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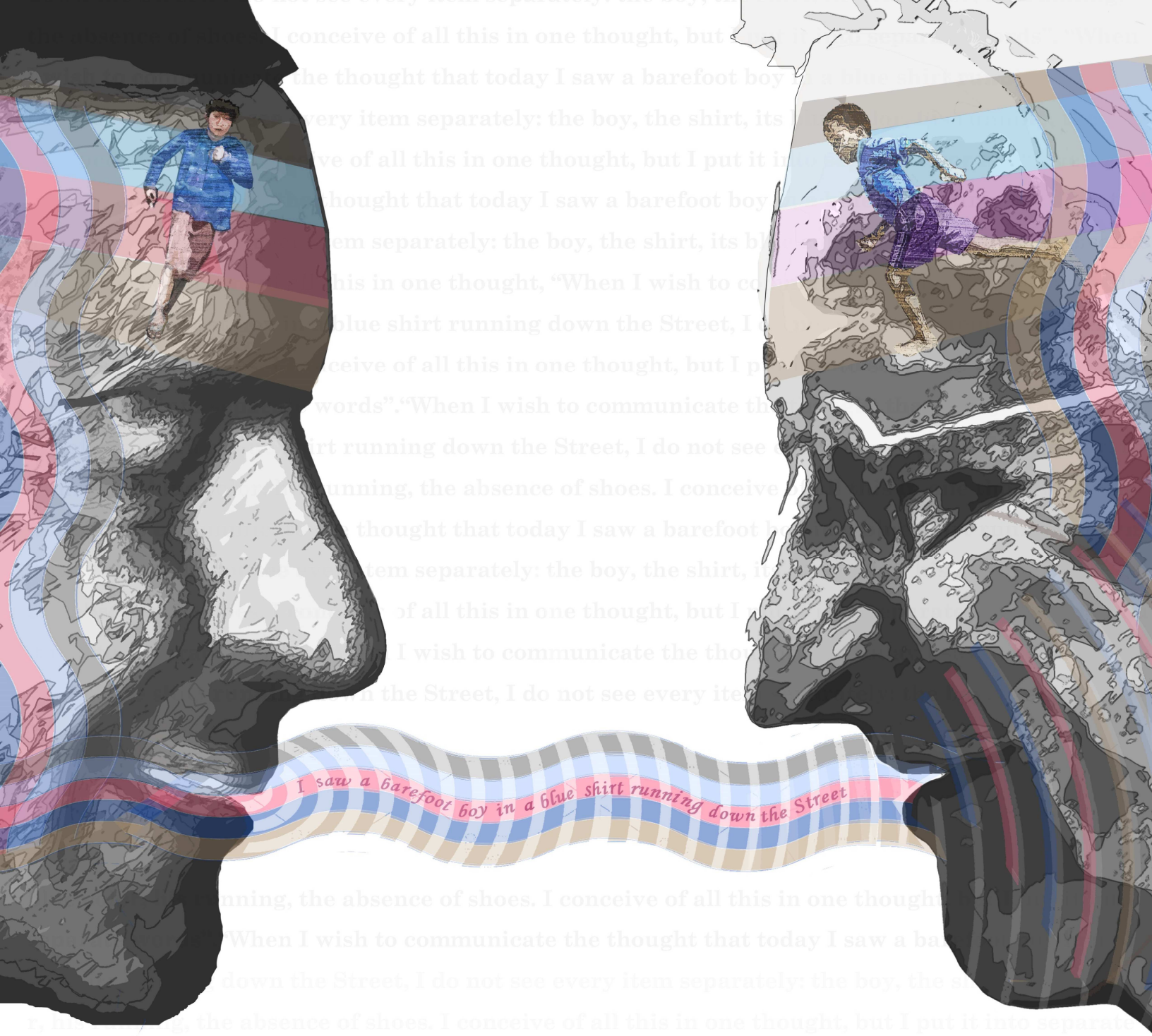
Spyros Christou



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Directors: Dra. Mónica Sanz-Torrent & Dr. Llorenç Andreu Barrachina

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Desenvolupament i Psicologia
de l'Educació

Edifici de Ponent
Passeig de la Vall d'Hebron, 171
08035 Barcelona

Tel. + 34 93 3125160
Fax + 34 93 4021363
www.ub.edu/psicologia
s.christou@ub.edu

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& Dr. Llorenç Andreu Barrachina

Programa de Doctorat en Psicologia Clínica i de la Salut

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Language is evolved and it's designed as a mode of creating and interpreting thought. It's a system of thought basically.

Noam Chomsky (2014)

CONTENTS

ACKNOWLEDGEMENTS

El momento en el que se cierra un ciclo vital por esfuerzo propio, es un momento emancipador. El terreno de la psicolingüística del cuál fruto es la presente tesis, es sin lugar a duda una apasionante disciplina que trata algunos de los fenómenos más relevantes de la naturaleza de la mente humana, como el pensamiento, el lenguaje y la conciencia. Sin embargo, sería imprescindible comentar que a lo largo de la carrera de Psicología, aunque la psicolingüística me producía un enorme respeto, jamás había considerado la posibilidad de dedicarme a ella. De hecho mientras cursaba el máster de Psicología Clínica y de la Salud de la Universitat de Barcelona (UB), había iniciado el proceso para realizar un doctorado en la Univesitat Autònoma de Barcelona (UAB) con objeto de estudio la violencia que marcó las generaciones que vivieron la Guerra Civil Española (1936-1939) y la posterior Dictadura (1939-1975) y compararla con la correspondiente realidad de la Guerra Civil Griega (1946-1949) y la posterior Dictadura (1967-1974). El compromiso de conocer y tratar los traumas y las secuelas de la violencia política y militar, no nace de la nada, sino que aparece como una profunda necesidad, por el hecho de venir de una familia y una tierra que la experimentó en su propia carne (Guerra de Chipre, 1974). Hasta hoy, Chipre está dividida por la mitad y Nicosia se considera la última capital dividida de Europa, probablemente, en el mayor conflicto dentro de la Unión Europea en términos de violación de derechos humanos fundamentales. En este sentido, en la sociedad chipriota todavía existen centenares de miles de refugiadas/os y dos millares de desaparecidas/os de las/los cuales, hasta la fecha, se ha podido identificar a la mitad. Tristemente, la sociedad chipriota todavía sangra por heridas que no ha podido cerrar. Todas estas razones me acercaron a una profesora e investigadora, cuya amistad es un inestimable regalo, quien me puso en contacto con los colectivos, las plataformas y las instituciones del mundo de la Memoria Histórica de la sociedad catalana, ejemplo paradigmático y punto de referencia, a un nivel tanto nacional, como internacional. En este contexto, y al lado de la Dra. Conchi San Martín, realicé (junto con otras tres compañeras) mi primer trabajo empírico de investigación, financiado por el *Institut Català de les Dones* que consistió en el diseño y la

realización de 40 entrevistas a personas jóvenes respecto la experiencia de sus familiares en la guerra civil, la posguerra y la posterior dictadura. Cuestiones profundamente desagradables y ajenas a mi decisión de realizar el mencionado doctorado, como también circunstancias que pueden considerarse como paradojas de la vida, me llevaron al campo de la psicolingüística. En este recorrido, debo agradecer desde lo más profundo de mi corazón, a la Dra. Imma Clemente por ser una fuente insaciable de inspiración académica y afecto humano. Me gustaría expresar con la más sincera claridad que la interacción con la Dra. San Martín y la Dra. Clemente ha sido una de las experiencias más extraordinarias de mi vida y para siempre las tendré en mi pensamiento.

El presente estudio duró cinco años y participaron de mayor o menor medida unas 400 personas: 260 niños/as de la escuela *Pla de la Vinyes* para la selección y formación de los grupos control, una treintena de niños/as con disfuncionalidad lingüística que fueron evaluados/as en nuestros laboratorios, un total de 50 estudiantes universitarios para la selección y la formación del grupo control de adultos, una treintena de familiares de los/las niños/as con disfuncionalidad lingüística, una veintena de maestros/as del centro escolar, y por último una decena de investigadores/as. Es importante comentar que he tenido el privilegio de poder realizar este trabajo de forma remunerada, de manera que sería imprescindible nombrar en primer lugar, la *Fundación A.G. Leventis* que financió los dos primeros años, y en segundo lugar, la *Universitat de Barcelona* que financió los últimos tres, a través de una beca de investigación predoctoral. En estos cinco años hay dos personas cuyo conocimiento, paciencia y confianza hicieron posibles los resultados fructíferos que aparecen hoy: la Dra. Mónica Sanz-Torrent y el Dr. Llorenç Andreu Barrachina. A mi directora y director de tesis les debo todo este proceso que jamás se hubiese dado, si no fuera por la acogida en su Grupo de Investigación de la Cognición y el Lenguaje (GRECIL). La Dra. Sanz-Torrent es una persona que tiene profundamente arraigado el concepto de la justicia, su capacidad de imaginación no tiene limites y es a ella que debo mi evolución en esta etapa vital de mi formación como doctor. De la manera más sincera posible, se trata de una excelente profesora universitaria que confió en mi criterio, racional

e intuitivo, y me ha permitido todos estos años trabajar en condiciones de libertad. Por esta libertad que me ha dado y por su compromiso en la horizontalidad, tendrá siempre mi más profundo respeto. El Dr. Andreu es una mente inquieta, cuyo movimiento tiene una forma de expresión artística y en paralelo rigurosa. Si no fuera por el impacto de su tesis doctoral y por la importancia de sus trabajos publicados, la presente investigación jamás podría plantear los avances que plantea. A Llorenç le debo la perseverancia que requiere el difícil camino ascendente de la investigación científica.

He tenido el enorme privilegio de realizar una estancia de investigación en la Universidad de Chile. La colaboración con el Dpto. de Fonoaudiología de la Facultad de Medicina, como también con el centro de Investigación Avanzada en Educación (CIAE), fue la mejor opción posible para el cierre de la tesis. A la Dra. Carmen Julia Coloma en particular, y al equipo de lingüistas del Dpto. de Fonoaudiología en general, les debo el fortalecimiento profundo de la tesis en términos teóricos. El interés, sus perspectivas e ideas están dialogando de la manera más sustancial posible con el contenido del presente trabajo, enriqueciéndolo de un modo sincero. Por otra parte, la aportación del Dr. Ernesto Guerra, profesor de estadística e investigador postdoctoral en el CIAE, ha sido realmente inestimable ya que sus conocimientos y experiencia aseguraron un fortalecimiento metodológico profundo. El viaje al Sur de Chile ha sido un regalo que ha marcado mi vida para siempre. La experiencia en la Universidad de Chile, tanto en términos de formación científica e investigadora, como también en términos personales, ha sido extraordinaria. He tenido el enorme privilegio de conocer el compromiso de las y los doctoras/es, investigadoras/es, profesoras/es de la Universidad de Chile, su labor para tratar el sufrimiento de las personas que padecen trastornos del lenguaje, como también, la perspectiva que entiende el conocimiento científico en servicio de la sociedad.

Especialmente quiero agradecer a Jose Buj, mi compañera de doctorado, a Javier Rodriguez-Ferreiro por su fuerza de pensamiento y a Claudia Araya por su amistad y apoyo. A Giorgos Papakokkinos por todo lo que hemos compartido estos años y por su ayuda que ha sido siempre incondicional e inestimable. He tenido la enorme oportunidad

de observar desde cerca la evolución del lenguaje y el pensamiento de tres niñas y un niño, cuestión que ha sido elemental en el desarrollo de este trabajo. Desde la profundidad de mi ser agradezco a Mayia de Nísiros, a Konstantina de Lemnos, a Siria de Ametlla del Vallès y a Paris de Tenerife. A estas niñas/o y a todos/as los/las niños/as del estudio les dedico la tesis por ser la posibilidad de un mundo más humano.

Ahora que se cierra este ciclo vital de mi formación como psicólogo clínico, doctor e investigador, siento la necesidad de expresar mis más profundos agradecimientos hacía la sociedad catalana por la acogida de estos 12 años. Viniendo de una sociedad marcada por la destrucción y la guerra, siento que ha sido un regalo de la vida la posibilidad de vivir y crecer en Barcelona, ciudad de referencia internacional por su pasado histórico en la lucha libertaria por la causa de la emancipación humana. Al final de esta etapa, y a pesar de la solidez de mi perspectiva atea, quiero agradecer por una parte, a Charo por ser una maestra espiritual con el conocimiento ancestral de la fuerza anímica humana, cuya sabiduría y amistad significaron, en términos existenciales, un antes y un después. Por otra parte, a Jaume, a Javier y a Dani por el enorme privilegio de poder finalizar la tesis viviendo en el antiguo monasterio de Sant Jeroni de la Murtra, una joya arquitectónica y cultural del s.xv, que me permitió circunstancias óptimas de belleza natural y humana. Soy plenamente consciente, que no podía existir mejor manera para cerrar este ciclo, y por la posibilidad dada estaré siempre y desde mis entrañas agradecido tanto a la Murtra, como a la comunidad que la gestiona.

Por último, a mi hermana y a mis hermanos por arroparme en los momentos más difíciles y por la felicidad de coexistir, y a nuestra madre y a nuestro padre, por su lúcido compromiso con el concepto de la verdad, a quienes queremos con todo corazón:

Η μάνα μας την αξιοπρέπεια, την αλληλεγγύη, την αγάπη.

Ο πατέρας μας την αμφιβολία, την αυτονομία, την άναρχη σκέψη.

8 de marzo de 2018, día de huelga feminista por la igualdad.

La Murtra.

ABSTRACT

Children with Specific Language Impairment (SLI) show considerable difficulties in the linguistic production of verbal morphology marks and function words. The present study analyzes the capacity of children with SLI, children with typical language development and adults to process the mentioned linguistic elements of the Spanish language in six online comprehension tasks. Simple sentences structures were used with the objective to reduce, as much as possible, the lexical difficulty in order to focus the analysis on the morphological dimension, with the minimum possible distraction. All the experimental tasks were based on the *visual world paradigm* which allows, through the technology of eye tracking, optimal conditions of psycholinguistic experimentation. Under the main hypothesis, the morphological characteristics of the linguistic stimulus guide the comprehension of the sentence and the visual analysis of the graphic scene. In this sense, it was expected that children with SLI would obtain worse results than children among control groups, considering the possibility of a deficit in the comprehension of the mentioned linguistic elements. The empirical data reveal that the children with SLI - in the present experimental conditions and in the context of the simple sentence - present a less atypical comprehension in comparison to the initial hypothesis. The results of the study allow us to suggest the possibility that the apparent difficulty in language comprehension of children with SLI follows a pattern where the accumulation of small processing difficulties in quantitative terms causes an impact in qualitative terms, which is manifested as a lower general comprehension. We suggest that the apparent difficulty in the linguistic comprehension of children with SLI might be more related to a pattern of accumulation of the difficulty, and less to isolated linguistic elements, such as verbal morphology and function words.

RESUMEN

Los niños y las niñas con Trastorno Específico del Lenguaje (TEL) muestran dificultades considerables en la producción lingüística de las marcas de la morfología verbal y las palabras funcionales. El presente estudio analiza la capacidad de procesar los mencionados elementos lingüísticos de la lengua española en seis tareas de comprensión online, en niños/as con TEL, en niños/as con desarrollo típico del lenguaje y en adultos. Estructuras de oración simple fueron utilizadas con el objetivo de reducir, en la mayor medida posible, la dificultad léxica para poder enfocar el análisis, con la menor distracción posible, en la dimensión morfológica. Las seis tareas están basadas en el *paradigma del mundo visual* que permite, a través de la tecnología de eye tracking, circunstancias óptimas de experimentación psicolingüística. La hipótesis central plantea que si las características morfológicas del estímulo lingüístico guían la comprensión de la oración y el análisis visual de la escena gráfica, entonces las mencionadas dificultades se verán expresadas en la ejecución y en el patrón de los movimientos oculares a lo largo de las diferentes tareas. Los datos empíricos revelan que los/las niños/as con TEL, en las presentes circunstancias experimentales y en el contexto de la oración simple, muestran una comprensión del lenguaje menos atípica en comparación a la hipótesis inicial. Los resultados del estudio nos permiten sugerir la posibilidad de que la aparente dificultad en la comprensión lingüística de los//las niños/as con TEL, sigue un patrón donde la acumulación de pequeñas dificultades de procesamiento en términos cuantitativos, provoca un impacto en términos cualitativos, que se manifiesta como una comprensión general más baja. En este sentido, sugerimos que la aparente dificultad en la comprensión lingüística de los/las niños/as con TEL, puede estar más relacionada a un patrón de acumulación de la dificultad, y menos a elementos lingüísticos aislados, como la morfología verbal y las palabras funcionales.

CHAPTER 1

INTRODUCCION

1. In the field of psycholinguistics

Two major disciplinary traditions intersect in the psycholinguistic field: rationalism and empiricism. Despite the theoretical and methodological differences (Watt, 1970; Reber, 1987) their interaction consists in an epistemological challenge that offers a valuable opportunity in the approach of the two main questions surrounding the habitual use of language: first, cognitive processes engaged in linguistic communication (e.g. thought, memory, perception) and second, implicated areas of linguistic knowledge (semantics, syntax, phonology and pragmatics) in the use of language (Carroll, 2006).

Noam Chomsky (1928 – present) is considered to be the most influential linguist of the 20th century (Pinker, 1994; Carroll, 2006), whose thought on language studies qualify as an authentic revolution (Newmeyer, 1986). Before dealing with the Chomskian influence on the evolution of psycholinguistics in greater detail, it would be essential - in a very brief way - to review the trajectory of scientific research in the area of linguistic knowledge and the cognitive processes implicated in comprehension, production and acquisition of language. The interest in the nature of language, and consequently the nature of thought, is undoubtedly one of the main questions in the study of human psychology (Vygotsky, 1986) and, more recently, in the study of cognitive science (Garduer, 1985), the theoretical body of which extends to the branches of psychology, linguistics, neuroscience and philosophy.

In this sense, within the framework of scientific psychology, empirical studies of language appear with the first psychological laboratory in the University of Leipzig (Germany, 1879), founded by Wilhelm Wundt (1832-1920). Wundt, one of the most emblematic figures in the history of psychology -sometimes referred to as the *master psycholinguist*- considered the study of language very important, since a greater understanding of the nature of mind can be achieved through the possible experimental findings and their interpretation (Blumenthal, 1970).

However, in the 20s of the twentieth century, the theoretical domain of behaviourism was consolidated. This reality ended up creating a division between psychology and linguistics, and consequently, a minimization of research on language (Carroll, 2006). According to Cuetos, González and de Vega (2015), behavioural perspective was rejecting the study of mental processes, since its interest was fundamentally inclined to the study of objective behaviours. From a positivist point of view and a rigorous methodology, it was based on laboratory experiments mostly with no human animals, where eventually language lacked interest. At that time, instead of "language" the term "verbal behaviour" was preferred, which is the title to the classic book by Skinner (1957). From Skinner's perspective, language was treated as a mere response to the stimuli from the environment, conditioned by the principles of reinforcement, association and imitation (Myers, 2013).

Under these circumstances of disconnection between the fields of psychology and linguistics, as well as the lack of scientific studies in language, the so-called Chomskian revolution appeared in order to radically change the panorama and to consolidate the second period of psycholinguistics.

Chomsky (1957, 1959) asserted that behavioural principles were inappropriate for the interpretation and explanation of the nature of language; furthermore, he later stated (1968) that the study of language could shed light on the inherent properties of the human mind, since linguistics could be considered as a branch of psychology:

> Viewed in this way, linguistics is simply a part of human psychology: the field that seeks to determine the nature of human mental capacities and to study how these capacities are put to work. (Chomsky, 2006, pag. 90-91).

In this sense, the contribution of the Chomskian theory mainly lies in the link between linguistics and psychology, since linguistics is perceived as a "window" which allows insights to the processes of the human mind (Pinker, 1994). The breakthrough that Chomskian thought created in the study and understanding of the nature of our cognition is a widely acknowledged issue, the impact of which is considered, as noted above, as a revolution.

In Pinker's words:

> In this century, the most famous argument that language is like an instinct comes from Noam Chomsky, the linguist who first unmasked the intricacy of the system and perhaps the person most responsible for the modern revolution in language and cognitive science (pag. 21).

And later:

> Chomsky is currently among the ten most-cited writers in all of the humanities [...] and the only living member of the top ten (Pinker, 1994; pag. 23).

From Chomsky's perspective (2006), when we study human language we come closer to what is sometimes called the "human essence", since the distinctive qualities of mind involved in linguistic communication processes are inseparable from any

critical phase of human existence, in both personal and social terms. In this sense, the creative aspect of natural use of language – in terms of "an infinite use of finite media"- is a fundamental factor that allows us to distinguish human language from any other known animal communication system.

According to Leonard (2014), one of the first applications of Chomskian theory was Menyuk's study (1964) in relation to the grammatical deficits of children with Specific Language Impairment (SLI). The emergent perspective which dealt with linguistics as a branch of psychology put the importance of studying language impairments into consideration once again (Menyuk 1964; Leonard, 1972; Morehead and Ingram, 1973), in order to be able to treat the problems of people enduring it, on the one hand; and on the other, to understand the mechanisms of human cognition in greater depth.

2. Specific Language Impairment (SLI)

2.1. Clinical frame

SLI is a clinically significant delay in acquisition and development of language that occurs in the absence of potentially harmful factors (Bishop, 1997) such as psycho-pathological problems, hearing deficits, socio-affective instability, brain injuries or neurological deficits. According to the diagnostic criteria established by Stark and Tallal (1981) and the revision by Leonard (2014), to identify this disorder the child should present at least one year delay in language, with respect to their chronological or mental age.

The term "specific" refers to the exclusion criteria it considers, that according to Aguilera and Botella (2008) are:

a) Hearing below 25dB.

b) Emotional or behavioural problems.

c) Manipulative intelligence quotient less than 85.

d) Evidence of neurological deficits.

According to ASHA (American Speech-Language-Hearing Association, 1980), it is an abnormal acquisition of comprehension or expression of written or spoken language. It can involve one, some, or all of the phonological, morphological, semantic and/or pragmatic components of the linguistic system. Children with SLI tend to have problems in language processing or abstraction of significant information for memory retrieval and storage (Fresneda & Mendoza, 2005). Regarding the age of the diagnosis, it is essential to point out that the diagnosis of SLI is considerably difficult in the first evolutionary periods of language, since its main characteristics are shared with language delay. Figure 1 shows the course of linguistic acquisition in children with SLI, children with language delay, and children with typical acquisition. Up to 5 years of age, children with language delay have a similar profile to children with SLI, and later they present an evolutionary leap that reaches the level of children with typical acquisition. For this reason, as it is indicated in the *Consensus document by the SLI expert committee on the diagnosis of the disorder* (Aguado, et al., 2015):

> It is very difficult to diagnose SLI in very small children. For example, at the age of 3 it is very difficult to determine the permanence of the problem and it is complex to differentiate it from other disorders [...]. *As a general rule, at the age of 4 we can talk about a possible SLI diagnosis, to be confirmed at the age of 5* (pag. 2).

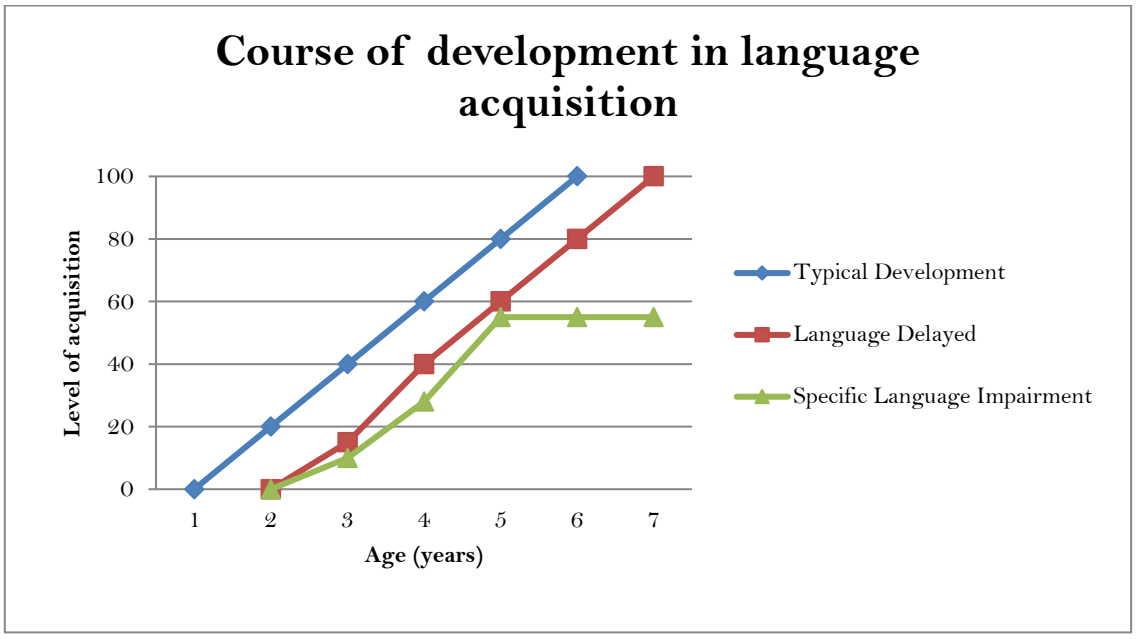


Figure 1. The course of development in language acquisition (Leonard, 1998; taken and adapted from Andreu, 2013).

Having said that, it is important to emphasize the fact that language disorders in general, and SLI in particular, have considerable relevance from the perspective of clinical psychology. Thus, it is essential to point out the burden that this problem may come to cause on the lives of the children who experience it, and the variety of different difficulties that they may face. Human beings manage to represent the world, interpret the reality that surrounds them, express their feelings and desires, and interact with their social context through language (Sanz-Torrent & Andreu, 2013).

The absence or limitation of such a possibility may turn into suffering and discomfort (Brinton & Fujiki, 1993; Conti-Ramsden & Botting, 2008; Fujiki, Brinton, Morgan & Todd, 1996). A child having this impairment from a very early age will, very likely, be exposed to a series of demands that they will not be able to respond. The distress or frustration created by the lack of communication is often a multidirectional

reality (child/parents/relatives/schools, etc.) that increases the problem and complicates it.

It is fundamental to remember that an altered language acquisition is closely related to school failure. In fact, the majority of children with SLI present complications in reading and poor school performance (Sanz-Torrent, Andreu, Badia & Serra, 2010) which is frequently accompanied by emotional and/or behavioural difficulties. In this sense, different studies indicate a great presence of psychosocial problems in children and young people with SLI: Wadman, Botting, Durkin and Conti-Ramsden (2011) indicate a greater number of symptoms of depression and anxiety in the SLI group in relation to their equivalent controls; St Clair, Pickles, Durkin and Conti-Ramsden (2011) find a higher level of behavioural, emotional and social difficulties in the SLI group; and Wadman, Durkin and Conti-Ramsden (2011) show that young people with SLI present a greater degree of social stress.

For all these reasons, it is necessary to broaden and deepen the theoretical framework that addresses this disorder; on the one hand, to be able to understand its nature and expression better, and on the other, to assist and support these children by introducing adequate knowledge in relation to their evolutionary process, accompanying them in an optimal and specialized way in their language development, psychological state, and social interaction.

Carroll (2006) supports that scientific studies which focus on the human being require acknowledging the social dimension of language. In this sense, the study of SLI offers a paradigmatic example: the aetiology of the disorder, that is at least partially due to genetic factors (Bishop, North y Donlan 1995; Rice, Smith & Gayan, 2009) does not

deny the perspective that suggests that the environment has a major role in its evolution, in terms of duration, frequency and intensity of the symptomatology.

In this regard, the possibility of an early diagnosis and an early intervention allows the proposal and the certainty of a better prognosis. On the other hand, the possibility of a pedagogical material aimed precisely to these problems, and in parallel with a curricular adaptation, can be the essential basis to build up simple sentences, as a structural core in language acquisition, and the key to achieve, eventually, a richer and more complex grammar and –consequently– a more fluid language production.

2.2. Aetiology and diagnosis

People who experience SLI show a dysfunction, problem or difficulty essentially in their linguistic capacity. Despite the possible co-morbidity with other disorders, there is a quite consolidated perspective that the focus of attention is on the dimension of language. From this perspective, language is understood as a modularized capacity that requires specialized brain structures, which in turn creates a mental module composed of several sub-systems (Coloma, 2013). Thus, children with SLI would suffer partial or global dysfunction in one or various sub-systems, without presenting other limitations in brain structures which are independent from language (Aguado, 2007).

The diagnosis of SLI is a complicated task, since the characteristics of people who suffer from this disorder are very heterogeneous, creating considerably diverse linguistic profiles (Aguado, 2007; Coloma, 2013).

However, some characteristics are more or less agreed upon in a consensual way, since they appear rather homogeneously in people experiencing this language impairment (Leonard, 2014):

a. Morpho-syntactic problems:

- Use of tense and agreement morphemes inconsistently.
- Low accuracy in repeating sentences.
- Low comprehension of sentences with complex syntactic structure.

b. Difficulty in repetition of nonwords (two to four syllables long).

Morpho-syntactic problems have traditionally been the most studied question within the theoretical framework that encompasses SLI (e.g. Bedore & Leonard, 2001; Conti-Ramsden, Botting & Faragher, 2001; Grinstead, De la Mora, Pratt & Flores 2009; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997; Leonard. Miller & Gebrer, 1999; Restrepo, 1998; Sanz-Torrent, Serrat, Andreu & Serra, 2008). However, to our knowledge, there are no studies, with the eye tracker method, that examine the online morphological comprehension of children with SLI in the peer-reviewed scientific literature. It is important to emphasize that there are different perspectives regarding classification, aetiology and interpretation of Specific Language Impairment. It is also worth mentioning that various approaches are grouped together practically in two theoretical standpoints, in two different points of view.

On the one hand, the linguistic approach (Lahey & Edwards, 1999; Leonard, Nippold, Kail & Hale, 1983; McGregor & Appel, 2002) lays out the existence of a selective deficit in specialized areas for language learning. From this perspective, morpho-syntactic errors are due to a limited knowledge of grammatical rules, in other words, language deficiencies are produced by a specific brain module that regulates grammatical acquisition inadequately. On the other hand, the processing approach (Ellis

Weismer, Evans & Hesketh, 1999; Miller, Kail, Leonard & Tomblin, 2001; Montgomery, 2000) suggests rather a brain ability deficit, in terms of interpretation of the linguistic input and/or possibility to access the linguistic knowledge stored in the memory. That is to say, from this theoretical perspective, there exists a deficit in functioning of phonological working memory or a deficiency in the speed of processing verbal information (Gardner & Petersen, 2011). However, until now, the aetiology of this clinical picture is not clear, so the question still remains open.

In relation to the prevalence of the disorder, Leonard (2014) states that before 1997 it was difficult to reach an agreed percentage, since the criteria for diagnosis and the inclusion of participants varied a lot. Thus, the discrepancy in prevalence range of SLI was set from 0.6% to 12.5% of the children population (Beitchman, Nair, Clegg & Patel, 1986; Stevenson & Richman, 1976; Tower, 1979; etc.). Tomblin et al. (1997), with an initial sample of 7000 people, established the prevalence of SLI, setting it around 7% of the children population in the United States (6% in girls and 8% in boys). Later, Norbury et al. (2016) conducted an epidemiological study and they evaluated the language level, the nonverbal intellectual coefficient, the social, emotional and behavior problems, as well as the academic level of British children of age 4-5 years old. The results showed that 4.8% of the children presented a language disorder, while they showed a nonverbal intellectual coefficient of 85 approximately. The 2.78% had a language disorder and their nonverbal intellectual coefficient (was in the range of 70-85). In this way, their prevalence increases up to 7.58% of the children. Additionally, 2.34% satisfied the criteria of language disorder but they presented intellectual disability (NVIQ lower than 70) and a known medical condition (for example, autism).

