Chapter 4, we investigated retrieval interference in a different syntactic dependency, namely object-clitic pronoun resolution in Spanish; where clitic pronouns exhibit pronominal and inflectional behavior alike: they can be syntactically predicted in certain contexts and, similarly to reflexive pronouns in English, they must be bound by a previous constituent in the same clause. The goal was to examine how different sets of cues are involved and combined during antecedent search after Dillon (2011) and Phillips et al. (2011) suggested that different linguistic dependencies could deploy qualitatively different retrieval mechanisms (see Dillon et al., 2013). Research on the on-line implementation of syntactic binding constraints has focused on pronoun processing and reflexive licensing in English. In the present dissertation, however, we tested a linguistic dependency where we argued that top-down expectations during on-line sentence comprehension do not remove the need for memory retrieval in our study. We showed that object-clitic pronoun resolution in Spanish is susceptible to attraction-based interference and that the effects in grammatical sentences were also modulated by the grammatical role of the attractor; consistent with Engelmann et al.'s retrieval-based model. In addition to this, we compared gender and number processing between experiments and found that number information was accessed faster than gender, presumably, because of number being cognitively a more prominent feature according to the Feature Hierarchy Hypothesis (Greenberg, 1963; Carminati, 2005). We interpret our results as evidence for a content-addressable, cue-based retrieval mechanism which primarily weights syntactic information over non-structural cues and number over gender information when it comes to agreement features.

Taken together, the empirical evidence presented in the second part of this dissertation adds to the increasing amount of evidence from subject-verb agreement and other kinds of linguistic expressions supporting the idea that a general-cognitive, content-addressable, cue-based retrieval mechanism with distinct patterns of sensitivity to different retrieval cues subserves the computation of all linguistic dependencies.

A Item sets of Experiments 1 and 2

The experiments consisted of 40 item sets distributed in 4 conditions. In Experiment 1, the antecedent and the repeated NP/pronoun were in subject position. In Experiment 2, the antecedent was in object position and the repeated NP/pronoun in an adjunct PP. Conditions were as follows:

Condition a:	high frequency antecedent	repeated NP
Condition b:	low frequency antecedent	repeated NP
Condition c:	high frequency antecedent	pronoun
Condition d:	low frequency antecedent	pronoun

An example of a full set:

a. [Un ministro] criticó a la reina durante el discurso de ayer. [El ministro] censuró la monarquía.

b. [Un senador] criticó a la reina durante el discurso de ayer. [El senador] censuró la monarquía.

c. [Un ministro] criticó a la reina durante el discurso de ayer. [Él] censuró la monarquía.

d. [Un senador] criticó a la reina durante el discurso de ayer. [Él] censuró la monarquía.

"A minister/senator critized the queen during yesterday's speech. The minister/senator/He condemned the monarchy."

Materials of Experiment 1

High frequency antecedent conditions:

1. [Un chico] robó a la profesora muy cerca de la universidad. [El chico/Él] era muy astuto.

"A boy robbed the teacher (somewhere) very close to university. The boy/He was very cunning."

2. [Un hombre] empujó a la camarera en la cafetería del hotel. [El hombre/Él] pidió disculpas rápidamente.
"A man pushed the waitress at the hotel café. The man/He quickly apologized."

3. [Un ministro] criticó a la reina durante el discurso de ayer. [El ministro/Él] censuró la monarquía.
"A minister criticized the queen during the yesterday's speech. The minister/He condemned the monarchy."

4. [Un director] besó a la chica con mucha pasión e intensidad. [El director/Él] estaba realmente emocionado.
"A director kissed the girl with much passion and intensity. The director/He was really thrilled."

5. [Un ciudadano] votó a la alcaldesa unas horas antes del almuerzo. [El ciudadano/Él] apoyó el programa electoral.
"A citizen voted for the mayoress few hours before lunch. The citizen/He supported the election manifesto."

6. [Un obispo] atacó a la princesa después del sermón de Pascua. [El obispo/Él] ignoró las consecuencias.
"A bishop attacked the princess after Easter sermon. The bishop/He ignored the consequences."

7. [Un médico] corrigió a la enfermera antes del turno de noche. [El médico/Él] era muy meticuloso.
"A doctor corrected the nurse before the night shift. The doctor/He was very meticulous."

8. [Un científico] vio a la directora con un humor de perros. [El científico/Él] evitó cualquier confrontación.
"A scientist saw the director in a foul mood. The scientist/He avoided any confrontation."

9. [Un conde] despidió a la asistenta en un momento de locura. [El conde/Él] desoyó la recomendación de su mujer.
"A Count fired the cleaning lady in a moment of madness. The Count/He disregarded his wife's advice."

10. [Un político] abrazó a la madrina con mucho tacto y amabilidad. [El político/Él] cautivó a los invitados.
"A politician hugged the godmother very tactfully and kindly. The politician/He captivated the guests."

11. [Un profesor] felicitó a la alumna por el resultado del examen. [El profesor/Él] apreciaba el esfuerzo.
"A teacher congratulated the pupil for the exam result. The teacher/He appreciated the effort."

12. [Un crítico] alabó a la bailarina por la actuación en televisión. [El crítico/Él] disfrutó del espectáculo.
"A critic praised the dancer for the television performance. The critic/He enjoyed the show."

13. [Un enfermo] mordió a la señora con una rabia nunca vista. [El enfermo/Él] escapó de Psiquiatría.
"A patient bit the lady with a rage never seen before. The patient/He ran away from Psychiatry."

14. [Un camarero] llamó a la cocinera por un error del pedido. [El camarero/Él] estaba enfadado.
"A bartender called the cook for an error in the order. The bartender/He was angry."

15. [Un piloto] tranquilizó a la azafata unos minutos antes del aterrizaje. [El piloto/Él] aterrizó sin problemas.
"A pilot calmed the flight attendant down some minutes before the landing. The pilot/He landed without problems."

16. [Un ingeniero] convocó a la secretaria por el interfono del despacho. [El ingeniero/Él] pidió un informe.
"An engineer called the secretary by the office intercome. The engineer/He asked a report."

17. [Un soldado] protegió a la niña durante el bombardeo de anoche. [El soldado/Él] recibió una medalla.
"A soldier protected the girl during last nights bombing. The soldier/He received a medal."

18. [Un inspector] evaluó a la maestra a lo largo del día. [El inspector/Él] mandó un expediente al ministerio.

"An inspector evaluated the teacher along the day. The inspector/He sent an expedient to the ministry."

19. [Un abogado] molestó a la mujer durante la sesión del parlamento. [El abogado/Él] era muy persuasivo.
"A lawyer bothered the lady during the parliamentary session. The lawyer/He was very persuasive."

20. [Un escritor] ofendió a la prostituta con un gesto muy obsceno. [El escritor/Él] actuó por convicción.
"A writer offended the prostitute with a very obscene gesture. The writer/He acted on conviction."

21. [Un alcalde] recibió a la señora en la entrada del ayuntamiento. [El alcalde/Él] escuchó las críticas.
"A mayor welcomed the lady at the city hall entrance. The mayor/He listened to the critiques."

22. [Un jefe] insultó a la secretaria por un documento mal rellenado. [El jefe/Él] despertó muy malhumorado.
"A boss insulted the secretary for a badly filled-in document. The boss/He woke up very cranky."

23. [Un vecino] acompañó a la anciana hasta la tienda de abajo. [El vecino/Él] fue muy amable.
"A neighbor walked with the elder woman to the down shop. The neighbor was very kind."

24.[Un presidente] amenazó a la directora después del robo de ayer. [El presidente/Él] obró en consecuencia.
"A chairman threatened the director before the yesterday's robbery. The chairman/He acted in consequence."

25. [Un gobernador] sobornó a la redactora con una cena de lujo. [El gobernador/Él] controlaba el periódico local.
"A governor bribed the editor with a fancy dinner. The governor/He controlled the local newspaper."

26. [Un corredor] detuvo a la maestra durante el recorrido del tren. [El corredor/Él] preguntó por la parada de destino.
"A runner stopped the teacher during the train journey. The runner/He asked about the destination stop."

27. [Un entrenador] saludó a la mujer poco antes del evento deportivo. [El entrenador/Él] recordó viejos tiempos.
"A coach greeted the woman shortly before the sport event. The coach/He remembered the (good) old times."

28. [Un jugador] plantó a la novia durante las vacaciones de verano. [El jugador/Él] disfrutó de su soltería.
"A player dumped the bride on summer vacation. The player/He enjoyed his bachelorhood."

29. [Un compañero] homenajeó a la amiga con un poema muy emotivo. [El compa nero/Él] admiraba a su colega.
"A classmate honored the friend with a very touching poem. The classmate/He admired his colleague."

30. [Un muchacho] increpó a la actriz durante la gala de anoche. [El muchacho/Él] odiaba la soberbia de algunos famosos.
"A guy rebuked the actress during last night's gala. The guy/He hated the arrogance of some celebrities."

31. [Un anciano] humilló a la empleada delante de todo el vecindario. [El anciano/Él] tenía problemas mentales.
"An elder man humilliated the employee in front of the entire neighborhood. The elder man/He had mental problems."

32. [Un conductor] salvó a la pasajera del famoso naufragio del Concordia. [El conductor/Él] murió poco después.
"A driver saved the passenger of the famous Concordia shipwreck. The driver/He died some time after."

33. [Un espectador] abucheó a la actriz durante la entrevista en público. [El espectador/Él] mostró su indignación.
"A spectator booed the actress during the public interview. The spectator/He showed his outrage."

34. [Un sacerdote] admitió a la monja en la orden religiosa católica. [El sacerdote/Él] estaba satisfecho de su decisión.
"A priest accepted the nun in the catholic religious order. The priest/He was satisfied with his decision."

35. [Un príncipe] agredió a la princesa durante la gala de anoche. [El príncipe /Él] justificó su actitud ante el juez.

"A prince hit the princess during the night gala. The prince/He justified his atittude in front of the judge."

36. [Un empleado] reconoció a la chica en la foto del taller. [El empleado/Él] llamó a la policía.
"An employee recognized the girl on the workshop pic. The employee//He called the police."

37. [Un candidato] bautizó a la hija en la ermita del pueblo. [El candidato/Él] gastó todos sus ahorros.
"A candidate baptized the daugther in the village chapel. The candidate/He spent all his savings."

38. [Un técnico] buscó a la jefa toda la mañana sin éxito. [El técnico/Él] volvió al trabajo.
"A technician searched for the boss all the morning unsuccessfully. The technician/He went back to work."

39. [Un empresario] despidió a la asistenta de la reunión de trabajo. [El empresario/Él] clausuró el acto.
"An employer sent the assistant out of the meeting. The employer/He closed the act."

40. [Un actor] mató a la amante con un cuchillo bien afilado. [El actor/Él] admitió su culpa en el juicio.
"An actor killed the lover with a really sharp knife. The actor acknowledged his guilt at trial."

Low frequency antecedent conditions:

1. [Un manco] robó a la profesora muy cerca de la universidad. [El manco/Él] era muy astuto.
"A one-armed man robbed the teacher (somewhere) very close to university. The one-armed man/He was very cunning."

2. [Un bedel] empujó a la camarera en la cafetería del hotel. [El bedel/Él] pidió disculpas rápidamente.
"A porter pushed the waitress at the hotel café. The porter/He quickly apologized. "

3. [Un senador] criticó a la reina durante el discurso de ayer. [El senador/Él] censuró la monarquía.

"A senator criticized the queen during the yesterday's speech. The senator/He condemned the monarchy."

4. [Un auditor] besó a la chica con mucha pasión e intensidad. [El auditor/Él] estaba realmente emocionado.
"An auditor kissed the girl with much passion and intensity. The auditor/He was really thrilled."

5. [Un boticario] votó a la alcaldesa unas horas antes del almuerzo. [El boticario/Él] apoyó el programa electoral.
"A druggist voted for the mayoress few hours before lunch. The druggist/He supported the election manifesto."

6. [Un colono] atacó a la princesa después del sermón de Pascua. [El colono /Él] ignoró las consecuencias.
"A settler attacked the princess after Easter sermon. The settler/He ignored the consequences."

7. [Un galeno] corrigió a la enfermera antes del turno de noche. [El galeno/Él] era muy meticuloso.
"A physician corrected the nurse before the night shift. The physician/He was very meticulous."

8. [Un operario] vio a la directora con un humor de perros. [El operario/Él] evitó cualquier confrontación.
"A worker saw the director in a foul mood. The worker/He avoided any confrontation."

9. [Un barón] despidió a la asistenta en un momento de locura. [El barón/Él] desoyó la recomendación de su mujer.
"A baron fired the cleaning lady in a moment of madness. The baron/He disregarded his wife's advice."

10. [Un presentador] abrazó a la madrina con mucho tacto y amabilidad. [El presentador/Él] cautivó a los invitados.
"An anchorman hugged the godmother very tactfully and kindly. The anchorman/He captivated the guests."

11. [Un decano] felicitó a la alumna por el resultado del examen. [El decano/Él] apreciaba el esfuerzo.
"A dean congratulated the pupil for the exam result. The dean/He appreciated the effort."

12. [Un modisto] alabó a la bailarina por la actuación en televisión. [El modisto/ Él] disfrutó del espectáculo.
"A designer praised the dancer for the television performance. The designer /He enjoyed the show."

13. [Un sirviente] mordió a la señora con una rabia nunca vista. [El sirviente /Él] escapó de Psiquiatría.
"A servant bit the lady with a rage never seen before. The servant/He ran away from Psychiatry."

14. [Un panadero] llamó a la cocinera por un error del pedido. [El panadero /Él] estaba enfadado.
"A baker bit the lady with a rage never seen before. The baker/He ran away from Psychiatry."

15. [Un instructor] tranquilizó a la azafata unos minutos antes del aterrizaje. [El instructor/Él] aterrizó sin problemas.
"A instructor calmed the flight attendant down some minutes before the landing. The instructor/He landed without problems."

16. [Un programador] convocó a la secretaria por el interfono del despacho. [El programador/Él] pidió un informe.
"A coder called the secretary by the office intercome. The coder/He asked a report."

17. [Un bombero] protegió a la niña durante el bombardeo de anoche. [El bombero/Él] recibió una medalla.
"A firefighter protected the girl during last night's bombing. The firefighter/ He got a medal."

18. [Un regidor] evaluó a la maestra a lo largo del día. [El regidor/Él] mandó un expediente al ministerio.
"A manager evaluated the teacher along the day. The manager/He sent an expedient to the ministry."

19. [Un subastador] molestó a la mujer durante la sesión del parlamento. [El subastador/Él] era muy persuasivo.
"An auctioneer bothered the lady during the parliamentary session. The auctioneer/He was very persuasive."

20. [Un librero] ofendió a la prostituta con un gesto muy obsceno. [El librero/Él] actuó por convicción.

"A bookseller offended the prostitute with a very obscene gesture. The bookseller/He acted on conviction."

21. [Un mercader] recibió a la señora en la entrada del ayuntamiento. [El mercader/Él] escuchó las críticas.
"A merchant welcomed the lady at the city hall entrance. The merchant/He listened to the critiques."

22. [Un reo] insultó a la secretaria por un documento mal rellenado. [El reo/Él] despertó muy malhumorado.
"A defendant insulted the secretary for a badly filled-in document. The defendant/He woke up very cranky."

23. [Un peatón] acompañó a la anciana hasta la tienda de abajo. [El peatón/Él] fue muy amable.
"A pedestrian walked with the elder woman to the down shop. The pedestrian was very kind."

24. [Un secuestrador] amenazó a la directora después del robo de ayer. [El secuestrador/Él] obró en consecuencia.
"A kidnapper threatened the director before the yesterday's robbery. The kidnapper/He acted in consequence."

25. [Un estafador] sobornó a la redactora con una cena de lujo. [El estafador/Él] controlaba el periódico local.
"A fraudster bribed the editor with a fancy dinner. The fraudster/He controlled the local newspaper."

26. [Un revisor] detuvo a la maestra durante el recorrido del tren. [El revisor/Él] preguntó por la parada de destino.
"A ticket conductor stopped the teacher during the train journey. The ticket conductor/He asked about the destination stop."

27. [Un escalador] saludó a la mujer poco antes del evento deportivo. [El escalador/Él] recordó viejos tiempos.
"A climber greeted the woman shortly before the sport event. The climber/He remembered the (good) old times."

28. [Un moroso] plantó a la novia durante las vacaciones de verano. [El moroso/Él] disfrutó de su soltería.
"A debtor dumped the bride on summer vacation. The debtor/He enjoyed his bachelorhood."

29. [Un compositor] homenajeó a la amiga con un poema muy emotivo. [El compositor/Él] admiraba a su colega.
"A composer honored the friend with a very touching poem. The composer/He admired his colleague."

30. [Un seguidor] increpó a la actriz durante la gala de anoche. [El seguidor/Él] odiaba la soberbia de algunos famosos.
"A follower rebuked the actress during last night's gala. The follower/He hated the arrogance of some celebrities."

31. [Un bandido] humilló a la empleada delante de todo el vecindario. [El bandido/Él] tenía problemas mentales.
"A crook humilliated the employee in front of the entire neighborhood. The crook/He had mental problems."

32. [Un nadador] salvó a la pasajera del famoso naufragio del Concordia. [El nadador/Él] murió poco después.
"A swimmer saved the passenger of the famous Concordia shipwreck. The swimmer/He died some time after."

33. [Un tertuliano] abucheó a la actriz durante la entrevista en público. [El tertuliano/Él] mostró su indignación.
"A tak show guest booed the actress during the public interview. The tak show guest/He showed his outrage."

34. [Un ermitaño] admitió a la monja en la orden religiosa católica. [El ermitaño/Él] estaba satisfecho de su decisión.
"A hermit accepted the nun in the catholic religious order. The hermit/He was satisfied with his decision."

35. [Un granjero] agredió a la princesa durante la gala de anoche. [El granjero/Él] justificó su actitud ante el juez.
"A farmer hit the princess during the night gala. The farmer/He justified his atittude in front of the judge."

36. [Un tapicero] reconoció a la chica en la foto del taller. [El tapicero/Él] llamó a la policía.
"An upholsterer recognized the girl on the workshop pic. The upholsterer/He called the police."

37. [Un leñador] bautizó a la hija en la ermita del pueblo. [El leñador/Él] gastó todos sus ahorros.

"A lamberjack baptized the daugther in the village chapel. The lamberjack/He spent all his savings."

38. [Un minero] buscó a la jefa toda la mañana sin éxito. [El minero/Él] volvió al trabajo.
"A miner searched for the boss all the morning unsuccessfully. The miner/He went back to work."

39. [Un decorador] despidió a la asistenta de la reunión de trabajo. [El decorador/Él] clausuró el acto.
"An (interior) decorator sent the assistant out of the meeting. The decorator/He closed the act."

40. [Un mimo] mató a la amante con un cuchillo bien afilado. [El mimo/Él] admitió su culpa en el juicio.
"A mime killed the lover with a really sharp knife. The mime acknowledged his guilt at trial."

Materials of Experiment 2

High frequency antecedent conditions:

1. La profesora protegió [a un chico] en un callejón del barrio. Enseguida preguntó [por el chico/por él] en la cafetería.
"The teacher protected a boy in a neighborhood alley. Right away, (she) asked about the boy/him at the café."

2. La camarera empujó [a un hombre] en la cafetería del hotel. Luego cenó [con el hombre/con él] en una pizzería.
"The waitress pushed a man at the hotel caf/'e. Then, (she) had dinner with the man/him in a pizzeria."

3. La reina criticó [a un ministro] durante el discurso de ayer. Posteriormente arremetió [contra el ministro/contra él] en el parlamento.
"The queen criticized a minister during yesterday's speech. Later, (she) attacked the minister/him in the parliament."

4. La chica besó [a un director] con mucha pasión e intensidad. Ayer habló [sobre el director/sobre él] en los medios.

“The girl kissed a director in a very passionate and intense way. Yesterday, (she) talked about the director/him on the media."

5. La alcaldesa admitió [a un ciudadano] en el pleno del municipio. Hoy debatió [con el ciudadano/con él] sobre los presupuestos.
“The mayoress admitted a citizen in the city council of the local government. Today, (she) discussed with the citizen/him about the budget."

6. La princesa tranquilizó [a un obispo] antes del sermón de Pascua. Después paseó [con el obispo/con él] por el jardín.
“The princess reassured a bishop before the Easter sermon. Afterwards, (she) walked with the bishop/him in the garden."

7. La enfermera corrigió [a un médico] antes del turno de noche. Después confió [en el médico/en él] para la cirugía.
“The nurse corrected a doctor before the night shift. Afterwards, (she) trusted the doctor/him for the surgery."

8.La directora evaluó [a un científico] durante las clases de mecánica . Ayer redactó [con el científico/con él] un buen informe.
“The principal evaluated a scientist during mechanics class. Yesterday, (she) wrote a good report along with the scientist/him."

9. La asistenta mordió [a un conde] en un momento de locura. Luego arrojó [contra el conde/contra él] el viejo candelabro.
“The cleaning woman bit a Count in a moment of madness. Then, (she) threw the old chandelier to the Count/him."