CHAPTER 2

LANGUAGE COMPREHENSION IN SLI

1. Production vs comprehension

It is important to note that most of the studies that examine the problem of verbal morphology acquisition and its use by children with SLI deal with the production of language. In this sense, Muñoz, Carballo, Fresneda and Mendoza (2014), in a study that measured the grammatical comprehension of children with SLI, indicated that there is a small number of studies investigating linguistic comprehension. According to these authors' work, the vast majority of previous studies evaluated difficulties in language production of children with SLI.

The empirical studies that have dealt with comprehension are relatively few (e.g. Bishop & Adams, 1992; Cain & Mari, 2007; Joffe, Muñoz, Carballo, Fresneda & Mendoza, 2014; Montgomery, 2000a, b, 2002, 2004). Even scarcer is research on comprehension in online sentence tasks (Andreu, Sanz-Torrent, Guardia & Macwhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Marinis & van der Lely, 2007). In the psycholinguistic literature, and under the prism of several authors, language production and comprehension are separate processes (Bock, 1995; Levelt, 1993; MacDonald, 1999).

According to different authors, comprehension precedes to production in a typical process of language acquisition (Bates, Bretherton & Snyder, 1988; Cuetos, Gonzalez & De Vega, 2015; Ingram, 1974). More specifically, Cuetos, Gonzalez and De Vega (2015) offer the example of a 1-year-old child who can understand sentences

such as: "put the cookie on the table" or "put the ball on the chair" despite the fact of not being able to produce them yet. Under this perspective, the process of comprehension is significantly ahead of the production process, so that a child can have thought processes without having their own speech yet. In this line, different studies using an online methodology with children with SLI have proposed that language comprehension is found within the limits of normality, in contrast to their language production, which is often expressed with significant difficulty (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013).

According to Leonard (2014), the available data through studies conducted on Spanish-speaking children with SLI suggest that the capacity for language comprehension is frequently superior in relation to the capacity for production. Additionally, this observation is also registered in studies with German-speaking children with SLI (Grimm, 1993; Grimm & Weinert, 1990). The empirical studies which have focused on language comprehension, compared to the studies which have researched language production, are relatively few (e.g. Bishop & Adams, 1992; Joffe, Cain & Mari, 2007; Montgomery, 2004**)**, and there are even fewer which have specifically studied verbal morphology, or in more general terms, linguistic comprehension in online sentence tasks (Andreu, Sanz-Torrent, Guardia & Macwhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Marinis & van der Lely, 2007).

More specifically, in the study by Andreu, Sanz-Torrent and Rodriguez-Ferreiro (2016) the prediction of arguments and complements through the comprehension of verb semantics was registered. The participants (SLI group, control group and adults

group) were exposed to simple sentences such as: “The man reads carefully a story on the bed”, and their capacity for distinguishing the argument from the verb (“a story”) in 1000 ms before its appearance was evaluated. Results suggest that children with SLI are capable of anticipating language references, since they can extract relevant knowledge from the verb’s semantics, even before mentioning its argument. Thus, their comprehension regarding the use of the verb semantics in simple sentences doesn't seem to be significantly affected.

Inquiring more about their comprehension of language, Bishop in one of the first studies in this field (1979) administered receptive tests of vocabulary and grammar to two groups of children, the first one with a diagnosis of expressive language disorder (affecting production) and the second group with receptive-expressive language disorder (affecting both production and comprehension), and found that the two groups had a significantly lower level of comprehension compared to children of the same age with a typical language development. On the other hand, it is worth considering that the semantic representation of words, a functional nucleus in the dimension of language comprehension, is relatively weak in children with SLI according to different authors (Dockrell, Messer & George, 2001; Dockrell, Messer, George & Wilson, 1998; Marinelle & Johnson, 2002).

Mainela-Arnold, Evans and Coady (2008) investigated the lexical access of children with SLI in a gating task (Frequency-Manipulated Gating Task) and suggested that children with SLI experience a greater interference of words from previous tests, an issue that could point towards a greater vulnerability precisely because of the competition introduced by the stimuli of previous tests in the linguistic task process. This interpretation would be in agreement with previous studies on verbal working

memory, which support that the linguistic capacity of the SLI group is more vulnerable due to the interference of previously presented words (Ellis, Weismer, Evans & Hesketh, 1999).

Also, Montgomery and Evans (2009) studied the relationship between working memory and complex sentence comprehension through several experimental tasks (non-word repetition task, competing language processing task and a sentence comprehension task). They concluded that the limited comprehension of complex sentences presented by children with SLI is significantly associated with a limitation in working memory. In this research, both the SLI group and the control groups showed an adequate comprehension of the simple sentence, although the authors of the study suggested that the children with SLI require more cognitive resources in their processing trajectory.

However, more recent research (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013) has raised the possibility that language comprehension among children with SLI is less atypical than it is generally thought of in the psycholinguistic community. The results of these authors, through the use of the eye tracking technology, indicate that in terms of comprehension (of verbs in simple sentences, separated or in narration style), children with SLI present a level of competence more preserved than expected.

2. Limitations in verbal morphology

There is a wide body of empirical literature (e.g. Bishop, 1997; Conti-Ramsden & Jones, 1997; Leonard, 2014) providing evidence on significant linguistic effects regarding verb processing in Specific Language Impairment (SLI). Verbal morphology

production in children who suffer SLI appears with considerable errors and delays since the verb, as a morphosyntactic unit, maintains a crucial role in the development of language grammatical dimension (Bates & MacWhinney, 1987; Gleitman, 1990; Tomasello, 1992). In this sense, the psycholinguistic difficulties regarding production reduce substantially the capacity of a child with SLI for communicating their feelings and ideas with others, which complicates and obstructs the possibility of their proper development as a person within their social-affective circle.

Within the aforementioned bibliography, there appear different theoretical perspectives that interpret and try to explain verb-related linguistic difficulties present in children affected by SLI. Bishop (1994) emphasized the vulnerability of linguistic markers and the importance of language processing. In this sense, the problem with grammatical morphemes presented by children with SLI, both in terms of comprehension and of production, does not seem to be a consequence of a lack of grammatical competence, but rather of a burden on the processing of those kinds of markers.

More specifically, from this perspective, these children's linguistic performance depends on the circumstances of the immediate context, that is, on the processing demands related to the complexity of each specific linguistic task. Along a similar line, Evans (1996) observed that the omission of inflectional morphemes does not have a uniform distribution in some children with SLI, but that it appears at times with increased demands of linguistic processing, as in spontaneous language circumstances. Leonard, Eyer, Bedore and Grela (1997) supported the idea that children with SLI do not present a defective grammar, except for some emerging deficiencies attributable to processing limitations. Similarly, Marchman, Wulfeck and Ellis Weismer (1995)

observed that omissions of grammatical morphemes occur in verbs of low occurrence, an issue that made them think that this difficulty could be a reflection of a defective processing, and not a consequence of a deficit in the underlying grammatical characteristics.

In contrast to the studies mentioned so far, Clahsen (1991), Gopnik and Grago (1991) and van der Lely (1996) propose the existence of a deficit in the grammatical competence of children with SLI. In more detail, van der Lely (1996) suggested the existence of a subgroup of children with SLI that present mainly or exclusively this grammatical problem, in this sense, children with grammatical SLI would be characterized by a disproportionate deterioration in grammatical comprehension and production of language, due to their unbalanced grammatical abilities. In an extensive review, Mendoza (2012) emphasizes an idea which was originally exposed in the work of Bishop (1994). Under this perspective, studies that underline the grammatical competence deficit hypothesis are, perhaps, pointing out the most severe and persistent dimension of SLI.

Difficulties in the morphological processing are reflected in different studies in many languages (see Leonard, 2014). Among English-speaking children suffering from SLI, the most important difficulties are reflected in the errors and omissions of verbal inflection of third-person singular (-s), of the past tense (-ed), and of the present progressive tense (-ing) (Conti-Ramsden, Botting & Faragher, 2001; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997). Bishop (2014) summarized the evidence of problems with the production of tense marking in children with SLI. She collected evidence from elicitation tasks (e.g. Marshall & van der Lely, 2012; Rice, Wexler, Marquis & Hershberger, 2000; van der Lely & Ullman, 2001), sentence

repetition (e.g. Dalal & Loeb, 2005) and written language (e.g. Windsor, Scott & Street, 2000).

Regarding a language of rich morphology such as Spanish or Catalan, the most important morphological errors of children with SLI are reflected in the verbal inflection of tense, number and person, as well as in the use of infinitives (Bedore & Leonard, 2001; Grinstead et al., 2013; Sanz-Torrent, Serrat, Andreu & Serra, 2008). More specifically, Sanz-Torrent, Serrat, Andreu and Serra (2008), in a longitudinal study, collected linguistic expression data through speech therapy sessions (every month), as well as through interviews with the participants of the experimental groups (once a year for 3 years). According to the research results, the children with SLI constructed their linguistic production practically through the use of infinitives, which was significantly higher in comparison to the use of infinitives by the control group. Additionally, the group with SLI presented a greater number of errors and omissions in verbal inflections and substitution in the marked forms.

In this perspective, the aforementioned studies have analysed the production difficulties in verbal morphology among children with SLI. Furthermore, there are recent research that has studied the comprehension of children with SLI through a narrative discourse protocol (Pavez, Coloma & Maggiolo, 2008). These studies (Coloma, Maggiolo & Pavez, 2013; Coloma, Mendoza & Carballo, 2017; Coloma & Pavez, 2017) evaluated the comprehension of complex sentences in narrative style. Results indicated that the SLI group presents a lower level of comprehension, compared to the chronological control group. However, there are relatively few studies which have tried to analyse the verbal inflection in terms of language comprehension.

There are some crosslinguistic studies (Bedore & Leonard, 2001; Bortolini & Leonard, 1996; Leonard, McGrecor & Allen, 1992) that have pointed out that children with SLI who speak languages rich in morphological inflections show a better use of these linguistic marks, in comparison to homologous children who speak languages with low morphological inflections.

More specifically, Bortolini and Leonard (1996) conducted a study comparing English- and Italian-speaking children with SLI and demonstrated a higher level of use of morphological marks by the Italian-speaking group. Under Mendoza's perspective (2012), since Spanish is such a rich language in morphological terms, it could be hypothesized that Spanish-speaking children with SLI will have a higher linguistic capacity than other children with SLI who speak morphologically poorer languages.

Language acquisition cannot be reduced to the imitation of the linguistic stimuli that surrounds the infant, but it emerges, founded on an underlying biological device, which is reflected on the mistakes that children make when they learn to speak (Chomsky, 1957, 1959, 1968; Pinker, 1994). In this sense, Bishop (2014) argues that when children learn to speak they do not merely imitate the speech they hear, but that their production reflects the limitations of their language immaturity.

According to this perspective, both children with a normal acquisition and children with an atypical acquisition of language show a considerable difficulty with the consolidation and use of verbal morphology and, although there is a long history of research regarding this problem, the question of its origins still remains open.

3. Limitations in function words

3.1. Articles

Children with SLI present problems in learning article marks and article–noun agreement. Children with SLI are characterized by developmental delays in verbal abilities that are not accompanied by nonverbal cognitive deficits (Bishop, 1997; Leonard, 2014). Mendoza (2012, 2016) argues that children with SLI face their most severe language problems in morphological production and comprehension. Along these lines, different studies (e.g. Leonard, Eyer, Bedore & Grela, 1997; Leonard, 1995, Rice & Wexler, 1996; Rice, Wexler & Cleave, 1995) with English speaking children with SLI have shown that the most remarkable difficulties in their language seem to appear in mode of omission and/or substitution with morphological marks of verb and with function words.

As regard the use of articles in English-speaking children with SLI, Polite, Leonard and Roberts (2011) found that 5-years-olds with SLI showed less use of definite articles in comparison with control-matched children, but no differences were found in the use of indefinite articles. The authors suggested that the article limitations of the children with SLI (mainly substitution of definite articles) were attributable in part to an incomplete comprehension of how definite articles are to be used, and finally, they proposed the possibility of considering the inadequate use of article as a clinical marker of SLI.

Similarly, Chondrogianni and Marinis (2015) examined definite and indefinite article production in 7.5-year-olds English-speaking children with SLI, age-matched controls and vocabulary-matched controls. Results showed that in the definite article

contexts, children with SLI and vocabulary-matched controls produced significantly more substitutions than the age-matched controls. In the indefinite article contexts, the three groups did not differ in terms of accuracy or error patterns. In this research, the authors disagreed on the suggestion of considering the articles as a clinical marker for diagnosing SLI.

In rich morphology languages, all the nouns have grammatical gender and number, with obligatory marking on preceding articles. In Spanish, these articles mark gender and number both in definite (*el/los* are 'the' masc., sing./pl. and *la/las* are 'the" fem., sing./pl.) and indefinite forms (*un/unos* are 'a' masc., sing./pl. And *una/unas* are 'a' fem., sing./pl.). Children have to learn this noun phrase agreement in oral language from early age. According to Auza and Mariscal (2017) in Spanish-speaking children the acquisition of article-noun agreement appears by the age of 3. A similar process is also develop in French- and Italian-speaking children (Pizzuto & Caselli, 1992).

Studies with Spanish-and/or Catalan-speaking children with SLI also indicate a tendency towards omission and substitution of verbal morphological marks and function words in these children (Aguilar, Sanz-Torrent & Serra, 2007; Auza & Morgan, 2013a; Bedore & Leonard, 2001, 2005; Grinstead et al., 2009; Restrepo, 1995; Sanz-Torrent, Serrat, Andreu & Serra, 2008). For instance, Restrepo (1995) showed that Spanish-speaking children with SLI omitted and substituted grammatical morphemes more frequently than children in the control groups, and that the most frequent error appeared in the use of articles.

According to Auza et al. (2009, 2013a), most of the studies indicate that a great difficulty appears in the use of definite articles (Auza, 2009; Auza & Morgan, 2013a; Bedore & Leonard, 2005; Restrepo & Gutiérrez-Clellen, 2001; Restrepo & Kruth,

2000). Nevertheless, a smaller proportion of studies, indicates that the difficulty arises in the use of indefinite articles (Anderson & Souto, 2005; Bedore & Leonard, 2001).

Similarly, Italian-speaking children with SLI presented limited use of function words compared to the children in their chronological control groups. More specifically, children with SLI omitted articles and clitics more frequently (Cipriani, Chilosi, Bottari, Pfanner, Poli & Sarno, 1991; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992). These results were confirmed in cross-linguistic studies between English-speaking and Italian-speaking children with SLI where, despite minor differences, both groups presented similar percentages of article use and omission (Leonard, Sabbadini, Leonard & Volterra, 1987; Leonard, Sabbadini, Volterra & Leonard, 1988).

As discussed above, numerous studies in different sociolinguistic scenarios point out a significant difficulty in the production of function words and, more specifically, in the production of articles. However, to date, no study has examined the online comprehension of definite and indefinite articles.

3.2. Prepositions

Problems with grammatical morphology are characteristic of children with SLI according to empirical literature. Leonard (2014), in a wide review, argues that many of the hypotheses regarding the nature of SLI focus their interest on grammar, because morphosyntactic problems in SLI are notorious. In a similar approach, Mendoza (2012) states that the most severe difficulties in SLI are found in the production and comprehension of morphological particles.

Auza et al. (2009, 2013a, 2013b) suggest that the problems with grammatical morphology in children with SLI vary according to the characteristics of every

language. Under their perspective, in romance languages there is evidence of fragility in the use of prepositions, articles and clitic pronouns. Empirical research has dealt to a greater extent with some of these particles rather than with others, i.e., there is more research on clitic pronouns (Jacobson & Schwartz, 2002; Morgan, Restrepo & Auza, 2013; Restrepo & Gutiérrez-Clellen, 2001; Theodorou & Grohmann, 2015; Tuller, Delage, Monjauze, Piller & Barthez, 2011) and articles (Auza & Morgan, 2013b; Bedore & Leonard, 2001, 2005; Bosch & Serra, 1997; Chondrogianni & Marinis, 2015; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992; Polite, Leonard & Roberts, 2011), than on prepositions.

Regarding prepositions, the few existing empirical studies generally indicate a significant effect on the production of these morphological particles in children with SLI (Auza & Morgan, 2013b; Grela, Rashiti & Soares, 2004; Puglisi, Befi-Lopes & Takiuchi, 2005; Sanz-Torrent, Badia & Serra, 2008). However, there is a discrepancy as to which is the most problematic issue in their linguistic production of prepositions, since some studies point towards omission (Auza & Morgan, 2013b; Sanz-Torrent, Badia & Serra, 2008) and others towards substitution (Grela, Rashiti & Soares, 2004; Puglisi, Befi-Lopes & Takiuchi, 2005). On the other hand, there are some studies that point out a consolidation of prepositions in SLI, especially in their ability to understand them (Puglisi, Befi-Lopes & Takiuchi, 2005; Watkins & Rice 1991).

Inquiring further, Grela, Rashiti and Soares (2004) evaluated the ability of English-speaking children with SLI to produce the locative prepositions “in” and “on” (as in “Put in the box” and “Put on the table”) and the dative preposition "to" ("Give it to her"). The results of the study confirmed the initial hypothesis, which stated that children with SLI would make more mistakes than the children in the control groups.

The errors that the children with SLI made (substitution of dative preposition) allowed the authors to suggest a problem in the semantic function of prepositions, rather than in their syntactic function. Sanz-Torrent, Badia and Serra (2008) analyzed the language of bilingual (Spanish and Catalan-speaking) children with SLI in order to establish error patterns in their language expression. One of the most frequent errors found was omission related to different particles (prepositions, determinants, pronouns, etc.). Specifically, prepositions were the most omitted particle by children with SLI, whose production was significantly lower than the production of children in a chronological control group, and similar to the production of a linguistic control group. Along a similar line, Auza and Morgan (2013b) analyzed errors in the production of prepositions by Spanish-speaking children with SLI. Thus, they evaluated the proper use of seven Spanish prepositions (SP: "a", "con", "de", "en", "hacia", "hasta" y "para") (EN: "to", "with", "from/to/of", "in/on", "towards", "until", and "for") in a story retelling task with graphical representations. They found differences in the overall production of prepositions in comparison to control groups, with a significantly greater number of omissions. The greatest problem was found in polysemous, monosyllabic and unstressed prepositions (SP: "a", "en" and "con") (EN: "to", "in/on" and "with"). From the author's perspective, these characteristics may be responsible for the difficulty recorded. On the other hand, children with SLI would require more time in learning and mastering the different functions fulfilled by prepositions.

According to Grela, Rashiti and Soares (2004) closed class particles (articles, pronouns, and prepositions) usually assume a syntactic function in the connection of different phrasal elements. Leonard (2014) recognizes that in the case of closed class particles -such as prepositions- syntactic knowledge is essentially required, but that semantic knowledge also plays a role in the difficulty of acquiring and using them. In

this sense, the polysemy of prepositions consists in that one same preposition, according to its sentence function, can establish one meaning or another. The difficulties observed in the production of prepositions by children with SLI may be explained by the surface hypothesis (Leonard, 1989, 2014). This hypothesis suggests that children with SLI have a greater difficulty with those grammatical elements which have a shorter duration and are phonologically less salient. On the other hand, Evans, Saffran and Robe-Torres (2009) suggest that the difficulty with these kinds of grammatical particles is not due to a lack in their perception, but rather caused by a greater cognitive effort, which hinders an already deficient processing mechanism. At the same time, it would be important to mention that results of translingual studies in children with SLI (Bedore & Leonard, 2001, 2005; Leonard, 2014; Leonard et al., 1987, 1988) have also led to the proposal of the morphological richness account. Under this theoretical perspective, children with SLI who acquire a rich language in morphological terms, have a better performance using the morphological particles of their language than children with SLI who acquire a language with poor morphological marks. Along the same lines, Mendoza (2012, 2016) argues that, as Spanish is so morphologically rich, it is worth considering the possibility that Spanish-speaking children with SLI may present a greater capacity to use morphological marks compared to other children who speak morphologically poorer languages. However, according to this author and Grela et al. (2004), the diversity of research findings regarding the acquisition of closed class particles maintains the open question of whether children with SLI have an abnormal development pattern or, perhaps, a pattern of delay when compared to children of their same age who do not have SLI.

CHAPTER 3

OBJECTIVES AND HYPOTHESES

1. Objectives

As mentioned in the previous pages, the most frequent mistakes that children with SLI make in their language production are related to verbal marks and function words (Andreu, Sanz-Torrent, Buil & MacWhinney, 2012; Andreu, Sanz-Torrent, Guardia & McWhinney, 2011; Sanz-Torrent, Serrat, Andreu & Serra, 2008; Sanz-Torrent, Andreu, Badia & Sidera, 2011).

However, the expression and the characteristics of real-time processing of these particles in comprehension of simple sentences are unknown. In this sense, this research addresses a particularly novel subject: the study of real-time comprehension of lexical and morpho-syntactic elements in children with SLI.

The main objective is to analyse the different aspects involved in children with SLI's comprehension of simple structure sentences, in order to be able to enquire more clearly and specifically where their main difficulties are concentrated; that is to say, whether the main focus of difficulty is in the processing and comprehension of morphological marks and function words.

Thus, the results of the study might allow us to further improve the knowledge of the causes that provoke alterations in linguistic comprehension of SLI.

The specific objectives are all comprised in the morpho-syntactic field and based on the study of real-time oral comprehension through tracking of eye movements:

1. To study the processing of verbal marks of time and number during oral comprehension in simple sentence structures (Experiments 1, 2 and 3).

2. To study the processing of function words under the same circumstances as in the previous point (Experiments 4 and 5).

3. To study the temporal course of the comprehension of each experimental task, in terms of entirety of time (the whole sentence), as well as in terms of time fragmentation (time-windows of 1000 ms).

4. To study the temporal course of the comprehension of each experimental task, in terms of chronological age, creating subgroups (younger and older children) within the three groups of children (SLI, AGE, and MLU-w).

Each one of these objectives is specified in the experiments that will evaluate the processing of comprehension of different elements (verbal marks and function words), the speed of processing, as well as the correction (or not) in the conduct of each experimental task, in children with typical and atypical (associated with SLI) language development, in order to distinguish the type of difficulties in understanding simple sentences in real time, as clearly as possible.

2. Hypotheses

The hypotheses on which the objectives of the study are based are:

1. If the morphological characteristics of linguistic stimuli guide the comprehension of sentences and the visual analysis of an event, then the deficits in morpho-syntactical processing will be reflected in the conduct and in the pattern of eye movements during comprehension tasks.

2. If children with SLI have difficulty in producing studied linguistic elements, then they will show difficulties in the speed and/or the conduct of comprehension tasks of those elements.

3. If children with SLI follow not only a delayed, but also a deviant language acquisition pattern, then there will be differences in the speed and/or the conduct of comprehension tasks when compared with the control group matched by linguistic level.

4. We expect children with SLI to have the worst results, compared to their control groups. In the case that the hypotheses of the study are not confirmed, and children with SLI do not have significantly different comprehension levels from the control groups, it may be suggested that there is possibly a greater capacity when processing studied linguistic elements, and, consequently, of a less atypical comprehension than what is generally thought.

This research seeks to study these particles in detail at a linguistic comprehension level, in real time, and in simple sentence structures. As the problems that children with SLI have with the morpho-syntactic dimension of expressive language are already known, we created sentence structures as simple as possible, in order to be able to study morphological marks and function words of the Spanish language, with the least distraction possible. In other words, we tried to reduce the lexical difficulty as much as possible, to fully focus on the morphological dimension.

CHAPTER 4

METHODOLOGY

1. Eye tracking method

Eye tracking technology allows us to understand the relationship between what a person listens and what they look at in real time, providing valuable information with regard to the processing of different particles that form a possible sentence and its corresponding visual scenario. It won't be wrong to say that the Eye Tracker tool allows us to build a *quantitative image of comprehension.* The six experimental tasks that form this research fall within the *visual world paradigm* (Cooper, 1974; Tanenhaus, Spivey-Knowlton, Eberhard & Sedivy, 1995), an experimental framework that allows obtaining quantitative evidence regarding the interaction between language and thought, through a systematic recording of eye movements. This paradigm provides optimal circumstances for recording and evaluating the cognitive processing of a participant faced with audio-visual scenes. This possibility, within the field of experimental psycholinguistics, opens a window that allows us to study and understand the cognitive processing of the interaction between language and thought. Within the theoretical context of "Verbal Thought", introduced by the notorious work of psychologist Lev Vygotsky (1986) it is argued that despite different roots in evolutionary development, eventually, thought is verbalized and language is rationalized (Frawley, 1997; Rimassa, 2016). In this sense, appears the possibility of a quantitative representation of the interaction between language (words/sentences) and thought (graphic scenes).

Tyler (1992) supports that the tools that capture and analyse the processing of language in real time offer the possibility to evaluate unconscious automatic operations and mental representations regarding the comprehension and interaction between perception and language. On the other hand, Trueswell (2008) states that the Eye Tracker tool shows, in a relatively easier way, a detailed record of the way children and adults focus their visual attention while listening. This detailed expression of language processing, according to this author, allows a comprehensive description of the participant's visual reference facing reality. It was not for nothing that Andreu, Sanz-Torrent and Trueswell (2013) argued in favour of the use of eye tracking tool to make possible the recording of the cognitive processing of linguistic elements within a sentence, exactly at the time of its occurrence. Additionally, they suggested that the previous studies based on off-line tools could have limitations when recording the real linguistic comprehension capacity of children with SLI.

One of the studies with a great impact on psycholinguistic literature is by Altmann and Kamide (2009). These authors, by means of the eye tracking tool, explored the mapping between language and mental representations of visual events in English-speaking adults. According to their empirical results, language is capable of mediating in the update of mental representation of a scene. Furthermore, they support that a mental representation can be the basis for the subsequent direction of attention. A considerably important contribution is the perspective of these authors, which suggests that this mental representation is precisely what guides human behaviour.

On this matter, it is worth pointing out the complexity when dealing in experimental terms with language in children who present a language disorder. Especially in the case of the evaluation of language comprehension, one can say that

there is a distance between what the person is potentially capable of understanding and what is recorded through off-line evaluation tools. The complex interaction of human communication, and especially the need to show the level of understanding though language production, allows us to suggest that eye tracking offers a valuable research alternative. It is valuable in the sense that the language production, as a method of demonstrating the level of understanding -as it occurs with off-line tools, does not exist and therefore it does not intervene.

However, an important limitation of eye tracking methodology is the fact that the linguistic, psychological and social reality of human communication is undeniably different from the experimental circumstances that this tool creates in the laboratory. In other words, the audio-visual stimuli that represent the simple sentence structure, and the relative comfort of responding an experimental task only through eye movements, is a context which is very distant from the reality of linguistic interaction that surrounds the children with SLI every day.

Despite what is stated above, the recording of eye movements allows for an empirical knowledge regarding the interaction between language (words, sentences and speech) and thought (mental representation), which builds a valuable quantitative image of cognitive processing of human comprehension. In this sense, the percentage of times the person looks at the target (correct answer) allows us to know the exact comprehension level of the participants in every moment, which is particularly important when evaluating the characteristics of the linguistic disorder in question, in terms of dynamics and limitations. Under these optimal circumstances of psycholinguistic experimentation, a detailed knowledge regarding the nature of SLI can arise.

2. Participants

All participants were native speakers of the Catalan and Spanish language and they reside in the city of Barcelona and other areas of Catalonia[1]. The sample consists of 4 groups: 24 children with SLI (age range 4;06-12, average age 7;08), 24 children with the same age range as the children with SLI as control group (average age 7;08), 24 children with the same linguistic level (based on Mean Length of Utterance by words, MLU-w, with ages ranging between 4;03-9;04 with an average age of 6;08). The last group of the sample was a group of adults of 24 university students with ages between 18-30 and an average age of 22;05.

For the selection of the SLI group the standard diagnostic criterion for SLI was utilized (Stark and Tallal, 1981; Leonard, 2014; Watkins, 1994). Both for the formation of SLI group well as the formation of two control groups of children (chronological and linguistic), an extensive evaluation was conducted previously (see Material below) in a set of 260 children with age range between 3;09-12. The children who presented a cognition and linguistic level within the parameters of normality passed to the next stage, where spontaneous speech samples were recorded for the analysis of the MLU-w.

Subsequently, the ideal candidates were selected in order to form control groups that are comparable to the SLI group in terms of age and MLU-w. On the other hand, because of the amplitude of age range of the SLI group, we decided to create two subgroups, one of younger children (SLI1: n=12 and average age 6;00) and one of older (SLI2: n=12, average age 9;07).

[1]Its important to highlight that in Catalonia it is very difficult to separate monolingual and bilingual children. It is important to be aware that in Catalonia both Spanish and Catalan are official languages, thus the proficiency of both Spanish and Catalan is if not native, native-like.

This classification was extrapolated to the rest of the children control groups: Age control group (AGE1: average age 6;03 and AGE2: average age 9;04) and MLU-w control group (MLU-w1: average age 5;04 and MLU-w2: average age 8;02). The descriptive data of the groups are summarized in Table 1.

Table 1. Average individual measures per group and pairwise contrasts (Welch two sample*t*-test, two-tailed)

	SLI	**AGE**	**MLU-w**	**SLI vs. AGE**		**SLI vs. MLU-w**	
Full sample (n=24)		*Means*		*t*	*p*	*t*	*p*
Age (years)	7;08	7;08	6;08	-0.04	0.964	1.91	0.063
MLU-w	4.94	8.53	5.37	6.46	0.000	-1.07	0.292
PPVT-III	87.0	106.0	107.0	5.52	0.000	-5.68	0.000
CEG	20.0	46.0	42.0	3.77	0.001	-2.88	0.006
KBIT-VOC	87.0	110.0	108.0	2.14	0.039	-2.62	0.012
KBIT-MAT	92.0	101.0	103.0	0.78	0.442	-2.04	0.047
Younger children (n=12)		*Means*		*t*	*p*	*t*	*p*
Age (years)	6;00	6;03	5;04	0.44	0.665	1.51	0.149
MLU-w	3.10	6.91	4.15	4.67	0.000	-0.80	0.435
PPVT-III	90.0	109.0	108.0	3.66	0.003	-3.20	0.005
CEG	23.0	42.0	25.0	2.56	0.018	-2.13	0.045
KBIT-VOC	87.0	110.0	86.0	0.41	0.688	-0.81	0.429
KBIT-MAT	89.0	105.0	98.0	0.27	0.791	-0.95	0.352
Older children (n=12)		*Means*		*t*	*p*	*t*	*p*
Age (years)	9;07	9;04	8;02	-0.55	0.588	3.26	0.004
MLU-w	6.03	10.02	6.11	6.55	0.000	-1.01	0.323
PPVT-III	83.0	104.0	109.0	4.21	0.001	-4.84	0.000
CEG	18.0	49.0	40.0	2.83	0.012	-1.90	0.074
KBIT-VOC	87.0	110.0	109.0	4.45	0.000	-3.21	0.004
KBIT-MAT	93.0	99.0	109.0	0.94	0.356	-1.86	0.078

Chronological age in years; MLU-w (mean length of utterance by words); PPVT-III (Peabody Picture Vocabulary Test-Third Edition) in standard score (mean=100; SD;15); CEG (Comprehension Test of Grammatical Structures) in standard score (mean=100; SD;15); KBIT-VOC (Kaufman Brief Intelligence Test-Verbal IQ) in standard score (mean=100; SD;15); KBIT-MAT (Kaufman Brief Intelligence Test-Non Verbal IQ) in standard score (mean=100; SD;15).

3. Materials

Both for the formation of the SLI group as well as the formation of two control groups of children (chronological and linguistic) an extensive evaluation based on various standardized tests has been conducted. Particularly, the conducted tests were the Peabody Picture Vocabulary Test—Third Edition (PPVT-III; Dunn & Dunn, 1997), the Kaufman Brief Intelligence Test (KBIT, Spanish version; Kaufman & Kaufman, 2004), the Comprehension Test of Grammatical Structures (CEG; Mendoza, Carballo, Muñoz, Fresneda, 2006), the Test of Nonverbal Intelligence II (TONI-2; Brown, Sherbenou & Johnsen, 1995) and the Spanish protocol for the evaluation of language delay (AREL; Pérez & Serra, 1998).

For the language experiments the eye movement register system *Tobii T120* with an integrated monitor TFT 17" was used. The stimuli were presented and the eye tracking data were collected through the *Tobii Studio Software.* For the creation of the stimuli different criteria were used. Regarding the visual criteria, it is worth mentioning that all the images used were of people or objects with unambiguous or unabstract characteristics that maintained vivid but not excessively colors. In general, the images of the distracters were carefully chosen so as not to establish a semantic relation with the action of the scene. As for the linguistic criteria, we used high frequency words, without a polysyllabic structure, and as far as possible, without irregular grammatical characteristics that could hinder their processing. We try to create a sense of familiarity and coherence between images and words (for more detail see the section *Stimuli* of each study).

4. Procedure

The stimuli had video format of 800 x 600 pixels and they appeared on the integrated monitor TFT of 17" of *Tobii T120 Eye Tracker*, at a horizontal distance of approximately 22" from the eyes of the participant. Both the presentation of the stimuli, as well as the collection of the obtained eye movement data were carried out through *Tobii Studio Software.* At the beginning of the experiment a calibration of 20s was done in order to validate the tracking and the registration of the eye movement. There were four test trials before the experimental task (two past and two future sentences) so that the participant could become familiar with the sequence of events. Each participant was given the following instructions: *"You will see some images and you will hear a sentence, search as quickly as possible for the correct image and stay looking at it".*

The images of the test were presented in random order and the participant was exposed either to List A or List B. At the beginning of each trial before the appearance of the stimulus, a cross was shown at the center of the screen for 1000 ms. Subsequently, each stimulus appeared for 6000 ms. The evaluation of the participants took place at psycholinguistic laboratories of the Universitat de Barcelona (UB) and the Universitat Oberta de Catalunya (UOC). The parents of the children with SLI and the adult's participants gave their written consent for participating in the present research and the school director authorize the realization of the experimental tasks inside the institution.

CHAPTER 5

Study 1: real time comprehension of verbal tense

Introduction

The present work tries to study the comprehension of the verbal morphology of tense in children with SLI. In particular, the study focuses on the verbal marks of future and past, and its idea is constructed from the study of Altmann and Kamide (2009) which explored, through the register of eye movements, the mapping between language and the mental representations of visual events in English-speaking adults. More specifically, the participants in the study showed anticipatory glances at experimental elements related to the tense morphology of the verb. For instance, when presenting a static scene (which consisted of a woman, a glass, a bottle, a table, and a library) and the corresponding sentence: “The woman will take the bottle and carefully will put wine into the glass”, an anticipation was observed in the fixations of glances to the image of the glass, before the production of the word glass. The results of this study demonstrate how language is able to mediate in the updating of the mental representation of a scene, and how this mental representation can form the basis for the subsequent direction of attention. According to the perspective of the authors of this study, it is precisely this mental representation that guides our behaviour.

For the construction of the present language experiment, the design of the study exposed in the paragraph above has been simplified, emphasizing the marks of future and of past in the context of simple sentences. For this reason we isolated, to the greatest extent possible, the morphological marks of tense and evaluated them experimentally.

This experiment puts the emphasis on the verbal morphology of tense, since the empirical bibliography indicates this as a source of errors and difficulty. In this sense, if we accept that the characteristics of the verb (linguistic stimulus) guide the comprehension of the sentence, then the deficits in the morphological processing will be reflected both in the execution and in the pattern of glances during comprehension tasks.

Thus, under the hypothesis raised, it would be expected of the children with SLI to present worse results, compared to their controls. Results that could suggest the possibility of a deficit in the comprehension of the morphological marks of the verb and, consequently, a significantly more diminished comprehension of the verbal morphology.

Conversely, if the children with SLI show a similar comprehension regarding their control groups, this would allow us to suggest that their process of comprehension of the verbal morphology is shown to be relatively preserved. A question which in turn, would raise the possibility of a not significantly atypical representation of the notion of the past/future, in spite of being evidently affected and besides the errors that appear in the production of verbs.

1. Stimuli

The approach used by Altmann and Kamide (2009) was adopted and adapted to the needs of the present study which focuses on children. In this context, 60 sentences of simple structure (subject-verb-object) were created; 30 in past form and 30 in future form. For example (figure 1): *"The girl climbed the tree/The girl will climb the tree".* Two experimental lists (each containing 15 past sentences and 15 future sentences) were created and used randomly in search of greater rigurosity.

When a stimulus appeared in its past version in List A, in List B appeared its future version, in that way a child never faced the two versions of the same stimulus. This experimental structure provides the possibility of evaluating the past and future flexions separately, in order to detect if there are any significant differences. For the elaboration of the visual stimuli, Clip Art images were selected and occasionally modified for a greater control of possible strange variables.

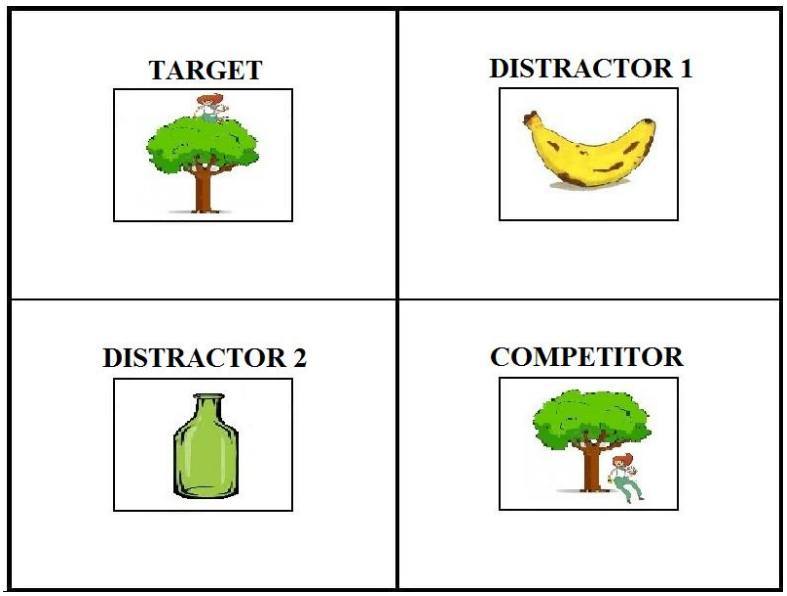


Figure 1. Example of the visual stimulus display in a trial.

The visual stimuli were created by images of 800 x 600 pixels and they were presented on a monitor screen set to 1024 x 768 pixels. Every stimulus was composed by four squares (target, competitor and two distractors not semantically related to the sentence). Every square consisted of an image placed in its interior. The lines of the square were black and the background white.

The sentences were recorded by a native Spanish speaker at a normal speaking velocity at 44,100 Hz. The stimuli were evaluated and selected by judges (collaborators and authors of the research) with the objective to reduce as much as possible the

presence of strange variables that could decrease the adequacy of the stimuli.

2. Data analysis

Four areas of interest corresponding to the location and size of the displayed pictures (i.e., the target, the competitor and two distractor objects) were defined using the software Tobii Studio. This software provides participants gaze location at both the horizontal and vertical axes each 8,33 ms (sample rate of 120 Hrz). Consequently, it was possible to determine, for each gaze sample, whether it was located inside of any of the areas of interest.

Three 1000 ms critical time-windows were analyzed. These time-windows corresponded to the first silent window following the critical verb (1000 to 2000 ms from sentence onset), the critical noun window (2000 to 3000 ms from sentence onset), and the second silent window, which followed the critical noun (3000 to 4000 ms from sentence onset).

Using the R Project software, steps of one ms were inspected per participant and trial for each of these time-windows and a value of 1 was given to the area of interest that participant were fixating at time step. The fixation sum and the proportion of fixation (number of fixation to an area of interest/total number of fixations) was calculated per participant on a trial basis for the four areas of interest (the target, the competitor and the two distractor objects on the display). For visualization, we aggregated fixations into 50 ms steps (see Figure 2).

For statistical analysis, the log-transformed fixation proportion difference between the target and the competitor (log(diff), see, Jaeger, 2008) was computed per participant and per trial. To obtain the log(diff), we divided the proportion of fixation towards the target plus a constant value (i.e., 1) by the proportion of fixation towards the competitor plus that constant.

Thus, in the log-transformed values, positive numbers represent the preference towards the target and negative numbers represent the preference towards the competitor. Inferential analysis was conducted with linear mixed-effects regressions (LMER, lmerTest in R). This multilevel approach is an alternative to separate by-participants by-items analysis (F1, F2 analyses), because it can include crossed random predictors for participants and items in a single analysis.

In addition, LMER analysis can model the variation of participants and items around the predictors. This characteristic is particularly valuable in the context of psycholinguistics data, due to the known intrinsic variation of participants and items added to that of the experimental manipulation (see Clark, 1973). Finally, LMER models are robust against missing values as it does not assume data homoscedasticity and sphericity (Baayen, Davidson & Bates, 2008).

Most literature in psycholinguistics advocate the use of fully specified models, that is, the inclusion of maximal random structure justified by the design (see Barr, Levy, Scheepers & Tily, 2013). However, some have recently argued warn against the overfitting of the data in the use of LMER (see Matuschek, Kliegl, Vasishth, Baayen & Bates, 2017). For the present data, we began using maximal structure, and simplified it whenever the model did not converge. In that, we followed recommendations given in Barr et al. (2013).

Two main analyses were carried out with the data from all four groups (for an alternative analysis using only children's data). First, we compared the experimental group (SLI) against all three control groups (Age control, MLU-w control and Adult control groups) with time-window as a factor. The second analysis examined the differences between groups on each time-window of interest, separately.

The first analysis used a successive difference contrast (MASS package in R) to compare the changes in time along the three time-windows of interest. In both analysis, we used a treatment contrast (MASS package in R) to compare the between-subject predictors (i.e., independent groups). This meant that in both analysis the Intercept of the model represented the mean log-transformed fixation proportion difference between target and competitor for the SLI group across the three time-windows. We report the estimates, standard error of the mean, *t*-values, and *p*-values.

The LMER structure of the first analysis included as fixed factors participants' group as between-subject predictor, time-window as within-subject predictor and the interaction between them. It also included random intercepts for participants and items, a random slope of time-window for subjects, and of group and time-window for items. The second LMER structure included group as single predictor, random intercepts for participants and items, and a random slope of group for items.

3. Results

Figure 2 shows the log-transformed difference between the target object and the competitor object on each time-window, averaged by participants and divided by each independent group. These time-course plots also include the 95% confidence intervals shown by the grey area surrounding the central line.

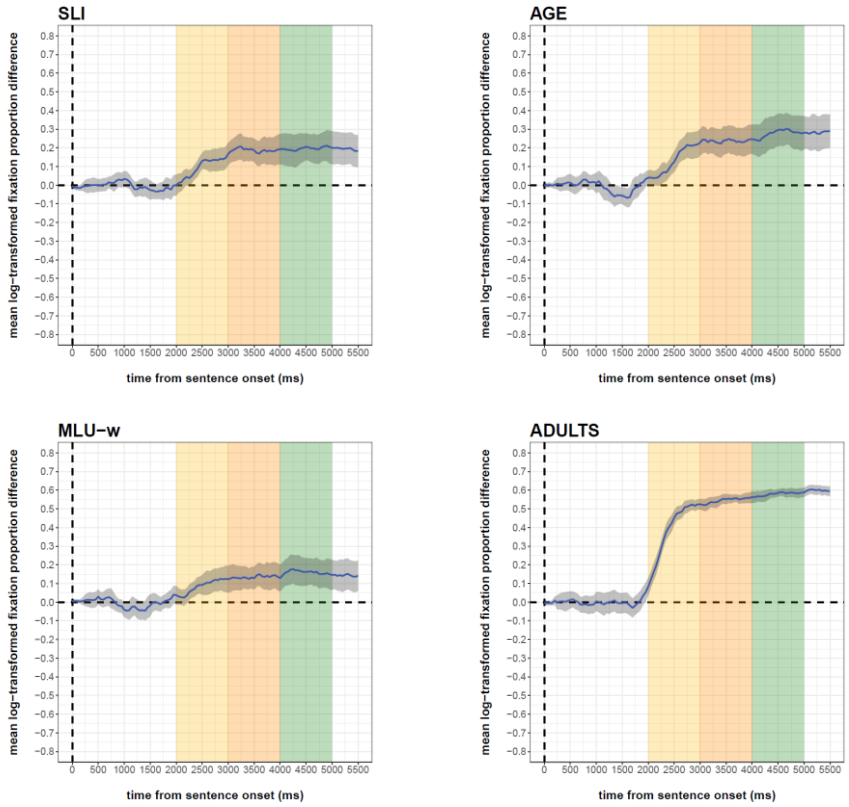


Figure 2. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas around the average represent 95% confidence intervals.

As it can be seen in the graphs, all groups showed an increase on the proportion of fixations towards the target during the beginning of the first time-window. This preference reaches a peak in the second time-window and it is maintained in the third time-window for all groups. The graphs also show that the Adult control group evidences a clear advantage in terms of the speed of preference, namely, the moment in time in which the preference for the target is clear, and in terms of effect of size, that is the amount of attention given to the target relative to the competitor. Among the children groups, the graphs suggest more subtle differences. While all three children groups evidence a preference for the target object from the first time-window, the Age control group appears to have an advantage in terms of size of this effect relative to the Experimental and MLU-w groups. LMER analysis clarifies these potential differences.

Table 1. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*P*	
(Intercept)	0,157	0,020	8,059	0,000	***
Age-control	0,055	0,026	2,094	0,040	*
MLU-w-control	-0,032	0,027	-1,199	0,235	
Adult-control	0,342	0,024	14,453	0,000	***
Time-window2-1	0,098	0,024	4,072	0,000	***
Time-window3-2	0,010	0,018	0,533	0,594	
Age-control:Time-window2-1	0,011	0,034	0,323	0,748	
MLU-w-control:Time-window2-1	-0,044	0,034	-1,312	0,194	
Adult-control:Time-window2-1	0,066	0,029	2,263	0,027	*
Age-control:Time-window3-2	0,032	0,026	1,265	0,207	
MLU-w-control:Time-window3-2	0,016	0,026	0,640	0,522	
Adult-control:Time-window3-2	0,026	0,022	1,166	0,244	
****p < 0,001; **p < 0,01; *p < 0,05*					

Table 2. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,089	0,018	4,998	0,000	***
Age-control	0,037	0,024	1,519	0,135	
MLU-w-control	-0,008	0,024	-0,334	0,740	
Adult-control	0,289	0,022	12,887	0,000	***
Time-window 2	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,187	0,024	7,621	0,000	***
Age-control	0,048	0,034	1,399	0,168	
MLU-w-control	-0,052	0,034	-1,522	0,134	
Adult-control	0,355	0,028	12,763	0,000	***
Time-window 3	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,196	0,026	7,570	0,000	***
Age-control	0,080	0,035	2,302	0,025	*
MLU-w-control	-0,036	0,037	-0,967	0,337	
Adult-control	0,381	0,031	12,212	0,000	***
****p < 0,001; **p < 0,01; *p < 0,05*					

The LMER results from the first analysis are presented in Table 1. They show that overall, the SLI group had more looks to the target object compared to the competitor (Intercept). Moreover, the results revealed, as expected, that the Adult control group had an overall significant advantage over the SLI group. Similarly, the Age control group also evidenced an overall advantage over the SLI group. In addition, we observed a significant increase of the proportion of fixation towards the target relative to the competitor on the second time-window relative to the first time-window in the SLI group. The third time-window, however, did not differ from the second time-window. Finally, the LMER showed a significant interaction effect between the experimental group (SLI) and the Adult control group difference and the difference between time-windows 1 and 2. This reflects that the advantage observed in both groups on the second time-window of interest over the first time-window of interest, is greater in the adults compared to the SLI group. This effect is evident in Figure 2, as well. The absence of other interaction (all $t < |2|$), shows that the advantage of second time-window over first time-window observed for the SLI group, as well as the absence of difference between the second and the third time-windows, are similar to those on the other two control groups (Age-control, MLU-w-control). The results of the second analysis (by window) are presented in Table 2. They confirm that the adults evidence a stronger preference for the target object (vs. competitor) in all time-windows compared to the SLI group. Moreover, they clarify that the difference between the SLI and the Age control group appeared to be significant only in the third time-window. Finally, both the children groups and the adults group have obtained higher comprehension percentages when the sentence verbs were in the past tense (Figure 3).

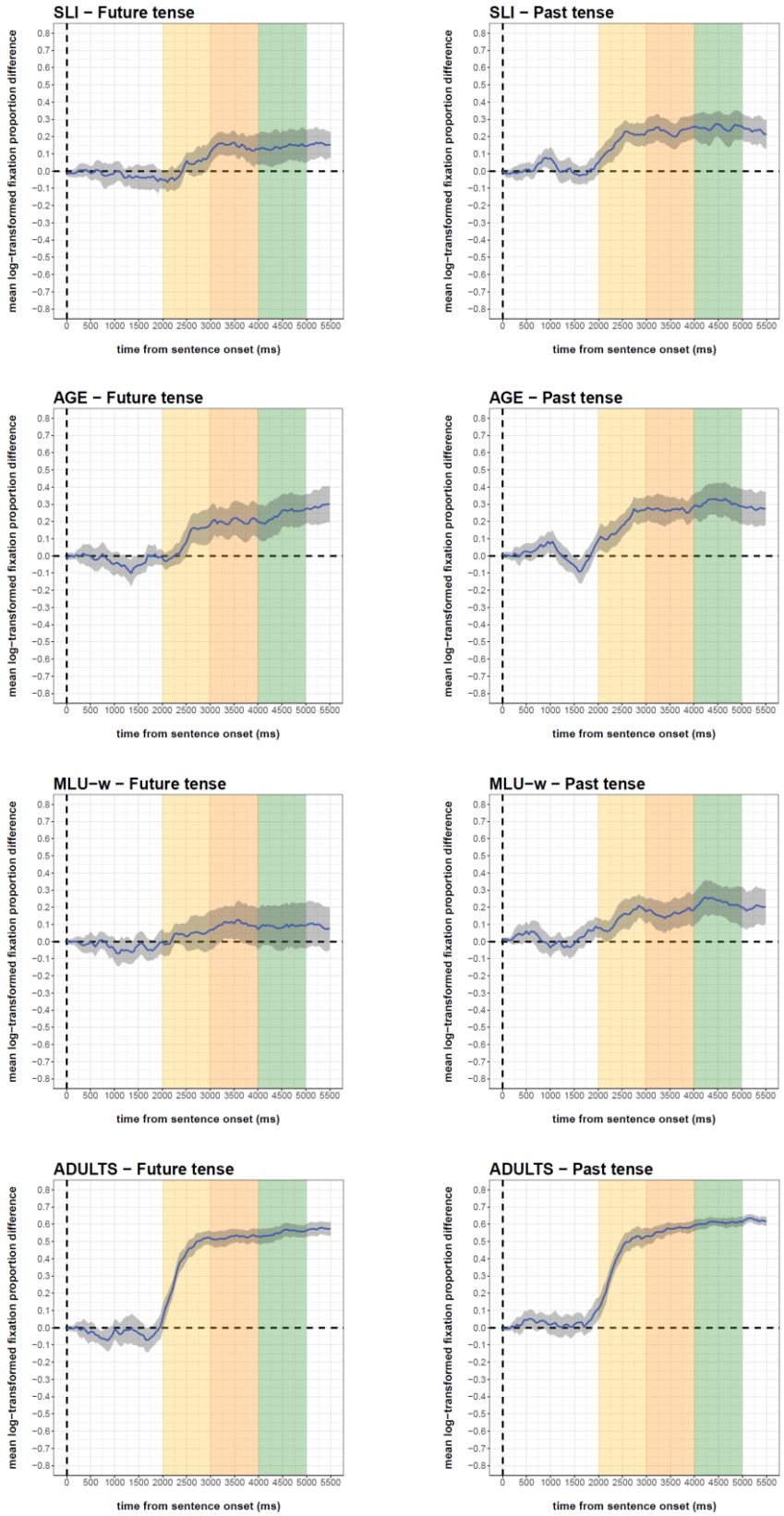


Figure 3. Mean log-transformed fixation proportion differences between future and past verbs by experimental group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

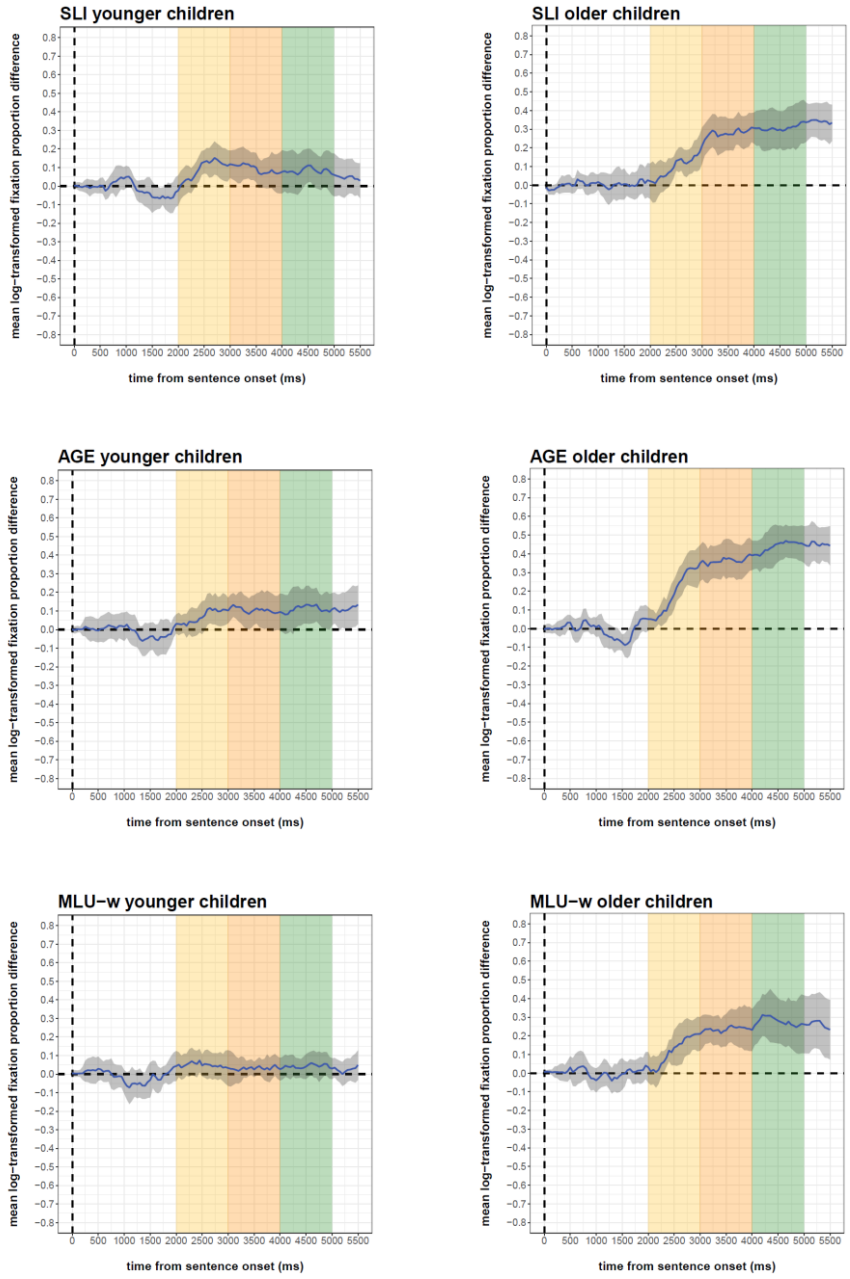


Figure 4. Mean log-transformed fixation proportion differences between target and competitors by group, sub-groups and time-window. Grey areas around the average represent 95% confidence intervals.

Figure 4 shows the time-course plots of the log-transformed fixation proportion difference, averaged by participants, divided by each independent group and age-subgroups. The grey area shows the 95% confidence intervals.

As it can be seen in the graphs, a similar pattern emerges for all three groups: older children within groups, showed an increased on the proportion of fixations towards the target from the first time-window, while younger children within groups do not exhibit a preference for target or the competitor (the younger SLI group, however, show a trend for preference between the first and the second time-windows). The overall preference in older children (from all groups) peaks in the second time-window and it is maintained in the third one in all groups. Among the older children, the Age control group seems to present some advantage in the third time-window. The LMER results clarify these differences.

Two further analysis concentrated on the data from the three children groups, and examines in detail the role of age subgroups (younger and older children) within the experimental and children control groups. Tables 3 and 4, present the results from the LMER analyses including all three children groups, time-window and the age subgroups within a single regression (Table 3) and by time-window (Table 4). The LMER models included children groups, time-window and the age subgroups as main effects and their interaction.

Random intercepts for participants and items were also included as well as random slopes for all fix terms except for group by participants.

Table 3. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*P*	*Sig.*
(Intercept)	0,154	0,020	7,604	0,000	***
Age-control	0,053	0,027	1,912	0,064	.
MLU-w-control	-0,031	0,028	-1,110	0,274	
Time-window2-1	0,094	0,026	3,603	0,001	***
Time-window3-2	0,010	0,018	0,548	0,584	
Age-subgroup	0,067	0,020	3,305	0,002	**
Age-control * Time-window2-1	0,013	0,037	0,346	0,731	
MLU-w-control * Time-window3-2	-0,041	0,037	-1,117	0,271	
Age-control * Time-window2-1	0,029	0,026	1,125	0,262	
MLU-w-control * Time-window3-2	0,014	0,026	0,524	0,601	
Time-window2-1 * Age-subgroup	0,085	0,018	4,701	0,000	***
Time-window3-2* Age-subgroup	0,019	0,018	1,045	0,296	
Age-control* Age-subgroup	0,047	0,029	1,641	0,110	
MLU-w-control* Age-subgroup	0,016	0,029	0,548	0,587	
Age-control * Time-window2-1 * Age-subgroups	-0,014	0,026	-0,541	0,588	
MLU-w-control * Time-window3-2* Age-subgroups	-0,016	0,026	-0,616	0,538	
Age-control * Time-window2-1* Age-subgroups	0,014	0,026	0,553	0,580	
MLU-w-control * Time-window3-2* Age-subgroups	-0,007	0,026	-0,279	0,780	

Table 4. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,088	0,015	5,722	0,000	***
Age-control	0,034	0,021	1,656	0,107	
MLU-w-control	-0,008	0,021	-0,395	0,695	
Age-subgroup	0,005	0,014	0,333	0,742	
Age-control * Age-subgroup	0,052	0,019	2,750	0,010	**
MLU-w-control * Age-subgroup	0,029	0,018	1,576	0,121	
Time-window 2	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,182	0,026	6,896	0,000	***
Age-control	0,047	0,037	1,261	0,216	
MLU-w-control	-0,049	0,037	-1,316	0,197	
Age-subgroup	0,089	0,014	6,535	0,000	***
Age-control * Age-subgroup	0,038	0,021	1,774	0,085	.
MLU-w-control * Age-subgroup	0,013	0,020	0,639	0,526	
Time-window 3	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,192	0,028	6,828	0,000	***
Age-control	0,076	0,038	1,997	0,054	.
MLU-w-control	-0,036	0,040	-0,888	0,380	
Age-subgroup	0,108	0,015	7,133	0,000	***
Age-control * Age-subgroup	0,052	0,021	2,504	0,016	*
MLU-w-control * Age-subgroup	0,006	0,022	0,257	0,799	

4. Discussion

The purpose of the research was a real-time study of the aspects of verbal morphology of tense in language comprehension tasks in children with SLI. The results have shown that both the children of the SLI group and the children of the control groups are able to understand the dimensions of past and future in simple sentences. Contrary to the initial hypothesis, where it was argued that children with SLI would have worse results compared to their controls, the results indicate that online comprehension of the verbal morphology of tense in children with SLI is more preserved than expected.

Analysis of the three time-windows (W1_Silence, W2_Complement and W3_Final Silence) showed that the SLI group, in general terms, presented percentages of task comprehension not significantly different from the control age group and MLU-w control group. Delving further into this subject, it is worth highlighting that the statistical effect found in the first global analysis (Table 1) came out marginal in the second global analysis (Table 3)**,** probably due to the accumulation of non-significant differences throughout the task and to the higher performance registered by the oldest children of Age-control group (AGE2).

Results of the research could be interpreted in a similar perspective to Leonard's review (2014), who supported that studies with Spanish-speaking children with SLI show a greater capacity in language comprehension than in production, an issue also supported by Grimm and Weinert (1990) and Grimm (1993) for German-speaking children with SLI. The difficulties the children with SLI present in the production of verbal morphology are an issue that has been well documented by different authors in different sociolinguistic contexts. In English-speaking children with SLI, the most important problems appear in verbal inflection (third person singular, past, present

progressive) (Conti-Ramsden, Botting & Faragher, 2001; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997; Rice, Wexler & Cleave, 1995; Rice & Wexler, 1996).

Among Spanish- and/or Catalan-speaking children with SLI, the most significant difficulties appear in the verbal inflection of tense, number and person, as well as in the use of infinitives (Anderson, 2001; Bedore & Leonard 2001; Grinstead et al., 2009; Sanz-Torrent, Serrat, Andreu & Serra, 2008). Similar findings indicate a significant problem in the production of verbal morphology in French-, German-, Greek- and Arabic-speaking children with SLI (Abdalla & Crago, 2008; Jakubowicz, Nash & van der Velde, 1999; Paradis & Crago, 2001; Stavrakaki, 2005). The significant differences that children with SLI present between their ability to understand and to produce language, is still an open question and its explanation being unclear. From the perspective of different authors, comprehension - in evolutionary terms - comes previously than production (Bates, Bretherton & Snyder, 1988; Cuetos, Gonzalez & De Vega, 2015; Ingram, 1974) while, according to other authors, they are treated as separate processes (Bock, 1995; Levelt, 1993; MacDonald, 1999).

On the other hand, both the children groups and the adults group have obtained higher comprehension percentages when the sentence verbs were in the past tense (Figure 3). Probably the highest percentages in the past condition are due to different causes, both cognitive and methodological. In linguistic theory the nucleus of a conceptual situation is formed from two types of units: the "things" (nouns) and the "relationships" (verbs). A conceptual situation is a temporal unit, and information relevant to its time of occurrence can be transmitted through the grammatical morphology of the verb. In this sense, the verbal morphology of tense is a grammatical

form that allows to represent and express past, present and future (Radden and Dirven, 2007).

According to these authors, the emitter occupies a position in the present moment in the continuum of time, where the future extends forward and the past unfolds backward. Thus, the fundamental function of the verbal morphology of tense is locating the conceptual situation within the continuous axis of time. This grammatical possibility permits distinguishing, in linguistic and in conceptual terms, known reality from projected reality. The fundamental difference that distinguishes them is the definitive dimension (definiteness) of past. Conversely, the future always contains a degree of uncertainty since, in conceptual terms, the projected reality is subjected to and inseparable from human imagination. The methodological dimension of proposed explanation may be another cause of the effect found. In this sense, the specific character of the graphic representation of the stimuli may have an important weight in the differences found.

For example, if we consider the stimulus explained above: “The girl climbed the tree”/ “The girl will climb the tree” (see Figure 1) we can see that in the version of the past (“The girl climbed the tree”) it is more likely to choose the target (girl on the tree) than the competitor (girl under the tree). Conversely, in the future version the distinction between target and competitor is less likely, since both images may be coherent in conceptual terms. Projection into the future (“The girl will climb the tree”) can be represented mentally by both the target (girl under the tree) and the competitor (girl on the tree). The found effect illustrates an interesting cognitive phenomenon, where the importance of mental representation of the concept seems to have more force than its linguistic representation. In other words, in the interaction between language

(grammatical morpheme) and thought (illustrated concept) it seems that the second plays a superior role since, in grammatical terms, both morphemes (past and future) are defined with a similar clarity.

The findings of this study introduce more empirical evidence, in a relatively recently perspective indicating the possibility of a less atypical comprehension of language by children with SLI than is generally considered (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013).