10. La madrina abrazó [a un político] de manera amable y cordial. Ayer posó [para el político/para él] durante la conferencia.
“The godmother hugged a politician so welcoming and friendly. Yesterday, (she) posed for the politician/him at the conference."

11. La alumna felicitó [a un profesor] por la exposición de arte. Luego criticó [ante el profesor/ante él] el arte contemporáneo.
“The pupil congratulated a teacher for the art exhibition. Then, (she) criticized contemporary art in front of the teacher/him."

12. La bailarina alabó [a un crítico] por la valoración del espectáculo. Después adquirió [para el crítico/para él] unas flores rojas.
“The dancer praised a critic for the assessment of the dance show. Afterwards, (she) bought some red flowers for the critic/him."

13. La señora pegó [a un enfermo] con una rabia nunca vista. Enseguida extendió [sobre el enfermo/sobre él] una crema sedante.
"The woman hit a patient with a rage never seen before. (She) spread a narcotic cream on the patient/him immediately."

14. La cocinera llamó [a un camarero] por un error del pedido. Luego asumió [ante el camarero/ante él] parte de culpa.
"The cook called a bartender for an error in the order. Then, (she) assumed part of the blame to the bartender/him."

15. La azafata detuvo [a un piloto] unos minutos antes del despegue. Después presentó [ante el piloto/ante él] los motivos reales.
"The flight attendant stopped a pilot some minutes before the take-off. Afterwards, (she) told the pilot/him the real causes."

16. La presidenta convocó [a un ingeniero] por el interfono del despacho. Ayer discutió [con el ingeniero/con él] la política sindical.
"The president called an engineer by the office intercom. Yesterday, (she) discussed with the engineer/him the Union policy."

17. La niña vio [a un soldado] durante el bombardeo de anoche. Hoy corrió [hasta el soldado/hasta él] muerta de miedo.
"The girl saw a soldier during last night's bombing. Today, (she) ran to the soldier/him scared to death."

18. La maestra engañó [a un inspector] a lo largo del día. Enseguida interpuso [contra el inspector/contra él] una demanda oficial.
"The teacher fooled an inspector along the day. (She) demanded the inspector/him immediately."

19. La mujer molestó [a un abogado] durante la sesión de tarde. Hoy firmó [para el abogado/para él] los papeles necesarios.
"The woman bothered a lawyer during the afternoon session. Today, (she) signed the necessary papers for the lawyer/him."

20. La prostituta ofendió [a un escritor] con un gesto muy obsceno. Posteriormente respondió [ante el escritor/ante él] por la ofensa.
"The prostitute offended a writer with a very obscene gesture. Afterwards, she faced the writer/him for the insult."

21. La señora atacó [a un alcalde] en la entrada del pueblo. Luego difundió [sobre el alcalde/sobre él] varios rumores falsos.

"The woman attacked a mayor at the town entrance. Then, (she) spread several false rumors against the mayor/him."

22. La secretaria insultó [a un jefe] por un documento mal rellenado. Pronto escribió [sobre el jefe/sobre él] en un blog.
"The secretary insulted a boss for a badly filled-in document. (She) wrote about the boss/him in a blog soon."

23. La anciana acompañó [a un vecino] hasta la tienda de regalos. Siempre contó [con el vecino/con él] desde ese día.
"The elder lady went with a neighbor to the gift shop. (She) always counted with the neighbour//him since that day."

24. La directora denunció [a un presidente] por el robo de ayer. Luego lanzó [contra el presidente/contra él] una acusación legal.
"The principal denounced a chairman for yesterday's theft. Then, (she) launched a legal prosecution against the chairman/him."

25. La redactora sobornó [a un gobernador] con una cena de lujo. Después dirigió [hacia el gobernador/hacia él] una mirada cómplice.
"The editor bribed a governor with a fancy dinner. Afterwards, (she) casted a knowing look to the governor/him."

26. La mujer reanimó [a un corredor] durante el trayecto en tren. Enseguida preparó [para el corredor/para él] un té caliente.
"The woman revived a runner during the train ride. (She) immediately prepared some hot tea for the runner/him."

27. La maestra elogió [a un entrenador] unas horas antes del evento. Ayer compró [para el entrenador/para él] una medalla dorada.
"The teacher praised a coach few hours before the event. Yesterday, (she) bought a golden medal for the coach/him."

28. La novia plantó [a un jugador] durante las vacaciones de verano. Hoy escribió [para el jugador/para él] una carta sincera.
"The bride stood a player up on summer vacation. Today, (she) wrote a sincere letter for the player/him."

29. La amiga homenajeó [a un compañero] con un poema muy emotivo. Hoy ofreció [por el compañero/por él] un recital clásico.
"The friend paid tribute to a classmate with a very touching poem. Today, (she) offered a classical recital for the classmate/him."

30. La actriz defendió [a un muchacho] durante la gala de anoche. Posteriormente coincidió [con el muchacho/con él] en una fiesta.
"The actress stood up for a boy during last night's gala. Later on, (she) coincided with the boy/him at a party."

31. La empleada humilló [a un anciano] delante de todo el vecindario. Hoy anduvo [sin el anciano/sin él] por el parque.
"The employee humilliated an elder man in front of the whole neighborhood. Today, (she) went to the park without the elder man/him."

32. La delegada inscribió [a un conductor] en las pruebas de hoy. Después vertió [contra el conductor/contra él] acusaciones de dopaje.
"The delegate registered a driver in today's tests. Afterwards, (she) threw doping allegations against the driver/him."

33. La actriz increpó [a un espectador] durante la entrevista en público. Pronto apareció [con el espectador/con él] en un restaurante.
"The actress rebuked a member of the audience during the public interview. (She) soon showed up with the member of the audience/him at a restaurant."

34. La monja ayudó [a un sacerdote] en el camino al monasterio. Enseguida preguntó [por el sacerdote/por él] en el pueblo.
"The nun assisted a priest on the way to the monastery. (She) immediately asked about the priest/him in the village."

35. La infanta saludó [a un príncipe] durante la recepción de ayer. Posteriormente prometió [ante el príncipe/ante él] una ayuda social.
"The Infanta greeted a prince at yesterday's reception. Later on, (she) promissed social assistance in front of the prince/him."

36. La chica reconoció [a un empleado] en la foto del periódico. Enseguida contactó [con el empleado/con él] en el bar.
"The girl recognized an employee on the newspaper picture. (She) soon contacted with the employee/him in the bar."

37. La ministra salvó [a un candidato] de la caída del tronco. Posteriormente celebró [con el candidato/con él] el feliz desenlace.
"The minister rescued a candidate from the fall of the tree-trunk. Later on, (she) celebrated with the candidate/him the happy ending."

38. La jefa buscó [a un técnico] toda la mañana sin éxito. Ayer compró [para el técnico/para él] un localizador nuevo.

"The boss looked for a technician all morning without success. Yesterday, (she) bought a new pager for the technician/him."

39. La asistenta amenazó [a un empresario] en la reunión de trabajo. Posteriormente testificó [contra el empresario/contra él] en el juicio.
"The assistant threatened an employer at the meeting. Later on, (she) testified against the employer/him in court."

40. La amante mató [a un actor] con un cuchillo bien afilado. Siempre mantuvo [con el actor/con él] una relación tormentosa.
"The lover killed an actor with a really sharp knife. (She) always had a stormy relationship with the actor/him."

Low frequency antecedent conditions:

1. La profesora protegió [a un manco] en un callejón del barrio. Enseguida preguntó [por el manco/por él] en la cafetería.
"The teacher protected a one-armed man in a neighborhood alley. Then, (she) asked about the one-armed man/him at the café."

2. La camarera empujó [a un bedel] en la cafetería del hotel. Luego cenó [con el bedel/con él] en una pizzería.
"The waitress pushed a porter at the hotel café. Then, (she) had dinner with the porter/him in a pizzeria."

3. La reina criticó [a un senador] durante el discurso de ayer. Posteriormente arremetió [contra el senador/contra él] en el parlamento.
"The queen criticized a senator during the yesterday's speech. Later, (she) attacked the senator/him at the parliament."

4. La chica besó [a un auditor] con mucha pasión e intensidad. Ayer habló [sobre el auditor/sobre él] en los medios.
"The girl kissed an auditor in a very passionate and intense way. Yesterday, (she) talked about the auditor/him on the media."

5. La alcaldesa admitió [a un boticario] en el pleno del municipio. Hoy debatió [con el boticario/con él] sobre los presupuestos.
"The mayoress admitted a druggist in the city council of the local government. Today, (she) discussed with the druggist/him about the budgets."

6. La princesa tranquilizó [a un colono] antes del sermón de Pascua. Después paseó [con el colono/con él] por el jardín.

"The princess reassured a settler before the Easter sermon. Afterwards, (she) walked with the settler/him in the garden."

7. La enfermera corrigió [a un galeno] antes del turno de noche. Después confió [en el galeno/en él] para la cirugía.
"The nurse corrected a physician before the night shift. Afterwards, (she) trusted the physician/him for the surgery."

8.La directora evaluó [a un operario] durante las clases de mecánica . Ayer redactó [con el operario/con él] un buen informe.
"The principal evaluated a worker during mechanics class. Yesterday, (she) wrote a good report along with the worker/him."

9. La asistenta mordió [a un barón] en un momento de locura. Luego arrojó [contra el barón/contra él] el viejo candelabro.
"The cleaning woman bit a baron in a moment of madness. Then, (she) threw the old chandelier to the baron/him ."

10. La madrina abrazó [a un presentador] de manera amable y cordial. Ayer posó [para el presentador/para él] durante la conferencia.
"The godmother hugged an anchorman so welcoming and friendly. Yesterday, (she) posed for the anchorman/him at the conference."

11. La alumna felicitó [a un decano] por la exposición de arte. Luego criticó [ante el decano/ante él] el arte contemporáneo.
"The pupil congratulated a dean for the art exhibition. Then, (she) criticized contemporary art in front of the dean/him."

12. La bailarina alabó [a un modisto] por la valoración del espectáculo. Después adquirió [para el modisto/para él] unas flores rojas.
"The dancer praised a fashion designer for the assessment of the dance show. Afterwards, (she) bought some red flowers for the fashion designer/him."

13. La señora pegó [a un sirviente] con una rabia nunca vista. Enseguida extendió [sobre el sirviente/sobre él] una crema sedante.
"The woman attacked a servant with a rage never seen before. (She) spread a narcotic cream on the servant/him immediately."

14. La cocinera llamó [a un panadero] por un error del pedido. Luego asumió [ante el panadero/ante él] parte de culpa.
"The cook called a baker for an error in the order. Then, (she) assumed part of the blame to the baker/him."

15. La azafata detuvo [a un instructor] unos minutos antes del despegue. Después presentó [ante el instructor/ante él] los motivos reales.
"The flight attendant stopped an instructor some minutes before the take-off. Afterwards, (she) told the instructor/him the real causes."

16. La presidenta convocó [a un programador] por el interfono del despacho. Ayer discutió [con el programador/con él] la política sindical.
"The president called a coder by the office intercom. Yesterday, (she) discussed with the code/him the Union policy."

17. La niña vio [a un bombero] durante el bombardeo de anoche. Hoy corrió [hasta el bombero/hasta él] muerta de miedo.
"The girl saw a firefighter during last night's bombing. Today, (she) ran to the firefighter/him scared to death."

18. La maestra engañó [a un regidor] a lo largo del día. Enseguida interpuso [contra el regidor/contra él] una demanda oficial.
"The teacher fooled a manager along the day. (She) demanded the manager/him immediately."

19. La mujer molestó [a un subastador] durante la sesión de tarde. Hoy firmó [para el subastador/para él] los papeles necesarios.
"The woman bothered an auctioneer during the afternoon session. Today, (she) signed the necessary papers for the auctioneer/him."

20. La prostituta ofendió [a un librero] con un gesto muy obsceno. Posteriormente respondió [ante el librero/ante él] por la ofensa.
"The prostitute offended a bookseller with a very obscene gesture. Afterwards, she replied at the bookseller/him for the insult."

21. La señora atacó [a un mercader] en la entrada del pueblo. Luego difundió [sobre el mercader/sobre él] varios rumores falsos.
"The woman attacked a merchant at the town entrance. Then, (she) spread several false rumors against the merchant/him."

22. La secretaria insultó [a un reo] por un documento mal rellenado. Pronto escribió [sobre el reo/sobre él] en un blog.
"The secretary insulted a defendant for a badly filled document. (She) wrote about the defendant/him in a blog soon."

23. La anciana acompañó [a un peatón] hasta la tienda de regalos. Siempre contó [con el peatón/con él] desde ese día.

"The elder lady went with a pedestrian to the gift shop. (She) always counted with the pedestrian/him since that day."

24. La directora denunció [a un secuestrador] por el robo de ayer. Luego lanzó [contra el secuestrador/contra él] una acusación legal.
"The principal denounced a kidnapper for yesterday's theft. Then, (she) launched a legal prosecution against kidnapper/him."

25. La redactora sobornó [a un estafador] con una cena de lujo. Después dirigió [hacia el estafador/hacia él] una mirada cómplice.
"The editor bribed a fraudster with a fancy dinner. Afterwards, (she) casted a knowing look to the fraudster/him."

26. La mujer reanimó [a un revisor] durante el trayecto en tren. Enseguida preparó [para el revisor/para él] un té caliente.
"The woman brought a ticket conductor round during the train ride. (She) immediately prepared some hot tea for the ticket conductor/him."

27. La maestra elogió [a un escalador] unas horas antes del evento. Ayer compró [para el escalador/para él] una medalla dorada.
"The teacher praised a climber few hours before the event. Yesterday, (she) bought a golden medal for the climber/him."

28. La novia plantó [a un moroso] durante las vacaciones de verano. Hoy escribió [para el moroso/para él] una carta sincera.
"The bride stood a debtor up during summer vacation. Today, (she) wrote a sincere letter for the debtor/him."

29. La amiga homenajeó [a un compositor] con un poema muy emotivo. Hoy ofreció [por el compositor/porél] un recital clásico.
"The friend paid tribute to a composer with a very touching poem. Today, (she) offered a classical recital for the composer/him."

30. La actriz defendió [a un seguidor] durante la gala de anoche. Posteriormente coincidió [con el seguidor/con él] en una fiesta.
"The actress stood up for a fan during last night's gala. Later on, (she) coincided with the fan/him at a party."

31. La empleada humilló [a un bandido] delante de todo el vecindario. Hoy anduvo [sin el bandido/sin él] por el parque.
"The employee humilliated a crook in front of the whole neighborhood. Today, (she) went to the park without the crook/him."

32. La delegada inscribió [a un nadador] en las pruebas de hoy. Después vertió [contra el nadador/contra él] acusaciones de dopaje.
"The delegate registered a swimmer in today's tests. Afterwards, (she) threw doping allegations against the swimmer/him."

33. La actriz increpó [a un tertuliano] durante la entrevista en público. Pronto apareció [con el tertuliano/con él] en un restaurante.
"The actress rebuked a talk show guest during the public interview. (She) soon showed up with the talk show guest/him at a restaurant."

34. La monja ayudó [a un ermitaño] en el camino al monasterio. Enseguida preguntó [por el ermitaño/por él] en el pueblo.
"The nun assited a hermit on the way to the monastery. (She) immediately asked about the hermit/him in the village."

35. La infanta saludó [a un granjero] durante la recepción de ayer. Posteriormente prometió [ante el granjero/ante él] una ayuda social.
"The Infanta greeted a farmer at yesterday's reception. Later on, (she) promissed social assistance to the farmer/him."

36. La chica reconoció [a un tapicero] en la foto del periódico. Enseguida contactó [con el tapicero/con él] en el bar.
"The girl recognized an upholsterer on the newspaper picture. (She) soon contacted with the upholsterer/him in the bar."

37. La ministra salvó [a un leñador] de la caída del tronco. Posteriormente celebró [con el leñador/con él] el feliz desenlace.
"The minister rescued a lamberjack from the fall of the tree-trunk. Later on, (she) celebrated with the lamberjack/him the happy ending."

38. La jefa buscó [a un minero] toda la mañana sin éxito. Ayer compró [para el minero/para él] un localizador nuevo.
"The boss looked for a miner all morning without success. Yesterday, (she) bought a new pager for the miner/him."

39. La asistenta amenazó [a un decorador] en la reunión de trabajo. Posteriormente testificó [contra el decorador/contra él] en el juicio.
"The assistant threatened an (interior) decorator at the meeting. Later on, (she) testified against the decorator/him in court."

40. La amante mató [a un mimo] con un cuchillo bien afilado. Siempre mantuvo [con el mimo/con él] una relación tormentosa.

“The lover killed a mime with a really sharp knife. (She) always had a stormy relationship with the mime/him."

B Item sets of Experiment 3

The experiments consisted of 40 item sets distributed in 4 conditions. The antecedent was in object position whereas the NP/pronoun was in an adjunct PP. Conditions were the same as in Experiments 1 & 2. Two factors were crossed: frequency of the antecedent (high/low) and anaphor type (repeated NP/pronoun).

Materials of Experiments 3

High frequency antecedent conditions:

1. La vendedora protegió [a un chico y a una chica] en un callejón del barrio. Ayer preguntó [por el chico/por él] en la cafetería de la esquina.
“The seller protected a boy and a girl in a neighborhood alley. Yesterday, (she) asked about the boy/him at the corner café."

2. La camarera empujó [a un hombre y a una mujer] en la cafetería del hotel. Luego cenó [con el hombre/con él] en una pizzería de la plaza.
“The waitress pushed a man and a woman at the hotel caf/’e. Later, (she) had dinner with the man/him in a pizzeria on the plaza."

3. La senadora criticó [a un ministro y a una parlamentaria] durante el discurso de ayer. Posteriormente arremetió [contra el ministro/contra él] en los medios nacionales y europeos.
“The senator criticized a minister and a member of parliament during yesterday’s speech. Later, (she) attacked the minister/him on the national and European media."

4. La redactora besó [a un director y a una artista] con mucho afecto y cariño. Enseguida habló [sobre el director/sobre él] en las revistas de cine independiente.

"The editor kissed a director and an artist very lovingly. Right away, (she) talked about the director/him on the independent movie making magazines."

5. La alcaldesa admitió [a un ciudadano y a una niña] en el pleno del municipio. Hoy conversó [con el ciudadano/con él] sobre las obras en la carretera.
"The mayoress admitted a citizen and a girl in the city council of the local government. Today, (she) discussed with the citizen/him about the construction works on the road."

6. La abadesa ignoró [a un obispo y a una hermana] antes del sermón de Pascua. Después debatió [con el obispo/con él] cerca del claustro de las Clarisas.
"The abbess ignored a bishop and a nun before the Easter sermon. Afterwards, (she) discussed with the bishop/him near the Clarisas' cloister."

7. La comadrona corrigió [a un médico y a una responsable] antes del turno de noche. Después confió [en el médico/en él] para la cirugía de cesárea planificada.
"The midwife corrected a doctor and a manager before the night shift. Afterwards, (she) trusted the doctor/him for the planned c-section surgery."

8.La bióloga evaluó [a un científico y a una científica] durante las prácticas no remuneradas. Posteriormente redactó [con el científico/con él] un informe detallado sobre los experimentos.
"The biologist evaluated a (male) scientist and a (female) scientist during the unpaid internships. Right away, (she) wrote a detailed report with the (male) scientist/him about the experiments."

9. La limpiadora hirió [a un conde y a una princesa] en un momento de locura. Luego arrojó []contra el conde/contra él] el viejo candelabro de plata fina.
"The cleaning woman hurt a Count and a princess in a moment of madness. Later, (she) threw the old, fine silver chandelier to the Count/him."

10.La anfitriona abrazó [a un político y a una joven] de manera amable y cordial. Ayer posó [con el político/con él] durante la conferencia por la paz.
"The hostess hugged a politician and a youngster so welcoming and friendly. Yesterday, (she) posed for the politician/him at the peace conference"

11.La pintora felicitó [a un profesor y a una intelectual] por la exposición de arte. Luego criticó [ante el profesor/ante él] el arte vanguardista del siglo XX.
"The painter congratulated a teacher and an intellectual for the art exhibition. Later, (she) criticized 20th century avant-garde art in front of the teacher/him."

12.La diseñadora aplaudió [a un crítico y a una famosa] por el éxito del espectáculo. Después adquirió [para el crítico/para él] unas flores rojas del jardín botánico.
"The designer praised a critic and a celebrity for the success of the show. Afterwards, (she) bought some red flowers from the botanic garden for the critic/him."

13. La emperatriz alabó [a un niño y a una esposa] por una valentía nunca vista. Enseguida charló [sobre el niño/sobre él] con el mayordomo durante la cena.
"The empress praised a boy and a wife for a courage never seen before. Right away, (she) talked about the boy/him with the butler at dinner."

14. La pastelera llamó [a un empleado y a una señorita] por un error del pedido. Luego asumió [ante el empleado/ante él] parte de culpa en la elaboración.
"The baker called an employer and a lady for an error in the order. Later, (she) assumed part of the blame to the employer/him in the production."