However, it would be essential to emphasize the existence of a series of studies, also recent, in which opposite results are presented (Coloma, Maggiolo & Pavez, 2013; Coloma, Mendoza & Carballo, 2017; Coloma & Pavez, 2017). In this sense, Coloma and col. (2013, 2017, 2017) studied the comprehension by children with SLI through a narrative discourse protocol (Pavez, Coloma & Maggiolo, 2008) that evaluates the natural role of spoken language (complex sentences in narrative style, absence of visual cues, offline methodology). These studies indicate that the SLI group presents a lower level of comprehension, compared to the chronological control group, an issue that is extremely important when contrasting it with the present results. Several reasons may be involved in the presence of this apparent antithesis. On the one hand, studies demonstrating more preserved comprehension abilities in children with SLI (Andreu & col., 2011, 2013, 2016) are based on simpler structures of language, on eye tracking methodology (which does not require linguistic production to indicate the level of comprehension), and language is always held in visual scenes. On the other hand, studies that demonstrate a more atypical comprehension (Coloma & col., 2013, 2017, 2017) do not have visual support, the comprehension is evidenced through verbal

responses of the children with SLI (working memory takes a very important role) and the characteristics of the studied language are much closer to the real-world circumstances of day-to-day linguistic communication.

In the present study, children with SLI were exposed to online linguistic stimuli of verbal morphology of tense in simple sentence structures. Thus, it would be essential to emphasize that the difficulty of the linguistic, psychological and social interaction within human communication is very different from the grammatical structure designed for this research. In other words, the construction of simple sentence stimuli and the adequate circumstances for psycholinguistic experimentation provided by the methodology of eye tracking do not represent the enormous complexity faced by the children with SLI in their daily verbal interaction. The findings of this study introduce more empirical evidence, in a relatively recently perspective indicating the possibility of a less atypical comprehension of language by children. In this regard, the empirical results that we have obtained allow us to raise the possibility of a not significantly atypical comprehension of the verbal morphology of tense, so that the evident effect in production of the temporal dimension of verbs could be a result of other limitations or cognitive difficulties.

CHAPTER 6

Study 2: real time comprehension of verbal number (transitive verbs)

Introduction

In this study we intend to investigate linguistic comprehension of the verbal morphology of number in children with SLI. In other words, our objective is to evaluate through eye tracking technology the use of the morphological information of verbal number in simple language sentences. More specifically, we study the ability of a person to differentiate between the verbal inflection of the third person singular and the third person plural in sentences comprising transitive verbs. If we accept that the characteristics of the verb guide the comprehension of a sentence, then the problems in processing the verbal morphology of number will be reflected in the execution and in the pattern of glances in the recording of the comprehension experimental task. Thus, under the proposed hypothesis, it would be expected that children with SLI will obtain worse results than children among control groups. If significant differences appear, one may consider the possibility of a deficit in the comprehension of the morphological marks of number and, consequently, a more limited comprehension of these verbal morphological marks. On the contrary, if the quantitative data of the children with SLI from our sample present similar values to those of children from the control groups, the possibility of a not significantly atypical representation of the verbal notion of singular and plural may be considered. A question that, in turn, would allow suggesting, in a broader way, the presence of a more preserved comprehension of verbal morphology than it is generally thought, despite the obvious difficulty that characterizes the

production of the verb in the oral language performance of children affected from this linguistic disorder**.**

2. Stimuli

For the needs of the experimental task, 64 sentences were created using singular and plural verbal number inflections, following an atypical yet grammatical structure (verb - direct object - subject). Regarding the composition of an atypical structure, it is important to stand out that Spanish is a free-word-order language, thus the order becomes relevant depending on how the speakers structure the meaning (RAE, 2009, 2010). From a descriptive grammar perspective, the syntactic function (subject, direct object, etc.) inside a sentence is not fixed and the structure of Spanish language considers it acceptable. This dislocation of elements in syntactic structure creates a non-canonical sentence, which is, nevertheless, grammatically correct (RAE, 2009, 2010).

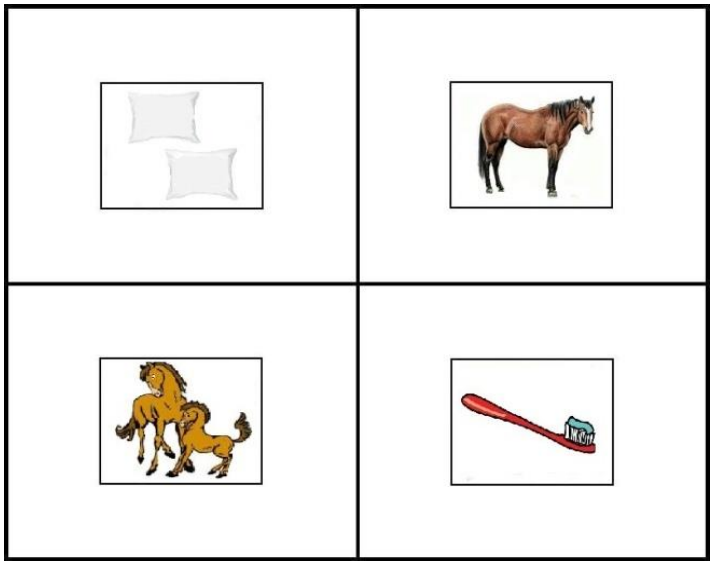
An example of a sentence with a transitive verb appears in Figure 1: SP: *"Bebe agua el caballo"* (Target: "caballo", Competitor: "caballos"); EN*: "Drinks water the horse*" (Target: "horse", Competitor: "horses"). Two experimental lists were created and randomly used. When a stimulus appeared in its singular version in List A (16 sentences in singular and 16 sentence in plural), it appeared in plural version in List B (16 sentences in singular and 16 sentences in plural). This way, every stimulus, whether in singular or in plural, only appeared once in each experimental list. The visual stimuli were created through collected Clip art images of 800×600 pixels and they were presented on a screen set to 1024×768 pixels. Every stimulus was composed of four squares (target, competitor, and two distracters not semantically related to the sentence). Each square consisted of an image located in its interior, the color black was used for the lines of the squares and white was used for its background.

The auditive stimuli (the sentences) were recorded at a normal speaking velocity of 44,100 Hz by a native Spanish speaker. The stimuli were evaluated (in terms of adequacy and pertinence) and selected by judges (collaborators and authors of the research).

Figure 1. Stimulus example.

EN: *"Drinks water... the horse*" (Target: the horse [singular], Competitor: horses [plural])

SP: "Bebe agua... el caballo"



2. Data analysis

Data analysis in the present experiment was identical to Experiment 1, with the exception that for the present data, four critical time-windows were analyzed of 1000 ms each. This means that data preprocessing, dependent variable calculation and statistical approach (both 95% confidence intervals interpretation and LMER) were all the same as in Experiment 1. Consequently, we present two main analyses (and two more as secondary analysis).

The critical time-windows corresponded to the critical verb (1000 ms to 2000 ms from sentence onset), the first silent window following the verb (2000 ms to 3000 ms from sentence onset), the critical noun (3000 ms to 4000 ms from sentence onset) and the second silent window of the sentence (4000 ms to 5000 ms from sentence onset), which followed the critical noun.

3. Results

Figure 2 shows the log-transformed difference between the target object and the competitor object on each time-window, averaged by participants and divided by each independent group. These time-course plots also include the within-subjects adjusted 95% confidence intervals showed by the grey area surrounding the central line. The graphs showed contrasting differences between the experimental group (SLI) and the control groups.

Overall, all groups showed a preference for the target over the competitor. However, the groups appear to differ in the timing and effect size of this preference. For instance, the SLI group manifests a trend of preference from the first critical time-window which turns clearly significant in the last time-window. By contrast, the Age-control group exhibits a clearly significant increase in the preference of the target from the first time-window, which continues to the fourth time-window.

On the other hand, the MLU-w control group showed less evident preference for the target object, which begins to increase in the second time-window. This drift is maintained through the third and the fourth time-windows. In this sense, the MLU-w control group behaves similar to the SLI experimental group. Finally, the Adult control group displays a strong advantage compared to all the other groups from the first time-

window, in which a peak of preference is reached and steadily maintained through the subsequent windows.

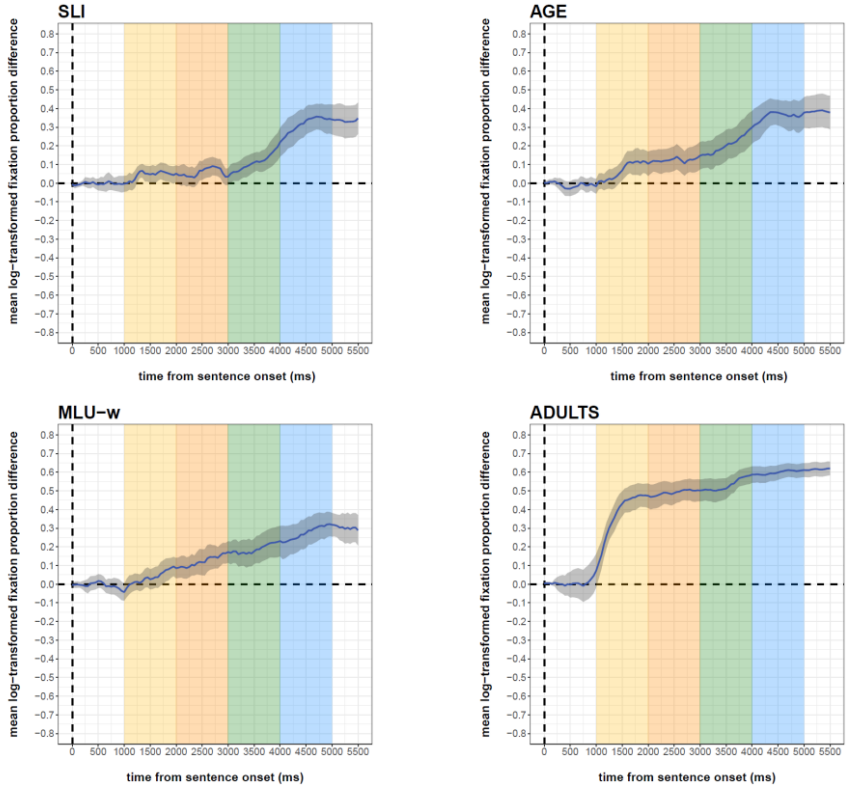


Figure 2. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

The results from the LMER analysis are presented in Table 1. In coherence with what was observed in the graphs, the results reveal a significant overall difference between the experimental group (SLI) and the Adult control group, but not between SLI and MLU-w or the Age control groups ($t < |2|$).

The examination of the time course through the comparison between the distinct time-windows for the SLI shows that while the first and the second time-windows did not differed, a significant increase is observed in the third and fourth critical time-windows relative to the immediately previous one.

In addition, the LMER showed a number of statistically significant interaction effects (see Table 1). We observe interaction effects between the SLI and the MLU-w and the Adult group difference and the difference between time-windows 2 and 3, and 3 and 4.

All these effects represent a larger advantage for the late time-window (namely, time-window 3 in the contrast 3-2, and time-window 4 in the contrast 4-3) in the SLI group, compared to the lack of differences between these time-windows in the MLU-w and Adults groups.

Table 1

	Estimate	*se*	*t*	*P*	
(Intercept)	0.126	0.024	5.23	0.000	***
Age-control	0.056	0.034	1.64	0.104	
MLU-w-control	0.024	0.034	0.69	0.491	
Adult-control	0.367	0.034	10.69	0.000	***
Time-window2-1	0.018	0.020	0.93	0.356	
Time-window3-2	0.046	0.016	2.85	0.005	**
Time-window4-3	0.205	0.022	9.33	0.000	***
Age-control:Time-window2-1	0.040	0.028	1.42	0.159	
MLU-w-control:Time-window2-1	0.069	0.028	2.45	0.016	*
Adult-control:Time-window2-1	0.111	0.028	3.96	0.000	***
Age-control:Time-window3-2	0.031	0.023	1.35	0.181	
MLU-w-control:Time-window3-2	0.019	0.023	0.84	0.401	
Adult-control:Time-window3-2	-0.004	0.023	-0.19	0.850	
Age-control:Time-window4-3	-0.055	0.031	-1.79	0.077	.
MLU-w-control:Time-window4-3	-0.120	0.031	-3.88	0.000	***
Adult-control:Time-window4-3	-0.138	0.031	-4.45	0.000	***

As in Experiment 1, the second analysis examined the differences between groups on each time-window separately. The LMER results of these contrasts are shown in Table 2.

Table 2

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.036	0.020	1.78	0.078	.
Age-control	0.021	0.029	0.71	0.479	
MLU-w-control	-0.010	0.028	-0.37	0.712	
Adult-control	0.328	0.028	11.77	0.000	***

Time-window 2	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.056	0.026	2.17	0.033	*
Age-control	0.064	0.036	1.76	0.081	.
MLU-w-control	0.061	0.036	1.68	0.096	.
Adult-control	0.431	0.036	11.85	0.000	***

Time-window 3	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.102	0.031	3.30	0.001	**
Age-control	0.095	0.044	2.17	0.032	*
MLU-w-control	0.080	0.043	1.85	0.068	.
Adult-control	0.427	0.043	9.96	0.000	***

Time-window 4	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.307	0.032	9.57	0.000	***
Age-control	0.040	0.045	0.87	0.384	
MLU-w-control	-0.040	0.044	-0.90	0.371	
Adult-control	0.289	0.045	6.45	0.000	***

The LMER results from the second analysis are coherent with those from first analysis. This analysis adds to the previous one that the reliable preference for the critical object (relative to the competitor) in the SLI group clearly appears from the second time-window and on. Moreover, there is a reliable advantage for the Age group over the SLI group only in the third time-window.

Children exhibit faster and more robust preference for the critical visual object when the sentence referred a pair of objects (plural) compared to a single object (Figure 3).

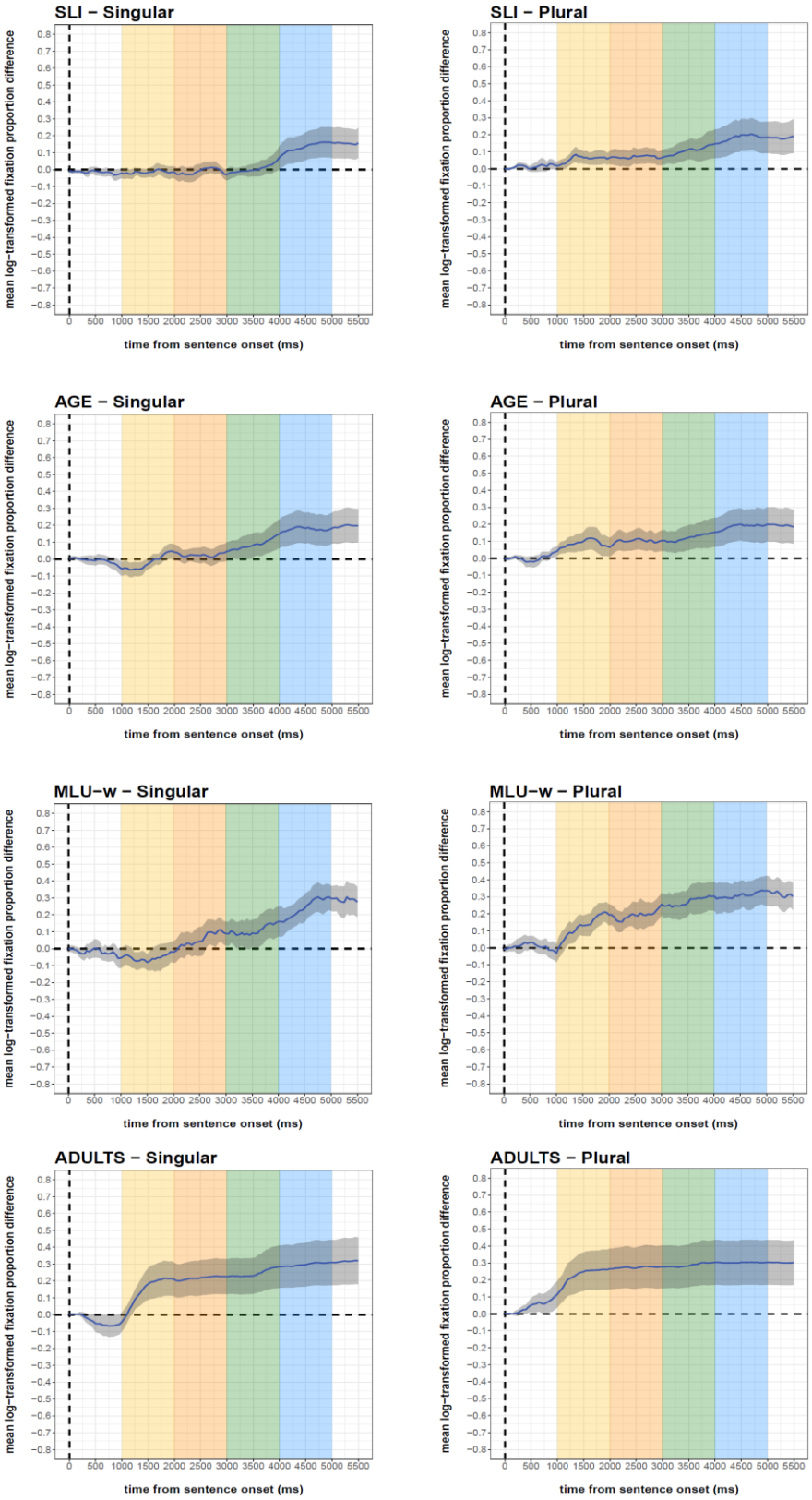


Figure 3. Mean log-transformed fixation proportion differences between singular (on the left-side panels) and plural (on the right-side panels) verbs by experimental group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

We provide two further analyses, which compare the three children groups adding an age factor, namely younger children vs. older children (within each group). The first analysis included time-window as predictor and the second analysis present one regression model per time-window. All aspects of data analysis were identical to those already described in the main analysis.

Table 3.

	Estimate	se	t	P	
(Intercept)	0.126	0.018	6.962	0.000	***
Age-control	0.056	0.025	2.188	0.032	*
MLU-w-control	0.024	0.026	0.918	0.361	
Time-window2-1	0.018	0.020	0.914	0.364	
Time-window3-2	0.046	0.018	2.592	0.012	*
Time-window4-3	0.205	0.022	9.399	0.000	***
Age	0.066	0.018	3.753	0.000	***
Age-control:Time-window2-1	0.040	0.028	1.414	0.162	
MLU-w-control:Time-window2-1	0.069	0.028	2.438	0.017	*
Age-control:Time-window3-2	0.031	0.025	1.242	0.219	
MLU-w-control:Time-window3-2	0.019	0.025	0.777	0.440	
Age-control:Time-window4-3	-0.055	0.030	-1.823	0.073	.
MLU-w-control:Time-window4-3	-0.120	0.030	-3.956	0.000	***
Time-window2-1:Age	0.035	0.020	1.756	0.084	.
Time-window3-2:Age	-0.004	0.018	-0.223	0.824	
Time-window4-3:Age	0.093	0.021	4.317	0.000	***
Age-control:Age	0.020	0.025	0.802	0.425	
MLU-w-control:Age	0.011	0.025	0.428	0.670	
Age-control:Time-window2-1:Age	0.000	0.028	-0.017	0.987	
MLU-w-control:Time-window2-1:Age	-0.017	0.028	-0.587	0.559	
Age-control:Time-window3-2:Age	0.041	0.025	1.666	0.100	
MLU-w-control:Time-window3-2:Age	0.040	0.025	1.608	0.113	
Age-control:Time-window4-3:Age	-0.094	0.030	-3.090	0.003	**
MLU-w-control:Time-window4-3:Age	-0.106	0.030	-3.484	0.001	***

Table 4.

Time-window 1	***Estimate***	***se***	***t***	***P***	
(Intercept)	0.037	0.016	2.369	0.021	*
Age-control	0.024	0.023	1.055	0.296	
MLU-w-control	-0.007	0.023	-0.316	0.753	
Age	0.019	0.016	1.133	0.262	
Age-control:Age	0.023	0.022	1.028	0.308	
MLU-w-control:Age	0.030	0.024	1.231	0.223	

Time-window 2	***Estimate***	***se***	***t***	***P***	
(Intercept)	0.056	0.022	2.581	0.012	*
Age-control	0.064	0.030	2.146	0.036	*
MLU-w-control	0.061	0.031	1.964	0.054	.
Age	0.053	0.021	2.548	0.013	*
Age-control:Age	0.023	0.030	0.746	0.458	
MLU-w-control:Age	0.013	0.030	0.432	0.667	

Time-window 3	***Estimate***	***se***	***t***	***P***	
(Intercept)	0.102	0.026	3.914	0.000	***
Age-control	0.095	0.037	2.576	0.012	*
MLU-w-control	0.080	0.037	2.194	0.032	*
Age	0.050	0.025	1.957	0.055	.
Age-control:Age	0.064	0.036	1.790	0.078	
MLU-w-control:Age	0.053	0.037	1.410	0.163	

Time-window 4	***Estimate***	***se***	***t***	***P***	
(Intercept)	0.307	0.025	12.055	0.000	***
Age-control	0.040	0.036	1.103	0.274	
MLU-w-control	-0.040	0.035	-1.141	0.258	
Age	0.142	0.025	5.732	0.000	***
Age-control:Age	-0.030	0.035	-0.863	0.391	
MLU-w-control:Age	-0.053	0.035	-1.521	0.133	

Table 3 and 4, show that the results are in coherence with those from the first analysis. This analysis adds to the previous one, that there seem to be no reliable difference in the time-windows, besides that for the contrast between the SLI group and the Adult control group.

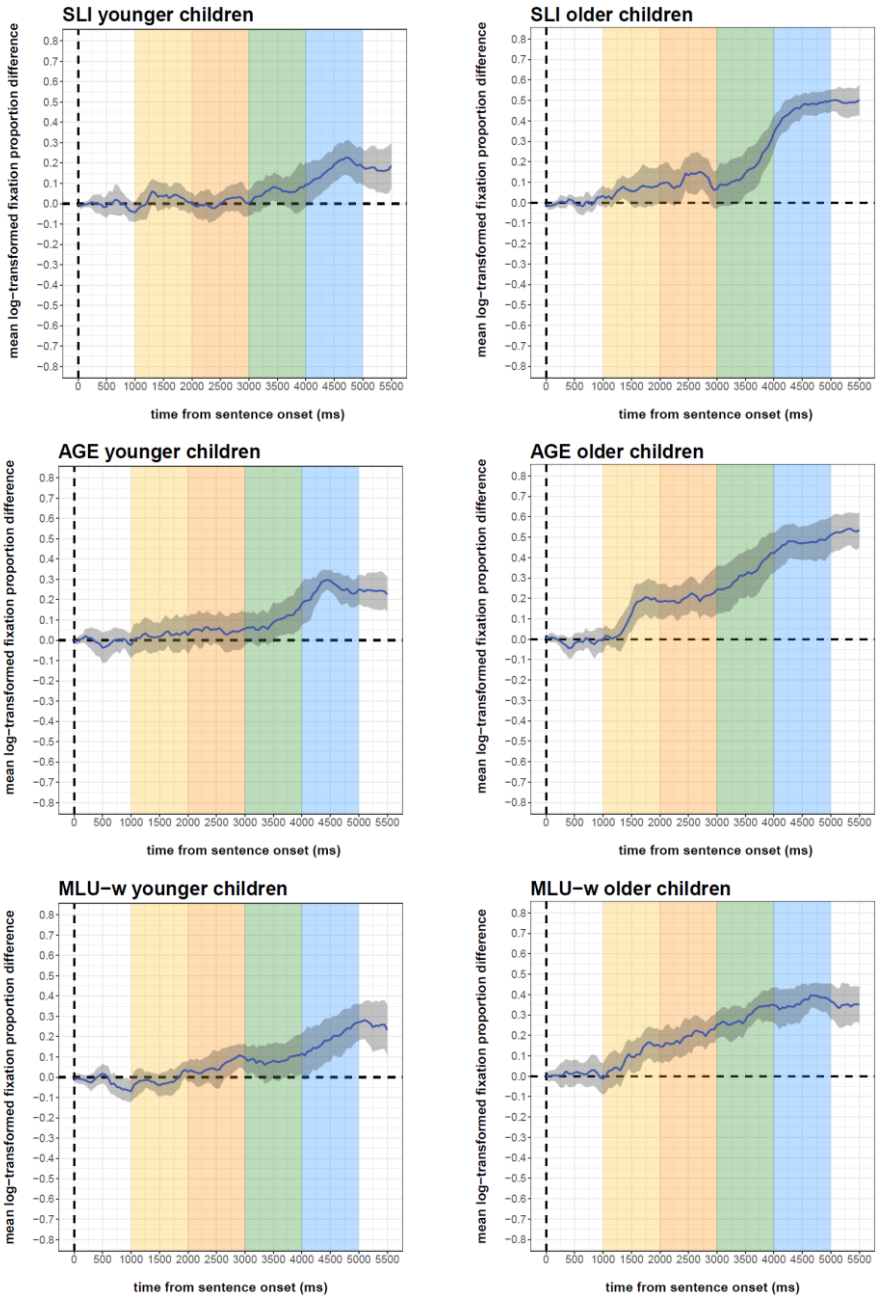


Figure 4. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and age. Grey areas represent the within-subject adjusted 95% confidence intervals.

Figure 4 shows an overall advantage for older children relative to younger children across groups. Yet, there are clear differences between groups. For instance, both the SLI and MLU-w younger children seem unable to identify the appropriate referent. Besides, the younger children from the Age control group evidence clear preference for the target object at the last time-window of interest. On the other hand,

older SLI children appear to be able to identify the correct target object from the first critical time-window, a tendency that increases along the subsequent time-windows, yet the size of the effect of the preference is smaller relative to that of the Age control group (significantly smaller only in the third time-window). Similarly, the older children in the MLU-w control group seem to prefer the target over the competitor, at least from the second time-window of interest, yet this preference only appears clearly after the third time-window.

4. Discussion

The objective of the study was to investigate in real time aspects of the verbal morphology of number (verbal marks of singular and plural) in a language comprehension task by children with SLI. The obtained results indicate the absence of a significant difference between the SLI group and the Age control group, and the research's general quantitative image suggests that children with SLI's comprehension of verbal marks of number is less atypical than what we proposed in the initial hypothesis. In this sense, this significant effect was found only in one of the four analysis windows. More specifically, the effect appears in the third windows (3000-3999 ms) and is due to the significant differences between the older children of the SLI Group (SLI2, average age: 9;07) and the older children of the Age control group (AGE2, average age: 9;04). It is important to emphasize that the younger children with SLI (SLI1, average age: 6;00) show no significant differences throughout the statistical analysis with the corresponding subgroup of the Age control group (AGE1, average age: 6;03) or the corresponding subgroup of the MLU-w control group (MLU-w1, average age: 5;04). Thus, through the empirical data of the present investigation, two different quantitative images of the comprehension of the verbal morphology of number

appear in children diagnosed with SLI. In the first place, there are no differences between the three subgroups of younger children (SLI1, AGE1, MLU-w1). We can therefore suggest and highlight the possibility of an evolutionary pattern of language comprehension, which allows small children to comprehend verbal marks of number in a similar way. Secondly, differences appear among the three subgroups of older children, taking the expression of a typical Gaussian curve. In other words, in the first window of analysis (1000-1999 ms) there are no differences between the three subgroups of older children (SLI2, AGE2, MLU-w2), probably because all the children are still finding out the correct answer between target and competitor in those first 1000 ms, unlike the group of adults who have already consolidated it. In the next two windows (2000-3999 ms), the older children of the Age control group (AGE2) present significantly higher comprehension levels, in relation to the corresponding subgroups within the SLI group and the Linguistic control group (MLU-w2). However, in the last analysis window, the older children of the SLI Group (SLI2) reach similar comprehension levels to those of the Age control group (AGE2). Older children with SLI (SLI2) present in the second (marginal) and third time-window (significal) a higher level of glances to the target than the older children of the linguistic control group (MLU-w2, average age: 8;02). This interesting effect allows us to suggest that comprehension of verbal morphology of number in children with SLI is more preserved than we expected in the initial hypothesis. These findings also show a slower processing in children with SLI although at the end of the experimental task they present a similar comprehension level to that of children of the Age control group.

On the other hand, and regarding the differences found between the proportions of glances towards the target when the verbal inflection was presented in singular or plural, we could observe that in all the groups of children (SLI, AGE, MLU-w), a higher

comprehension performance appears with plural morphological marks. In the group of adults, despite the fact that higher percentages are given when the verb's inflection appears in plural, these differences are not significant. There may be different causes that explain this finding. On the one hand, in linguistic terms, verbs with plural marks can only be interpreted in indicative mode. For example, if we think of the example presented above: SP: "Bebe/beben agua (…) el caballo/los caballos"; EN: "Drinks/drinks water (…) the horse/horses", we can consider that after the appearance of the plural verb, the agent is necessarily constructed from the indicative mode: SP: "Beben…ellos/ellas"; EN: "Drink…they". Conversely, verbs with singular marks can be interpreted in both indicative and imperative modes: SP: "Bebe…él/ella"; EN: "Drinks…he/she" (indicative mode) or SP: "Bebe…tú"; EN: "Drink…you" (imperative mode). This may cause more confusion, and may have some weight in the discussed effect. Another possible explanation may be linked to the graphic representation of the stimuli. After the exhibition and recognition of the verb, there should be an implicit activation in the participant of the information associated with the arguments of the verb (Carlson and Tenenhaus, 1988; Mauner and Koenig, 2000; Trueswell and Tanenhaus, 1994). Thus, the participant will have enough implicit and immediate information of the agent of the verb (SP: "beben"; EN: "drink"), being necessarily plural, what makes it more likely for the target to be recognized (the horses) in relation to the competitor (the horse). Conversely, in sentences with singular marks, the participant can instantly experience greater confusion since the agent of the verb (SP: "bebe"; EN: "drinks") can be located both in the target (the horse) and in the competitor (two horses), in the sense that in the competitor's image, the agent appears doubly. Finally, this effect of significant improvement when the verbal mark is presented in plural may be related to the Surface Hypothesis (Leonard, 1989, 2014). According to this hypothesis, children

with SLI present a greater difficulty when it comes to processing language elements that are shorter in duration and less salient in phonological terms. From the perspective of Evans, Saffran and Robe-Torres (2009), the problem does not emerge in the perception of less salient and lasting grammatical morphemes, but in fact that they require a greater cognitive demand, and consequently the already deficient processing system of these children gets hindered. In sum, we can observe that, in Spanish, the inflections of the singular verbs ("beb*e*") are less salient and lasting in comparison to the inflections of the verbs in plural ("beb*en*").

The results of the study raise the possibility that children with SLI have a less atypical comprehension than it is generally thought (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013). These research findings also introduce further empirical evidence into the perspective that emphasizes the difficulty of language processing that characterizes children with SLI (Bishop, 1994; Evans, 1996; Evans, Saffran & Robe-Torres, 2009; Leonard, Eyer, Bedore & Grela, 1997; Marchman, Wulfeck & Ellis Weismer, 1999). Along these lines, Bishop and Adams (1992) suggested that, during the process of language maturation, children with SLI improve their comprehension; Weismer and Evans (2002) proposed that when linguistic processing demands increase, their comprehension performance decays; and Marinis & van der Lely (2007) concluded that the online comprehension of children with SLI is adequate but slower, when compared to the comprehension of control groups. In theoretical terms, it should be noted that Bishop (1994), in a classic study, seeked to dialogue with the work by Gopaik and Grago (1991), who proposed that children with SLI suffered from a defective semantic-syntactic representation in their grammar, and that morphological frames would have to be either absent or arbitrarily produced, without comprehension

of their grammatical meaning. She also presented the work of Clahsen (1991), who argued that children with SLI either had the parameters of their universal grammar not fixed yet or, if they were fixed, they were not at a value corresponding to their native language. The evolution of the theoretical body of language study, brought by the emergence of Chomsky's notorious thoughts (1928 - present) questioned Skinner's behavioral principles (1957) of imitation, association and reinforcement. After studying the errors in child's language, he proposed the theory of poverty of the stimulus (1980). However, those studies that use generative grammar concepts to justify the language problems present in children with SLI, seems to make a qualitative leap that probably does not correspond to reality. In other words, errors in child's language such as: "*he volvido*" in Spanish (rather than "*he vuelto*") or "*I breaked*" in English (rather than "*I broke*") emphasize the dynamics of the biological mechanism of language in evolutionary terms, and there does not seem to be any conclusive evidence that the mistakes made by children with SLI have to do with deterioration in their universal grammar. Rather, as indicated by Bishop (2014), what is reflected at the beginning of children's language expression are the limitations of their immature state. Thus, this study, along in a similar line to previous ones, does not argue in terms of a lack in structures, but in terms of different processing dynamics.