15. La azafata alertó [a un piloto y a una famosa] de un retraso no previsto. Después presentó [ante el piloto/ante él] los verdaderos motivos de la anulación.
"The flight attendant warned a pilot and a celebrity about an unexpected delay. Afterwards, (she) told the pilot/him the real causes of the (flight) cancellation."

16. La arquitecta convocó [a un ingeniero y a una estudiante] por el interfono del despacho. Ayer discutió [con el ingeniero/con él] la política sindical del gremio autónomo.
"The architect called an engineer and a student by the office intercom. Yesterday, (she) discussed with the engineer/him the Union policy for the self-employed."

17. La enfermera vio [a un soldado y a una americana] durante el ataque de ayer. Enseguida corrió [hasta el soldado/hasta él] con el botiquín de primeros auxilios.
"The nurse saw a soldier and an American woman during last night's bombing. Right away, (she) ran to the soldier/him with the first-aid kit."

18. La psicóloga orientó [a un productor y a una agente] a lo largo del proyecto. Hoy interpuso [contra el productor/contra él] una demanda judicial por mala conducta.

"The psychologist oriented a producer and an agent along the project. Today, (she) demanded the producer/him due to bad conduct."

19. La mecanógrafa incordió [a un abogado y a una periodista] durante la sesión de tarde. Hoy reunió [para el abogado/para él] los papeles necesarios para esa semana.
"The typist bothered a lawyer and a journalist during the afternoon session. Today, (she) gathered the necessary papers for that week for the lawyer/him."

20. La prostituta ofendió [a un escritor y a una fiscal] con un gesto muy obsceno. Posteriormente respondió [ante el escritor/ante él] por la ofensa en los tribunales.
"The prostitute offended a writer and a district attorney with a very obscene gesture. Afterwards, she faced the writer/him for the insult at court."

21. La artesana atacó [a un alcalde y a una artista] en la entrada del ayuntamiento. Luego difundió '[sobre el alcalde/sobre él] varios rumores infundados sobre su labor.
"The craftswoman attacked a mayor and an artist at the townhall entrance. Then, (she) spread several, baseless, false rumors against the mayor/him on his task."

22. La funcionaria criticó [a un extranjero y a una científica] por un documento mal rellenado. Pronto informó [sobre el extranjero/sobre él] a la Administración por una subsanación.
"The civil servant criticized a foreigner and a (female) scientist for a badly filled-in document. Soon, (she) reported about the foreigner/him to the administraction for an amendment."

23. La portera acompañó [a un vecino y a una religiosa] hasta la tienda de regalos. Siempre contó [con el vecino/con él] desde ese día para cualquier tema.
"The porter woman walked with a neighbor and a nun to the gift shop. (She) always counted with the neighbour/him since that day for anything."

24. La joyera denunció [a un presidente y a una política] después del robo de ayer. Enseguida / Pronto elaboró [contra el presidente/contra él] una acusación legal por asociación criminal.
"The jeweler denounced a chairman and a politician after yesterday's robbery. Right away, (she) launched a legal prosecution against the chairman/him because of criminal organization."

25. La embajadora sobornó [a un gobernador y a una actriz] con una cena de lujo. Después dirigió [hacia el gobernador/hacia él] una mirada cómplice como seña secreta.
"The ambassador bribed a governor and an actress with a fancy dinner. Afterwards, (she) casted a knowing look to the governor/him as a secret sign."

26. La taquillera atendió [a un músico y a una dama] durante el trayecto en tren. Enseguida preparó [para el músico/para él] una té caliente con pastas dulces.
"The ticket clerk assisted a musician and a lady during the train ride. Right away, (she) immediately prepared some hot tea with sweet pastries for the musician/him."

27. La monitora elogió [a un entrenador y a una intelectual] unas horas antes del evento. Ayer compró [para el entrenador/para él] una medalla dorada al mérito deportivo.
"The teacher praised a coach and an intellectual few hours before the event. Yesterday, (she) bought a golden sport merit medal for the coach/him."

28. La arqueóloga plantó [a un historiador y a una universitaria] durante las jornadas de verano. Hoy escribió [para el historiador/para él] una carta pública de disculpa formal.
"The archeologist stood a historian and a college student up on summer work days. Today, (she) wrote a public, formal apology letter for the historian/him."

29. La poetisa homenajeó [a un compañero y a una amiga] con un soneto muy emotivo. Hoy ofreció [por el compañero/por él] un recital clásico por su trayectoria.
"The poetess paid tribute to a classmate and a girl friend with a very touching sonet. Today, (she) offered a classical recital to the career of the classmate/him."

30. La presentadora defendió [a un famoso y a una periodista] durante la gala de anoche. Posteriormente tropezó [con el famoso/con él] en una fiesta de la cadena.
"The anchorwoman stood up for a celebrity and a journalist during last night's gala. Later on, (she) coincided with the celebrity/him at the channel's party."

31. La traductora agredió [a un senador y a una administrativa] delante de todo el vecindario. Hoy apareció [con el senador/con él] en un programa de juicios televisivos.
"The translator hit a senator and an administrative officer in front of the whole

neighborhood. Today, (she) showed up with the senator/him on a TV court programme."

32. La delegada inscribió [a un conductor y a una ciclista] en la competición entre naciones. Después formuló [contra el conductor/contra él] una denuncia formal por dopaje reiterado.
"The delegate registered a driver and a cyclists in the international competition. Afterwards, (she) formulated formal allegations for reiterated doping against the driver/him."

33. La reportera increpó [a un caballero y a una señorita] durante la entrevista en público. Pronto apareció [con el caballero/con él] en un restaurante de la ciudad.
"The reporter rebuked a gentleman and a lady during the public interview. (She) soon showed up with the gentleman/him at a city's restaurant."

34. La novicia ayudó [a un sacerdote y a una cristiana] en el camino al monasterio. Luego preguntó [por el sacerdote/por él] en la capital de la región.
"The novice assisted a priest and a christian on the way to the monastery. Later, (she) asked about the priest/him in the region's capital town. "

35. La baronesa saludó [a un secretario y a una presidenta] durante la recepción de ayer. Posteriormente prometió [ante el secretario/ante él] grandes ayudas económicas a los artistas.
"The baroness greeted a secretary and a (female) president at yesterday's reception. Later on, (she) promissed large money grants to artists in front of the secretary/him."

36. La peluquera reconoció [a un asesino y a una víctima] en la foto del periódico. Enseguida coincidió [con el asesino/con él] en un bar del Casco Viejo.
"The hairdresser recognized a murderer and a victim on the newspaper picture. (She) soon run into with the murderer/him in a bar in the Old Quarter in town."

37. La cajera salvó [a un anciano y a una muchacha] de la caída del panel. Posteriormente celebró [con el anciano/con él] el feliz desenlace con un brindis.
"The cashier rescued an old man and a young girl from the fall of the board. Later on, (she) celebrated with the old man/him the happy ending with a toast."

38. La jefa buscó [a un técnico y a una actriz] toda la mañana sin éxito. Después compró [para el técnico/para él] un localizador nuevo de alta calidad.
"The boss looked for a technician and an actress all morning long unsuccessfully. Afterwards, (she) bought a new, high-quality pager for the technician/him."

39. La gestora amenazó [a un empresario y a una ministra] en la reunión de trabajo. Ayer testificó [contra el empresario/contra él] en el juicio por enriquecimiento ilícito.
"The consultant threatened a bussinessman and a minister at the work meeting. Yesterday, (she) testified against the businessman/him in the unjust enrichment trial."

40. La fotógrafa mató [a un actor y a una cantante] con un cuchillo de caza. Anteriormente mantuvo [con el actor/con él] una tormentosa relación de amor-odio.
"The photographer killed an actor and a singer with a hunting knife. Previously, (she) had had a stormy, love-hate relationship with the actor/him."

Low frequency antecedent conditions:

1. La vendedora protegió [a un manco y a una chiquilla] en un callejón del barrio. Ayer preguntó [por el manco/por él] en la cafetería de la esquina.
"The seller protected a one-armed man and a little girl in a neighborhood alley. Yesterday, (she) asked about the one-armed man/him at the corner café."

2. La camarera empujó [a un bedel y a una inspectora] en la cafetería del hotel. Luego cenó [con el /con el bedelél] en una pizzería de la plaza.
"The waitress pushed a porter and an inspector at the hotel caf/'e. Later, (she) had dinner with the porter/him in a pizzeria on the plaza."

3. La senadora criticó [a un banquero y a una alcaldesa] durante el discurso de ayer. Posteriormente arremetió [contra el banquero/contra él] en los medios nacionales y europeos.
"The senator criticized a banker and a mayoress during yesterday's speech. Later, (she) attacked the banker/him on the national and European media."

4. La redactora besó [a un auditor y a una editora] con mucho afecto y cariño. Enseguida habló [sobre el auditor/sobre él] en las revistas de cine independiente.

"The editor kissed an auditor and an editor very lovingly. Right away, (she) talked about the auditor/him on the independent movie making magazines."

5. La alcaldesa admitió [a un geólogo y a una funcionaria] en el pleno del municipio. Hoy conversó [con el geólogo/con él] sobre las obras en la carretera.
"The mayoress admitted a geologist and a civil servant in the city council of the local government. Today, (she) discussed with the geologist/him about the construction works on the road."

6. La abadesa ignoró [a un beato y a una creyente] antes del sermón de Pascua. Después debatió [con el beato/con él] cerca del claustro de las Clarisas.
"The abbess ignored a lay brother and a believer before the Easter sermon. Afterwards, (she) discussed with the lay brother/him near the Clarisas' cloister."

7. La comadrona corrigió [a un galeno y a una matrona] antes del turno de noche. Después confió [en el galeno/en él] para la cirugía de cesárea planificada.
"The midwife corrected a physician and a midwife before the night shift. Afterwards, (she) trusted the physician/him for the planned c-section surgery."

8.La bióloga evaluó [a un operario y a una doctoranda] durante las prácticas no remuneradas. Posteriormente redactó [con el operario/con él] un informe detallado sobre los experimentos.
"The biologist evaluated a (male) worker and a (female) PhD student during the unpaid internships. Right away, (she) wrote a detailed report with the (male) worker/him about the experiments."

9. La limpiadora hirió [a un edil y a una procuradora] en un momento de locura. Luego arrojó [contra el edil/contra él] el viejo candelabro de plata fina.
"The cleaning woman hurt a council member and an attorney in a moment of madness. Later, (she) threw the old, fine silver chandelier to the council member/him."

10.La anfitriona abrazó [a un presentador y a una bailarina] de manera amable y cordial. Ayer posó [con el presentador/con él] durante la conferencia por la paz.
"The hostess hugged an anchorman and a dancer so welcoming and friendly. Yesterday, (she) posed for the anchorman/him at the peace conference."

11.La pintora felicitó [a un decano y a una aristócrata] por la exposición de arte. Luego criticó [ante el decano/ante él] el arte vanguardista del siglo XX.

"The painter congratulated a dean and an aristocrat for the art exhibition. Later, (she) criticized 20th century avant-garde art in front of the dean/him."

12.La diseñadora aplaudió [a un modisto y a una costurera] por el éxito del espectáculo. Después adquirió [para el modisto/para él] unas flores rojas del jardín botánico.
"The designer praised a dressmaker and a seamstress for the success of the show. Afterwards, (she) bought some red flowers from the botanic garden for the dressmaker."

13. La emperatriz alabó [a un siervo y a una trabajadora] por una valentía nunca vista. Enseguida charló [sobre el siervo/sobre él] con el mayordomo durante la cena.
"The empress praised a servant and a worker for a courage never seen before. Right away, (she) talked about the servant/him with the butler at dinner."

14. La pastelera llamó [a un panadero y a una cocinera] por un error del pedido. Luego asumió [ante el panadero/ante él] parte de culpa en la elaboración.
"The baker called a baker and a cook for an error in the order. Later, (she) assumed part of the blame to the baker/him in the production."

15. La azafata alertó [a un instructor y a una tenista] de un retraso no previsto. Después presentó [ante el instructor/ante él] los verdaderos motivos de la anulación.
"The flight attendant warned a instructor and a tennis player about an unexpected delay. Afterwards, (she) told the instructor/him the real causes of the (flight) cancellation."

16. La arquitecta convocó [a un programador y a una asesora] por el interfono del despacho. Ayer discutió [con el programador/con él] la política sindical del gremio autónomo.
"The architect called a coder and a consultant by the office intercom. Yesterday, (she) discussed with the coder/him the Union policy for the self-employed."

17. La enfermera vio [a un bombero y a una conductora] durante el ataque de ayer. Enseguida corrió [hasta el bombero/hasta él] con el botiquín de primeros auxilios.
"The nurse saw a firefighter and a driver during last night's bombing. Right away, (she) ran to the firefighter/him with the first-aid kit."

18. La psicóloga orientó [a un regidor y a una ecologista] a lo largo del proyecto. Hoy interpuso [contra el regidor/contra él] una demanda judicial

por mala conducta.
"The psychologist oriented a councilor and an ecologist along the project. Today, (she) demanded the councilor/him due to bad conduct."

19. La mecanógrafa incordió [a un subastador y a una tasadora] durante la sesión de tarde. Hoy reunió [para el subastador/para él] los papeles necesarios para esa semana.
"The typist bothered an auctioneer and an assessor during the afternoon session. Today, (she) gathered the necessary papers for that week for the auctioneer/him."

20. La prostituta ofendió [a un librero y a una viajera] con un gesto muy obsceno. Posteriormente respondió [ante el viajero/ante él] por la ofensa en los tribunales.
"The prostitute offended a bookseller and a traveler with a very obscene gesture. Afterwards, she faced the bookseller/him for the insult at court."

21. La artesana atacó [a un mercader y a una consejera] en la entrada del ayuntamiento. Luego difundió '[sobre el mercader/sobre él] varios rumores infundados sobre su labor.
"The craftswoman attacked a merchant and a counselor at the townhall entrance. Then, (she) spread several, baseless, false rumors against the merchant/him on his task."

22. La funcionaria criticó [a un camionero y a una empresaria] por un documento mal rellenado. Pronto informó [sobre el camionero /sobre él] a la Administración por una subsanación.
"The civil servant criticized a truck driver and a businesswoman for a badly filled-in document. Soon, (she) reported about the truck driver/him to the administraction for an amendment."

23. La portera acompañó [a un peatón y a una minusválida] hasta la tienda de regalos. Siempre contó [con el peatón/con él] desde ese día para cualquier tema.
"The porter woman walked with a pedestrian and a disabled person to the gift shop. (She) always counted with the pedestrian/him since that day for anything."

24. La joyera denunció [a un secuestrador y a una ladrona] después del robo de ayer. Enseguida / Pronto elaboró [contra el secuestrador/contra él] una acusación legal por asociación criminal.
"The jeweler denounced a kidnapper and a thief after yesterday's robbery.

Right away, (she) launched a legal prosecution against the kidnapper/him because of criminal organization."

25. La embajadora sobornó [a un estafador y a una auditora] con una cena de lujo. Después dirigió [hacia el estafador/hacia él] una mirada cómplice como seña secreta.
"The ambassador bribed a swindler and an auditor with a fancy dinner. Afterwards, (she) casted a knowing look to the swindler/him as a secret sign."

26. La taquillera atendió [a un revisor y a una ingeniera] durante el trayecto en tren. Enseguida preparó [para el revisor/para él] una té caliente con pastas dulces.
"The ticket clerk assisted a ticket collector and an engineer during the train ride. Right away, (she) immediately prepared some hot tea with sweet pastries for the ticket collector/him."

27. La monitora elogió [a un escalador y a una gimnasta] unas horas antes del evento. Ayer compró [para el escalador/para él] una medalla dorada al mérito deportivo.
"The teacher praised a climber and a gymnast few hours before the event. Yesterday, (she) bought a golden sport merit medal for the climber/him."

28. La arqueóloga plantó [a un admirador y a una investigadora] durante las jornadas de verano. Hoy escribió [para el admirador/para él] una carta pública de disculpa formal.
"The archeologist stood a fan and a researcher up on summer work days. Today, (she) wrote a public, formal apology letter for the fan/him."

29. La poetisa homenajeó [a un filólogo y a una musicóloga] con un soneto muy emotivo. Hoy ofreció [por el filólogo/por él] un recital clásico por su trayectoria.
"The poetess paid tribute to a philologist and a musicologist with a very touching sonet. Today, (she) offered a classical recital to the career of the philologist/him."

30. La presentadora defendió [a un seguidor y a una congresista] durante la gala de anoche. Posteriormente tropezó [con el seguidor/con él] en una fiesta de la cadena.
"The anchorwoman stood up for a follower and a congresswoman during last night's gala. Later on, (she) coincided with the follower/him at the channel's party."

31. La traductora agredió [a un vándalo y a una tránsfuga] delante de todo el vecindario. Hoy apareció [con el vándalo/con él] en un programa de juicios televisivos.
"The translator hit a hooligan and an fugitive in front of the whole neighborhood. Today, (she) showed up with the hooligan/him on a TV court programme."

32. La delegada inscribió [a un nadador y a una gimnasta] en la competición entre naciones. Después formuló [contra el nadador/contra él] una denuncia formal por dopaje reiterado.
"The delegate registered a swimmer and a gymnast in the international competition. Afterwards, (she) formulated formal allegations for reiterated doping against the swimmer/him."

33. La reportera increpó [a un tertuliano y a una historiadora] durante la entrevista en público. Pronto apareció [con el tertuliano/con él] en un restaurante de la ciudad.
"The reporter rebuked a talk show guest and a historian during the public interview. (She) soon showed up with the talk show guest/him at a city's restaurant."

34. La novicia ayudó [a un ermitaño y a una peregrina] en el camino al monasterio. Luego preguntó [por el ermitaño/por él] en la capital de la región.
"The novice assisted a hermit and a pilgrim on the way to the monastery. Later, (she) asked about the hermit/him in the region's capital town."

35. La baronesa saludó [a un ilustrador y a una fotógrafa] durante la recepción de ayer. Posteriormente prometió [ante el ilustrador/ante él] grandes ayudas económicas a los artistas.
"The baroness greeted an illustrator and a photographer at yesterday's reception. Later on, (she) promissed large money grants to artists in front of the illustrator/him."

36. La peluquera reconoció [a un defraudador y a una notaria] en la foto del periódico. Enseguida coincidió [con el defraudador/con él] en un bar del Casco Viejo.
"The hairdresser recognized a fraudster and a notary public on the newspaper picture. (She) soon run into with the fraudster/him in a bar in the Old Quarter in town."

37. La cajera salvó [a un tendero y a una beata] de la caída del panel. Posteriormente celebró [con el tendero/con él] el feliz desenlace con un brindis.
"The cashier rescued a storekeeper and a lay sister from the fall of the board. Later on, (she) celebrated with the storekeeper/him the happy ending with a toast."

38. La jefa buscó [a un minero y a una contable] toda la mañana sin éxito. Después compró [para el minero/para él] un localizador nuevo de alta calidad.
"The boss looked for a miner and an accountant all morning long unsuccessfully. Afterwards, (she) bought a new, high-quality pager for the miner/him."

39. La gestora amenazó [a un tesorero y a una mecenas] en la reunión de trabajo. Ayer testificó [contra el tesorero/contra él] en el juicio por enriquecimiento ilícito.
"The consultant threatened a treasurer and a sponsor at the work meeting. Yesterday, (she) testified against the treasurer/him in the unjust enrichment trial."

40. La fotógrafa mató [a un mimo y a una columnista] con un cuchillo de caza. Anteriormente mantuvo [con el mimo/con él] una tormentosa relación de amor-odio.
"The photographer killed a mime and a columnist with a hunting knife. Previously, (she) had had a stormy, love-hate relationship with the mime/him."

C Item sets of Experiments 4 and 5

Experiment 4 contained 40 sentences, whereas Experiment 5 consisted of 48 item sets. They were distributed in 4 conditions. The NP within the relative clause (the attractor) could be singular or plural, subject or object, and an adverb always intervened between the attractor and the verb of the main clause, which was in present perfect and could match or not with the subject of the main clause in number. Conditions were as follows:

Condition a:	grammatical	singular attractor
Condition b:	grammatical	plural attractor
Condition c:	ungrammatical	singular attractor
Condition d:	ungrammatical	plural attractor

An example of a full set:

4a. El reportero al que saluda [ese ministro] diariamente [ha aparecido] esta madrugada en el congreso.

4b. El reportero al que saludan [esos ministros] diariamente [ha aparecido] esta madrugada en el congreso.

4c. *El reportero al que saluda [ese ministro] diariamente [han aparecido] esta madrugada en el congreso.

4d. *El reportero al que saludan [esos ministros] diariamente [han aparecido] esta madrugada en el congreso.

5e. El reportero que saluda [a ese ministro] diariamente [ha aparecido] esta madrugada en el congreso.

5f. El reportero que saluda [a esos ministros] diariamente [ha aparecido] esta madrugada en el congreso.