CHAPTER 7

Study 3: real time comprehension of verbal number (verbs in intransitive form)

Introduction

In the present study we investigated in real time the comprehension of the verbal morphology marks of number (singular-plural/third person) in children with SLI. If we accept that these verbal marks guide sentence comprehension, then difficulties in processing verbal inflections of number will have to be reflected in the pattern of glances recorded through eye tracking. Under the proposed hypothesis, it is expected that children with SLI will have worse results, compared to the children of the control groups.

If significant differences appear, it will be possible to lay out a deficit in the comprehension of the verbal morphology of number and, consequently, a rather atypical linguistic comprehension in relation to that of the children in the control groups. Conversely, if the SLI group's level of glance proportion turns out to have similar values to those of the children of the control groups, it could be argued that the verbal notion of singular and plural may have a representation, which is not significantly atypical.

If this possibility is confirmed, it may allow suggesting, that the comprehension of verbal inflection (both singular and plural) by children with SLI seems to be more preserved than what it is generally thought in the psycholinguistic, speech therapeutic, and academic community.

1. Stimuli

A total of 64 simple-structure sentences were created in singular and plural number, using intransitive or transitive verbs without a direct object. In Figure 1, a stimulus of a transitive verb without a direct object is shown: SP: "*Escribe/ Escriben...la/las abuela/abuelas*"; EN: "*Writes/write... grandma/grandmas*"; and in Figure 2 stimulus of an intransitive verb is exemplified: SP: "*Sale/salen...el/los abuelo/abuelos*"; EN: "*Leaves/leave...grandpa/grandpas*".

Two lists were created (List A and List B), where the half of the sentences consisted of intransitive verbs (8 sentences in singular and 8 in plural number) and the other half had transitive verbs without a direct object (8 sentences in singular and 8 in plural number). It is important to point out that the sentence structure used for this experiment is an atypical structure. Since Spanish is a free-word-order language, changes in order respond to the subtleties in the intended meaning given by the person who speaks. From the point of view of descriptive grammar the dislocation of the elements in the syntactic structure creates a non-canonical yet grammatical sentence (RAE, 2009, 2010), which is the case for the sentence structures used in this research. Visual stimuli were created through collected Clip art images of 800 x 600 pixels and presented on a screen set to 1024 x 768 pixels. All stimuli were composed by four squares with an image (target, competitor, and two distracters not semantically related to the sentence). Background was white with black dividing lines. Sentences were recorded at a normal speaking velocity of 44,100 Hz, by a native Spanish speaker. The stimuli were assessed (in terms of adequacy and pertinence) and selected by expert judges (collaborators and authors of the research).

Figure 1. Stimulus – transitive verb without a direct object.

EN: "*Writes...grandma*" (Target: grandma[singular],Competitor: grandmas[plural]).

SP: "*Escribe...la abuela*".

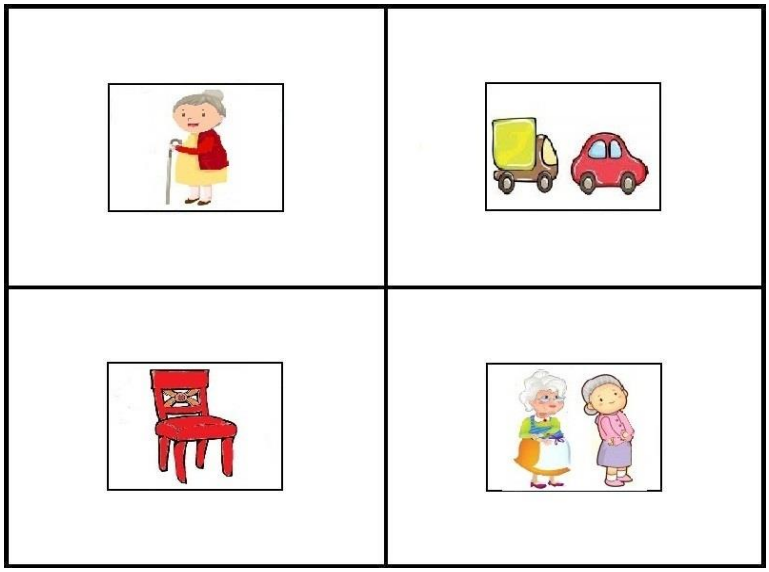
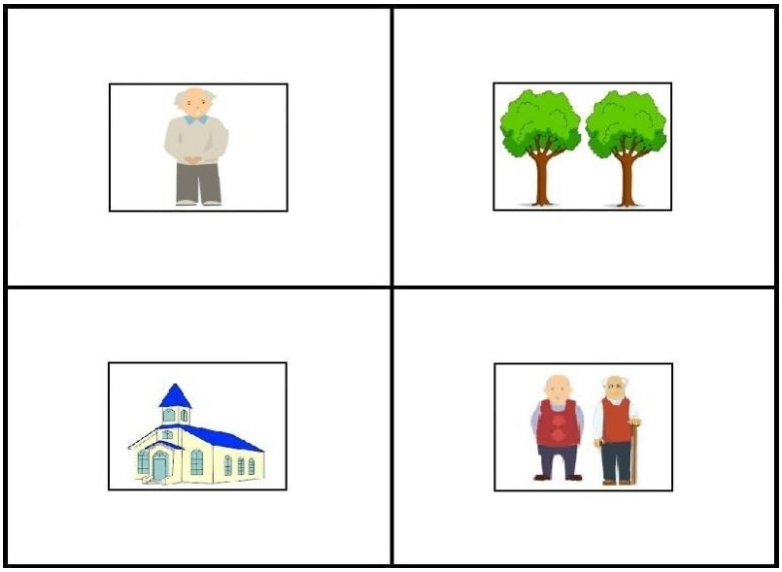


Figure 2. Stimulus – intransitive verb.

EN: "*Leave...grandpas*" (Target: grandpas[plural],Competitor: grandpa[singular]).

SP: "*Salen...los abuelos*".



2. Data analysis

Data analysis in Study 3 was identical to that in Study 2, except for the number of time-windows defined as critical. Therefore, data preprocessing, log-difference calculation and the statistical approach (both 95% confidence intervals interpretation and LMER) were the same as in Study 2. Two main analyses are presented, one that compared the SLI group against the Age-, MLU-w-, and the Adult control group, and a similar one for each time-window separately. Then, we also provide another contrast that compared the SLI group against the Age- and the MLU-w control group, in addition to a within-group age predictor (younger vs. older children) and its corresponding analysis by time-window. The first 1000 ms critical time-windows corresponded to the critical verb (1000 ms to 2000 ms from sentence onset), the second to the first silent window following the verb (2000 ms to 3000 ms from sentence onset) and the third to the critical noun (3000 ms to 4000 ms from sentence onset).

3. Results

Log-transformed difference between the target object and the competitor object on each time-window are presented in Figure 3. This graphs show the log transformed fixation proportion difference averaged by participants and divided by each independent group, with the within-subjects adjusted 95% confidence intervals (grey around central line).

As it can be seen in the time course plots, all groups are clearly able to quickly distinguish between the target and the competitor. There is an evident advantage, both in terms of speed and effect size for the Adult control group.

The potential difference between the other groups is less evident. Apparently, the SLI group shows an overall disadvantage in terms of the effect size (the amount of attention to the target) relative to the other children control groups. The LMER should clarify these differences.

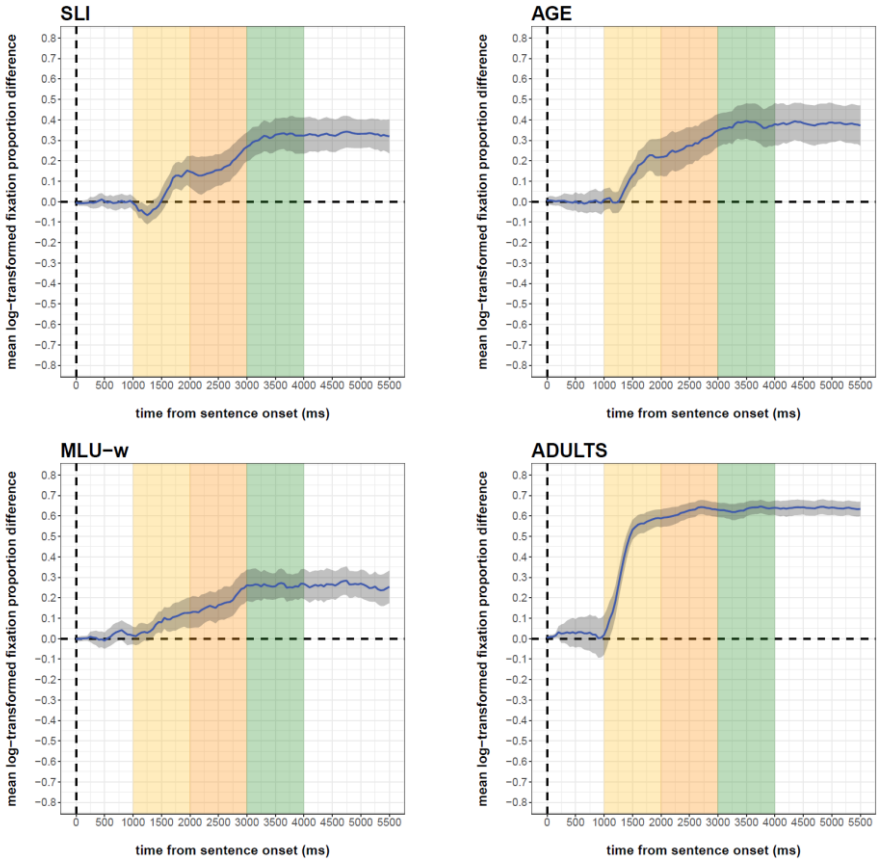


Figure 3. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

The LMER results (Table 1) showed a significant difference between the SLI group and the Age control group and between the SLI group and the Adult control group. We also found for the SLI a reliable increasing advantage on each subsequent time-window (time-window contrast 1 and 2; time-window contrast 2 and 3).

Finally, we observed reliable interaction effects between the SLI and the Adult control group in both time-window contrasts (time-window contrast 1 and 2; time-window contrast 2 and 3.

These effects evidence the opposite direction and reflect that, on the one hand, the difference between the first and the second time-window is much greater for adults (due to a fast increase on target preference) relative to the SLI group.

On the other hand, while the difference between the second and the third time-window was greater for the SLI relative to the Adult group the SLI kept increasing while the Adults reached peak of preference, on the second time-window.

Table 1. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	se	t	p	
(Intercept)	0.167	0.026	6.332	0.000	***
Age-control	0.079	0.038	2.103	0.038	*
MLU-w-control	-0.004	0.037	-0.111	0.912	
Adult-control	0.382	0.037	10.287	0.000	***
Time-window2-1	0.135	0.025	5.343	0.000	***
Time-window3-2	0.146	0.021	6.884	0.000	***
Age-control:Time-window2-1	0.024	0.036	0.665	0.508	
MLU-w-control:Time-window2-1	-0.039	0.036	-1.088	0.280	
Adult-control:Time-window2-1	0.075	0.036	2.086	0.040	*
Age-control:Time-window3-2	-0.048	0.030	-1.621	0.108	
MLU-w-control:Time-window3-2	-0.058	0.030	-1.958	0.053	.
Adult-control:Time-window3-2	-0.134	0.030	-4.472	0.000	***

The second analysis (Table 2) compares the experimental group to the Age-, MLU-w- and Adult control groups dividing the data in three data subsets, based on each critical time-window. All data analysis specification were identical to those from the previous experiments.

Table 2. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.028	0.022	1.277	0.205	
Age-control	0.080	0.031	2.598	0.011	*
MLU-w-control	0.041	0.030	1.363	0.176	
Adult-control	0.377	0.030	12.435	0.000	***

Time-window 2	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.163	0.035	4.730	0.000	***
Age-control	0.103	0.050	2.084	0.040	*
MLU-w-control	0.002	0.049	0.049	0.961	
Adult-control	0.452	0.049	9.308	0.000	***

Time-window 3	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.309	0.034	9.110	0.000	***
Age-control	0.055	0.048	1.155	0.251	
MLU-w-control	-0.056	0.047	-1.185	0.239	
Adult-control	0.318	0.047	6.711	0.000	***

Table 2 shows that the Adult control group evidences an advantage relative to the SLI group. The Age-control shows a similar advantage in the first two time-windows, but not in the last one. The SLI group at the end of the experimental task shows similar levels of comprehension with the Age control group.

As we can observe in Figure 4, children exhibit faster and more robust preference for the critical visual object when the sentence referred to a pair of referents (verb in plural form) compared to a single one (verb in singular form).

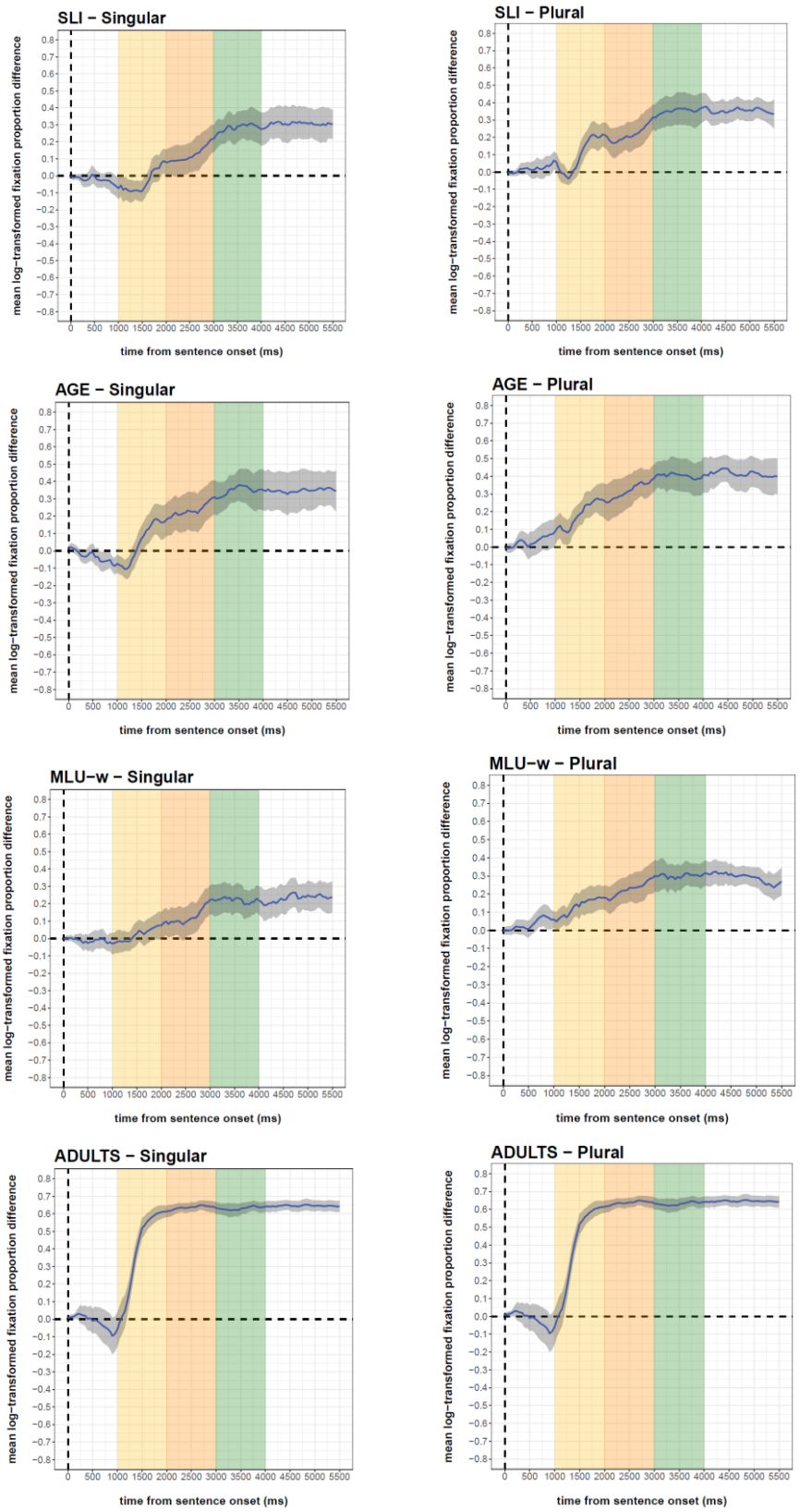


Figure 4. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and number. Grey areas represent the within-subject adjusted 95% confidence intervals.

We provide two further analyses, which compare the three children groups adding an age factor, namely younger children vs. older children (within each group). The first analysis included time-window as predictor and the second analysis presents one regression model per time-window. All aspects of data analysis were identical to those already described in the main analysis.

Table 3 and 4 show that the results are in coherence with those from the first analysis: across all time-windows, the Adult control group shows an advantage relative to the SLI group. Additionally, the Age-control shows a similar advantage in the first two time-windows, but not in the last one.

As it can be seen, they reveal the same significant difference between SLI group and the Age control group, the reliable increasing advantage on each subsequent time-window (Table 3). Critically, we observed a significant effect of the age predictor.

In addition, we found an interaction effect for the contrast between time-window 1 and 2 and the two age subgroups within the SLI experimental group as well for time-window 2 and 3; this reflects that increase observed in the second time-window present for older SLI children and absent for younger SLI children.

Finally, the overall advantage for older SLI children appears significant along the three time-windows (See Figure 5).

Table 3. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	se	t	p	
(Intercept)	0.167	0.016	10.340	0.000	***
Age-control	0.079	0.023	3.407	0.001	**
MLU-w-control	-0.004	0.023	-0.182	0.856	
Time-window2-1	0.135	0.021	6.477	0.000	***
Time-window3-2	0.146	0.024	5.983	0.000	***
Age	0.096	0.016	6.049	0.000	***
Age-control:Time-window2-1	0.024	0.030	0.807	0.422	
MLU-w-control:Time-window2-1	-0.039	0.030	-1.320	0.191	
Age-control:Time-window3-2	-0.048	0.034	-1.413	0.162	
MLU-w-control:Time-window3-2	-0.058	0.034	-1.706	0.093	.
Time-window2-1:Age	0.070	0.021	3.336	0.001	**
Time-window3-2:Age	0.027	0.024	1.128	0.263	
Age-control:Age	0.045	0.023	2.013	0.048	*
MLU-w-control:Age	0.001	0.023	0.038	0.969	
Age-control:Time-window2-1:Age	0.034	0.030	1.147	0.256	
MLU-w-control:Time-window2-1:Age	0.012	0.030	0.396	0.693	
Age-control:Time-window3-2:Age	-0.034	0.034	-1.004	0.319	
MLU-w-control:Time-window3-2:Age	-0.032	0.034	-0.934	0.354	

Table 4. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.028	0.017	1.650	0.105	
Age-control	0.080	0.024	3.367	0.001	**
MLU-w-control	0.041	0.024	1.758	0.084	.
Age	0.041	0.018	2.271	0.027	*
Age-control:Age	0.034	0.025	1.384	0.172	
MLU-w-control:Age	0.004	0.026	0.143	0.886	

Time-window 2	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.163	0.024	6.686	0.000	***
Age-control	0.103	0.035	2.926	0.005	**
MLU-w-control	0.002	0.035	0.069	0.945	
Age	0.111	0.024	4.610	0.000	***
Age-control:Age	0.068	0.034	2.015	0.048	*
MLU-w-control:Age	0.015	0.034	0.456	0.650	

Time-window 3	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.309	0.022	13.975	0.000	***
Age-control	0.055	0.031	1.769	0.082	.
MLU-w-control	-0.056	0.031	-1.836	0.071	.
Age	0.138	0.022	6.413	0.000	***
Age-control:Age	0.034	0.030	1.108	0.272	
MLU-w-control:Age	-0.017	0.031	-0.533	0.596	

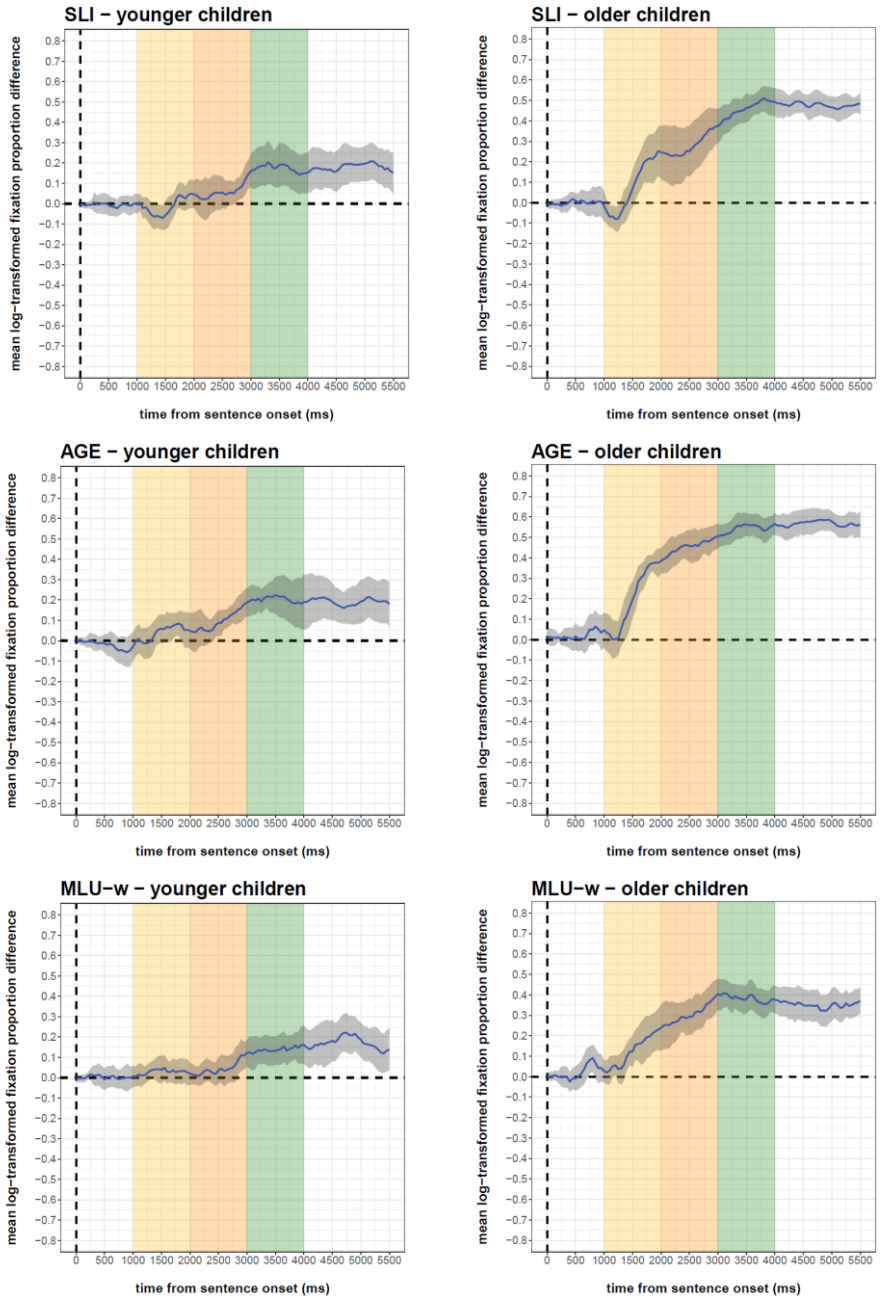


Figure 5. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and age. Grey areas represent the within-subject adjusted 95% confidence intervals.

These additional analyses evaluate the role of age subgroups within the experimental group and the other two children groups. Time course plots in Figure 5, show that there is a clear age predictor difference; older children from the three groups (SLI, AGE- and MLU-w control group) clearly increase from the first critical time-window throughout the other ensuing time-windows. Instead, the younger children of

these groups clearly do not prefer the target. Only at the third time-window they show a trend of preference for the target. As for the first analysis, some differences between the groups seem to be present, but they are less clear.

4. Discussion

The purpose of this study was to examine, in real time and in a simple sentence structure (verb – subject), the comprehension of verbal morphology marks of number in children with Specific Language Impairment. For the design of this experimental task we used intransitive and transitive verbs without a direct object, and tried to record the ability of children with SLI to distinguish between targeted singular or plural subjects in a sentence.

According to the initial hypothesis, we proposed that the problems of children with SLI regarding verbal morphology (Bedore & Leonard, 2001; Conti-Ramsden, Botting & Faragher, 2001; Grinstead et al., 2009; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997; Sanz-Torrent et al., 2008; Sanz-Torrent et al., 2011) would have to be reflected in their pattern of glances and, in this sense, in a lesser comprehension of the morphology marks of number, in comparison to the children from the control groups. However, we observed that the differences are less significant than expected and, therefore, we can argue that the linguistic comprehension of the SLI group in this experimental task is less atypical than what we posed in our initial hypothesis.

In more detail, when analysing the three windows of time, intergroup differences between the SLI group and the Age control group appear in the first two (1000-2999 ms), and are due to the differences between the older children in both groups (SLI2 - AGE2).

However, these differences disappear in the third and last window (3000-3999 ms), where children with SLI reach a level of comprehension of morphological marks similar to the children of the Age control group. Moreover, in this last window of analysis, both the older children with SLI (SLI2, average age: 9;07), and the older children in the AGE control group (AGE2, average age: 9;04) present a better level of comprehension than the older children of the MLU-w control group (MLU-w2, average age: 8;02). This interesting effect emphasizes the evolutionary pattern of language comprehension, since children with SLI obtain better results despite their linguistic condition than younger children without linguistic problems, due to the fact that they are about 18 months older.

On the other hand, when observing the intergroup glance proportions among younger children with SLI (SLI1, average age: 6;00) compared with the corresponding children in the chronological control group (AGE1, average age: 6;03) and the linguistic control group (MLU-w1, average age: 5;04), no significant differences are observed. Again, this result raises the possibility of the existence of an evolutionary pattern in verbal morphology comprehension since, regardless of presence or absence of the linguistic impairment, all groups of younger children follow a similar developing pattern.

Regarding the differences in proportion of glances between the morphological marks of singular and plural number we have observed that all groups of children (SLI, AGE, MLU-w) show a higher performance, in terms of linguistic comprehension, when the morphological marks of number are presented in plural. For the group of adults, although they present a certain tendency in favour of plural marks, this tendency does not become significant.

The effect found in the three groups of children may have different linguistic and methodological explanations. First, from a linguistic perspective, it can be argued that plural inflections can only be interpreted in indicative mode. If we think of the first example presented above, in Spanish: "*Escribe/Escriben la/las abuela/abuelas*"*; in English:*"*Writes/Write the grandma/grandmas*", we can see that once the verbal mark has been presented in plural, the subject of the sentence can be built exclusively in an indicative way: SP: *"Escriben...ellas*"; EN: "*Write...they*". Conversely, the verbal form in Spanish for the third person singular in indicative ("*escribe*") coincides with the form in imperative mode, so that both interpretations are possible in the first window of time: SP: "*Escribe...ella*"; EN: "*Writes...she*" (indicative mode), or SP: "*Escribe...tú*"*;* EN: "*Write...you*" (imperative mode). The possibility arises that, in a matter of milliseconds, the participant may cognitively experience some uncertainty between both interpretations and, in this sense, experience singular inflection sentences as slightly more difficult stimuli.

Another possibility to explain this effect concerns a methodological aspect related to the graphic representation of the stimuli. According to several authors (Carlson & Tanenhaus, 1988; Mauner & Koenig, 2000; Trueswell & Tanenhaus, 1994), after the appearance of the verb there emerges an implicit activation of the information associated with its argument. Similarly, when a verb with a plural inflection of number appears, immediately there is implicit information about the Subject of the sentence. In the given example, when presenting the verb SP: "*escriben*"*; EN:* "*write*" it is much more likely for the participants to look at the target (two grandmothers) than to the competitor (one grandmother). However, when the verb SP: "*escribe*"*; EN:* "*writes*" is presented, the difference between target (one grandmother) and competitor (two

grandmothers) is less clear because, basically, in the image of the competitor the Subject appears duplicated (two grandmothers).

Finally, this preference effect found in the three groups of children may be related to the Surface Hypothesis (Leonard, 1989, 2014). From this perspective, children with SLI experience greater difficulty when processing those linguistic elements that are shorter in duration and less salient in phonological terms. In this sense, we could observe that the verbal singular mark in the SP: "escrib*e*" is less salient and lasting in comparison to the verbal mark in the plural SP: "escrib*en*". This hypothesis basically tries to interpret language characteristics in children with SLI; however, it may be extrapolated to children's language in general, and to some extent, explain the preference effect shown by the three groups of children towards plural number morphological marks.

It may be possible that the combination of these three possibilities, that is, the activation of the indicative and imperative mode, the graphic effect of the stimuli and the phonological characteristics of the morphological marks of the singular, are responsible for the differences found in relation to the greater comprehension of plural marks shown by the three groups of children. It's important to highlight that the effect of a higher comprehension of plural number marks was also registered among the three groups of children in the previous study (verbal number/transitive verbs).

With the present experiment, through the technology of eye tracking, we have been able to suggest that comprehension of children with SLI is more preserved in tasks regarding verbal morphology of number (singular and plural marks) in simple non-canonical sentence structures (verb - subject). It may be argued that a simple sentence is rare in the complex language surrounding the reality of children with SLI.

However, the stimuli that we have created try to measure specific issues of the language of these children, which have been found to be especially difficult in their language production, with verbal morphology being one of the focuses of greatest research interest (Bedore & Leonard, 2001; Conti-Ramsden, Botting & Faragher, 2001; Grinstead et al., 2009; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997; Sanz-Torrent, Serrat, Andreu & Serra, 2008).

In this sense, we consider that the use of simple sentence structures in these kinds of experimental tasks can clarify in greater depth the issue that has long been accompanying the empirical investigation of SLI, creating a theoretical dichotomy between the perspective that deals with the difficulties related to the verb as an expression of deficient grammatical structures, and the perspective that considers them, rather, a consequence of limitations in the language processing. Thus, by creating a simple sentence structure, we are limiting the number of elements, to the highest possible level, in order to have a clear quantitative image of the studied effect, as objectively as possible. In this study of verbal morphology of number with the simple sentence structure of the type: SP: "*Escribe/Escriben la/las abuela/abuelas*" EN: "*Writes/Write the grandma/grandmas*", children with SLI show a lower degree of initial comprehension, but when the sentences is disambiguate at the last time-window, they reach a similar level with the children of the control group matched by age. The results of the experiment, allow us to argue against the perspective that perceive the difficulty of the verbal morphology of children with SLI as a structural lack in their underlying mechanisms of language (Clahsen, 1991; Gopaik & Grago, 1991). Thus, the opposite perspective suggesting a dynamic language processing seems to be more coherent (Bishop, 1994; Evans, 1996; Marchman, Wulfeck & Ellis Weismer, 1999; Montgomery & Evans, 2009; Weimer & Evans, 2002).

In this sense, language could depend on the surrounding circumstances, the characteristics of the task and, from a psycholinguistic point of view, on the cognitive state of the child; in other words, on the linguistic and also the psychological circumstances.

CHAPTER 8

Study 4: real time comprehension of articles

Introduction

With the present study, we try to assess the online comprehension of definite and indefinite articles by Spanish-speaking children with SLI. More specifically, through a simple sentence structure (subject - verb - direct object) we isolate the grammatical elements in question as far as possible. Our intention is to be able to rigorously evaluate the level of difficulty in the cognitive processing of comprehension function words and in particular, of the articles in Spanish language.

In this sense, the empirical record of the experimental stimuli will show to what extent the articles can guide the comprehension of a sentence. In the occurrence of a deficit in the grammatical comprehension of the article, the effect will be reflected in the execution and the pattern of glances in the experimental task. In other words, if the children with SLI present significantly lower results compared to the children in the control groups, it will be possible to argue the presence of a deficit in article comprehension due to atypical grammatical structures or to processing difficulties.

Conversely, if children with SLI have a similar level of comprehension to that of their control groups, it will be possible to argue that their ability to understand the definite and indefinite article is more preserved than what is generally thought. Despite the fact that affection in the production of this grammatical mark is detailed documented in the empirical literature.

1. Stimuli

In total 64 sentences with simple structure (subject - verb - article - direct object) were created in order to study the capacity of the participant to comprehend articles in different forms. Three different conditions were evaluated: a) definite/indefinite, b) feminine/masculine, c) singular/plural. The 64 sentences were categorized in 8 subgroups of 8 sentences each where the article was presented in the following forms: i) definite, singular, feminine (/la/); ii) indefinite, singular, feminine (/una/); iii) definite, plural, feminine (/las/); iv) indefinite, plural, feminine (/unas/); v) definite, singular, masculine (/el/); vi) indefinite, singular, masculine (/un/); vii) definite, plural, masculine (/los/); viii) indefinite, plural, masculine (/unos/). We created two experimental lists (A and B) of these 64 sentences, 32 sentences each, to avoid possible effects in the order of presentation. We present illustrate examples of sentences with different article forms in Figures 1-8.

As it can be observed through the examples, in half of the stimuli (Figures 1, 3, 5 and 7) the target and competitor had different gender, whereas in the other half they differed in number (Figures 2,4,6 and 8). For a greater control of strange variables, in half of the stimuli the distracters were semantically incompatible with the verb of the sentences (Figure 1, 2, 3 and 4) and in the other half of the stimuli were compatible (Figure 5, 6, 7 and 8). For the elaboration of the stimuli, images from Clip Art collection were selected and occasionally modified in order to obtained higher control regarding possible strange variables (illustration preference effects). The stimuli images had a format of 800 x 600 pixels and were presented on a monitor set at 1024 x 768. Every stimulus has four squares (target, competitor and two distracters). In every square there is an image placed in its interior. The background was white, while the lines of the

squares were black. The sentences were recorded by a native Spanish speaker at a normal speaking velocity at 44,100 Hz. Finally the appropriateness of the stimuli was evaluated and selected by judges (collaborators and authors of the research).

Figure 1. Stimuli: Definite/singular/feminine

EN: "*The girl bites the...apple*" (Target: apple[feminine], Competitor: banana[masculine]).

SP: "*La chica muerde la….manzana*".

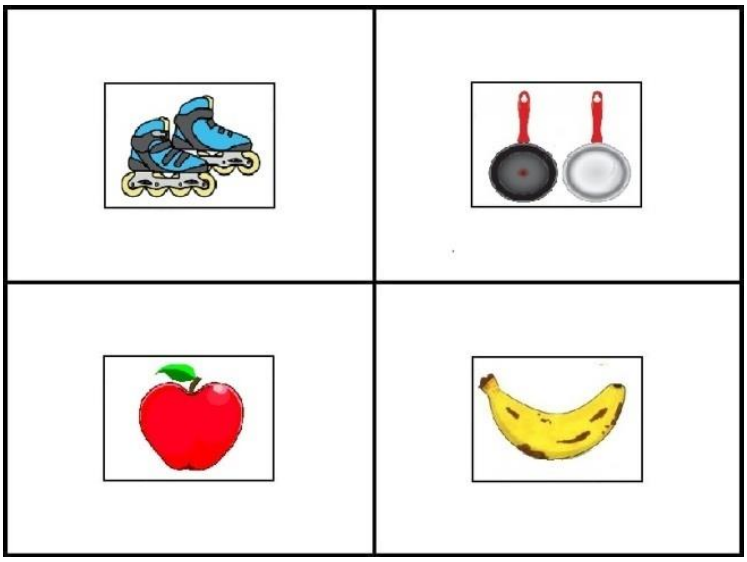


Figure 2. Stimuli: Indefinite/singular/feminine

EN: "*The girl throws a...stone*" (Target: stone[singular], Competitor: stones[plural]).

SP: *"La niña tira una….piedra".*

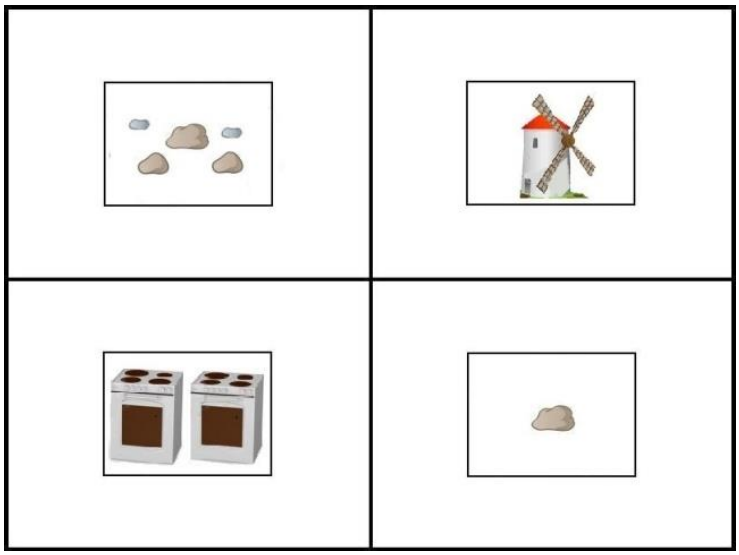


Figure 3. Stimuli: Definite/plural/feminine

EN: "*The girl bites the...apples*" (Target: apples[feminine], Competitor: bananas[masculine]).

SP: "*La chica muerde las….manzanas*".

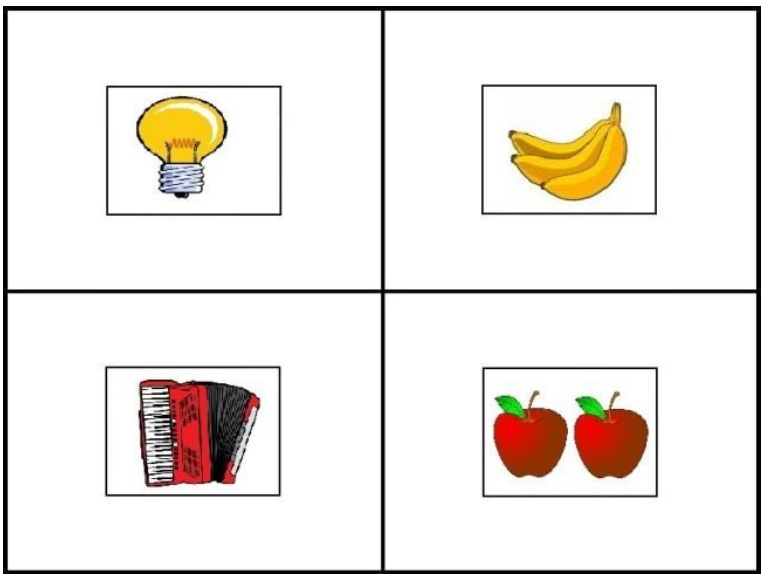


Figure 4. Stimuli: Indefinite/plural/feminine

EN: "*The girl throws some...stones*" (Target: stones[plural], Competitor: stone[singular]).

SP: "*La niña tira unas….piedras*".

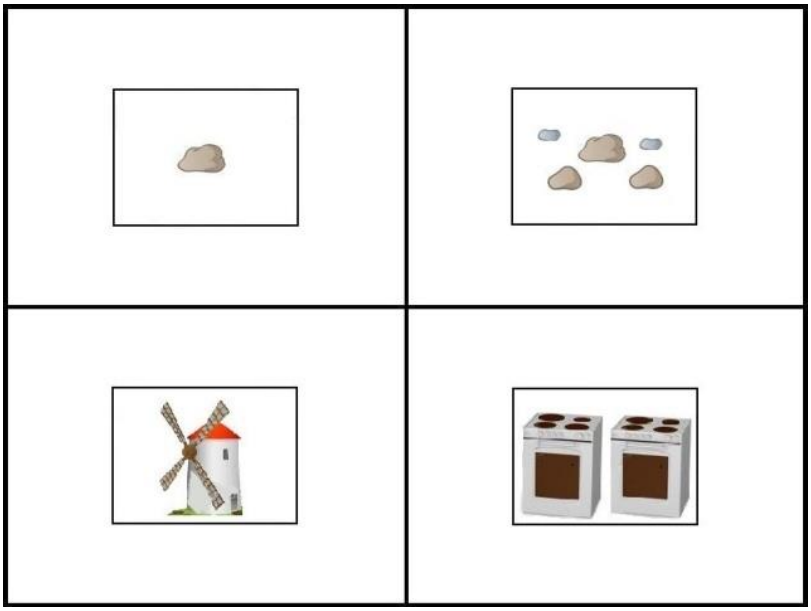


Figure 5. Stimuli: Definite/singular/masculine

EN: "*The grandmother touches the...tree*" (Target: tree[masculine], Competitor: flower[feminine]).

ES: "*La abuela toca el…árbol*".

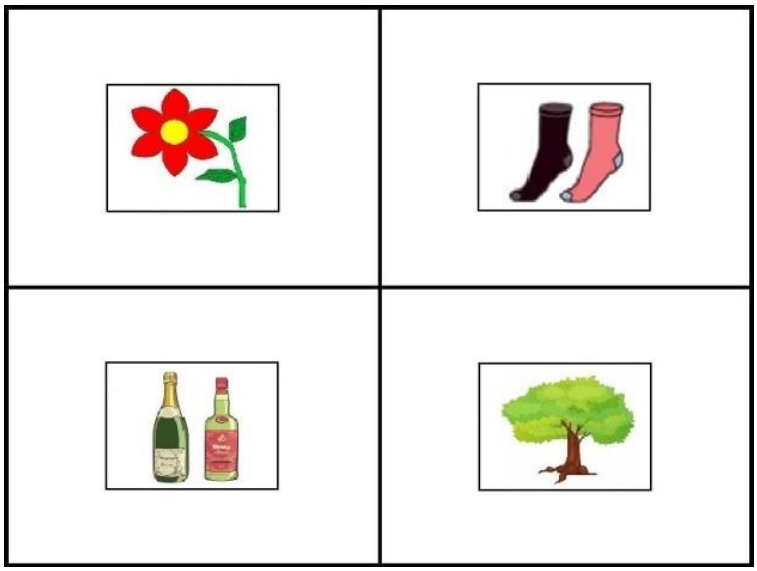


Figure 6. Stimuli: Indefinite/singular/masculine

EN: "*The boy brakes a...vase*" (Target: vase[singular] Competitor: vases[plural]).

ES: "*El niño rompe un…jarrón*"

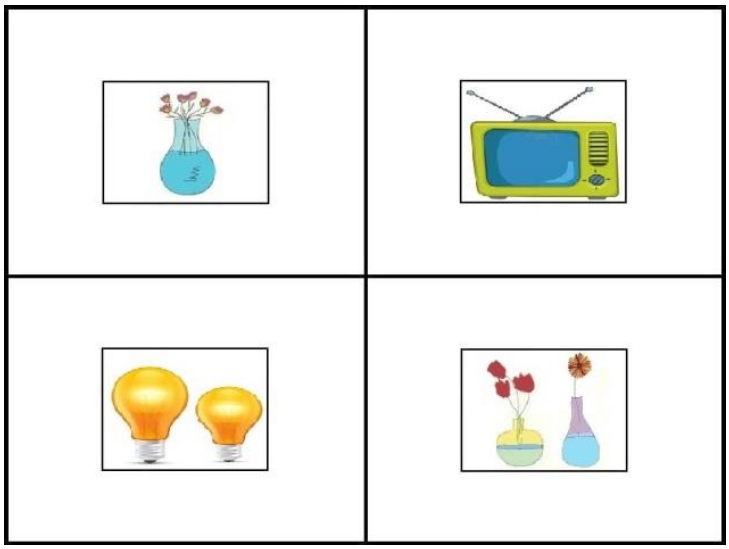


Figure 7. Stimuli: Definite/plural/masculine

EN: "*The grandmother touches the...trees*" (Target: trees[masculine], Competitor: flowers[feminine]).

ES: "*La abuela toca los…árboles*".

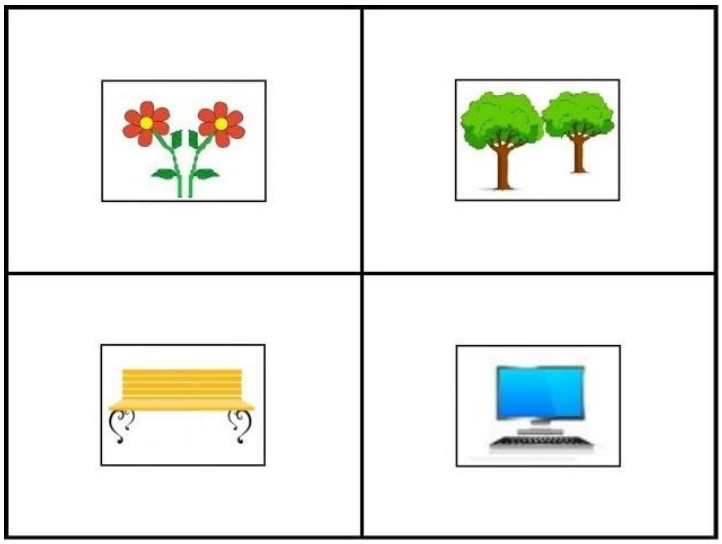
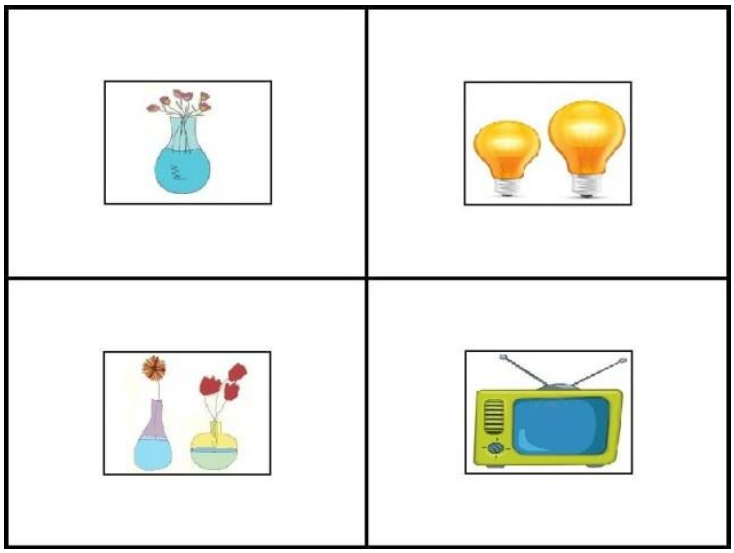


Figure 8. Stimuli: Indefinite/plural/masculine

EN: "*The boy brakes some...vases*" (Target: vases[plural] Competitor: vase[singular]).

ES: "*El niño rompe unos…jarrones*".



2. Data analysis

As in previous experiments, data analysis was identical, including statistical approach, data pre-processing and definition of dependent variables. We present two main contrasts; the first compared the experimental group against the Age control group, the MLU-w control group, and the Adult control group and the second a similar analysis for each time-window separately. The critical time-window began at 3000 milliseconds after the onset of the critical sentence. The first window corresponded to the silence following the critical article (3000 ms to 4000 ms from sentence onset). The second window corresponded to the critical noun (4000 ms to 5000 ms from sentence onset). Finally, the third window corresponded to the silence following the critical noun (5000 ms to 6000 ms from sentence onset).

3. Results

Figure 9 show the fixation proportion differences between the target and the competitor (log-transformed) on each critical time-window. Plots present the dependent variable averaged by participants over time, divided by each independent group, and within-subjects adjusted 95% confidence intervals (grey error band). The graphs show how all groups clearly distinguish between the target from the competitor from or even before the first silent window. An expected advantage, in terms of speed and size of the effect is observed for the Adult control group. Differences between the children groups appear less clearly. While the SLI group and Age control group present a similar pattern of gaze behavior, the time course for the MLU-w control group is somehow different.

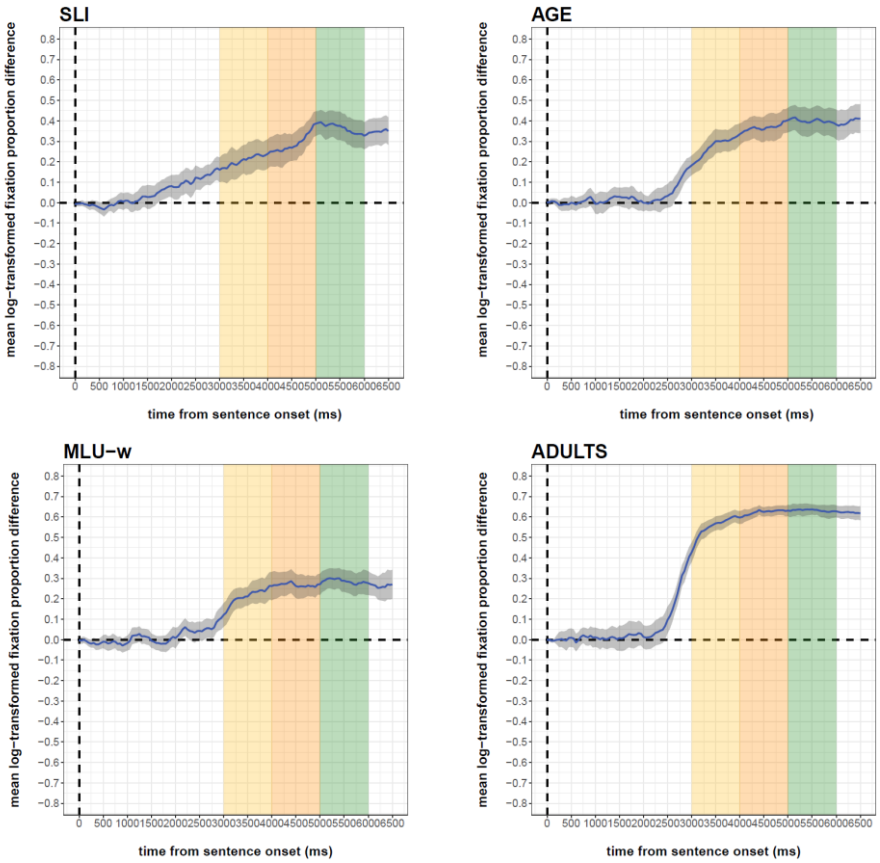


Figure 9. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

The LMER should clarify these differences. Table 1 showed the results from the LMER analysis. As expected a significant overall difference between SLI group and the Adult control group is observed. We also found significant differences in both time-window contrasts (time-window contrast 1 and 2; time-window contrast 2 and 3), reflecting the progressive advantage over time that the target object gained within the SLI group.

Moreover, the results showed a number of reliable interaction effects between the time-window comparisons and the group contrasts. First, the contrast between time-window 2 and 3 are significantly different for SLI relative to the Adult control group (time-window contrast 2 and 3). This effect reflect that the difference is much larger

between the second and the third time-window for adults compared to the SLI group. Finally, there is a significant interaction effect between the time-window contrast and the comparison between the SLI and the MLU-w group. This interaction reflects the increase observed in the third time-window in the SLI group, which is absent in the MLU-w control group.

Table 1. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*p*	
(Intercept)	0,273	0,025	10,781	0,000	***
Age-control	0,055	0,036	1,540	0,127	
MLU-w-control	-0,034	0,035	-0,953	0,343	
Adult-control	0,321	0,035	9,122	0,000	***
Time-window2-1	0,080	0,015	5,305	0,000	***
Time-window3-2	0,079	0,018	4,372	0,000	***
Age-control:Time-window2-1	0,013	0,021	0,615	0,539	
MLU-w-control:Time-window2-1	-0,022	0,021	-1,053	0,293	
Adult-control:Time-window2-1	0,000	0,021	-0,012	0,991	
Age-control:Time-window3-2	-0,042	0,026	-1,652	0,102	
MLU-w-control:Time-window3-2	-0,063	0,026	-2,469	0,015	*
Adult-control:Time-window3-2	-0,070	0,026	-2,740	0,007	**

The results presented in Table 2, are overall coherent with the previous analysis. Interestingly, the effect difference between SLI and MLU-w groups in the third time-window is significant. Two further analyses that contrast the three children groups are presented. Adding an age factor, we evaluated younger children vs. older children. The first analysis included time-window as predictor and the second analysis present one regression model per time-window. All aspect of data analysis were identical to those already described in the main analysis.

Table 2. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,193	0,027	7,218	0,000	***
Age-control	0,060	0,037	1,614	0,110	
MLU-w-control	0,002	0,038	0,057	0,955	
Adult-control	0,345	0,037	9,223	0,000	***

Time-window 2	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,273	0,028	9,871	0,000	***
Age-control	0,073	0,039	1,886	0,062	.
MLU-w-control	-0,020	0,038	-0,532	0,596	
Adult-control	0,344	0,038	8,957	0,000	***

Time-window 3	***Estimate***	***se***	***t***	***p***	
(Intercept)	0,352	0,027	12,928	0,000	***
Age-control	0,031	0,038	0,813	0,419	
MLU-w-control	-0,083	0,039	-2,147	0,034	*
Adult-control	0,274	0,038	7,164	0,000	***

Table 3. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	***se***	***t***	***p***	
(Intercept)	0,273	0,021	13,045	0,000	***
Age-control	0,055	0,029	1,867	0,066	.
MLU-w-control	-0,034	0,029	-1,158	0,251	
Time-window2-1	0,080	0,016	5,006	0,000	***
Time-window3-2	0,079	0,020	4,054	0,000	***
Age	0,108	0,020	5,312	0,000	***
Age-control:Time-window2-1	0,013	0,022	0,583	0,560	
MLU-w-control:Time-window2-1	-0,022	0,022	-1,000	0,319	
Age-control:Time-window3-2	-0,042	0,028	-1,525	0,132	
MLU-w-control:Time-window3-2	-0,063	0,028	-2,279	0,025	*
Time-window2-1:Age	0,012	0,016	0,739	0,461	
Time-window3-2:Age	-0,014	0,020	-0,708	0,481	
Age-control:Age	-0,019	0,028	-0,659	0,512	
MLU-w-control:Age	-0,037	0,028	-1,311	0,194	
Age-control:Time-window2-1:Age	0,019	0,022	0,873	0,384	
MLU-w-control:Time-window2-1:Age	-0,029	0,022	-1,295	0,197	
Age-control:Time-window3-2:Age	0,029	0,028	1,035	0,304	
MLU-w-control:Time-window3-2:Age	-0,020	0,028	-0,731	0,467	

Table 3 shows the significant difference between the time-window, and the reliable interaction effect between the time-window contrasts (windows 2 and 3) and the difference between the SLI group and the MLU-w control group. More importantly, it shows a main effect of age, in coherence with what is observed in Figure 10. These effects are relate to the fact SLI older children showed a greater preference for the target compared to that showed by older MLU-w group both, in the second and the third time-window.

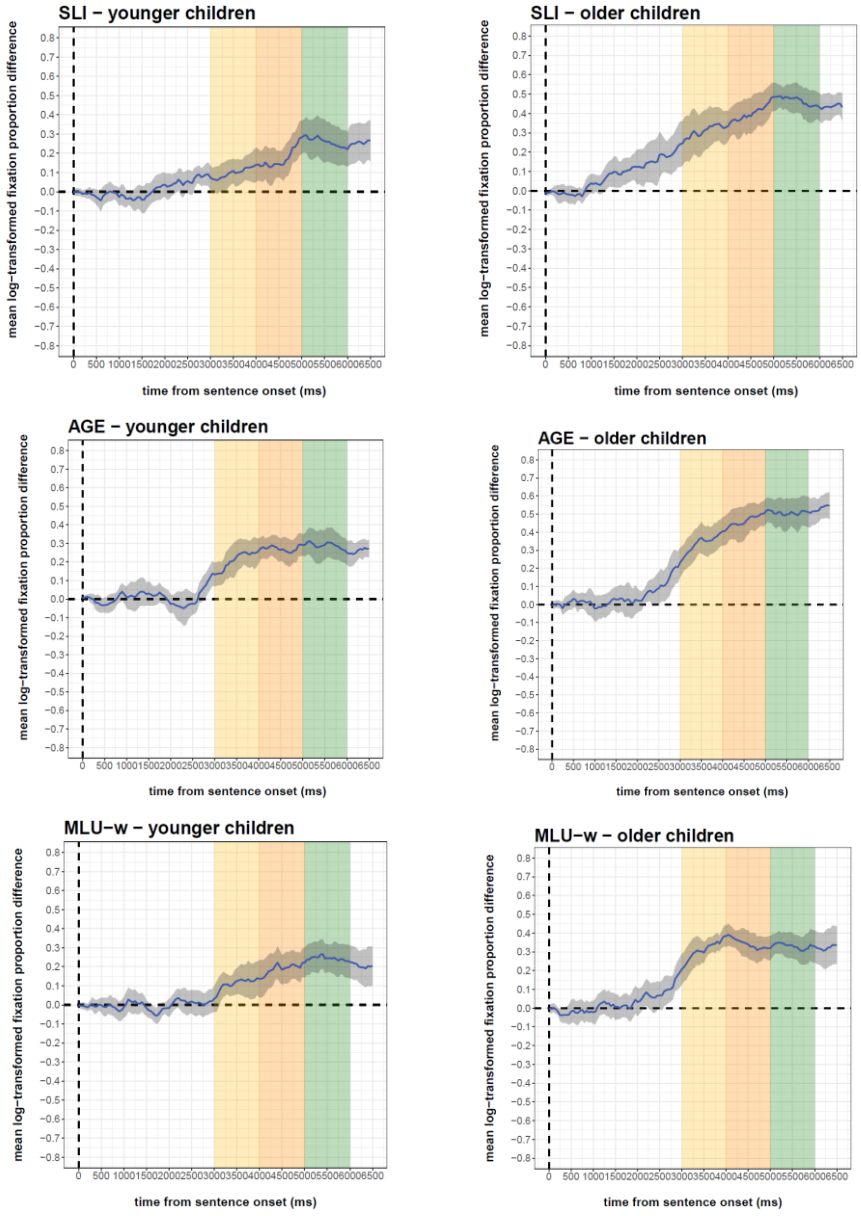


Figure 10. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and age. Grey areas represent the within-subject adjusted 95% confidence intervals.

Table 4. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	**Estimate**	**se**	**t**	**p**	
(Intercept)	0,193	0,023	8,562	0,000	***
Age-control	0,060	0,032	1,902	0,062	.
MLU-w-control	0,002	0,032	0,067	0,947	
Age	0,105	0,023	4,629	0,000	***
Age-control:Age	-0,041	0,032	-1,294	0,200	
MLU-w-control:Age	-0,011	0,034	-0,334	0,739	

Time-window 2	Estimate	se	t	p	
(Intercept)	0,273	0,023	11,629	0,000	***
Age-control	0,073	0,033	2,239	0,029	*
MLU-w-control	-0,020	0,032	-0,628	0,532	
Age	0,117	0,024	4,954	0,000	***
Age-control:Age	-0,022	0,032	-0,676	0,501	
MLU-w-control:Age	-0,040	0,034	-1,191	0,238	

Time-window 3	Estimate	se	t	p	
(Intercept)	0,352	0,024	14,780	0,000	***
Age-control	0,031	0,034	0,923	0,359	
MLU-w-control	-0,083	0,034	-2,455	0,017	*
Age	0,103	0,024	4,326	0,000	***
Age-control:Age	0,007	0,034	0,206	0,838	
MLU-w-control:Age	-0,060	0,034	-1,798	0,077	.

The results presented in Table 4, are also, overall coherent with previous analysis. In particular the overall advantage for older children appears again as a significant effect on each time-window. Also, we found reliable interactions between the contrast between younger and older children and that between SLI and MLU-w groups. Interestingly, the overall difference between the SLI and the Age-control group in the second time-window appears now as significant.

Finally, presents an exploration of secondary variable that were in the initial analysis pooled together. Specifically, we compared different types of articles such a singular vs. plural (Figure 11), masculine vs. feminine (Figure 12), and definitive vs. indefinite article (Figure 13).

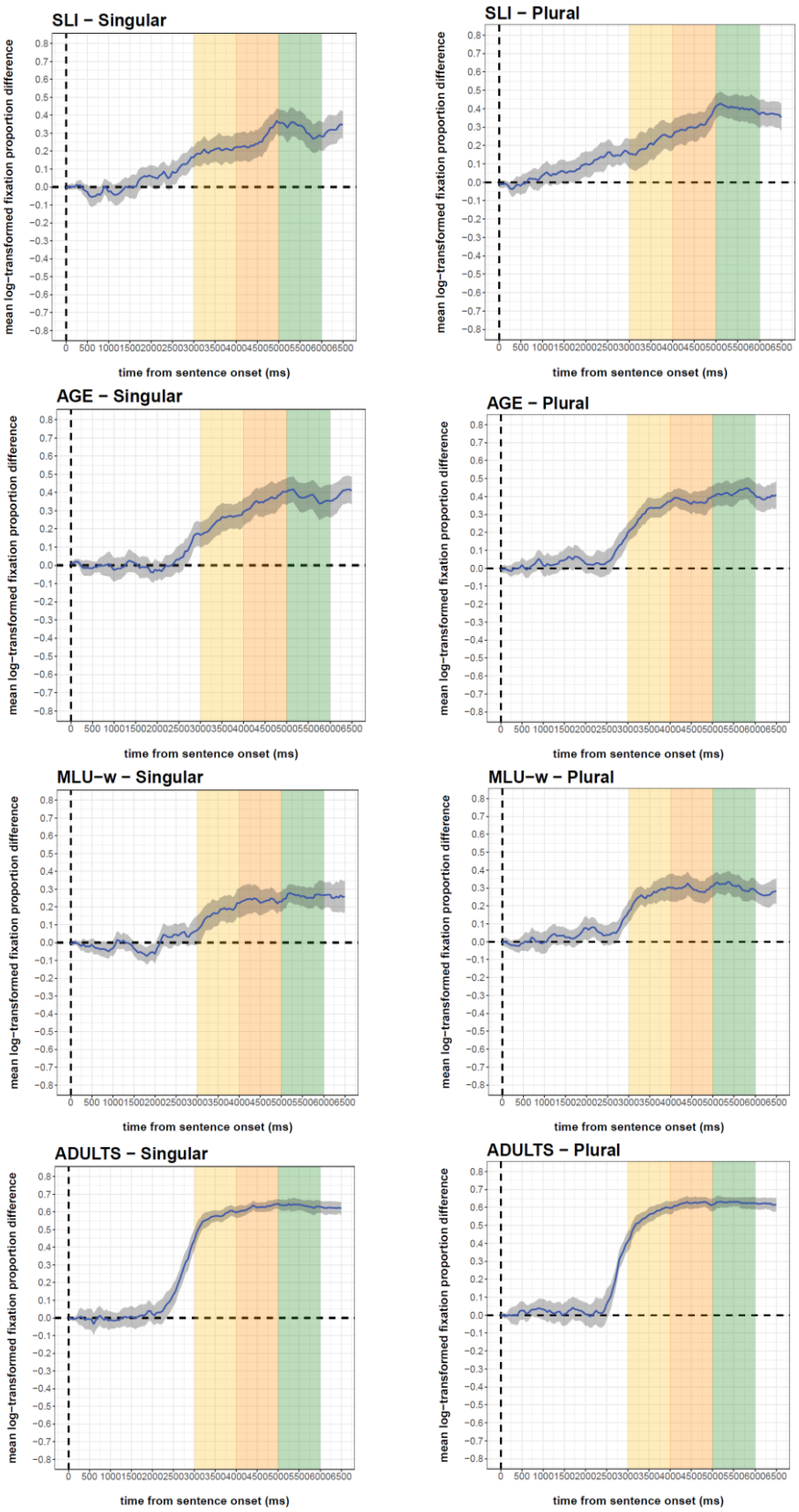


Figure 11. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and number. Grey areas represent the within-subject adjusted 95% confidence intervals.