5g. *El reportero que saluda [a ese ministro] diariamente [han aparecido] esta madrugada en el congreso.

5h. *El reportero que saluda [a esos ministros] diariamente [han aparecido] esta madrugada en el congreso.

"The reporter [who that (those) minister(s) greet(s) / who greets that(those) minister(s) daily] has(*have) shown up this early morning at the congress."

Materials of Experiments 4 & 5

1. El reportero (al) que saluda(n) (a)ese(esos) ministro(s) diariamente ha(*n) aparecido esta madrugada en el congreso.
"The reporter [who that (those) minister(s) greet(s) / who greets that(those) minister(s) daily] has(*have) shown up this early morning at the congress."

2. El escritor (al) que felicita(n) (a) ese(esos) pintor(es) efusivamente ha(*n) desayunado esta mañana en la cafetería.
"The writer [who that (those) painter(s) congratulate(s) / who congratulates that (those) painter(s) very warmly] has(*have) had breakfast this morning at the coffee shop."

3. El médico (al) que observa(n) (a) ese(esos) chico(s) atentamente ha(*n) hablado esta semana ante el comité.
"The doctor [who that (those) boy(s) observe(s) / who observes that (those) boy(s) carefully] has(*have) spoken this week to the committee."

4. El corredor (al) que defiende(n) (a) ese(esos) compañero(s) enérgicamente ha(*) confesado esta tarde en la federación.
"The runner [who that (those) colleague(s) stand(s) up for / who stands up for that (those) colleague(s) vigorously] has(*have) confessed this afternoon at the federation."

5. El director al que critica(n) ese(esos) secretario(s) constantemente ha(*n) estado este viernes en la sede.
"The director[who that (those) secretary(-ies) criticize(s) constantly] has(*have) been this Friday at the headquarters."

6. El jugador (al) que abraza(n) (a) ese(esos) fotógrafo(s) cordialmente ha(*n) salido este martes en el Marca.
"The player [who that (those) photographer(s) hug(s) / who hugs that (those) photographer(s) warmly] has(*have) come out this Tuesday on Marca (a well-known Spanish sports newspaper)."

7. El entrenador (al) que increpa(n) (a) ese (esos) directivo(s) habitualmente ha(*n) firmado este año por tres temporadas.

"The coach [who that (those) executive(s) rebuke(s) / who rebukes that (those) executive(s) habitually] has(*have) signed this year for three seasons."

8. El músico (al) que admira(n) (a) ese (esos) alumno(s) profundamente ha(*n) triunfado esta temporada con la orquesta.
"The musician [who that (those) student(s) admire(s) / who admires that (those) student(s) deeply] has(*have) succeeded this season with the orchestra."

9. El vecino al que atiende(n) ese(esos) portero(s) amablemente ha(*n) venido este sábado a la reunión.
"The neighbor [who that (those) porter(s) assist(s) kindly] has(*have) come this Saturday to the meeting."

10. El vendedor (al) que apoya(n) (a) ese(esos) alcalde(s) incondicionalmente ha(*n) acudido este mes a la feria.
"The seller [who that (those) mayor(s) support(s) / who supports that (those) mayor(s) unconditionally] has(*have) attended the farmer's market this month."

11. El empleado (al) que respalda(n) (a) ese (esos) asesor(es) abiertamente ha(*n) demandado este jueves a la empresa.
"The employer [who that (those) consultant(s) support(s) / who supports that (those) consultant(s) openly] has(*have) sued the company this Thursday."

12. El peluquero (al) que aparta(n) (a) ese maquillador(es) bruscamente ha(*n) desfilado este verano en Nueva York.
"The hairdresser [who that (those) make-up artist(s) push(es) aside/ who pushes that (those) make-up artist(s) aside sharply] has(*have) walked (on the runway) this Summer in New York."

13. El cocinero (al) que busca(n) (a) ese(esos) panadero(s) incansablemente ha(*n) estado este domingo en el mercado.
"The cook [who that (those) baker(s) look(s) for / who looks for that (those) baker(s) tirelessly] has(*have) been this Sunday at the market."

14. El diputado al que investiga(n) ese (esos) auditor(es) exhaustivamente ha(*n) discutido este martes con la fiscalía.
"The representative [who that (those) auditor(s) investigate(s) thoroughly] has(*have) had an argument this Tuesday with the district attorney's office."

15. El productor (al) que persigue(n) (a) ese(esos) director(es) obsesivamente ha(*n) huido esta noche de la gala.

"The producer [who that (those) director(s) chase(s) / who chases that (those) director(s) obsessively] has(*have) run away from the gala tonight."

16. El ingeniero (al) que elogia(n) (a) ese(esos) arquitecto(s) descaradamente ha(*n) entrado este miércoles en la plantilla.
"The engineer [who that (those) architect(s) praise(s) / who praises that (those) architect(s) brazenly] has(*have) joined up the staff this Wednesday."

17. El inspector (al) que recibe(n) (a) ese(esos) gobernador(es) abiertamente ha(*n) declarado este lunes en el juicio.
"The inspector [who that (those) governor(s) welcome(s) / who welcomes that (those) governor(s) openly] has(*have) declared this Monday in court."

18. El padrino (al) que besa(n) (a) ese(esos) novio(s) cariñosamente ha(*n) llegado esta mañana de Oriente Medio.
"The bestman [who that (those) groom (bride and groom) kiss(es) / who kisses that (those) groom (bride and groom) fondly] has(*have) reached this morning from the Middle East."

19. El investigador (al) que evita(n) (a) ese(esos) rector(es) intencionadamente ha(*n) cambiado este año de categoría profesional.
"The researcher [who that (those) rector(s) avoid(s) / who avoids that (those) rector(s) intentionally] has(*have) changed career this year."

20. El camarero (al) que molesta(n) (a) ese(esos) cliente(s) incesantemente ha(*n) renunciado este sábado a un descanso.
"The waiter [who that (those) client(s) disturb(s) / who disturbs that (those) client(s) unceasingly] has(*have) refused (having) a break this Saturday."

21. El abogado (al) que escucha(n) (a) ese(esos) magistrado(s) atentamente ha(*n) venido este mes con las pruebas.
"The lawyer [who that (those) judge(s) listen(s) to / who listens to that (those) judge(s) carefully] has(*have) come this month with the evidence."

22. El científico (al) que ataca(n) (a) ese(esos) profesor(es) constantemente ha(*n) viajado este curso a la Antártida.
"The scientist [who that (those) professor(s) attack(s) / who attacks that (those) professor(s) constantly] has(*have) traveled this academic year to the Antarctica."

23. El piloto (al) que humilla(n) (a) ese(esos) pasajero(s) públicamente ha(*n) aterrizado esta madrugada en otro destino.
"The pilot [who that (those) passenger(s) humilliate(s) / who humilliates that

(those) passenger(s) publicly] has(*have) landed in other destination this early morning."

24. El refugiado (al) que empuja(n) (a) ese(esos) soldado(s) violentamente ha(*n) dormido esta semana a la intemperie.
"The refugee [who that (those) soldier(s) push(es) / who pushes that (those) soldier(s) violently] has(*have) slept this week outdoors."

25. El empresario (al) que corrige(n) (a) ese(esos) consejero(s) educadamente ha(*n) declarado este lunes por cuatro delitos.
"The businessman [who that (those) adviser(s) correct(s) / who corrects that (those) adviser(s) politely] has(*have) declared this Monday due to four crimes."

26. El joyero (al) que golpea(n) (a) ese(esos) ladrón(es) repetidamente ha(*n) contactado esta quincena con la mafia.
"The jeweler [who that (those) robber(s) hit(s) / who hits that (those) robber(s) repeteadly] has(*have) contacted in these two weeks with the mafia."

27. El traductor (al) que despacha(n) (a) ese(esos) editor(es) rápidamente ha(*n) renunciado este cuatrimestre a varios encargos.
"The translator [who that (those) editor(s) check(s) in / who checks in that (those) editor(s) quickly] has(*have) rejected several order this four-month period."

28. El político (al) que insulta(n) (a) ese(esos) ciudadano(s) frecuentemente ha(*n) salido este semestre de la cárcel.
"The politician [who that (those) citizen(s) insult(s) / who insults that (those) citizen(s) frequently] has(*have) left jail this semester."

29. El obispo (al) que engaña(n) (a) ese(esos) peregrino(s) impunemente ha(*n) colaborado esta primavera con una ONG.
"The bishop [who that (those) pilgrim(s) deceive(s) / who deceives that (those) pilgrim(s) with impunity] has(*have) collaborated with an NGO this Spring."

30. El enfermero (al) que conoce(n) (a) ese(esos) anciano(s) personalmente ha(*n) vuelto este año a la universidad.
"The sick person [who that (those) old man (men) know(s) / who knows that (those) old man (men) personally] has(*have) come back this year to college."

31. El marinero (al) que cuida(n) (a) ese(esos) patrón(es) fielmente ha(*n) regresado este miércoles de alta mar.

"The sailor [who that (those) captain(s) look(s) after / who looks after that (those) captain(s) faithfully] has(*have) come back this Wednesday from the high seas."

32. El luchador (al) que agarra(n) (a) ese(esos) preparador(es) fuertemente ha(*n) peleado esta temporada contra varios campeones.
"The fighter [who that (those) personal trainer(s) hold(s) / who holds that (those) personal trainer(s) tightly] has(*have) competed this season against several champions."

33. El barrendero (al) que regaña(n) (a) ese(esos) vecino(s) regularmente ha(*n) trabajado esta noche durante la verbena.
"The street cleaner [who that (those) neighbor(s) scold(s) / who scolds that (those) neighbor(s) regularly] has(*have) worked tonight during the open-air dance."

34. El delegado (al) que consulta(n) (a) ese(esos) decano(s) trimestralmente ha(*n) ayudado esta tarde con las matrículas.
"The (school) delegate [who that (those) dean(s) consult(s) / who consults that (those) dean(s) quarterly] has(*have) helped this afternoon with (college) registrations."

35. El carnicero (al) que intimida(n) (a) ese(esos) pescadero(s) continuamente ha(*n) regresado este mes a la clínica.
"The butcher [who that (those) fishmonger(s) intimidate(s) / who intimidates that (those) fishmonger(s) continuously] has(*have) returned this month to the clinic."

36. El conductor (al) que esquiva(n) (a) ese(esos) peatón(es) hábilmente ha(*n) pasado este viernes por la comisaría.
"The driver [who that (those) pedestrian(s) avoid(s) / who avoids that (those) pedestrian(s) smartly] has(*have) gone this Friday to the police station."

37. El decorador al que sigue(n) ese(esos) obrero(s) obedientemente ha(*n) optado esta semana a un ascenso.
"The decorator [who that (those) worker(s) follow(s) obediently] has(*have) aimed for a promotion this week."

38. El compositor (al) que respalda(n) (a) ese (esos) anfitrión(es) totalmente ha(*n) participado este sábado en la ópera.
"The composer [who that (those) host(s) support(s) / who supports that (those) host(s) totally] has(*have) taken part this Saturday in the opera."

39. El pastor (al) que provoca(n) (a) ese (esos) cazador(es) nuevamente ha(*n) permanecido este invierno en la cabaña.
"The shepherd [who that (those) hunter(s) provoke(s) / who provokes that (those) hunter(s) again] has(*have) stayed this winter in the hut."

40. El técnico (al) que ignora(n) (a) ese(esos) supervisor(es) constantemente ha(*n) dimitido este otoño de la empresa.
"The technician [who that (those) supervisor(s) disregard(s) / who disregards that (those) supervisor(s) constantly] has(*have) stepped down from the company this Fall."

Additional Materials of Experiment 5

5. El secretario que critica a ese(esos) director(es) constantemente ha(*n) venido este viernes a la sede.
"The secretary [who criticizes that (those) director(s) constantly] has(*have) been this Friday at the headquarters."

9. El portero que atiende a ese(esos) vecino(s) amablemente ha(*n) venido este sábado a la reunión.
"The porter [who assist(s) that (those) neighbor(s) kindly] has(*have) come this Saturday to the meeting."

14. El auditor que investiga a ese(esos) diputado(s) exhaustivamente ha(*n) discutido este martes con la fiscalía.
"The auditor [who investigate(s) that (those) representative(s) thoroughly] has(*have) had an argument this Tuesday with the district attorney's office."

37. El obrero que sigue a ese(esos) decorador(es) obedientemente ha(*n) optado esta semana a un ascenso.
"The worker [who follow(s) that (those) decorator(s) obediently] has(*have) aimed for a promotion this week."

41. El modelo que escoge a ese(esos) diseñador(es) cuidadosamente ha(*n) destacado este otoño en las pasarelas.
"The model [who that (those) fashion designer(s) select(s) / who selects that (those) fashion designer(s) carefully] has(*have) stood out this Fall on the runway."

42. El farmacéutico que espera a ese(esos) repartidor(es) pacientemente ha(*n) trabajado esta semana en el laboratorio.

"The pharmacist [who that (those) deliveryman (deliverymen) wait(s) for / who waits for that (those) deliveryman (deliverymen) patiently] has(*have) worked this week in the laboratory."

43. El nadador que guía a ese(esos) anciano(s) torpemente ha(*n) surfeado esta tarde entre las olas.
"The swimmer [who that (those) old man(men) guide(s) / who guides that (those) old man(men) clumsily] has(*have) surfed this afternoon in the waves."

44. El profesor que censura a ese(esos) administrador(es) constantemente ha(*n) viajado este curso a las Canarias.
"The professor [who that (those) manager(s) condemn(s) / who condems that (those) manager(s) constantly] has(*have) traveled this academic year to the Canary Islands."

45. El bombero que acompaña a ese(esos) funcionario(s) diligentemente ha(*n) participado este invierno en las olimpiadas.
"The firefighter [who that (those) civil servant(s) walk(s) with / who walks with that (those) civil servant(s) speedily] has(*have) taken part this Winter in the Olympics."

46. El actor que desprecia a ese(esos) apuntador(es) escandalosamente ha(*n) colaborado esta temporada en una serie.
"The actor [who that (those) rehearsal aide(s) scorn(s)/ who scorns that (those) rehearsal aide(s) flagrantly] has(*have) collaborated this season in a series."

47. El espectador que responde a ese(esos) presentador(es) malamente ha(*n) intervenido este miércoles en otro programa.
"The spectator [who that (those) anchorman (anchormen) reply(-ies) / who replies that (those) anchorman (anchormen) badly] has(*have) intervened this Wednesday on other programme."

48. El monitor que presiona a ese(esos) montañero(s) insistentemente ha(*n) aparecido esta madrugada en la federación.
"The teacher [who that (those) mountaineer(s) pressure(s) / who pressures that (those) mountaineer(s) constantly] has(*have) shown up this early morning in the federation."

D Item sets of Experiments 6 and 7

The experiments contained 48 sentences distributed in 4 conditions. The NP within the relative clause (the attractor) could be singular or plural, subject or object, and an adverb always intervened between the attractor and the object clitic, which could match or not with the direct object of the main clause in number. Conditions were as follows:

Condition a:	grammatical	singular attractor
Condition b:	grammatical	plural attractor
Condition c:	ungrammatical	singular attractor
Condition d:	ungrammatical	plural attractor

An example of a full set:

6a. Al reportero que saluda [a ese ministro] diariamente [lo] han contratado esta mañana en la cadena.

6b. Al reportero que saluda [a esos ministros] diariamente [lo] han contratado esta mañana en la cadena.

6c. *Al reportero que saluda [a ese ministro] diariamente [los] han contratado esta mañana en la cadena.

6d. *Al reportero que saluda [a esos ministro] diariamente [los] han contratado esta mañana en la cadena.

7e. Al reportero que saluda [ese ministro] diariamente [lo] han contratado esta mañana en la cadena.

7f. Al reportero que saludan [esos ministros] diariamente [lo] han contratado esta mañana en la cadena.

7g. *Al reportero que saluda [ese ministro] diariamente [los] han contratado esta mañana en la cadena.

7h. *Al reportero que saludan [esos ministros] diariamente [los] han contratado esta mañana en la cadena.

"The reporter [who greets that(those) minister(s) / who is greeted by that (those) minister(s) daily] (him/*them) has been hired this morning in the (TV) channel."

Materials of Experiment 6

1. Al reportero que saluda a ese(esos) ministro(s) diariamente lo(*s) han contratado esta mañana en la cadena.
"The reporter [who greets that(those) minister(s) daily] (him/*them) has been hired this morning in the (TV) channel."

2. Al escritor que felicita a ese(esos) pintor(es) efusivamente lo(*s) han atacado esta madrugada en el bar.
"The writer [who congratulates that (those) painter(s) very warmly] (him/*them) has been attacked this early morning at the bar."

3. Al médico que observa a ese (esos) chico(s) atentamente lo(*s) han denunciado esta semana ante el comité.
"The doctor [who observes that (those) boy(s) carefully] (him/*them) has been reported this week to the committee."

4. Al corredor que defiende a ese(esos) compañero(s) vivamente lo(*s) han aplaudido esta tarde en la federación.
"The runner [who stands up for that (those) colleague(s) vigorously] (him/*them) has been applauded this afternoon at the federation."

5. Al secretario que critica a ese(esos) director(es) constantemente lo(*s) han convocado este viernes en la sede.
"The secretary [who criticizes that (those) directors constantly] (him/*them) has been called together this Friday at the headquarters."

6. Al jugador que abraza a ese(esos) fotógrafo(s) cordialmente lo(*s) han entrevistado este martes en el Marca.
"The player [who hugs that (those) photographer(s) warmly] (him/*them) has been interviewed this Tuesday on Marca (a well-known Spanish sports newspaper)."

7. Al entrenador que increpa a ese(esos) directivo(s) habitualmente lo(*s) han expulsado este año de la liga.
"The coach [who rebukes that (those) executive(s) habitually] (him/*them) has been expelled this year from the league."

8. Al músico que admira a ese(esos) alumno(s) profundamente lo(*s) han ascendido esta temporada en el conservatorio.
"The musician [who admires that (those) student(s) deeply] (him/*them) has been promoted this season in the school of music."

9. Al portero que ayuda a ese(esos) vecino(s) amablemente lo(*s) han asaltado este sábado en el supermercado.
"The porter [who assists that (those) neighbor(s) kindly] (him/*them) has been attacked this Saturday at the grocery store."

10. Al vendedor que apoya a ese(esos) alcalde(s) incondicionalmente lo(*s) han multado este mes en la playa.
"The seller [who supports that (those) mayor(s) unconditionally] (him/*them) has been fined this month on the beach."

11. Al empleado que amenaza a ese(esos) concejal(es) abiertamente lo(*s) han empujado esta noche por las escaleras.
"The employer [who supports that (those) councilman(councilmen) openly] (him/*them) has been pushed tonight in the staircase."

12. Al peluquero que despacha a ese(esos) maquillador(es) bruscamente lo(*s) han presentado este verano sobre la pasarela.
"The hairdresser [who pushes that (those) make-up artist(s) aside sharply] (him/*them) has been introduced this Summer on the runway."

13. Al cocinero que busca a ese(esos) panadero(s) incansablemente lo(*s) han premiado este domingo con una estrella.
"The cook [who looks for that (those) baker(s) tirelessly] (him/*them) has been awarded this Sunday with a (Michelin) star."

14. Al locutor que entrevista a ese(esos) diputado(s) agresivamente lo(*s) han sobornado esta semana desde la oposición.
"The radio speaker [who interviews that (those) representative(s) aggressively] (him/*them) has been bribed last week by the opposition."

15. Al productor que acompaña a ese(esos) director(es) normalmente lo(*s) han indemnizado este jueves por un malentendido.
"The producer [who walks with that (those) director(s) normally] (him/*them) has been compensated this Thursday due to a misunderstanding."

16. Al ingeniero que elogia a ese(esos) arquitecto(s) descaradamente lo(*s) han ascendido este miércoles en la plantilla.

“The engineer [who praises that (those) architect(s) brazenly] (him/*them) has been promoted within the staff this Wednesday."

17. Al modelo que escoge a ese(esos) diseñador(es) cuidadosamente lo(*s) han aplaudido este otoño en las pasarelas.
“The model [who selects that (those) fashion designer(s) carefully] (him/*them) has been applauded this Fall on the runway."

18. Al inspector que recibe a ese(esos) gobernador(es) abiertamente lo(*s) han apartado este lunes de la investigación.
“The inspector [who welcomes that (those) governor(s) openly] (him/*them) has been removed this Monday from the investigation."

19. Al padrino que besa a ese(esos) novio(s) cariñosamente lo(*s) han atropellado esta mañana en un cruce.
“The bestman [who kisses that (those) groom (bride and groom) fondly] (him/*them) has been run over this morning at a crossroads."

20. Al enfermero que escribe a ese(esos) abuelo(s) personalmente lo(*s) han invitado esta primavera a una boda.
“The nurse [who writes that (those) grandfather(grandparents) personally] (him/*them) has been invited to a wedding this Spring."

21. Al investigador que evita a ese(esos) rector(es) intencionadamente lo(*s) han destinado este año a otro departamento.
“The researcher [who avoids that (those) rector(s) intentionally] (him/*them) has been appointed to other department this year."

22. Al camarero que provoca a ese (esos) cliente(s) incesantemente lo(*s) han rechazado este mes para un ascenso.
“The waiter [who provokes that (those) client(s) unceasingly] (him/*them) has been denied a promotion this month."

23. Al nadador que guía a ese(esos) anciano(s) torpemente lo(*s) han rescatado esta tarde entre las olas.
“The swimmer [who guides that (those) old man(men) clumsily] (him/*them) has been rescued this afternoon from the waves."

24. Al abogado que escucha a ese(esos) magistrado(s) atentamente lo(*s) han homenajeado este sábado en la universidad.
“The lawyer [who listens to that (those) judge(s) carefully] (him/*them) has been honored this Saturday at university."

25. Al profesor que censura a ese(esos) administrador(es) constantemente lo(*s) han aclamado este curso desde las aulas.
"The professor [who condems that (those) manager(s) constantly] (him/*them) has been acclaimed this academic year from the lecture halls."

26. Al piloto que maldice a ese(esos) pasajero(s) públicamente lo(*s) han llevado esta madrugada ante las autoridades.
"The pilot [who curses that (those) passenger(s) publicly] (him/*them) has been taken to the authorities this early morning."

27. Al bombero que acompaña a ese(esos) funcionario(s) diligentemente lo(*s) han fichado este invierno para las olimpiadas.
"The firefighter [who walks with that (those) civil servant(s) speedily] (him/*them) has been signed up this Winter for the Olympics."

28. Al soldado que patea a ese(esos) refugiado(s) violentamente lo(*s) han enviado esta semana a un campo.
"The soldier [who kicks that (those) refugee(s) violently] (him/*them) has been sent this week to a (detention) camp."

29. Al actor que desprecia a ese(esos) regidor(es) escandalosamente lo(*s) han advertido esta temporada sobre las normas.
"The actor [who scorns that (those) rehearsal aide(s) flagrantly] (him/*them) has been warned this season about the rules."

30. Al empresario que despide a ese(esos) secretario(s) educadamente lo(*s) han imputado este lunes por cuatro delitos.
"The businessman [who says goodbye to that (those) secretary(-ies) politely] (him/*them) has been charged this Monday with four crimes."

31. Al conductor que persigue a ese(esos) chico(s) nerviosamente lo(*s) han echado este viernes de la taberna.
"The driver [who chases that (those) boy(s) nervously] (him/*them) has been thown out of the bar this Friday."

32. Al espectador que responde a ese(esos) presentador(es) malamente lo(*s) han requerido este miércoles en otro programa.
"The spectator [who replies that (those) anchorman (anchormen) badly] (him/*them) has been required this Wednesday on other programme."

33. Al traductor que ningunea a ese(esos) editor(es) completamente lo(*s) han cargado este cuatrimestre de trabajo extra.

"The translator [who brushes that (those) editor(s) aside fully] (him/*them) has been loaded with additional work this four-month period."

34. Al político que insulta a ese(esos) ciudadano(s) frecuentemente lo(*s) han liberado este ciclo de la cárcel.
"The politician [who insults that (those) citizen(s) frequently] (him/*them) has been released this term from jail."

35. Al obispo que engaña a ese(esos) peregrino(s) impunemente lo(*s) han descartado este año para las misiones.
"The bishop [who deceives that (those) pilgrim(s) with impunity] (him/*them) has been rejected this year from the missions."

36. Al farmacéutico que espera a ese(esos) repartidor(es) pacientemente lo(*s) han llamado este martes desde el laboratorio.
"The pharmacist [who waits for that (those) deliveryman (deliverymen) patiently] (him/*them) has been called this Tuesday from the laboratory."

37. Al científico que supervisa a ese(esos) biólogo(s) cuidadosamente lo(*s) han becado este curso para el proyecto.
"The scientist [who supervises that (those) biologist(s) carefully] (him/*them) has been awarded a grant for the project this academic year."

38. Al marinero que cuida a ese(esos) patrón(es) fielmente lo(*s) han alejado esta campaña de la mar.
"The sailor [who looks after that (those) captain(s) faithfully] (him/*them) has been moved away this season from the sea."

39. Al luchador que agarra a ese(esos) preparador(es) fuertemente lo(*s) han sancionado esta temporada de por vida.
"The fighter [who holds that (those) personal trainer(s) tightly] (him/*them) has been penalized this season for life."

40. Al monitor que presiona a ese(esos) montañero(s) insistentemente lo(*s) han amonestado esta madrugada en la federación.
"The teacher [who pressures that (those) mountaineer(s) constantly] (him/*them) has been booked this early morning in the federation."

41. Al barrendero que regaña a ese(esos) vecino(s) regularmente lo(*s) han contratado esta noche para las fiestas.
"The street cleaner [who scolds that (those) neighbor(s) regularly] (him/*them) has been hired tonight for the festival."

42. Al delegado que consulta a ese(esos) decano(s) trimestralmente lo(*s) han citado esta tarde en la biblioteca.
"The (school) delegate [who consults that (those) dean(s) quarterly] (him/*them) has been called this afternoon to the library."

43. Al carnicero que ofende a ese(esos) pescadero(s) públicamente lo(*s) han marginado este mes en el barrio.
"The butcher [who offends that (those) fishmonger(s) continuously] (him/*them) has been ostracized this month in the neighborhood."

44. Al joyero que apalea a ese(esos) ladrón(es) repetidamente lo(*s) han acosado esta quincena con varios anónimos.
"The jeweler [who hits that (those) robber(s) repeteadly] (him/*them) has been harassed in these two weeks with several anonymous (letters)."

45. Al obrero que sigue a ese(esos) decorador(es) obedientemente lo(*s) han recomendado esta semana para futuras reformas.
"The worker [who follows that (those) decorator(s) obediently] (him/*them) has been recommended this week for future remodelings."

46. Al compositor que respalda a ese(esos) anfitrión(es) totalmente lo(*s) han homenajeado este ciclo en la ópera.
"The composer [who supports that (those) host(s) totally] (him/*them) has been honored this season in the opera."

47. Al cazador que desafía a ese(esos) pastor(es) nuevamente lo(*s) han desprovisto este invierno de su licencia.
"The hunter [who challenges that (those) shepherd(s) again] (him/*them) has been deprived this winter of his license."

48. Al técnico que ignora a ese(esos) supervisor(es) constantemente lo(*s) han trasladado este otoño a otra sección.
"The technician [who disregards that (those) supervisor(s) constantly] (him/*them) has been transferred this Fall to another department."

Materials of Experiment 7

1. Al reportero que saluda(n) ese(esos) ministro(s) diariamente lo(*s) han contratado esta mañana en la cadena.
"The reporter [who that (those) minister(s) greet(s) daily] (him/*them) has been hired this morning in the (TV) channel."

2. Al escritor que felicita(n) ese(esos) pintor(es) efusivamente lo(*s) han atacado esta madrugada en el bar.
"The writer [who that (those) painter(s) congratulate(s) very warmly] (him/*them) has been attacked this early morning at the bar."

3. Al médico que observa(n) ese (esos) chico(s) atentamente lo(*s) han denunciado esta semana ante el comité.
"The doctor [who that (those) boy(s) observe(s) carefully] (him/*them) has been reported this week to the committee."

4. Al corredor que defiende(n) ese(esos) compañero(s) vivamente lo(*s) han aplaudido esta tarde en la federación.
"The runner [who that (those) colleague(s) stand(s) up for vigorously] (him/*them) has been applauded this afternoon at the federation."

5. Al secretario que critica(n) ese(esos) director(es) constantemente lo(*s) han convocado este viernes en la sede.
"The secretary [who that (those) director(s) criticize(s) constantly] (him/*them) has been called together this Friday at the headquarters."

6. Al jugador que abraza(n) ese(esos) fotógrafo(s) cordialmente lo(*s) han entrevistado este martes en el Marca.
"The player [who that (those) photographer(s) hug(s) warmly] (him/*them) has been interviewed this Tuesday on Marca (a well-known Spanish sports newspaper)."

7. Al entrenador que increpa(n) ese(esos) directivo(s) habitualmente lo(*s) han expulsado este año de la liga.
"The coach [who that (those) executive(s) rebuke(s) habitually] (him/*them) has been expelled this year from the league."

8. Al músico que admira(n) ese(esos) alumno(s) profundamente lo(*s) han ascendido esta temporada en el conservatorio.
"The musician [who that (those) student(s) admire(s) deeply] (him/*them) has been promoted this season in the school of music"

9. Al portero que ayuda(n) ese(esos) vecino(s) amablemente lo(*s) han asaltado este sábado en el supermercado.
"The porter [who that (those) neighbor(s) assist(s) kindly] (him/*them) has been attacked this Saturday at the grocery store."

10. Al vendedor que apoya(n) ese(esos) alcalde(s) incondicionalmente lo(*s) han multado este mes en la playa.

"The seller [who that (those) mayor(s) support(s) unconditionally] (him/*them) has been fined this month on the beach"

11. Al empleado que amenaza(n) ese(esos) concejal(es) abiertamente lo(*s) han empujado esta noche por las escaleras.
"The employer [who that (those) councilman (councilmen) support(s) openly] (him/*them) has been pushed tonight in the staircase."

12. Al peluquero que despacha(n) ese(esos) maquillador(es) bruscamente lo(*s) han presentado este verano sobre la pasarela.
"The hairdresser [who that (those) make-up artist(s) push(es) aside sharply] (him/*them) has been introduced this Summer on the runway."

13. Al cocinero que busca(n) ese(esos) panadero(s) incansablemente lo(*s) han premiado este domingo con una estrella.
"The cook [who that (those) baker(s) look(s) for tirelessly] (him/*them) has been awarded this Sunday with a (Michelin) star."

14. Al locutor que entrevista(n) ese(esos) diputado(s) agresivamente lo(*s) han sobornado esta semana desde la oposición.
"The radio speaker [who that (those) representative(s) interview(s) aggressively] (him/*them) has been bribed last week by the opposition."

15. Al productor que acompaña(n) ese(esos) director(es) normalmente lo(*s) han indemnizado este jueves por un malentendido.
"The producer [who that (those) director(s) walk(s) with normally] (him/*them) has been compensated this Thursday due to a misunderstanding."

16. Al ingeniero que elogia(n) ese(esos) arquitecto(s) descaradamente lo(*s) han ascendido este miércoles en la plantilla.
"The engineer [who that (those) architect(s) praise(s) brazenly] (him/*them) has been promoted within the staff this Wednesday."

17. Al modelo que escoge(n) ese(esos) diseñador(es) cuidadosamente lo(*s) han aplaudido este otoño en las pasarelas.
"The model [who that (those) fashion designer(s) select(s) carefully] (him/*them) has been applauded this Fall on the runway."

18. Al inspector que recibe(n) ese(esos) gobernador(es) abiertamente lo(*s) han apartado este lunes de la investigación.
"The inspector [who that (those) governor(s) welcome(s) openly] (him/*them) has been removed this Monday from the investigation."

19. Al padrino que besa(n) ese(esos) novio(s) cariñosamente lo(*s) han atropellado esta mañana en un cruce.
"The bestman [who that (those) groom (bride and groom) kiss(es) fondly] (him/*them) has been run over this morning at a crossroads."

20. Al enfermero que escribe(n) ese(esos) abuelo(s) personalmente lo(*s) han invitado esta primavera a una boda.
"The nurse [who that (those) grandfather (grandparents) write(s) personally] (him/*them) has been invited to a wedding this Spring."

21. Al investigador que evita(n) ese(esos) rector(es) intencionadamente lo(*s) han destinado este año a otro departamento.
"The researcher [who that (those) rector(s) avoid(s) intentionally] (him/*them) has been appointed to other department this year."

22. Al camarero que provoca(n) ese (esos) cliente(s) incesantemente lo(*s) han rechazado este mes para un ascenso.
"The waiter [who that (those) client(s) provoke(s) unceasingly] (him/*them) has been denied a promotion this month."

23. Al nadador que guía(n) ese(esos) anciano(s) torpemente lo(*s) han rescatado esta tarde entre las olas.
"The swimmer [who that (those) old man (men) guide(s) clumsily] (him/*them) has been rescued this afternoon from the waves."

24. Al abogado que escucha(n) ese(esos) magistrado(s) atentamente lo(*s) han homenajeado este sábado en la universidad.
"The lawyer [who that (those) judge(s) listen(s) to carefully] (him/*them) has been honored this Saturday at university."

25. Al profesor que censura(n) ese(esos) administrador(es) constantemente lo(*s) han aclamado este curso desde las aulas.
"The professor [who that (those) manager(s) condem(s) constantly] (him/*them) has been acclaimed this academic year from the lecture halls."

26. Al piloto que maldice(n) ese(esos) pasajero(s) públicamente lo(*s) han llevado esta madrugada ante las autoridades.
"The pilot [who that (those) passenger(s) curse(s) publicly] (him/*them) has been taken to the authorities this early morning."

27. Al bombero que acompaña(n) ese(esos) funcionario(s) diligentemente lo(*s) han fichado este invierno para las olimpiadas.

"The firefighter [who that (those) civil servant(s) walk(s) with speedily] (him /*them) has been signed up this Winter for the Olympics."

28. Al soldado que patea(n) ese(esos) refugiado(s) violentamente lo(*s) han enviado esta semana a un campo.
"The soldier [who that (those) refugee(s) kick(s) violently] (him/*them) has been sent this week to a (detention) camp."

29. Al actor que desprecia(n) ese(esos) regidor(es) escandalosamente lo(*s) han advertido esta temporada sobre las normas.
"The actor [who that (those) rehearsal aide(s) scorn(s) flagrantly] (him/ *them) has been warned this season about the rules."

30. Al empresario que despide(n) ese(esos) secretario(s) educadamente lo(*s) han imputado este lunes por cuatro delitos.
"The businessman [who that (those) secretary(-ies) say(s) goodbye to politely] (him/*them) has been charged this Monday with four crimes."

31. Al conductor que persigue(n) ese(esos) chico(s) nerviosamente lo(*s) han echado este viernes de la taberna.
"The driver [who that (those) boy(s) chase(s) nervously] (him/*them) has been thown out of the bar this Friday."

32. Al espectador que responde(n) ese(esos) presentador(es) malamente lo (*s) han requerido este miércoles en otro programa.
"The spectator [who that (those) anchorman (anchormen) reply(-ies) badly] (him/*them) has been required this Wednesday on other programme."

33. Al traductor que ningunea(n) ese(esos) editor(es) completamente lo(*s) han cargado este cuatrimestre de trabajo extra.
"The translator [who that (those) editor(s) brush(es) aside fully] (him/*them) has been loaded with additional work this four-month period."

34. Al político que insulta(n) ese(esos) ciudadano(s) frecuentemente lo(*s) han liberado este ciclo de la cárcel.
"The politician [who that (those) citizen(s) insult(s) frequently] (him/*them) has been released this term from jail."

35. Al obispo que engaña(n) ese(esos) peregrino(s) impunemente lo(*s) han descartado este año para las misiones.
"The bishop [who that (those) pilgrim(s) deceive(s) with impunity] (him/ *them) has been rejected this year from the missions."

36. Al farmacéutico que espera(n) ese(esos) repartidor(es) pacientemente lo(*s) han llamado este martes desde el laboratorio.
"The pharmacist [who that (those) deliveryman (deliverymen) wait(s) for patiently] (him/*them) has been called this Tuesday from the laboratory."

37. Al científico que supervisa(n) ese(esos) biólogo(s) cuidadosamente lo(*s) han becado este curso para el proyecto.
"The scientist [who that (those) biologist(s)supervise(s) carefully] (him/*them) has been awarded a grant for the project this academic year."

38. Al marinero que cuida(n) ese(esos) patrón(es) fielmente lo(*s) han alejado esta campaña de la mar.
"The sailor [who that (those) captain(s) look(s) after faithfully] (him/*them) has been moved away this season from the sea."

39. Al luchador que agarra(n) ese(esos) preparador(es) fuertemente lo(*s) han sancionado esta temporada de por vida.
"The fighter [who that (those) personal trainer(s) hold(s) tightly] (him/*them) has been penalized this season for life."

40. Al monitor que presiona(n) ese(esos) montañero(s) insistentemente lo(*s) han amonestado esta madrugada en la federación.
"The teacher [who that (those) mountaineer(s) pressure(s) constantly] (him/*them) has been booked this early morning in the federation."

41. Al barrendero que regaña(n) ese(esos) vecino(s) regularmente lo(*s) han contratado esta noche para las fiestas.
"The street cleaner [who that (those) neighbor(s) scold(s) regularly] (him/*them) has been hired tonight for the festival."

42. Al delegado que consulta(n) ese(esos) decano(s) trimestralmente lo(*s) han citado esta tarde en la biblioteca.
"The (school) delegate [who that (those) dean(s) consult(s) quarterly] (him/*them) has been called this afternoon to the library."

43. Al carnicero que ofende(n) ese(esos) pescadero(s) públicamente lo(*s) han marginado este mes en el barrio.
"The butcher [who that (those) fishmonger(s) offend(s) continuously] (him/*them) has been ostracized this month in the neighborhood."

44. Al joyero que apalea(n) ese(esos) ladrón(es) repetidamente lo(*s) han acosado esta quincena con varios anónimos.

"The jeweler [who that (those) robber(s) hit(s) repeteadly] (him/*them) has been harassed in these two weeks with several anonymous (letters)."

45. Al obrero que sigue(n) ese(esos) decorador(es) obedientemente lo(*s) han recomendado esta semana para futuras reformas.
"The worker [who that (those) decorator(s) follow(s) obediently] (him/*them) has been recommended this week for future remodelings."

46. Al compositor que respalda(n) ese(esos) anfitrión(es) totalmente lo(*s) han homenajeado este ciclo en la ópera.
"The composer [who that (those) host(s) support(s) totally] (him/*them) has been honored this season in the opera."

47. Al cazador que desafía(n) ese(esos) pastor(es) nuevamente lo(*s) han desprovisto este invierno de su licencia.
"The hunter [who that (those) shepherd(s) challenge(s) again] (him/*them) has been deprived this winter of his license."

48. Al técnico que ignora(n) ese(esos) supervisor(es) constantemente lo(*s) han trasladado este otoño a otra sección.
"The technician [who that (those) supervisor(s) disregard(s) constantly] (him/*them) has been transferred this Fall to another department."

E Item set of Experiment 8

The experiments contained 48 sentences distributed in 4 conditions. The NP within the relative clause (the attractor) was in object position, could be masculine or feminine and match or not with the direct object of the main clause in gender. An adverb always intervened between the attractor and the object clitic. Conditions were as follows:

Condition a:	grammatical	masculine attractor
Condition b:	grammatical	feminine attractor
Condition c:	ungrammatical	masculine attractor
Condition d:	ungrammatical	feminine attractor

An example of a full set:

8a. Al reportero que saluda [a ese ministro] diariamente [lo] han contratado esta mañana en la cadena.

8b. Al reportero que saluda [a esa ministra] diariamente [lo] han contratado esta mañana en la cadena.

8c. *Al reportero que saluda [a ese ministro] diariamente [la] han contratado esta mañana en la cadena.

8d. *Al reportero que saluda [a esa ministra] diariamente [la] han contratado esta mañana en la cadena.

"The reporter [who greets $that_{masc/fem}$ $minister_{masc/fem}$ daily] (him/*her) has been hired this morning in the (TV) channel."

1. Al reportero que saluda a ese(esa) ministro (ministra) diariamente lo(*la) han contratado esta mañana en la cadena.
"The reporter [who greets $that_{masc/fem}$ $minister_{masc/fem}$ daily] (him/*her) has been hired this morning in the (TV) channel."

2. Al escritor que felicita a ese(esa) pintor(a) efusivamente lo(*la) han atacado esta madrugada en el bar.

"The writer [who congratulates $that_{masc/fem}$ $painter_{masc/fem}$ very warmly] (him/*her) has been attacked this early morning at the bar."

3. Al médico que observa a ese(esa) chico (chica) atentamente lo(*la) han denunciado esta semana ante el comité.
"The doctor [who observes $that_{masc/fem}$ *boy/girl* carefully] (him/ *her) has been reported this week to the committee."

4. Al corredor que defiende a ese(esa) compañero (compañera) vivamente lo(*la) han aplaudido esta tarde en la federación.
"The runner [who stands up for $that_{masc/fem}$ $colleague_{masc/fem}$ vigorously] (him/*her) has been applauded this afternoon at the federation."

5. Al secretario que critica a ese(esa) director(a) constantemente lo(*la) han convocado este viernes en la sede.
"The secretary [who criticizes $that_{masc/fem}$ $director_{masc/fem}$ constantly] (him/ *her) has been called together this Friday at the headquarters."

6. Al jugador que abraza a ese(esa) fotógrafo (fotógrafa) cordialmente lo(*la) han entrevistado este martes en el Marca.
"The player [who hugs $that_{masc/fem}$ $photographer_{masc/fem}$ warmly] (him/ *her) has been interviewed this Tuesday on Marca (a well-known Spanish sports newspaper)."