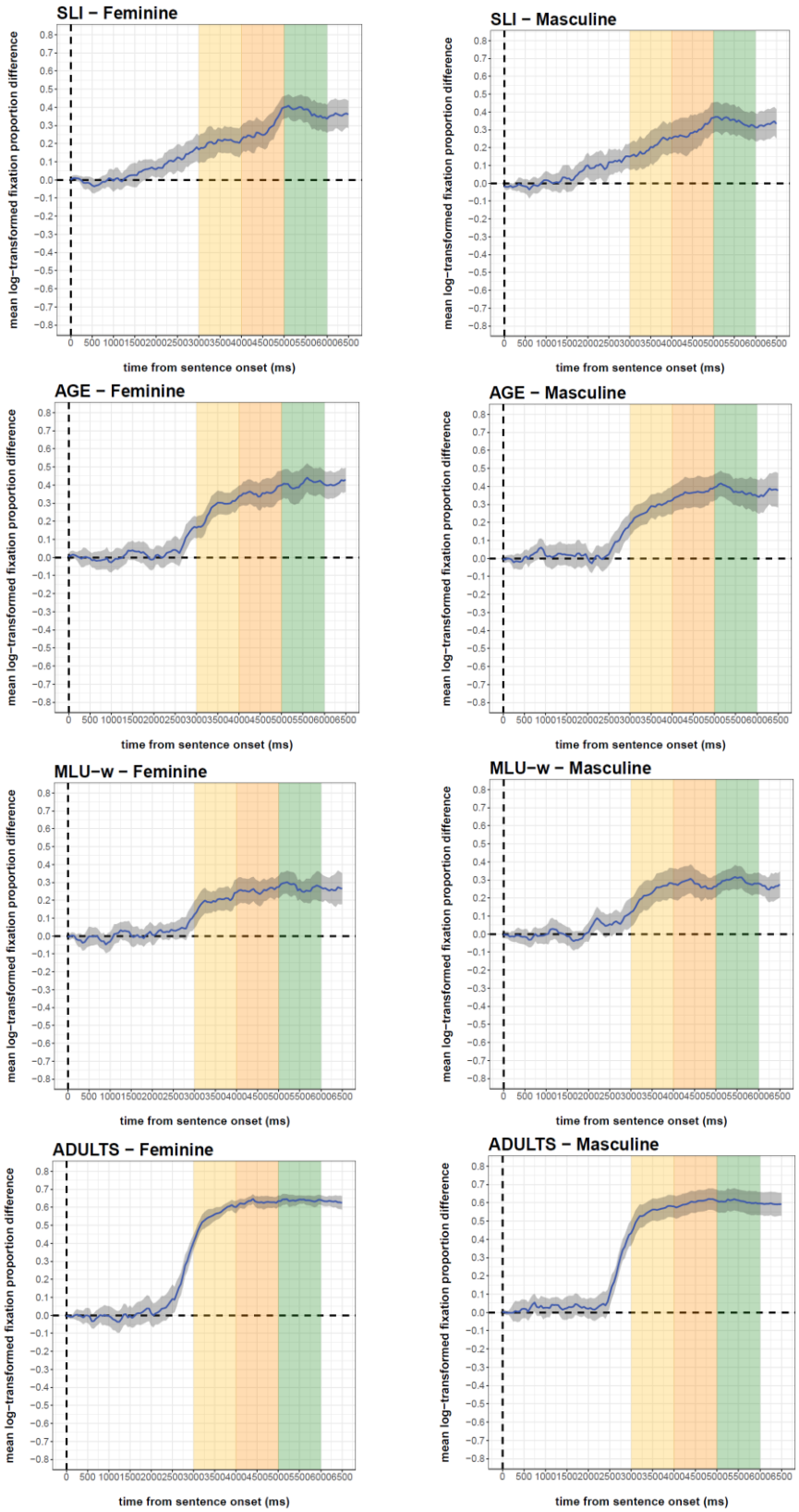


Figure 12. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and gender. Grey areas represent the within-subject adjusted 95% confidence intervals.

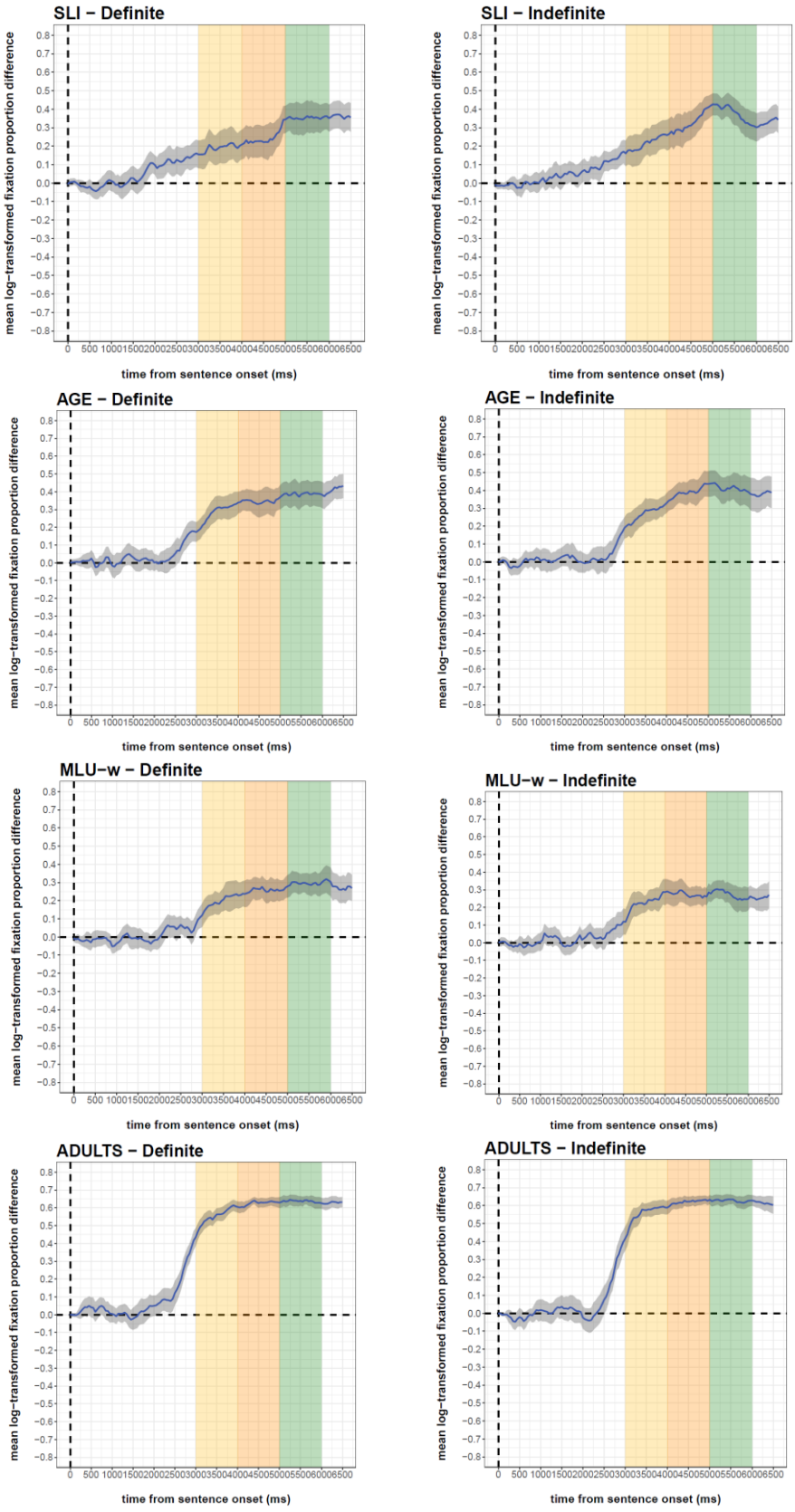


Figure 13. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and article type. Grey areas represent the within-subject adjusted 95% confidence intervals.

As it can be clearly observed in the graphs, there are no evident differences between the different types of articles. Participants in all groups of interest are able to use the article information adequately in order to distinguish the correct referent (i.e., the target) from a competitor. Participants do so right after they have heard the critical article, independently of the type of article.

4. Discussion

The purpose of the research was to study the comprehension of the relevant aspects of articles in Spanish language (definite/indefinite, singular/plural, feminine/masculine) in children with SLI. The results indicate that both the children with normal language acquisition and the children with SLI have the ability to understand the morphological marks of articles in a simple and canonical sentence structure. Contrary to the initial hypothesis, the empirical findings show that children with SLI have a better preserved capacity than expected.

In the analysis of the three time-window (W1_Silence, W2_Direct Object and W3_Final Silence), we observed that throughout the experimental task the SLI group (both younger and older children) presented a proportion of glances towards the target (correct response) similar to the Age control group. On the other hand, at the end of the experimental task, and specifically in the last window of analysis, the SLI group's proportion of glances significantly exceeded the proportion of the MLU-w control group. This interesting effect appeared due to the significant differences between the older children with SLI (SLI2, average age: 9;07) and the older children of the linguistic control group (MLU-w2, average age: 8;02). This effect suggests that at the end of the task (W3_Final Silence) an evolutionary pattern of linguistic comprehension is likely to be a consequence of the 15-month-gap between older children with SLI (SLI2) and

older children in the linguistic control group (MLU-w2). In further detail, there is no significant difference in the first and the third window of analysis (3000-3999 ms and 5000-5999 ms) between the SLI group (average age: 7;08 years), the chronological control group (average age: 7;08 years) and the linguistic control group (average age: 6;08 years). Both younger children (SLI1, average age: 6;00; AGE1, average age: 6;03; MLU-w1, average age: 5;04) and older children (SLI2, average age: 9;07; AGE2, average age: 9;04; MLU-w2, average age: 8;02) respond to the task in a similar way. However, as stated above, in the last analysis window (5000-5999 ms) the SLI group presents a level of comprehension similar to that of the chronological control group, and it significantly outperforms the linguistic control group. Quantitative data on the online comprehension of children with SLI provide a consistent picture of their ability to understand the articles of Spanish language in a simple sentence structure.

In the empirical literature, numerous studies in different cultural contexts have indicated a clear effect on the production of articles by children with SLI (Auza & Morgan, 2013a; Bedore & Leonard, 2001; 2005; Chondrogianni & Marinis, 2015; Cipriani, Chilosi, Bottari, Pfanner, Poli & Sarno, 1991; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992; Polite, Leonard & Roberts, 2011). In spite of the documented discrepancy, most studies indicate a greater effect on the definite articles (Auza, 2009; Auza & Morgan, 2013a; Bedore & Leonard, 2005; Restrepo & Gutiérrez-Clellen, 2001; Restrepo & Kruth, 2000) although some studies refer to the difficulty found in indefinite articles (Anderson & Souto, 2005; Bedore & Leonard, 2001). A number of studies indicate that children with SLI commit both omissions and substitutions of articles (Anderson & Souto, 2005; Auza & Morgan, 2013a; Bedore & Leonard, 2001; 2005; Bortolini, Caselli & Leonard, 1997; Leonard & Bortolini, 1998). In an attempt to further specify this issue, Bedore and Leonard (2005) remarked that

children with SLI had greater problems with the plural form of articles, and less problems with the singular form. When articles appeared in their plural version, the most frequent error was their substitution. Regarding the results of our study, it is important to emphasize that both the adult group and the three groups of children responded similarly to definite and indefinite articles, in singular or plural form and in masculine or feminine (Figures 11-13). Unlike previous studies that established patterns of greater or lesser difficulty in using articles (Bedore & Leonard, 2001; 2005; Auza & Morgan, 2013a; Chondrogianni & Marinis, 2015), our results indicate that children with SLI can understand articles regardless of their grammatical and morphological characteristics.

Different theoretical interpretations have tried to explain the evidences documented in the production of articles in the language of the children with SLI. According to Auza and Morgan (2013a), several studies have emphasized the low phonetic weight of these grammatical marks, as well as their weak and unfavourable position against the noun (Bedore & Leonard, 2001; 2005; Restrepo & Gutiérrez-Clellen 2001). According to the detailed work by Auza (2009) it seems that children with SLI have difficulty in detecting the features of the article in full, perhaps because the articles are considered as abstract categories that are not linked to the physical world, as opposed to what happens with nouns, verbs and adjectives. Such difficulty may also be related to an inadequate stored knowledge and/or a limited processing of morphological properties (Lahey & Edwards, 1999; McGregor & Appel, 2002; Weerdenger, Verhoeven & Barlkom, 2006; Windsor & Konhert, 2004). However, our empirical findings on linguistic comprehension indicate an adequate knowledge and processing of the grammatical marks of articles, in different sentences that share a simple structure (subject - verb - direct object).

CHAPTER 9

Study 5: real time comprehension of prepositions

Introduction

The objective of this study is to record and analyze the ability of children with SLI to process and understand different prepositions and prepositional locutions in a simple sentence structure. If we consider that linguistic particles guide the comprehension of a sentence, then a defective processing of prepositions and/or prepositional locutions will be reflected in the execution and in the glance pattern of the language comprehension register.

Under this hypothesis, it is expected that children with SLI will have a significantly lower comprehension compared to that of the control groups. If so, the possibility of a deficit in the comprehension of these linguistic particles and, consequently, of a more limited general linguistic comprehension, may be considered.

Conversely, if the empirical data of children with SLI are similar to the data of children in the control groups, it will be possible to argue in favour of a less atypical comprehension of these grammatical particles than what is generally thought. In the case that the study hypothesis is not confirmed, and the children with SLI register levels of comprehension not significantly different from the control groups, the possibility of a greater capacity to process prepositions and prepositional locutions of the Spanish language may be posed, despite the difficulty and significant difference observed in the production of these particles in previous studies.

1. Stimuli

A total of 60 simple structure sentences were created: 36 evaluated prepositions and 24 prepositional locutions. A propositional locution is a phrase that resembles a preposition in its syntactic behaviour or meaning (RAE, 2010). The following prepositions were evaluated: Spanish: “a”, “ante”, “bajo”, “con”, “contra”, “de”, “desde”, “en”, “entre”, “hacia”, “hasta”, “para”, “por”, “sin”, “sobre”, “tras”; in English: “to”, “facing/before”, “under”, “with”, “against”, “from/to/of”, “since/from”, “in/on”, “between”, “towards”, “until”, “for”, “through”, “without”, “over/on”, “behind/after”.

The following prepositional locutions were also evaluated: SP: “al lado de”, “alrededor de”, “cerca de”, “debajo de”, “delante de”, “dentro de”, “detrás de”, “encima de”, “en frente de”, “fuera de”, “junto a”, “lejos de”; EN: “next to”, “around the”, “close to”, “below of/under”, “in front of/opposite of”, “inside of”, “behind of”, “above of”, “in front of”, “outside of”, “next to”, “away from”. The fundamental criterion for the selection of the prepositions and the prepositional locutions was the possibility to represent them graphically. In this sense prepositions like: SP: “durante” and “según”; EN: “during” and “according to” were discarded because of their complexity to be graphically represented.

In Figure 1, a stimulus of a preposition can be observed: “The cat is *under* the table” (Target: cat under the table, Competitor: cat on the table).

In figure 2, a stimulus of a prepositional locution can be observed: “The bicycle is *in front of* the house” (Target: bicycle is in front of the house, Competitor: bicycle is behind the house).

Figure 1. Preposition stimulus

EN: "The cat is *under* the table" (Target: cat under the table, Competitor: cat on the table).

SP: "El gato está *bajo* la mesa".

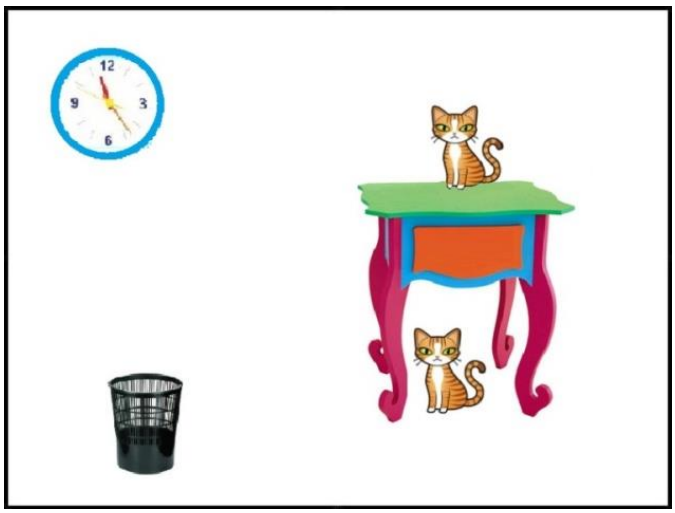
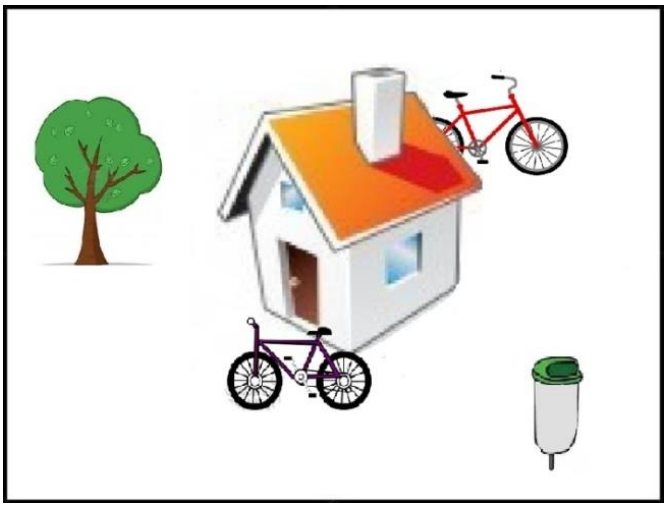


Figure 2. Prepositional locution stimulus

EN: "The bicycle is *in front of* the house" (Target: bicycle is in front of the house, Competitor: bicycle is behind the house).

SP: "La bicicleta está *en frente de* la casa".



In the case of prepositions, each stimulus contrasts a preposition with its contrary or with a different one ("The cat is *below/on* the table", "The girl walks *to/through* the park"). In each created image, two elements appear in the form of distracters and have no direct relation with the preposition under study, but contribute to the contextualization of the scene. The composition of the scene changes with respect to the nature of the preposition under study. In this sense, when studying a preposition of movement or direction (SP: "a", "de", "desde", "hacia", "hasta"/EN: "to", "from/to", "since/from", "towards", "until") we double the object (See Figure 3: "The bee flies *towards* the flower *from* the flower"). When we study a preposition of static representation (SP: "ante", "bajo", "con", "contra", "en", "entre", "para", "por", "sin", "sobre", "tras"; EN: "facing/before", "under", "with", "against", "in/on", "between", "for", "through", "without", "over/on", "behind/after"), we double the subject (See Figure 1: "The cat is *under/on* the table"). Finally, in some cases due the complexity of the scene (SP: "entre", "para", "por", "hacia"; EN: "between", "for", "through", "towards"), we double the object and subject (See Figure 4: "The train goes *through/towards* the tunnel").

As in the case of prepositions, each stimulus representing prepositional locutions was contrasted with its contrary or with a different one ("The bicycle is *in front of/ behind* the house"/"The bus is *in front of/next* to the store"). Similarly to what was described for the stimuli with prepositions, two related distracter elements were introduced in the scenes. In this condition the composition of the scene does not change, since the prepositional locutions that we study are all statics, therefore in every stimulus the subject is duplicated (See Figure 5: "The bus is *in front of/next* to the store").

Figure 3. Stimulus of Preposition graphing movement or direction

EN: "The bee flies *towards* the flower...*from* the flower" (Target: second flower, Competitor: first flower).

SP: "La abeja vuela *hasta* la flor...*desde* la flor".

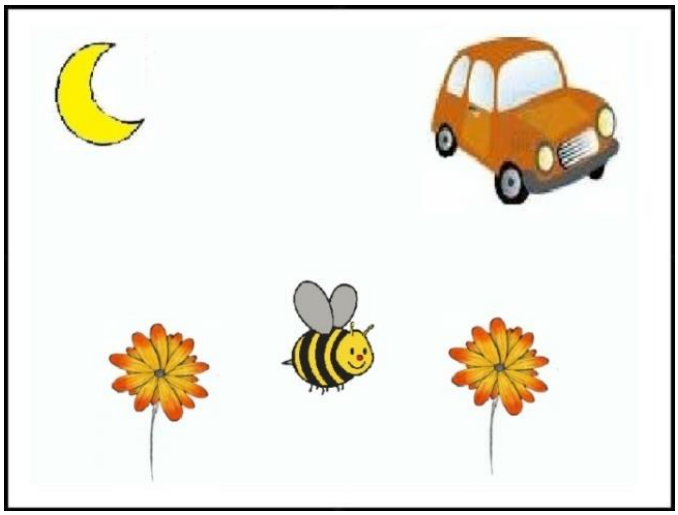
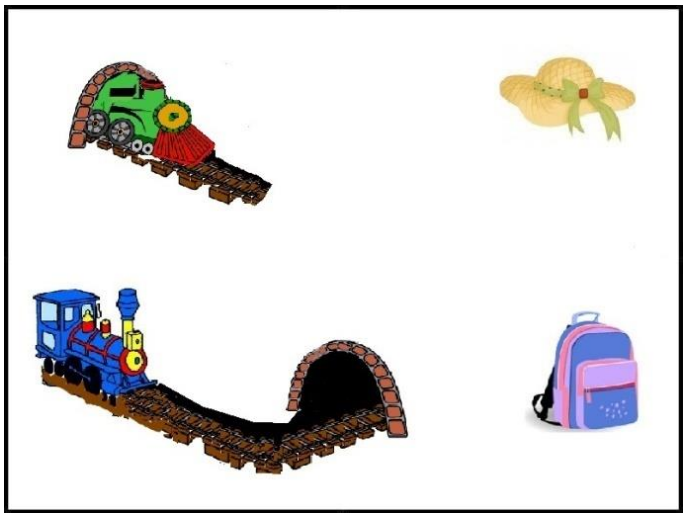


Figure 4. Stimulus of Preposition graphing movement or direction

EN: "The train goes *towards* the tunnel" (Target: train towards the tunnel, Competitor: train through the tunnel).

SP: "El tren va *hacia* el túnel".



It is worth mentioning that prepositions and prepositional locutions maintain a polysemic and heterogeneous character (RAE, 2010). In this sense, many of the analyzed prepositions of this study had different semantic values. For example, the preposition "*de*" (EN: "from"/"to"/"of") was used in its different meanings: SP: "Las flores *de* la niña"/EN: "The flower *of* the girl" (in a "possession sense") and SP: "La niña camina *de* la fuente a la otra fuente"/EN "The girl walks *from* the fountain to the other fountain" (in a "direction sense").

Two experimental lists were created (List A and List B). Each participant was exposed only to one condition of each scene ("The cat is *under* the table" or "The cat in *on* the table"). The visual stimuli were created by images of 800 x 600 pixels and presented as video format (800 x 600 pixels) on a monitor screen 17" TFT of *Tobii T120 Eye Tracker* set to 1024 x 768 pixels. Each stimulus has four graphic elements (target, competitor and two distracters). A native Spanish speaker recorded the experimental sentences at a normal speaking velocity at 44,100 Hz. Collaborators and authors of this research evaluated and selected the different stimulus in a search of the highest possible adequacy.

2. a. Data analysis (Prepositions)

The two main analysis presented here include a contrast between the experimental group against the Age control group, the MLU-w control group, and the Adult control group and a similar analysis by each time-window. Then, we provide a secondary analysis in which we contrast the SLI group against the Age- and the MLU-w control group, and younger vs. older children. This secondary analysis also presents a similar analysis by time-window. Critical time-windows started at 3000 milliseconds after beginning of the sentence, marking the start of the first silent window following

the critical preposition (3000 ms to 4000 ms from sentence onset), the second marking the critical noun (4000 ms to 5000 ms from sentence onset) and the third, the second silent window, which appeared following the critical noun (5000 ms to 6000 ms from sentence onset).

3. a. Results

Figure 5 shows the time course plots log-transformed proportion of fixation difference between the target and the competitor objects, averaged by participants by each independent group and with error bands depicting the within-subjects adjusted 95% confidence intervals. Two main effects can be observed: first, all participants are capable of distinguishing the target from the competitor beginning on the first time-window. This preference continues in the second and the third time-windows. The second effect is the evident advantage for the Adult control group in terms of speed and effect size compared to the children groups. Visual comparison among the children groups evidence a relative advantage for the Age control group, in particular from the second time-window.

The LMER clarify these differences. LMER results are presented in Table a.1. They confirmed what was observed in the graphs, namely, the significant difference between the Adult control group and the SLI experimental group. This is true, both in the global analysis and across the three critical time-windows. No other significant effects are observed (See Table a.2). Only a marginal difference is found between SLI and Age control, both globally, and in the first time-window as revealed by the window by window analysis. In general terms, the SLI group presents similar comprehension levels with the Age control group.

Finally, we eliminated the stimuli of some prepositions that graphically represent movement or directionality (SP: “a”, “de”, “desde”, “hacia”, “hasta”); (EN:“to”, “from/of”, “since/from”, “towards”, “until”) because all groups of children (SLI, AGE, and MLU-w) registered very low levels of target recognition, which basically indicates a lack of comprehension and an arbitrary performance.

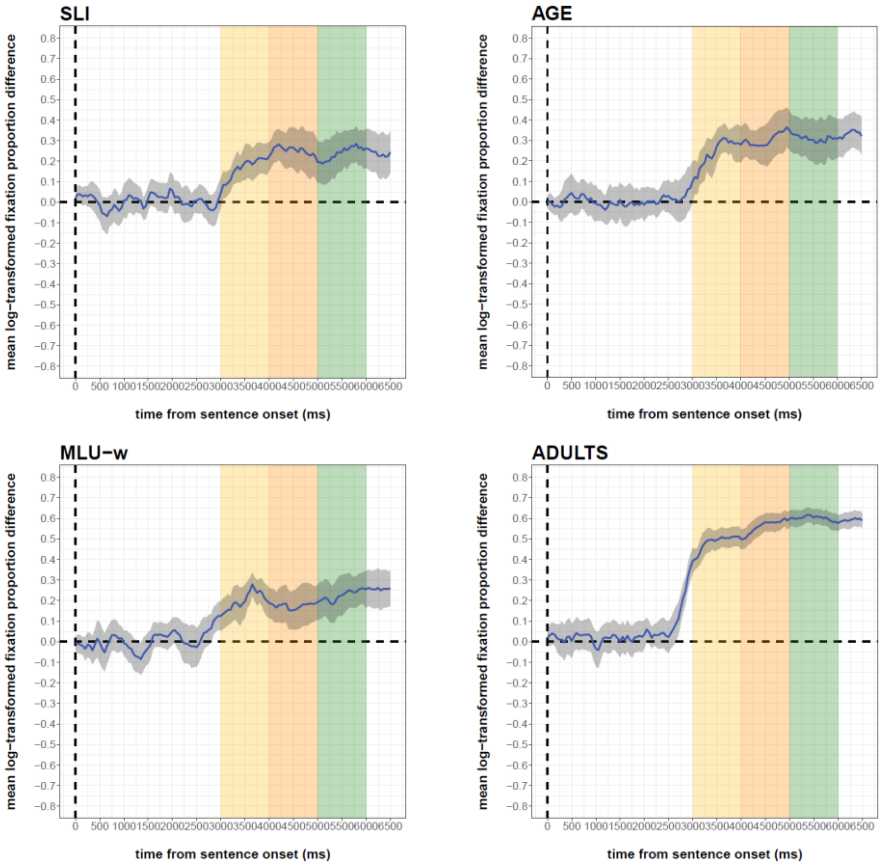


Figure 5. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

Table a.1. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	***se***	***t***	***p***	
(Intercept)	0.158	0.036	4.423	0.000	***
Age-control	0.071	0.036	1.987	0.050	.
MLU-w-control	0.035	0.036	0.978	0.331	
Adult-control	0.315	0.044	7.124	0.000	***
Time-window2-1	0.089	0.035	2.508	0.014	*
Time-window3-2	0.075	0.037	2.003	0.048	*
Age-control:Time-window2-1	-0.024	0.050	-0.488	0.626	
MLU-w-control:Time-window2-1	-0.109	0.050	-2.184	0.031	*
Adult-control:Time-window2-1	-0.008	0.050	-0.157	0.876	
Age-control:Time-window3-2	0.001	0.053	0.015	0.988	
MLU-w-control:Time-window3-2	-0.052	0.053	-0.986	0.327	
Adult-control:Time-window3-2	0.049	0.053	0.926	0.357	

Table a.2. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.158	0.035	4.477	0.001	***
Age-control	0.071	0.037	1.947	0.060	.
MLU-w-control	0.035	0.036	0.980	0.332	
Adult-control	0.315	0.046	6.885	0.000	***

Time-window 2	Estimate	Se	t	p	
(Intercept)	0.246	0.044	5.652	0.000	***
Age-control	0.047	0.049	0.956	0.343	
MLU-w-control	-0.073	0.053	-1.374	0.178	
Adult-control	0.307	0.055	5.552	0.000	***

Time-window 3	Estimate	Se	t	p	
(Intercept)	0.232	0.044	5.249	0.000	***
Age-control	0.072	0.055	1.312	0.195	
MLU-w-control	-0.017	0.054	-0.305	0.761	
Adult-control	0.364	0.056	6.441	0.000	***

We present two further analyses, which involved the comparison between the experimental group against the two children group and the age predictor. The first analysis includes a direct comparison among time-windows and the second one contrasts these groups and the age the predictor on each time-window separately. Data analysis is identical to that in the previous contrasts. Table a.3 and Table a.4, showed a reliable effect of the age predictor (younger vs. older children). Interestingly, while the global analysis (Table a.3) show an overall effect of children's age, the window-by-window analysis reveals that this effect does in fact appear only in the second window. Finally, the analysis presented in Table a.4, shows a significant difference between the SLI group and the Age control group only in first time-window.

Table a.3. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*p*	
(Intercept)	0.212	0.035	6.115	0.000	***
Age-control	0.063	0.034	1.848	0.070	.
MLU-w-control	-0.018	0.034	-0.529	0.599	
Time-window2-1	0.089	0.038	2.358	0.021	*
Time-window3-2	-0.014	0.033	-0.428	0.669	
Age	0.080	0.027	2.992	0.004	**
Age-control:Time-window2-1	-0.024	0.052	-0.468	0.641	
MLU-w-control:Time-window2-1	-0.109	0.052	-2.093	0.039	*
Age-control:Time-window3-2	0.025	0.046	0.548	0.584	
MLU-w-control:Time-window3-2	0.057	0.046	1.242	0.215	
Time-window2-1:Age	0.071	0.037	1.933	0.056	.
Time-window3-2:Age	-0.012	0.032	-0.373	0.709	
Age-control:Age	0.004	0.033	0.122	0.903	
MLU-w-control:Age	0.015	0.033	0.438	0.663	
Age-control:Time-window2-1:Age	-0.005	0.052	-0.091	0.927	
MLU-w-control:Time-window2-1:Age	0.005	0.052	0.095	0.924	
Age-control:Time-window3-2:Age	0.037	0.046	0.817	0.414	
MLU-w-control:Time-window3-2:Age	-0.009	0.046	-0.188	0.851	

Table a.4. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	**Estimate**	**se**	**t**	**p**	
(Intercept)	0.158	0.035	4.511	0.001	***
Age-control	0.071	0.035	2.019	0.048	*
MLU-w-control	0.035	0.036	0.977	0.334	
Age	0.036	0.037	0.979	0.349	
Age-control:Age	-0.005	0.040	-0.130	0.898	
MLU-w-control:Age	0.014	0.041	0.343	0.736	

Time-window 2	Estimate	se	t	p	
(Intercept)	0.246	0.041	6.018	0.000	***
Age-control	0.047	0.044	1.080	0.287	
MLU-w-control	-0.073	0.048	-1.542	0.137	
Age	0.108	0.037	2.939	0.009	**
Age-control:Age	-0.010	0.044	-0.226	0.822	
MLU-w-control:Age	0.019	0.053	0.364	0.721	

Time-window 3	Estimate	se	t	p	
(Intercept)	0.232	0.043	5.462	0.000	***
Age-control	0.072	0.053	1.371	0.177	
MLU-w-control	-0.017	0.050	-0.328	0.744	
Age	0.095	0.046	2.085	0.051	.
Age-control:Age	0.027	0.056	0.489	0.629	
MLU-w-control:Age	0.011	0.061	0.173	0.864	

Figure 7 shows how older children from all groups present a clear preference to the target compared to competitor. We can also observe how younger children of SLI group comprehend similarly with younger children of MLU-w control group and differently with the younger children of Age control group. The younger children of Age control group present a higher level of comprehension, in comparison with the other children (SLI and MLU-w), but the differences are not statistically significant.