7. Al entrenador que increpa a ese(esa) directivo (directiva) habitualmente lo(*la) han expulsado este año de la liga.
"The coach [who rebukes $that_{masc/fem}$ $executive_{masc/fem}$ habitually] (him/ *her) has been expelled this year from the league."

8. Al músico que admira a ese(esa) alumno (alumna) profundamente lo(*la) han ascendido esta temporada en el conservatorio.
"The musician [who admires $that_{masc/fem}$ $student_{masc/fem}$ deeply] (him/*her) has been promoted this season in the school of music."

9. Al portero que ayuda a ese(esa) vecino (vecina) amablemente lo(*la) han asaltado este sábado en el supermercado.
"The porter [who assists $that_{masc/fem}$ $neighbor_{masc/fem}$ kindly] (him/*her) has been attacked this Saturday at the grocery store."

10. Al vendedor que apoya a ese(esa) alcalde(sa) incondicionalmente lo(*la) han multado este mes en la playa.
"The seller [who supports $that_{masc/fem}$ $mayor_{masc/fem}$ unconditionally] (him/ *her) has been fined this month on the beach."

11. Al empleado que amenaza a ese(esa) concejal(a) abiertamente lo(*la) han empujado esta noche por las escaleras.
"The employer [who supports $that_{masc/fem}$ *councilman/councilwoman* openly] (him/*her) has been pushed tonight in the staircase."

12. Al peluquero que despacha a ese(esa) maquillador(a) bruscamente lo(*la) han presentado este verano sobre la pasarela.
"The hairdresser [who pushes $that_{masc/fem}$ $make-up\ artist_{masc/fem}$ aside sharply] (him/*her) has been introduced this Summer on the runway."

13. Al cocinero que busca a ese(esa) panadero (panadera) incansablemente lo(*la) han premiado este domingo con una estrella.
"The cook [who looks for $that_{masc/fem}$ $baker_{masc/fem}$ tirelessly] (him/*her) has been awarded this Sunday with a (Michelin) star."

14. Al locutor que entrevista a ese(esa) diputado (diputada) agresivamente lo(*la) han sobornado esta semana desde la oposición.
"The radio speaker [who interviews $that_{masc/fem}$ $representative_{masc/fem}$ aggressively] (him/*her) has been bribed last week by the opposition."

15. Al productor que acompaña a ese(esa) director(a) normalmente lo(*la) han indemnizado este jueves por un malentendido.
"The producer [who walks with $that_{masc/fem}$ $director_{masc/fem}$ normally] (him/*her) has been compensated this Thursday due to a misunderstanding."

16. Al ingeniero que elogia a ese(esa) arquitecto (arquitecta) descaradamente lo (*la) han ascendido este miércoles en la plantilla.
"The engineer [who praises $that_{masc/fem}$ $architect_{masc/fem}$ brazenly] (him/*her) has been promoted within the staff this Wednesday."

17. Al modelo que escoge a ese(esa) diseñador(a) cuidadosamente lo(*la) han aplaudido este otoño en las pasarelas.
"The model [who selects $that_{masc/fem}$ $fashion\ designer_{masc/fem}$ carefully] (him/*her) has been applauded this Fall on the runway."

18. Al inspector que recibe a ese(esa) gobernador(a) abiertamente lo(*la) han apartado este lunes de la investigación.
"The inspector [who welcomes $that_{masc/fem}$ $governor_{masc/fem}$ openly] (him/*her) has been removed this Monday from the investigation."

19. Al padrino que besa a ese(esa) novio (novia) cariñosamente lo(*la) han atropellado esta mañana en un cruce.

"The bestman [who kisses $that_{masc/fem}$ *groom/bride* fondly] (him/*her) has been run over this morning at a crossroads."

20. Al enfermero que escribe a ese(esa) abuelo (abuela) personalmente lo(*la) han invitado esta primavera a una boda.
"The nurse [who writes $that_{masc/fem}$ *grandfather/grandmother* personally] (him/*her) has been invited to a wedding this Spring."

21. Al investigador que evita a ese(esa) rector(a) intencionadamente lo(*la) han destinado este año a otro departamento.
"The researcher [who avoids $that_{masc/fem}$ $rector_{masc/fem}$ intentionally](him/*her) has been appointed to other department this year."

22. Al camarero que provoca a ese(esa) cliente (clienta) incesantemente lo(*la) han rechazado este mes para un ascenso.
"The waiter [who provokes $that_{masc/fem}$ $client_{masc/fem}$ unceasingly] (him/*her) has been denied a promotion this month."

23. Al nadador que guía a ese(esa) anciano (anciana) torpemente lo(*la) han rescatado esta tarde entre las olas.
"The swimmer [who guides $that_{masc/fem}$ *elder man /elder woman* clumsily] (him/*her) has been rescued this afternoon from the waves."

24. Al abogado que escucha a ese(esa) magistrado (magistrada) atentamente lo(*la) han homenajeado este sábado en la universidad.
"The lawyer [who listens to $that_{masc/fem}$ $judge_{masc/fem}$ carefully] (him/*her) has been honored this Saturday at university."

25. Al profesor que censura a ese(esa) administrador(a) constantemente lo (*la) han aclamado este curso desde las aulas.
"The professor [who condemns $that_{masc/fem}$ $manager_{masc/fem}$ constantly] (him/*her) has been acclaimed this academic year from the lecture halls."

26. Al piloto que maldice a ese(esa) pasajero (pasajera) públicamente lo(*la) han llevado esta madrugada ante las autoridades.
"The pilot [who curses $that_{masc/fem}$ $passenger_{masc/fem}$ publicly] (him/*her) has been taken to the authorities this early morning."

27. Al bombero que acompaña a ese(esa) funcionario (funcionaria) diligentemente lo(*la) han fichado este invierno para las olimpiadas.
"The firefighter [who walks with $that_{masc/fem}$ $civilservant_{masc/fem}$ speedily] (him/*her) has been signed up this Winter for the Olympics."

28. Al soldado que patea a ese(esa) refugiado (refugiada) violentamente lo(*la) han enviado esta semana a un campo.
"The soldier [who kicks $that_{masc/fem}$ $refugee_{masc/fem}$ violently] (him/*her) has been sent this week to a (detention) camp."

29. Al actor que desprecia a ese(esa) regidor(a) escandalosamente lo(*la) han advertido esta temporada sobre las normas.
"The actor [who scorns $that_{masc/fem}$ $rehearsalaide_{masc/fem}$ flagrantly] (him/*her) has been warned this season about the rules."

30. Al empresario que despide a ese(esa) secretario (secretaria) educadamente lo(*la) han imputado este lunes por cuatro delitos.
"The businessman [who says goodbye to $that_{masc/fem}$ $secretary_{masc/fem}$ politely] (him/*her) has been charged this Monday with four crimes."

31. Al conductor que persigue a ese(esa) chico (chica) nerviosamente lo(*la) han echado este viernes de la taberna.
"The driver [who chases $that_{masc/fem}$ *boy/girl* nervously] (him/*her) has been thown out of the bar this Friday."

32. Al espectador que responde a ese(esa) presentador(a) malamente lo(*la) han requerido este miércoles en otro programa.
"The spectator [who replies $that_{masc/fem}$ *anchorman/anchorwoman* badly] (him/*her) has been required this Wednesday on other programme."

33. Al traductor que ningunea a ese(esa) editor(a) completamente lo(*la) han cargado este cuatrimestre de trabajo extra.
"The translator [who brushes $that_{masc/fem}$ $editor_{masc/fem}$ aside fully] (him/*her) has been loaded with additional work this four-month period."

34. Al político que insulta a ese(esa) ciudadano (ciudadana) frecuentemente lo(*la) han liberado este ciclo de la cárcel.
"The politician [who insults $that_{masc/fem}$ $citizen_{masc/fem}$ frequently] (him/*her) has been released this term from jail."

35. Al obispo que engaña a ese(esa) peregrino (peregrina) impunemente lo(*la) han descartado este año para las misiones.
"The bishop [who deceives $that_{masc/fem}$ $pilgrim_{masc/fem}$ with impunity] (him/*her) has been rejected this year from the missions."

36. Al farmacéutico que espera a ese(esa) repartidor(a) pacientemente lo(*la) han llamado este martes desde el laboratorio.

"The pharmacist [who waits for $that_{masc/fem}$ *deliveryman (deliverywoman* patiently] (him/*her) has been called this Tuesday from the laboratory."

37. Al científico que supervisa a ese(esa) biólogo (bióloga) cuidadosamente lo(*la) han becado este curso para el proyecto.
"The scientist [who supervises $that_{masc/fem}$ $biologist_{masc/fem}$ carefully] (him/*her) has been awarded a grant for the project this academic year."

38. Al marinero que cuida a ese(esa) patrón (patrona) fielmente lo(*la) han alejado esta campaña de la mar.
"The sailor [who looks after $that_{masc/fem}$ $boss_{masc/fem}$ faithfully] (him/*her) has been moved away this season from the sea."

39. Al luchador que agarra a ese(esa) preparador(a) fuertemente lo(*la) han sancionado esta temporada de por vida.
"The fighter [who holds $that_{masc/fem}$ $personaltrainer_{masc/fem}$ tightly] (him/*her) has been penalized this season for life."

40. Al monitor que presiona a ese(esa) montañero (montañera) insistentemente lo(*la) han amonestado esta madrugada en la federación.
"The teacher [who pressures $that_{masc/fem}$ $mountaineer_{masc/fem}$ constantly] (him/*her) has been booked this early morning in the federation."

41. Al barrendero que regaña a ese(esa) vecino (vecina) regularmente lo(*la) han contratado esta noche para las fiestas.
"The street cleaner [who scolds $that_{masc/fem}$ $neighbor_{masc/fem}$ regularly] (him/*her) has been hired tonight for the festival."

42. Al delegado que consulta a ese(esa) decano (decana) trimestralmente lo(*la) han citado esta tarde en la biblioteca.
"The (school) delegate [who consults $that_{masc/fem}$ $dean_{masc/fem}$ quarterly] (him/*her) has been called this afternoon to the library."

43. Al carnicero que ofende a ese(esa) pescadero (pescadera) públicamente lo(*la) han marginado este mes en el barrio.
"The butcher [who offends $that_{masc/fem}$ $fishmonger_{masc/fem}$ continuously] (him/*her) has been ostracized this month in the neighborhood."

44. Al joyero que apalea a ese(esa) ladrón (ladrona) repetidamente lo(*la) han acosado esta quincena con varios anónimos.
"The jeweler [who hits $that_{masc/fem}$ $robber_{masc/fem}$ repeteadly] (him/*her) has been harassed in these two weeks with several anonymous (letters)."

45. Al obrero que sigue a ese(esa) decorador(a) obedientemente lo(*la) han recomendado esta semana para futuras reformas.
"The worker [who follows $that_{masc/fem}$ $decorator_{masc/fem}$ obediently] (him/*her) has been recommended this week for future remodelings."

46. Al compositor que respalda a ese(esa) anfitrión (anfitriona) totalmente lo(*la) han homenajeado este ciclo en la ópera.
"The composer [who supports $that_{masc/fem}$ $host_{masc/fem}$ totally] (him/*her) has been honored this season in the opera."

47. Al cazador que desafía a ese(esa) pastor(a) nuevamente lo(*la) han desprovisto este invierno de su licencia.
"The hunter [who challenges $that_{masc/fem}$ $shepherd_{masc/fem}$ again] (him/*her) has been deprived this winter of his license."

48. Al técnico que ignora a ese(esa) supervisor(a) constantemente lo(*la) han trasladado este otoño a otra sección.
"The technician [who disregards $that_{masc/fem}$ $supervisor_{masc/fem}$ constantly] (him/*her) has been transferred this Fall to another department."

F Results from Experiment 4 to Experiment 8

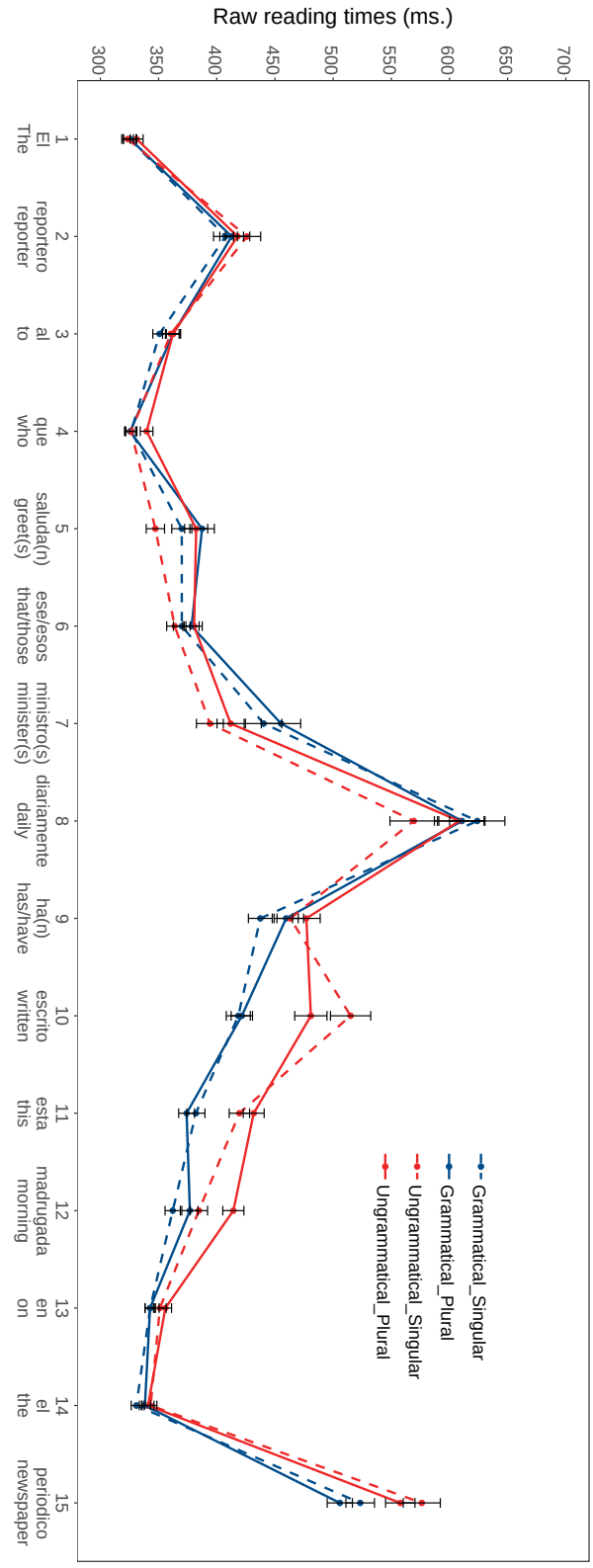

FIGURE F.1: Region-by-region means in milliseconds in Experiment 4. Error bars indicate the standard error of the mean.

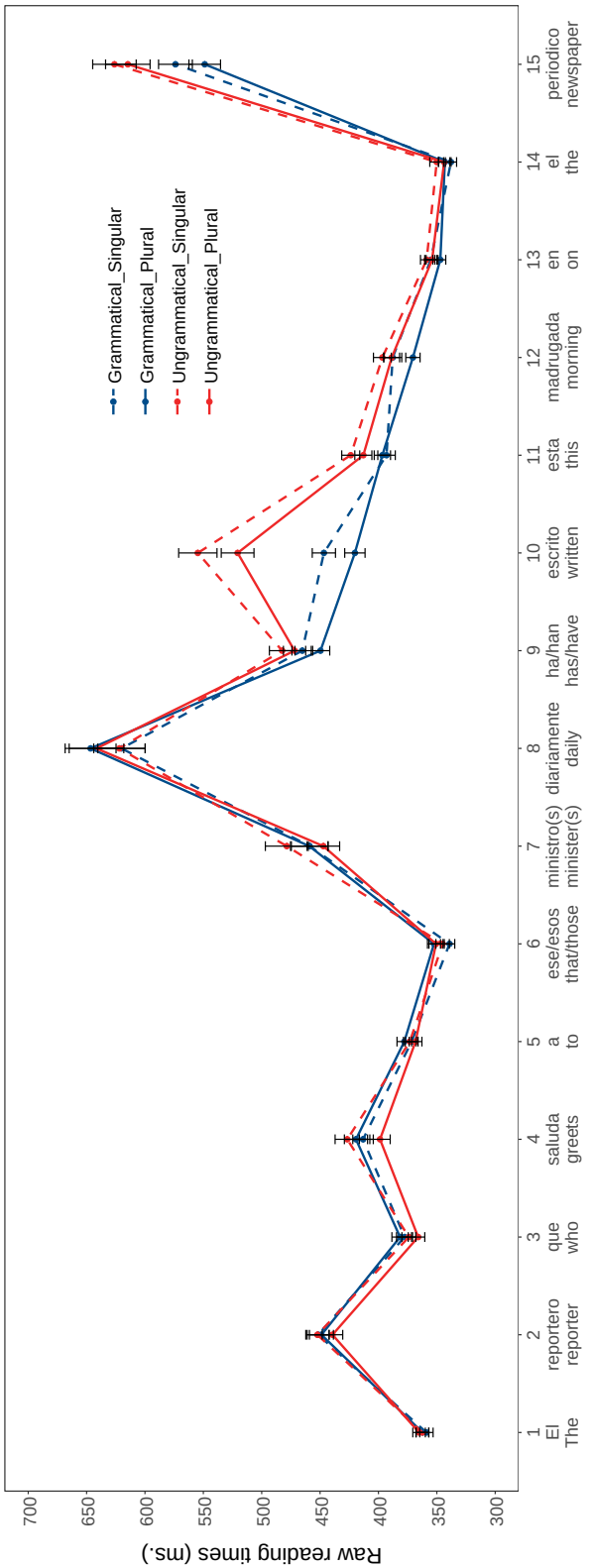

FIGURE F.2: Region-by-region means in milliseconds in Experiment 5. Error bars indicate the standard error of the mean.

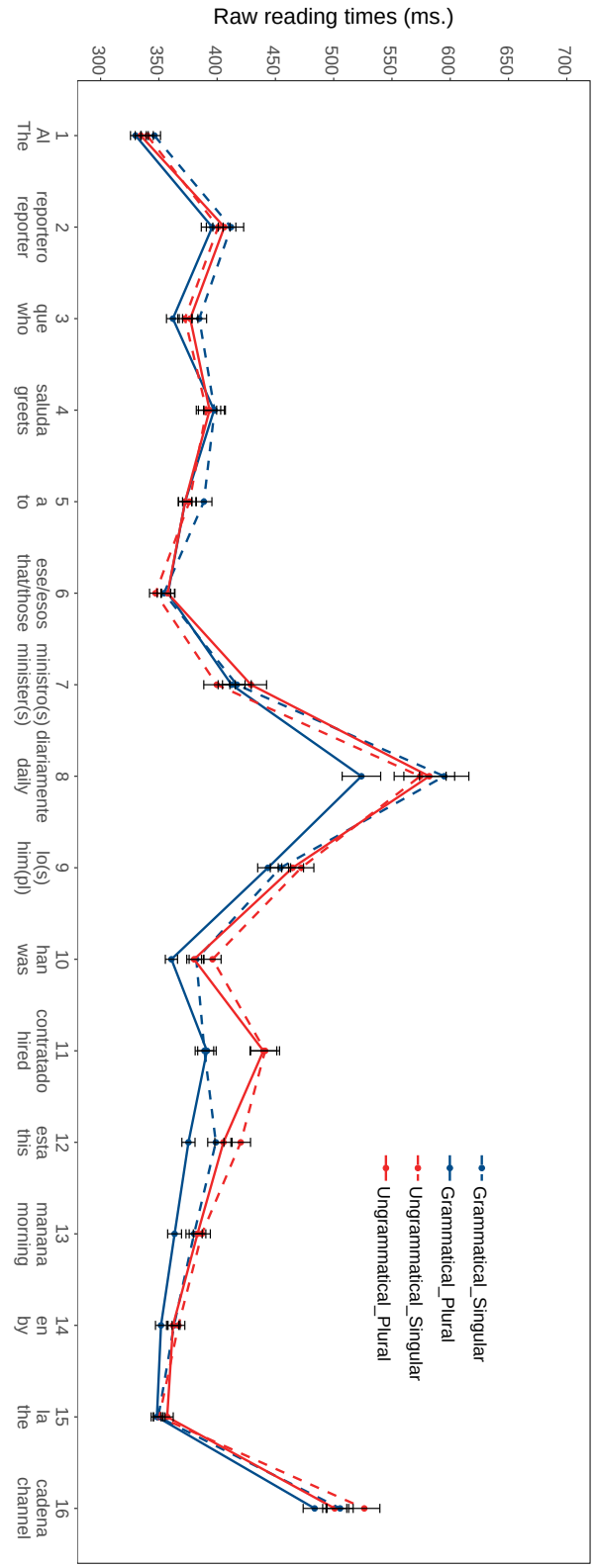

FIGURE F.3: Region-by-region means in milliseconds in Experiment 6. Error bars indicate the standard error of the mean.

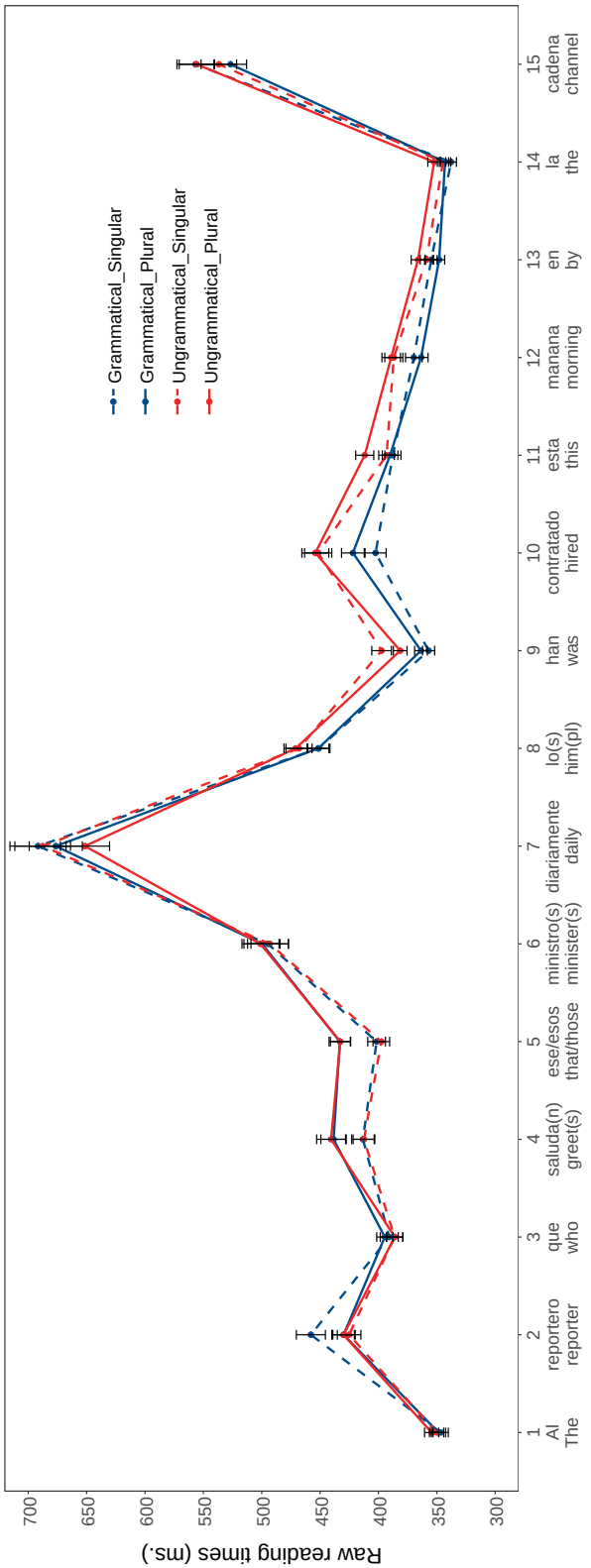

FIGURE F.4: Region-by-region means in milliseconds in Experiment 7. Error bars indicate the standard error of the mean.

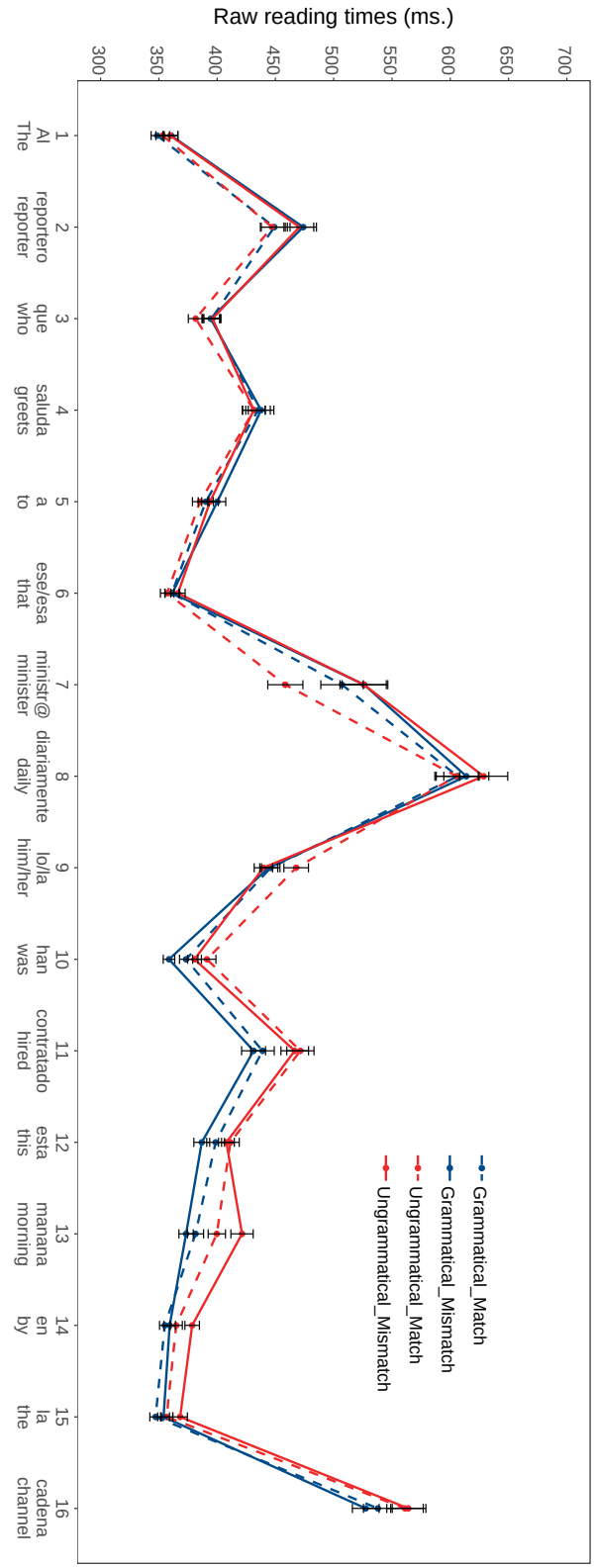

FIGURE F.5: Region-by-region means in milliseconds in Experiment 8. Error bars indicate the standard error of the mean.

Bibliography

Acuña-Fariña, J. C., Meseguer, E., and Carreiras, M. (2014). Gender and number agreement in comprehension in Spanish. *Lingua*, 143:108–128.

Alcocer, P. and Phillips, C. (2009). A cross-language reversal in illusory agreement licensing. In *Poster Presented at the 22nd Annual CUNY Conference on Human Sentence Processing (Davis: University of California)*.

Almeida, J., Knobel, M., Finkbeiner, M., and Caramazza, A. (2007). The locus of the frequency effect in picture naming: When recognizing is not enough. *Psychonomic bulletin & review*, 14(6):1177–1182.

Anderson, J. R. (2005). Human symbol manipulation within an integrated cognitive architecture. *Cognitive science*, 29(3):313–341.

Anderson, J. R., Bothell, D., Byrne, M. D., Douglass, S., Lebiere, C., and Qin, Y. (2004). An integrated theory of the mind. *Psychological Review*, 111(4):1036–1060.

Anton-Mendez, I. (1996). Clitics and attraction errors: an experimental study on language production. Master's thesis, University of Arizona.

Anton-Mendez, M. I. (1999). *Gender and number Agreement processing in Spanish*. PhD thesis, University of Arizona.

Anton-Mendez, M. I., Nicol, J., and Garett, M. F. (2002). The relation between gender and number agreement processing. *Syntax*, 5(1):1–25.

Ariel, M. (1990). Accessing noun-phrase antecedents. *Routlege, Londres. Linguistics, COLING*, 96:113–118.

Arnold, J. E. (1998). *Reference form and discourse patterns*. PhD thesis, Stanford University Stanford, CA.

Arnold, J. E., Eisenband, J. G., Brown-Schmidt, S., and Trueswell, J. C. (2000). The rapid use of gender information: Evidence of the time course of pronoun resolution from eyetracking. *Cognition*, 76(1):B13–B26.

Baayen, R. H., Davidson, D. J., and Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of memory and language*, 59(4):390–412.

Baddeley, A. D. and Hitch, G. (1974). Working memory. In *Psychology of learning and motivation*, volume 8, pages 47–89. Elsevier.

Badecker, W. and Kuminiak, F. (2007). Morphology, agreement and working memory retrieval in sentence production: Evidence from gender and case in Slovak. *Journal of Memory and Language*, 56:65–85.

Badecker, W. and Lewis, R. (2007). A new theory and computational model of working memory in sentence production: Agreement errors as failures of cue-based retrieval. In *20th annual CUNY sentence processing conference. San Diego, La Jolla, CA: University of California*.

Badecker, W. and Straub, K. (2002). The processing role of structural constraints on interpretation of pronouns and anaphors. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28(4):748–769.

Bates, D., Maechler, M., Bolker, B., and Walker, S. (2015). *Lme4: Linear mixed-effects models using Eigen and S4*. R package version 1.1-8.

Besner, D. and McCann, R. S. (1987). Word frequency and pattern distortion in visual word identification and production: An examination of four classes of models. *In M. Coltheart (Ed.), Attention and performance: The psychology of reading*, 12:201–219.

Betancort, M., Carreiras, M., and Sturt, P. (2009). The processing of subject and object relative clauses in spanish: An eye-tracking study. *The Quarterly Journal of Experimental Psychology*, 62(10):1915–1929.

Bock, K. and Cutting, J. C. (1992). Regulating mental energy: Performance units in language production. *Journal of Memory and Language*, 31:99–127.

Bock, K. and Eberhard, K. M. (1993). Meaning, sound and syntax in English number agreement. *Language and Cognitive Processes*, 8(1):57–99.

Bock, K., Eberhard, K. M., Cutting, J. C., Meyer, A. S., and Schriefers, H. (2001). Some attractions of verb agreement. *Cognitive Psychology*, 43:83–128.

Bock, K. and Miller, C. A. (1991). Broken agreement. *Cognitive Psychology*, 23:45–93.

Bonin, P. and Fayol, M. (2002). Frequency effects in the written and spoken production of homophonic picture names. *European Journal of Cognitive Psychology*, 14(3):289–313.

Brennan, S. E. (1995). Centering attention in discourse. *Language and Cognitive processes*, 10(2):137–167.

Brennan, S. E., Friedman, M. W., and Pollard, C. J. (1987). A centering approach to pronouns. In *Proceedings of the 25th annual meeting on Association for Computational Linguistics*, pages 155–162. Association for Computational Linguistics.

Brown, A. S. (2012). *The tip of the tongue state*. Taylor & Francis.

Brown, E. L. and Rivas, J. (2012). Grammatical relation probability: How usage patterns shape analogy. *Language Variation and Change*, 24(3):317–341.

Cacciari, C., Carreiras, M., and Cionini, C. B. (1997). When words have two genders: Anaphor resolution for italian functionally ambiguous words. *Journal of Memory and Language*, 37(4):517–532.

Carminati, M. N. (2005). Processing reflexes of the feature hierarchy (person> number> gender) and implications for linguistic theory. *Lingua*, 115(3):259–285.

Carreiras, M., Duñabeitia, J. A., Vergara, M., De La Cruz-Pavía, I., and Laka, I. (2010). Subject relative clauses are not universally easier to process: Evidence from basque. *Cognition*, 115(1):79–92.

Chafe, W. L. and Li, C. N. (1976). Givenness, contrastiveness, definiteness, subjects, topics, and point of view in subject and topic. In *Subject and topic: [papers]*, volume Academic Press rapid manuscript reproduction. Academic Press.

Chen, Z. and Cowan, N. (2005). Chunk limits and length limits in immediate recall: a reconciliation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 31(6):1235.

Chen, Z., Jäger, L., and Vasishth, S. (2012). How structure sensitive is the parser? evidence from Mandarin Chinese. *Empirical Approaches to Linguistic Theory: Studies of Meaning and Structure, Studies in Generative Grammar*, pages 43–62.

Chomsky, N. (1986). *Lectures on Government and Binding. The Pisa Lectures*. Foris Publications Holland, 5 edition.

Clackson, K., Felser, C., and Clahsen, H. (2011). Children's processing of reflexives and pronouns in English: Evidence from eye-movements during listening. *Journal of Memory and Language*, 65(2):128–144.

Clifton, C., Frazier, L., and Deevy, P. (1999). Feature manipulation in sentence comprehension: 2703. *Italian journal of linguistics*, 11(1):11–40.

Cloitrew, M. and Bever, T. G. (1988). Linguistic anaphors, levels of representation, and discourse. *Language and cognitive processes*, 3(4):293–322.

Colangelo, A., Holden, J. G., Buchanan, L., and Van Orden, G. C. (2004). Speculation about behavior, brain damage, and self-organization: The other way to herd a cat. *Brain and language*, 90(1):151–159.

Cowan, N. (2001). The magical number 4 in short-term memory: A reconsideration of mental storage capacity. *Behavioral and Brain Sciences*, 24(1):87–185.

Cowan, N. (2005). Working memory capacity limits in a theoretical context. In *Human learning and memory: Advances in theory and application. The 4th Tsukuba international conference on memory*, pages 155–175. Lawrence Erlbaum Associates, Publishers Mahwah.

Cowan, N. (2010). The magical mystery four: How is working memory capacity limited, and why? *Current directions in psychological science*, 19(1):51–57.

Crawley, R. A., Stevenson, R. J., and Kleinman, D. (1990). The use of heuristic strategies in the interpretation of pronouns. *Journal of Psycholinguistic Research*, 19(4):245–264.

Crocker, M. W. (1992). *A logical model of competence and performance in the human sentence processor*. PhD thesis, Human Communication Research Centre.

Crowder, R. G. (1993). Short-term memory: Where do we stand? *Memory & Cognition*, 21(2):142–145.

Cunnings, I. and Felser, C. (2013). The role of working memory in the processing of reflexives. *Language and Cognitive Processes*, 28(1-2):188–219.

Cunnings, I. and Sturt, P. (2014). Coargumenthood and the processing of reflexives. *Journal of Memory and Language*, 75:117–139.

Davis, C. J. and Perea, M. (2005). Buscapalabras: A program for deriving orthographic and phonological neighborhood statistics and other psycholinguistic indices in spanish. *Behavior Research Methods*, 37(4):665–671.

Dell, G. S. (1990). Effects of frequency and vocabulary type on phonological speech errors. *Language and cognitive processes*, 5(4):313–349.

Di Domenico, E. and De Vicenzi, M. (1995). Gender and number in the retrieval of pronoun antecedents: differences in use and representation. *Actes du deuxième colloqueLangues et grammaire', Paris 8 juin 1995*, pages 95–109.

Dillon, B. (2011). *Structured access in sentence comprehension*. PhD thesis, University of Maryland, College Park.

Dillon, B. (2014). Syntactic memory in the comprehension of reflexive dependencies: an overview. *Language and Linguistics Compass*, 8(5):171–187.

Dillon, B., Chow, W.-Y., Wagers, M., Guo, T., Liu, F., and Phillips, C. (2014). The structure-sensitivity of memory access: Evidence from Mandarin Chinese. *Frontiers in Psychology*, 5.

Dillon, B., Mishler, A., Sloggett, S., and Phillips, C. (2013). Contrasting intrusion profiles for agreement and anaphora: Experimental and modeling evidence. *Journal of Memory and Language*, 69(2):85–103.

Dominguez, A., Cuetos, F., and Segui, J. (1999). The processing of grammatical gender and number in spanish. *Journal of Psycholinguistic Research*, 28(5):485–498.

Drieghe, D., Pollatsek, A., Juhasz, B. J., and Rayner, K. (2010). Parafoveal processing during reading is reduced across a morphological boundary. *Cognition*, 116(1):136–142.

Drummond, A. (2013). Ibexfarm[software].

Duchon, A., Perea, M., Sebastián-Gallés, N., Martí, A., and Carreiras, M. (2013). Espal: One-stop shopping for spanish word properties. *Behavior research methods*, 45(4):1246–1258.

Eberhard, K. M. (1997). The marked effect of number on subject-verb agreement. *Journal of Memory and Language*, 36:147–164.

Eberhard, K. M., Cutting, J. C., and Bock, K. (2005). Making syntax of sense: Number agreement in sentence production. *Psychological Review*, 112(3):531–559.

Egusquiza, N., Navarrete, E., and Zawiszewski, A. (2016). Antecedent frequency effects on anaphoric pronoun resolution: Evidence from spanish. *Journal of Psycholinguistic Research*, 45(1):71–84.

Ellis, N. C. (2002). Frequency effects in language processing. *Studies in Second Language Acquisition*, 24(02):143–188.

Engelmann, F., Jäger, L. A., and Vasishth, S. (2016). The effect of prominence and cue association in retrieval processes: A computational account [dec 4 2016 accepted draft]. *Journal of Memory and Language*.

Falk, Y. N. (2006). *Subjects and universal grammar: An explanatory theory*, volume 113. Cambridge University Press.

Fayol, M., Largy, P., and Lemaire, P. (1994). Cognitive overload and orthographic errors: When cognitive overload enhances subject-verb agreement errors. a study in French written language. *The Quarterly Journal of Experimental Psychology*, 47A(2):437–464.

Ferreira, F. and Clifton Jr, C. (1986). The independence of syntactic processing. *Journal of memory and language*, 25(3):348–368.

Finocchiaro, C. and Caramazza, A. (2006). The production of pronominal clitics: Implications for theories of lexical access. *Language and Cognitive Processes*, 21(1-3):141–180.

Folk, J. R. and Morris, R. K. (2003). Effects of syntactic category assignment on lexical ambiguity resolution in reading: An eye movement analysis. *Memory & Cognition*, 31(1):87–99.

Foote, R. and Bock, K. (2012). The role of morphology in subject–verb number agreement: A comparison of mexican and dominican spanish. *Language and Cognitive Processes*, 27(3):429–461.

Foraker, S. and McElree, B. (2007). The role of prominence in pronoun resolution: Active versus passive representations. *Journal of Memory and Language*, 56(3):357–383.

Forster, K. I. (1979). Levels of processing and the structure of the language processes. *Sentence processing: Psycholinguistic studies presented to Merril Garret*, pages 27–84.

Forster, K. I. and Chambers, S. M. (1973). Lexical access and naming time. *Journal of Verbal Learning and Verbal Behavior*, 12(6):627–635.

Francis, W. N. (1986). Proximity concord in English. *Journal of English Linguistics*, 19(2):309–317.

Franck, J., Colonna, S., and Rizzi, L. (2015). Task-dependency and structure-dependency in number interference effects in sentence comprehension. *Frontiers in Psychology*, 6.

Franck, J., Cronel-Ohayon, S., Chillier, L., Frauenfelder, U. H., Hamann, C., Rizzi, L., and Zesiger, P. (2004). Normal and pathological development of subject–verb agreement in speech production: A study on french children. *Journal of Neurolinguistics*, 17(2):147–180.

Franck, J., Lassi, G., Frauenfelder, U. H., and Rizzi, L. (2006). Agreement and movement: A syntactic analysis of attraction. *Cognition*, 101:173–216.

Franck, J., Soare, G., Frauenfelder, U. H., and Rizzi, L. (2010). Object interference in subject–verb agreement: The role of intermediate traces of movement. *Journal of Memory and Language*, 62(2):166–182.

Franck, J., Vigliocco, G., and Nicol, J. (2002). Subject-verb agreement errors in French and English: The role of syntactic hierarchy. *Language and Cognitive Processes*, 17(4):371–404.

Franco, J. A. (1993). *On object agreement in Spanish*. University of Southern California. Graduate Students in Linguistics.

Frazier, L. (1987). Syntactic processing: evidence from dutch. *Natural Language & Linguistic Theory*, 5(4):519–559.

Frazier, L. (1990). Parsing modifiers: Special purpose routines in the human sentence processing mechanism. *Comprehension processes in reading*, pages 303–330.

Frazier, L. and Clifton, C. (1996). *Construal*. Mit Press.

Fuchs, Z., Polinsky, M., and Scontras, G. (2015). The differential representation of number and gender in spanish. *The linguistic review*, 32(4):703–737.

Gahl, S. and Garnsey, S. M. (2006). Knowledge of grammar includes knowledge of syntactic probabilities. *Language*, 82(2):405–410.

Garnham, A. (2001). *Mental models and the interpretation of anaphora*. Psychology Press.

Garnham, A., Oakhill, J., Ehrlich, M.-F., and Carreiras, M. (1995). Representations and processes in the interpretation of pronouns: New evidence from spanish and french. *Journal of Memory and Language*, 34(1):41.

Garnham, A., Traxler, M., Oakhill, J., and Gernsbacher, M. A. (1996). The locus of implicit causality effects in comprehension. *Journal of memory and language*, 35(4):517–543.

Garraffa, M. and Di Domenico, A. (2016). Interference in processing agreement: The impact of grammatical cues. *Journal of psycholinguistic research*, 45(2):337–358.

Gernsbacher, M. A. (1991). Cognitive processes and mechanisms in language comprehension: The structure building framework. *Psychology of Learning and Motivation*, 27:217–263.

Gernsbacher, M. A. and Hargreaves, D. J. (1988). Accessing sentence participants: The advantage of first mention. *Journal of Memory and Language*, 27(6):699–717.

Ghemawat, S., Gobioff, H., and Leung, S.-T. (2003). The google file system. In *Proceedings of the Nineteenth ACM Symposium on Operating Systems Principles*, SOSP '03, pages 29–43, New York, NY, USA. ACM.

Gianico, J. L. (2010). *Word concreteness and word frequency as moderators of the tip-of-the-tongue effect*. State University of New York at Albany.

Gillespie, M. and Pearlmutter, N. J. (2013). Against structural constraints in subject-verb agreement production. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 39(2):515–528.

Glanzer, M. and Adams, J. K. (1990). The mirror effect in recognition memory: data and theory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 16(1):5.

Gordon, P. C., Grosz, B. J., and Gilliom, L. A. (1993). Pronouns, names, and the centering of attention in discourse. *Cognitive science*, 17(3):311–347.

Gordon, P. C., Hendrick, R., and Johnson, M. (2001). Memory interference during language processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(6):1411.

Gordon, P. C., Hendrick, R., and Johnson, M. (2004). Effects of noun phrase type on sentence complexity. *Journal of Memory and Language*, 51(1):97–114.

Gordon, P. C., Hendrick, R., Johnson, M., and Lee, Y. (2006). Similarity-based interference during language comprehension: Evidence from eye tracking during reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 32(6):1304–1321.

Gordon, P. C., Hendrick, R., and Levine, W. H. (2002). Memory-load interference in syntactic processing. *Psychological science*, 13(5):425–430.

Gouvea, A. C., Phillips, C., Kazanina, N., and Poeppel, D. (2010). The linguistic processes underlying the p600. *Language and cognitive processes*, 25(2):149–188.

Greenberg, J. H. (1963). Some universals of grammar with particular reference to the order of meaningful elements. *Universals of language*, 2:73–113.

Grosz, B. J., Weinstein, S., and Joshi, A. K. (1995). Centering: A framework for modeling the local coherence of discourse. *Computational linguistics*, 21(2):203–225.

Hammer, A., Goebel, R., Schwarzbach, J., Münte, T. F., and Jansma, B. M. (2007). When sex meets syntactic gender on a neural basis during pronoun processing. *Brain research*, 1146:185–198.

Hankamer, J. and Sag, I. (1976). Deep and surface anaphora. *Linguistic inquiry*, 7(3):391–428.

Harrison, A. J. (2009). *Production of subject-verb agreement in Slovene and English*. PhD thesis, University of Edinburgh.

Hartsuiker, R. J., Antón-Méndez, I., and van Zee, M. (2001). Object attraction in subject-verb agreement construction. *Journal of Memory and Language*, 45(4):546–572.

Hartsuiker, R. J., Schriefers, H., Bock, K., and Kikstra, G. M. (2003). Morphophonological influences on the construction of subject–verb agreement. *Memory and Cognition*, 31(8):1316–1326.

Haskell, T. R. and MacDonald, M. C. (2003). Conflicting cues and competition in subject-verb agreement. *Journal of Memory and Language*, 48(4):760–778.

Heine, A., Tamm, S., Hofmann, M., Bösel, R. M., and Jacobs, A. M. (2006a). Event-related theta activity reflects memory processes in pronoun resolution. *Neuroreport*, 17(18):1835–1839.

Heine, A., Tamm, S., Hofmann, M., Hutzler, F., and Jacobs, A. M. (2006b). Does the frequency of the antecedent noun affect the resolution of pronominal anaphors?: An erp study. *Neuroscience Letters*, 400(1):7–12.

Igoa, J. M., Garcia-Albea, J. E., and Sanchez-Casas, R. (1999). Gender-number dissociations in sentence production in spanish. *Rivista di Linguistica*, 11(1):163–196.

Irmen, L. and Knoll, J. (1999). On the use of the grammatical gender of anaphoric pronouns in german. a comparison between finns and germans. *Sprache & Kognition*, 18(3-4):123–135.

Jäger, L. A., Benz, L., Roeser, J., Dillon, B. W., and Vasishth, S. (2015). Teasing apart retrieval and encoding interference in the processing of anaphors. *Frontiers in Psychology*, 6.

Jäger, L. A., Engelmann, F., and Vasishth, S. (2015). Retrieval interference in reflexive processing: Experimental evidence from Mandarin, and computational modeling. *Frontiers in Psychology*, 6.

Jäger, L. A., Engelmann, F., and Vasishth, S. (2017). Similarity-based interference in sentence comprehension: Literature review and Bayesian meta-analysis. *Journal of Memory and Language*, 94:316–339.

Järvikivi, J., van Gompel, R. P., Hyönä, J., and Bertram, R. (2005). Ambiguous pronoun resolution: Contrasting the first-mention and subject-preference accounts. *Psychological Science*, 16(4):260–264.

Jescheniak, J. D. and Levelt, W. J. (1994). Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 20(4):824.

Johnson, R. L., Perea, M., and Rayner, K. (2007). Transposed-letter effects in reading: Evidence from eye movements and parafoveal preview. *Journal of Experimental Psychology: Human Perception and Performance*, 33(1):209.

Just, M. A. and Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological review*, 87(4):329.

Just, M. A., Carpenter, P. A., and Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of experimental psychology: General*, 111(2):228.

Kaan, E. (2002). Investigating the effects of distance and number interference in processing subject-verb dependencies: An erp study. *Journal of Psycholinguistic Research*, 31(2):165–193.

Keenan, E. L. and Comrie, B. (1977). Noun phrase accessibility and universal grammar. *Linguistic inquiry*, 8(1):63–99.

Kennison, S. M. and Gordon, P. C. (1997). Comprehending referential expressions during reading: Evidence from eye tracking. *Discourse Processes*, 24(2-3):229–252.

Kennison, S. M. and Trofe, J. L. (2003). Comprehending pronouns: A role for word-specific gender stereotype information. *Journal of Psycholinguistic Research*, 32(3):355–378.

Knobel, M., Finkbeiner, M., and Caramazza, A. (2008). The many places of frequency: Evidence for a novel locus of the lexical frequency effect in word production. *Cognitive Neuropsychology*, 25(2):256–286.

Komogortsev, O. V., Jayarathna, S., Koh, D. H., and Gowda, S. M. (2010). Qualitative and quantitative scoring and evaluation of the eye movement classification algorithms. In *Proceedings of the 2010 Symposium on eye-tracking research & applications*, pages 65–68. ACM.

Kwon, N. and Sturt, P. (2016). Attraction effects in honorific agreement in korean. *Frontiers in Psychology*, 7.

Lago, M. S. (2014). *Memory and Prediction in Cross-Linguistic Sentence Comprehension*. PhD thesis, University of Maryland-College Park.

Lago, S., Shalom, D. E., Sigman, M., Lau, E. F., and Phillips, C. (2015). Agreement attraction in Spanish comprehension. *Journal of Memory and Language*, 82:133–149.

Laubstein, A. S. (1999). Lemmas and lexemes: The evidence from blends. *Brain and language*, 68(1):135–143.

Laubstein, A. S. (2002). Experimental evidence for serial models of lexical access: A judgment task. *Brain and language*, 81(1-3):424–431.

Levelt, W. J. (1999). Models of word production. *Trends in Cognitive Sciences*, 3(6):223–232.

Levelt, W. J., Roelofs, A., and Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22(1):1–38.

Lewis, R. L. (1993). *An Architecturally-based Theory of Human Sentence Comprehension*. PhD thesis, Carnegie Mellon University.

Lewis, R. L. (1996). Interference in short-term memory: The magical number two (or three) in sentence processing. *Journal of Psycholinguistic Research*, 25(1):93–115.

Lewis, R. L. and Vasishth, S. (2005). An activation-based model of sentence processing as skilled memory retrieval. *Cognitive Science*, 29(3):375–419.

Lewis, R. L., Vasishth, S., and Dyke, J. A. V. (2006). Computational principles of working memory in sentence comprehension. *Trends in Cognitive Sciences*, 10(10):447–454.

Lorimor, H., Bock, K., Zalkind, E., Sheyman, A., and Beard, R. (2008). Agreement and attraction in Russian. *Language and Cognitive Processes*, 23(6):769–799.

Lorimor, H., Jackson, C. N., and Foote, R. (2015). How gender affects number: Cue-based retrieval in agreement production. *Language, Cognition and Neuroscience*, 30(8):947–954.

Lowder, M. W., Choi, W., and Gordon, P. C. (2013). Word recognition during reading: The interaction between lexical repetition and frequency. *Memory & Cognition*, 41(5):738–751.

Lucas, M. M., Tanenhaus, M. K., and Carlson, G. N. (1990). Levels of representation in the interpretation of anaphoric reference and instrument inference. *Memory & Cognition*, 18(6):611–631.

Mak, W. M., Vonk, W., and Schriefers, H. (2008). Discourse structure and relative clause processing. *Memory & Cognition*, 36(1):170–181.

Malmberg, K. J. and Nelson, T. O. (2003). The word frequency effect for recognition memory and the elevated-attention hypothesis. *Memory & Cognition*, 31(1):35–43.

Martin, A. E. and McElree, B. (2008). A content-addressable pointer mechanism underlies comprehension of verb-phrase ellipsis. *Journal of Memory and Language*, 58(3):879–906.

Martin, A. E., Nieuwland, M. S., and Carreiras, M. (2014). Agreement attraction during comprehension of grammatical sentences: Erp evidence from ellipsis. *Brain and Language*, 135:42–51.

McElree, B. (2000). Sentence comprehension is mediated by content-addressable memory structures. *Journal of psycholinguistic research*, 29(2):111–123.

McElree, B. (2006). Accessing recent events. *Psychology of Learning and Motivation*, 46:155–200.

McElree, B., Foraker, S., and Dyer, L. (2003). Memory structures that subserve sentence comprehension. *Journal of Memory and Language*, 48(1):67–91.

Meyer, A. S. and Bock, K. (1999). Representations and processes in the production of pronouns: Some perspectives from dutch. *Journal of Memory and Language*, 41(2):281–301.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63(2):81–97.

Nairne, J. S. (1990). A feature model of immediate memory. *Memory & Cognition*, 18(3):251–269.

Navarrete, E., Basagni, B., Alario, F.-X., and Costa, A. (2006). Does word frequency affect lexical selection in speech production? *The Quarterly Journal of Experimental Psychology*, 59(10):1681–1690.

Ness, T. and Meltzer-Asscher, A. (2017). Working memory in the processing of long-distance dependencies: Interference and filler maintenance. *Journal of psycholinguistic research*, 46(6):1353–1365.

Nicenboim, B., Vasishth, S., Engelmann, F., and Suckow, K. (2018). Exploratory and confirmatory analyses in sentence processing: A case study of number interference in german. *Cognitive Science*, 42(S4):1075–1100.

Nicol, J., Foster, K., and Veres, C. (1997). Subject–verb agreement processes in comprehension. *Journal of Memory and Language*, 36:569–587.

Nicol, J. and Swinney, D. (1989). The role of structure in coreference assignment during sentence comprehension. *Journal of Psycholinguistic Research*, 18(1):5–19.

Nicol, J. L. and Swinney, D. (2003). The psycholinguistics of anaphora. *Anaphora: A reference guide*, pages 72–104.

Oberauer, K. and Kliegl, R. (2006). A formal model of capacity limits in working memory. *Journal of Memory and Language*, 55(4):601–626.

O'Brien, E. J. and Myers, J. L. (1985). When comprehension difficulty improves memory for text. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 11(1):12.

Oldfield, R. C. and Wingfield, A. (1965). Response latencies in naming objects. *Quarterly Journal of Experimental Psychology*, 17(4):273–281.

Olsen, A. (2012). The tobii i-vt fixation filter. *Tobii Technology*.

Ormazabal, J. and Romero, J. (2006). Object clitics, determiners, and agreement. ms. *University of the Basque Country/Hitt, University of Extremadura*.

Ormazabal, J. and Romero, J. (2007). The object agreement constraint. *Natural Language & Linguistic Theory*, 25(2):315.

Ormazabal, J. and Romero, J. (2013). Object clitics, agreement and dialectal variation. *International Journal of Latin and Romance Linguistics*, 25(2):301–344.

Pablos, L. (2006). *Pre-verbal Structure Building in Romance Languages and Basque*. PhD thesis, University of Maryland - College Park.

Parker, D., Lago, S., and Phillips, C. (2015). Interference in the processing of adjunct control. *Frontiers in Psychology*, 6.

Parker, D. and Phillips, C. (2017). Reflexive attraction in comprehension is selective. *Journal of Memory and Language*, 94:272–290.

Parker, D., Shvartsman, M., and Van Dyke, J. A. (2017). The cue-based retrieval theory of sentence comprehension: New findings and new challenges. *Language processing and disorders. Newcastle: Cambridge Scholars Publishing*.

Patil, U., Vasishth, S., and Lewis, R. L. (2016). Retrieval interference in syntactic processing: The case of reflexive binding in English. *Frontiers in Psychology*, 7.

Pearlmutter, N. (2000). Linear versus hierarchical agreement feature processing in comprehension. *Journal of Psycholinguistic Research*, 29(1):89–98.

Pearlmutter, N. J., Garnsey, S. M., and Bock, K. (1999). Agreement processes in sentence comprehension. *Journal of Memory and Language*, 41:427–456.

Phillips, C., Wagers, M. W., and Lau, E. F. (2011). Grammatical illusions and selective fallibility in real-time language comprehension. In Runner, J., editor, *Experiments at the Interfaces. Syntax & Semantics*, volume 37, pages 147–180. Emerald Group Publishing Limited.

Pineda, L. and Meza, I. (2005). The spanish pronominal clitic system. *Procesamiento del lenguaje natural*, 34.

Purkiss, E. (1978). The effect of foregrounding on pronominal reference. *Unpublished undergraduate thesis, Glasgow University, Glasgow, Scotland*.

Pynte, J. and Colonna, S. (2000). Decoupling syntactic parsing from visual inspection: The case of relative clause attachment in french. *Reading as a Perceptual Process*, pages 529–547.

Quirk, R., Greenbaum, S., Leech, G. N., and Svartvik, J. (1972). *A grammar of contemporary English*. Oxford Univ Press.

R Core Team (2014). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review*, 85(2):59–108.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin*, 114(3):510.

Rayner, K., Castelhano, M. S., and Yang, J. (2010). Preview benefit during eye fixations in reading for older and younger readers. *Psychology and Aging*, 25(3):714.

Rayner, K. and Duffy, S. A. (1986). Lexical complexity and fixation times in reading: Effects of word frequency, verb complexity, and lexical ambiguity. *Memory & Cognition*, 14(3):191–201.

Rayner, K., Raney, G. E., and Pollatsek, A. (1995). *Eye movements and discourse processing*. Lawrence Erlbaum Associates, Inc.

Rayner, K., Slattery, T. J., Drieghe, D., and Liversedge, S. P. (2011). Eye movements and word skipping during reading: effects of word length and predictability. *Journal of Experimental Psychology: Human Perception and Performance*, 37(2):514.

Rigalleau, F., Caplan, D., and Baudiffier, V. (2004). New arguments in favour of an automatic gender pronominal process. *The Quarterly Journal of Experimental Psychology Section A*, 57(5):893–933.

Rohde, D. (2001). Linger. http://tedlab.mit.edu/~dr/Linger/.

Ros, I., Egusquiza, N., and Laka, I. (2016). Agreement attraction effects in basque production and judgement acceptability data. Talk presented at Experimental Approaches to Arabic and Other Understudied Languages (EXAL+). NYU Abu Dhabi (EAU).

Sag, I. A. and Hankamer, J. (1984). Toward a theory of anaphoric processing. *Linguistics and Philosophy*, 7(3):325–345.

Salojärvi, J., Puolamäki, K., Simola, J., Kovanen, L., Kojo, I., and Kaski, S. (2005). Inferring relevance from eye movements: Feature extraction. In *Proceedings of the NIPS 2005 Workshop on Machine Learning for Implicit Feedback and User Modeling*. Publications in Computer and Information Science.

Sanford, A. J. and Garrod, S. C. (1981). *Understanding written language: Explorations of comprehension beyond the sentence*. John Wiley & Sons.

Schilling, H. E., Rayner, K., and Chumbley, J. I. (1998). Comparing naming, lexical decision, and eye fixation times: Word frequency effects and individual differences. *Memory & Cognition*, 26(6):1270–1281.

Shiffrin, R. M. (1976). Capacity limitations in information processing, attention, and memory. *Handbook of learning and cognitive processes*, 4:177–236.

Shiffrin, R. M. and Steyvers, M. (1997). A model for recognition memory: Rem—retrieving effectively from memory. *Psychonomic Bulletin & Review*, 4(2):145–166.

Simner, J. and Smyth, R. (1998). Anaphoric vs. stimulus-based lexical access. In *CUNY Conference on Human Sentence Processing, Rutgers University*.

Simner, J. and Smyth, R. (1999). Phonological activation in anaphoric lexical access (ala). *Brain and Language*, 68(1):40–45.

Solomon, E. S. and Pearlmutter, N. J. (2004). Semantic integration and syntactic planning in language production. *Cognitive Psychology*, 49:1–46.

Staub, A. (2009). On the interpretation of the number attraction effect: Response time evidence. *Journal of Memory and Language*, 60(2):308–327.

Staub, A. (2010). Response time distributional evidence for distinct varieties of number attraction. *Cognition*, 114(3):447–454.

Sturt, P. (2003). The time-course of the application of binding constraints in reference resolution. *Journal of Memory and Language*, 48(3):542–562.

Sturt, P. and Crocker, M. W. (1995). Incrementality and monotonicity in syntactic parsing. *Edinburgh Working Papers in Cognitive Science: Incremental Interpretation*, 11:23–66.

Tanner, D., Nicol, J., and Brehm, L. (2014). The time-course of feature interference in agreement comprehension: Multiple mechanisms and asymmetrical attraction. *Journal of Memory and Language*, 76:195–215.

Traxler, M. J., Morris, R. K., and Seely, R. E. (2002). Processing subject and object relative clauses: Evidence from eye movements. *Journal of Memory and Language*, 47(1):69–90.

Tucker, M. A., Idrissi, A., and Almeida, D. (2015). Representing number in the real-time processing of agreement: self-paced reading evidence from arabic. *Frontiers in Psychology*, 6.

Van Dyke, J. (2007). Interference effects from grammatically unavailable constituents during sentence processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 33(2):407.

Van Dyke, J. and Lewis, R. (2003). Distinguishing effects of structure and decay on attachment and repair: A cue-based parsing account of recovery from misanalyzed ambiguities. *Journal of Memory and Language*, 49(3):285–316.

Van Dyke, J. A. (2002). *Retrieval effects in sentence parsing and interpretation*. PhD thesis, University of Pittsburgh.

Van Dyke, J. A. and McElree, B. (2006). Retrieval interference in sentence comprehension. *Journal of Memory and Language*, 55(2):157–166.

Van Dyke, J. A. and McElree, B. (2011). Cue-dependent interference in comprehension. *Journal of Memory and Language*, 65(3):247–263.

Van Gompel, R. P. and Majid, A. (2004). Antecedent frequency effects during the processing of pronouns. *Cognition*, 90(3):255–264.

Vigliocco, G. (1996). One or more labels on the bottles? notional concord in dutch and french. *Language and Cognitive Processes*, 11(4):407–442.

Vigliocco, G., Butterworth, B., and Garett, M. F. (1996). Subject-verb agreement in Spanish and English: Differences in the role of conceptual constraint. *Cognition*, 61:261–298.

Vigliocco, G., Butterworth, B., and Semenza, C. (1995). Constructing subject-verb agreement in speech: The role of semantic and morphological factors. *Journal of Memory and Language*, 34:186–215.

Vigliocco, G. and Nicol, J. (1998). Separating hierarchical relations and word order in language production: Is proximity concord syntactic or linear? *Cognition*, 68:B13–B29.

Villata, S., Tabor, W., and Franck, J. (2018). Encoding and retrieval interference in sentence comprehension: Evidence from agreement. *Frontiers in psychology*, 9:2.

Vitevitch, M. S. and Sommers, M. S. (2003). The facilitative influence of phonological similarity and neighborhood frequency in speech production in younger and older adults. *Memory & Cognition*, 31(4):491–504.

Wagers, M. W., Lau, E. F., and Phillips, C. (2009). Agreement attraction in comprehension: Representations and processes. *Journal of Memory and Language*, 61:206–237.

Xiang, M., Dillon, B., and Phillips, C. (2009). Illusory licensing effects across dependency types: ERP evidence. *Brain & Language*, 108:40–55.

Yarbus, A. L. (1967). Eye movements during perception of complex objects. In *Eye movements and vision*, pages 171–211. Springer.