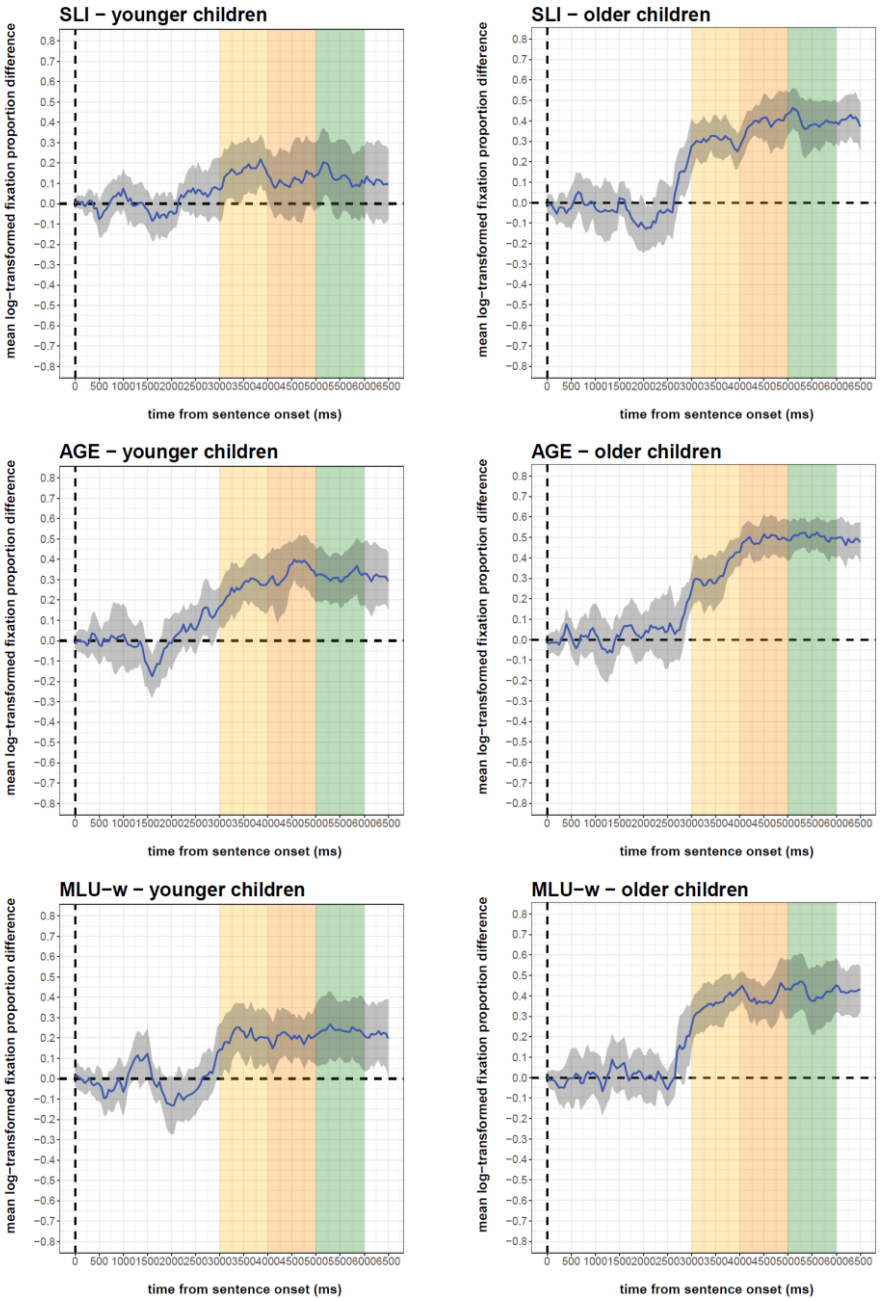


Figure 7. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and age. Grey areas represent the within-subject adjusted 95% confidence intervals.

2. b. Data analysis (Prepositional locutions)

Data analysis, critical time-windows and number of contrasts were identical to prepositions analysis. We also present the same secondary analysis among the three children groups, in terms of younger and older children.

3. b. Results

Figure 8 shows the time course plots for the log-transformed proportion of fixation difference between the target and the competitor objects. Records present the time shifts of the dependent variable averaged by participants in each independent group. Error bands (grey area around the line) show the within-subjects adjusted 95% confidence intervals.

Two observations are evident. First, participants from all groups are capable of identifying the target from the first time-window, and this preference is maintained along the following critical time-windows. Second, the Adult control group has a clear advantage both in terms of speed and the size of the preference effect, relative to the other groups.

The results from the LMER analysis in Table b.1 show two reliable effects. A significant overall difference between SLI group and the Adult control group was found. In addition, a significant difference between the SLI group and the Age control group was also.

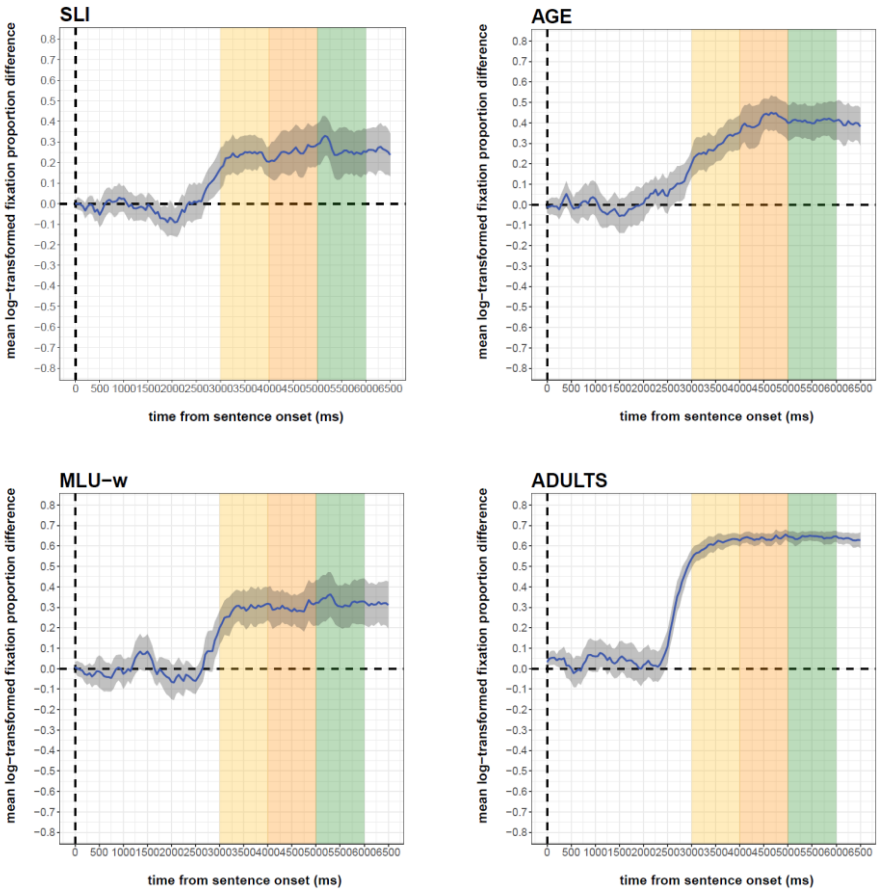


Figure 8. Mean log-transformed fixation proportion differences between target and competitors by group and time-window. Grey areas represent the within-subject adjusted 95% confidence intervals.

Table b.1. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*p*	
(Intercept)	0.244	0.038	6.442	0.000	***
Age-control	0.116	0.045	2.551	0.013	*
MLU-w-control	0.053	0.048	1.121	0.267	
Adult-control	0.378	0.047	8.002	0.000	***
Time-window2-1	0.015	0.028	0.540	0.590	
Time-window3-2	0.020	0.028	0.709	0.480	
Age-control:Time-window2-1	0.111	0.039	2.817	0.005	**
MLU-w-control:Time-window2-1	0.001	0.039	0.029	0.977	
Adult-control:Time-window2-1	0.018	0.039	0.468	0.640	
Age-control:Time-window3-2	-0.026	0.037	-0.711	0.478	
MLU-w-control:Time-window3-2	0.007	0.037	0.187	0.852	
Adult-control:Time-window3-2	-0.015	0.037	-0.406	0.685	

Table b.2. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	***Estimate***	***se***	***t***	***p***	
(Intercept)	0.227	0.038	5.981	0.000	***
Age-control	0.051	0.043	1.183	0.246	
MLU-w-control	0.050	0.042	1.188	0.243	
Adult-control	0.370	0.045	8.274	0.000	***
Time-window 2	Estimate	Se	t	p	
(Intercept)	0.242	0.044	5.461	0.000	***
Age-control	0.162	0.051	3.182	0.002	**
MLU-w-control	0.052	0.054	0.958	0.343	
Adult-control	0.389	0.055	7.119	0.000	***
Time-window 3	Estimate	Se	t	p	
(Intercept)	0.262	0.045	5.865	0.000	***
Age-control	0.136	0.058	2.327	0.023	*
MLU-w-control	0.058	0.059	0.991	0.325	
Adult-control	0.374	0.060	6.233	0.000	***

The results from the second LMER analysis (Table b.2) are in coherence with those from the first analysis. We observed a significant effect between the experimental group (SLI) and the Adult control group, on each time-window. This analysis also clarifies that the advantage observed for the Age control group appears in the second time-window and the third time-windows but not in the first one.

Two further analyses are presented: the first analysis contrasts the experimental group against the two children groups, with an age predictor and across time-windows as a factor. The second one does the same, but window by window. All aspects of data analysis are identical to that in the previous contrasts (see Table b.3 and Table b.4).

Table b.3. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor.

	Estimate	*se*	*t*	*p*	
(Intercept)	0.244	0.037	6.623	0.000	***
Age-control	0.116	0.043	2.667	0.010	**
MLU-w-control	0.053	0.046	1.171	0.247	
Time-window2-1	0.015	0.030	0.496	0.621	
Time-window3-2	0.020	0.030	0.673	0.503	
Age	0.107	0.029	3.635	0.001	***
Age-control:Time-window2-1	0.111	0.043	2.588	0.011	*
MLU-w-control:Time-window2-1	0.001	0.043	0.027	0.979	
Age-control:Time-window3-2	-0.026	0.042	-0.624	0.534	
MLU-w-control:Time-window3-2	0.007	0.042	0.164	0.870	
Time-window2-1:Age	0.058	0.030	1.919	0.057	.
Time-window3-2:Age	0.000	0.030	-0.010	0.992	
Age-control:Age	-0.043	0.041	-1.057	0.294	
MLU-w-control:Age	-0.016	0.041	-0.383	0.703	
Age-control:Time-window2-1:Age	-0.015	0.043	-0.340	0.734	
MLU-w-control:Time-window2-1:Age	-0.034	0.043	-0.802	0.424	
Age-control:Time-window3-2:Age	0.018	0.042	0.428	0.670	
MLU-w-control:Time-window3-2:Age	-0.004	0.042	-0.094	0.925	

Table b.4. Main and interaction effects in the linear mixed-effects regression on log-transformed fixation proportion difference between target and competitor by time-window.

Time-window 1	**Estimate**	**Se**	**t**	**p**	
(Intercept)	0.227	0.037	6.070	0.000	***
Age-control	0.051	0.042	1.203	0.240	
MLU-w-control	0.050	0.042	1.201	0.239	
Age	0.069	0.031	2.191	0.040	*
Age-control:Age	-0.040	0.042	-0.954	0.350	
MLU-w-control:Age	0.008	0.041	0.205	0.839	
Time-window 2	Estimate	Se	t	p	
(Intercept)	0.242	0.043	5.636	0.000	***
Age-control	0.162	0.049	3.273	0.002	**
MLU-w-control	0.052	0.051	1.006	0.321	
Age	0.127	0.034	3.677	0.001	***
Age-control:Age	-0.054	0.049	-1.112	0.272	
MLU-w-control:Age	-0.026	0.049	-0.532	0.598	
Time-window 3	Estimate	Se	t	p	
(Intercept)	0.262	0.044	5.923	0.000	***
Age-control	0.136	0.058	2.353	0.023	*
MLU-w-control	0.058	0.059	0.993	0.326	
Age	0.126	0.040	3.131	0.003	**
Age-control:Age	-0.036	0.057	-0.644	0.523	
MLU-w-control:Age	-0.030	0.057	-0.527	0.601	

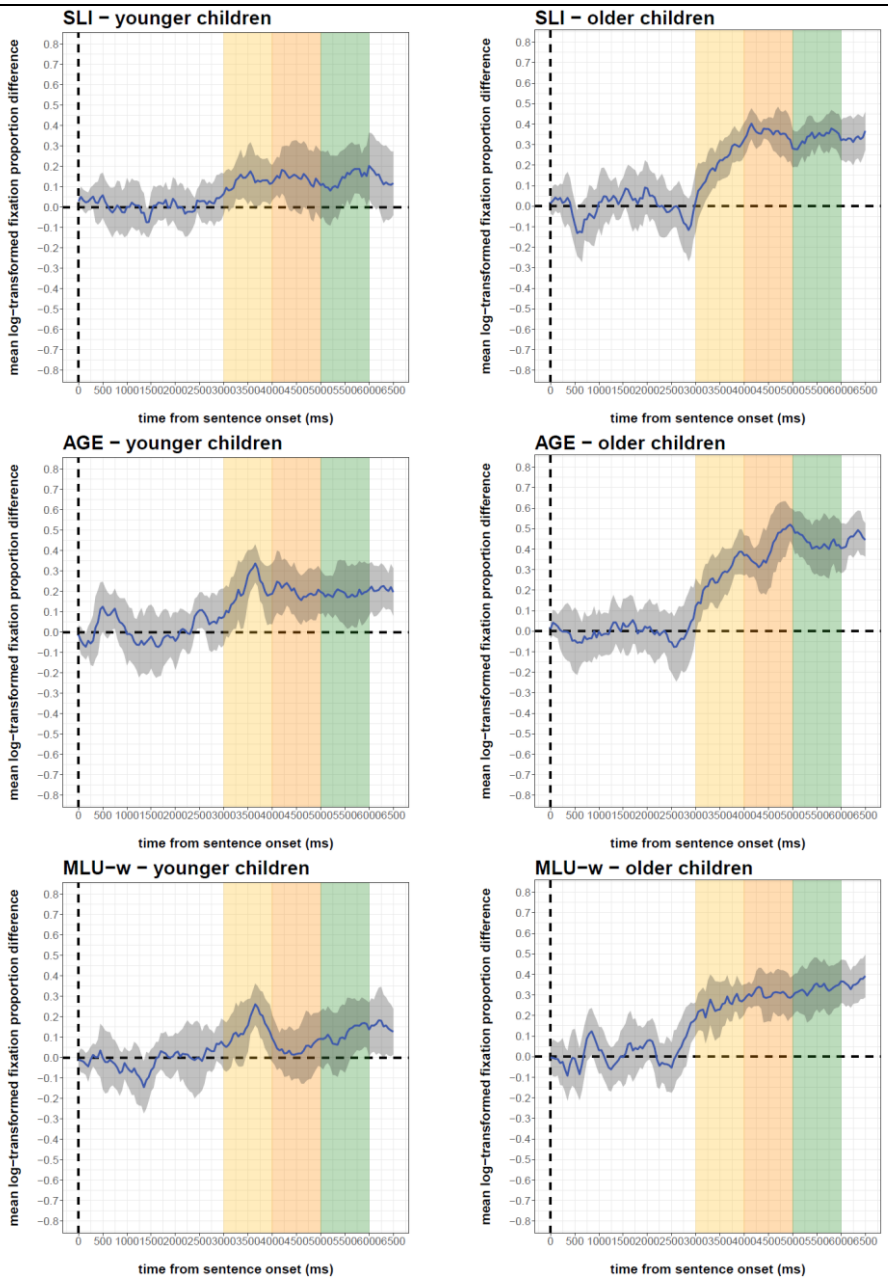


Figure 9. Mean log-transformed fixation proportion differences between target and competitors by group, time-window and age. Grey areas represent the within-subject adjusted 95% confidence intervals.

The results presented in Figure 9 show that older children from all groups evidence a large preference of the target compared to the competitor. However, among younger children there seem to be again some differences between the three groups of interest. SLI younger children seem to face some difficulty in order to identify the target from the competitor. The younger children in the Age control group seem more able to

do so. The younger children from the MLU-w control group, for their part, also prefer the target relative to the competitor, however, in a less clear and stable way relative to the younger Age control group children or older children in general.

These contrasts are coherent with the previous analysis. Overall, the graphs show a clear advantage for older children relative to younger children in all three groups. Interestingly, all three younger children groups, exhibit an initial trend towards the target in the first critical time-window. However, this trend vanishes in the second and third time-window. Older children, by contrast, began to prefer the target relative to the competitor in the first time-window and maintained such preference in the second and third time-windows. This pattern is confirmed by the significant effect of the age predictor in the global analysis, and in the window-by-window analysis.

4. Discussion

The objective of the study was to record and analyze in real time the capacity of Spanish-speaking children with SLI to process and comprehend different prepositions and prepositional locutions in a simple sentence structure. The research findings indicate that, despite some differences, both children with SLI and children in the control groups can process and comprehend prepositions and prepositional locutions in simple sentences. Contrary to the hypothesis of the study, the empirical data show that the SLI group maintains an ability to understand these morphological particles in a less atypical way than what is generally considered (Auza & Morgan, 2013b; Grela, Rashiti & Soares, 2004; Sanz-Torrent, Badia & Serra, 2008).

In the case of the prepositions, the analysis of the three windows (W1_Silence, W2_Complement and W3_Final Silence) indicates that children with SLI present a similar comprehension to that of the chronological control group, which spreads

homogeneously from the beginning to the end. Both young children (SLI1, AGE1, and MLU-w1) and older children (SLI2, AGE2, and MLU-w2) similarly comprehend the different stimuli of prepositions.

In the case of prepositional locutions, the analysis of the three time-windows (W1_Silence, W2_Complement and W3_Final Silence) indicates that, in general terms, the SLI group presents percentages of comprehension different to the percentages of the Age control group. In more detail, in the first window of analysis, which represents 1000 ms of silence immediately after the linguistic key (prepositional locution), the three groups of children (SLI, AGE, MLU-w) present a similar level of comprehension. However, in the second and third window of analysis, the SLI group presents a significantly lower comprehension than the Age control group, and similar to the level of comprehension of the MLU-w control group.

This effect found between the SLI group and the Age control group appears from both the difference between the younger children (SLI1 and AGE1) and between the older children (SLI2 and AGE2). In this sense, although in the first window these two groups (SLI and AGE) have a similar level of comprehension, in the second and in the third time-window, children in the Age control group statistically outperform children in the SLI group. This effect probably has to do with the linguistic advantage of children without SLI, who have a greater ability to process sentences more quickly and effectively.

It can be observed that the prepositions (SP: “ante”, “bajo”, “con”, “contra”, “en”, “entre”, “para”, “por”, “sin”, “sobre”, “tras”) (EN: “facing/before”, “under”, “with”, “against”, “in/on”, “between”, “for”, “by/through”, “without”, “over/on”, “behind/after”) turn out to be less prominent than prepositional locutions in Spanish

(SP: “al lado de”, “alrededor de”, “cerca de”, “debajo de”, “delante de”, “dentro de”, “detrás de”, “encima de”, “en frente de”, “fuera de”, “junto a”, “lejos de”) (EN: “beside/next to”, “around the”, “close to”, “under the/below of”, “in front of/opposite of”, “inside of”, “behind of”, “above of”, “in front of”, “outside of”, “next to”, “away from”) which are generally stressed structures. In this sense, it may be possible that the compound structure of prepositional locutions offers an advantage in terms of comprehension in children without SLI. In other words, both groups (SLI and AGE) comprehend prepositional locutions, but children without SLI show better skills in the experimental task.

One important limitation of the study was the elimination of prepositions that graphically represent movement or directionality (SP: “a”, “de”, “desde”, “hacia”, “hasta”) (EN:“to”, “from/of”, “since/from”, “towards”, “until”) because the three groups of children (SLI, AGE and MLU-w) presented very low gaze percentages at the target, which practically indicated, a lack of comprehension and a rather arbitrary performance. It should be noted that a further analysis has showed that this elimination does not change the overall quantitative picture of the study. However, it does reduce it, since the stimuli were not valid enough to evaluate these prepositions in the language of children with SLI.

According to different authors, language comprehension and production are separate processes (Bock, 1995; Levelt, 1993; MacDonald, 1999) and, from the perspective of others (Bates et al., 1988; Cuetos, Gonzalez & De Vega, 2015; Ingram, 1974), in the typical process of language acquisition, comprehension precedes production. According to Bishop (1992), despite the fact that both comprehension and production require a processing of semantic and syntactic information, the production of

language implies a further, sophisticated, phonological and linguistic processing. Linking this question to the linguistic reality of children with SLI, it is worth mentioning that in psycholinguistic literature, several authors suggest that SLI comprehension is more preserved than production (Castro-Rebolledo, Giraldo-Prieto, Hincapie-Henao, Lopera & Pineda, 2004; Dale, Price, Bishop & Plomin, 2003; Leonard, 2014).

Leonard (2014), in an extensive review, supported that Spanish-speaking children with SLI tend to have a greater ability to comprehend language, compared to their ability of producing it. Along similar lines, the findings of this study introduce more empirical evidence in a relatively recent perspective (using eye-tracking method), pointing to a less atypical linguistic comprehension in SLI than what is generally thought (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013).

On the other hand, it is essential to highlight a series of recent studies that present opposite results (Coloma, Maggiolo & Pavez, 2013; Coloma, Mendoza & Carballo, 2017; Coloma & Pavez, 2017). Coloma and col. (2013, 2017, 2017) assessed the language of children with SLI in more natural linguistic circumstances (narrative discourse, absence of visual cues, assessment of complex structures, offline methodology), and found significant differences compared to the level of comprehension of children in a chronological control group. The possibility of comparing these two lines of research (Andreu & col., 2011, 2013, 2016 and Coloma & col., 2013, 2017, 2017) is particularly important, as these different methodologies approach the study object from different angles. The possibility of integrating results from both empirical and theoretical perspectives considerably enriches the study of

linguistic comprehension in children with SLI. Additionally, this possibility allows the formulation of different hypotheses that will have to be answered by future studies, in search of a greater clarity regarding the nature of the comprehension mechanisms in this linguistic disorder.

Finally, it could be said that the problem that characterizes the language of children with SLI, both in terms of production and comprehension, is less a consequence of defective isolated linguistic elements (such as function words and, in particular, prepositions and prepositional locutions) and more a consequence of an overall difficulty in language production and comprehension. In other words, it could be a result not so much of an underlying and structural deficiency, but rather of a cognitive collapse, accentuated in the more critical moments of linguistic processing. On the other hand, it would be also interesting to think about how emotions are involved in the process of linguistic comprehension and production of children with SLI. Some studies have found that children with SLI suffer from social stress, emotional problems, and that they also present anxiety and depression symptoms (St Clair, Pickles, Durkin & Conti-Ramsden, 2011; Wadman, Botting, Durkin & Conti-Ramsden, 2011; Wadman, Durkin & Conti-Ramsden, 2011). Thus, it would not be wrong to think that children with SLI experience a significant distress with their language difficulties, and that it is likely that these language problems exacerbate emotional tension and vice versa. The psycholinguistic prism opens a window to the reality of children with SLI that raises the possibility of not only a linguistic, but also a psychological approach, in terms of morphological particles and syntactical structures, on the one hand, and in terms of the impact of emotions and thoughts, on the other.

CHAPTER 10

DISCUSSION

1. Summary of results

The overall vision of the research is presented below. The analysis is developed in four statistical levels where comprehension is assessed from the most general to the most specific:

i. First level is global: a value for all time-windows together, for each control group in comparison with SLI group (first table of each study).

ii. Second level is more specific: a value for each time-window, for each control group in comparison with SLI group (second table of each study).

iii. Third level is global again: a value for all of the time-windows, for the control groups/subgroups of children in comparison with SLI group/subgroups (third table of each study).

iv. Fourth level is even more specific: a value for each time-window, for the control groups/subgroups of children in comparison with SLI group/subgroups (fourth table of each study).

Stadistical level	Criteria
First level	A value for all time windows together – all groups
Second level	A value for each window – all groups
Third level	A value for all windows – groups and subgroups of children
Fourth level	A value for each window – groups and subgroups of children

In the contrasts below, a special emphasis is placed on the relationship between the SLI group and the Age group (Age-control condition, from now on: *cond2*), since in all time windows the SLI group shows a significantly lower comprehension in relation to the Adults group, and practically similar or higher comprehension in few cases in relation to the MLU-w group.

1. Study 1: Verbal morphology of time (Past-Future):

i. First level: In general terms, the SLI group presents significant differences compared to the Age control group (*cond2*).

ii. Second level: In the first two time windows there is no significant difference between the SLI group and the Age control group. In the third time window appears a significant effect (*cond2*).

iii. Third level: In general terms, the SLI group presents a marginal statistical effect compared to the Age control group (*cond2*).

iv. Fourth level: There are no significant differences between the SLI group and the Age control group (AGE2) (*cond2*).

Conclusion: The significant difference in the general analysis (3000 ms) disappears when we fragment the analysis into smaller temporal units (1000 ms x 3).

2. Verbal morphology of number (Transitive verbs):

i. First level: In general terms, the SLI group shows a similar comprehension compared to the Age control group (*cond2*).

ii. Second level: In the first two time windows there is no significant difference between the SLI group and the Age control group. In the third time window there appears a significant difference, which then disappears in the fourth window (*cond2*).

iii. Third level: SLI group presents significant differences compared to the Age control group (*cond2*).

iv. Fourth level: There are significant differences in the second and third window between the SLI group and Age control group that is due to the differences between the older children of the SLI group (SLI2) and the older children of the Age control group (AGE2, cond2: age).

Conclusion: The SLI group shows a rather different comprehension than the Age group in general terms, and a rather similar comprehension when in more fragmented time windows.

3. Study 3: Verbal morphology of number (Verbs in intransitive form):

i. First level: In general terms, the SLI group presents a significant differences compared to the Age control group (*cond2*).

ii. Second level: In the first two time windows there is a significant effect between the SLI group and the Age group. In the third time window, the significant effect disappears (*cond2*).

iii. Third level: In general terms, the SLI group presents a significant effect compared to the Age group (*cond2*).

iv. Fourth level: In the first two time-windows there are significant differences between the SLI group and the Age control group. In the third time-window the significant difference disappears, since the SLI group reaches a similar level of understanding (cond2).

Conclusion: The significant difference between the SLI group and Age control group persists in global terms and throughout the task. However in the last time-window where we have the disambiguation of the task, the SLI group reaches a similar level of comprehension with the Age control group.

4. Study 4: Function words (Articles):

i. First level: In general terms, the SLI group shows a similar comprehension compared to the Age group (*cond2*).

ii. Second level: In all time-windows, the SLI group presents a comprehension similar to the Age group. In the third time window, there are significant differences between the SLI group and the MLU-w group (SLI>MLU-w; *cond3*).

iii. Third level: In general terms, the SLI group presents only marginal differences compared to the Age control group (*cond2*).

iv. Fourth level: There are significant differences between the SLI group and the Age control group in the second time window (cond2: age). There are also significant differences between the SLI group and the MLU-w group in the third time window (cond3: age)

Conclusion: In general, the SLI group shows a comprehension similar to the Age control group, in terms of separate time-windows, and a marginal effect in global terms.

5. Study 5: Function words (Prepositions):

5. a. Prepositions

i. First level: In general terms, the SLI group shows a similar comprehension compared to the Age group (*cond2*).

ii. Second level: In all time windows, the SLI group presents a comprehension similar to the Age group (*cond2*).

iii. Third level: In general terms, the SLI group presents only marginal differences compared to the Age control group (*cond2*).

iv. Fourth level: There is a significant difference between SLI group and Age control group in the first time-window, but the in next two time-windows the significant differences disappear (*cond2*).

Conclusion: In general, the SLI group shows a comprehension similar to the Age group, in terms of separate time windows, but there is a marginal effect in global terms.

5. b. Prepositional locutions

i. First level: In general terms, the SLI group presents significant differences compared to the Age control group (*cond2*).

ii. Second level: In the second and third time windows there are significant differences between the SLI group and the Age control group (*cond2*).

iii. Third level: In general terms, the SLI group presents significant differences compared to the Age control group (*cond2*).

iv. Fourth level: In the second and third time windows there are significant differences between the SLI group and the Age control group (*cond2*).

Conclusion: In the first window, the SLI group shows a comprehension similar to the Age group; however, in the windows two and three a significant effect appears. In global terms, a significant effect appears between the SLI group and the Age group.

In an initial analysis it was planned to corroborate the time window that followed the "linguistic key" (that is, 1000 ms after the verb in the first three experiments and the function word in the last three). However, after verifying that in the time-window of analysis the SLI group showed a similar comprehension compared to the Age control group, we decided to extend the analysis both in terms of time (more windows analysis) and in chronological terms (subgroups of younger and older children). This decision of statistically extending the study allowed the possibility of eventually presenting a much deeper and much more comprehensive analysis. Before dealing with the contrasts found all together, it is worth pointing out what has been previously stated regarding the emphasis between similarities and differences of the SLI and Age groups, since in these contrasts the dynamics of SLI group's cognitive processing are reflected more clearly. In more detail, in the *first level* of analysis (general analysis) we found a significant effect between the SLI group and the Age control group in three of the six experimental tasks (Study 1, Study 3, and Study 5.b). However, when we moved to the *second level* of analysis and fragmented the time into

time windows of 1000 ms, the significant effect between the SLI group and the Age group was reduced to six out of a total of nineteen time windows analysed. In the *third level*, we carried out a general analysis for the subgroups and the groups of children, where we found a significant effect between the SLI group and the Age group in three of the six experimental tasks (Study 2, Study 3, and Study 5.b.) and marginal differences in the other three tasks (Study 1, Study 4, and Study 5.a.). Lastly, the *fourth level* of analysis allowed us to find out significant differences in eight out of nineteen analysis windows. In general these differences can be explained in intra-group terms: the older children from the Age control group (AGE2) present, in some cases, a significantly higher comprehension in relation to the older children from the SLI group (SLI2).

It is essential to state that the most important differences between the SLI group and the Age group appear in two of the six experimental tasks: on the one hand, in Study 3 (verbs in intransitive form), and on the other, in Study 5.b. (prepositional locutions). In Study 3, the Age group presents a significantly higher level of comprehension in relation to the SLI group in two of the three analysis windows; where the SLI group reaches a similar level only in the last window (when the disambiguation of the sentence occurs). In the Study 5.b, the SLI group presents a similar comprehension level in the first window; however, in the following two windows the Age group shows a significantly greater level of comprehension. In this sense, if we compare the results in the second level of statistical analysis (significant effect in six of the nineteen windows) and the fourth level (significant effect in eight of the nineteen windows), we can see that the differences in question have the greatest weight in terms of significance of all found effects (4/6 of the second level and 4/8 of fourth level). This question is considerably important because each one of the two studies mentioned

before maintain a direct relationship with one other study. In more detail, Study 3 (verbs in intransitive form) is related to the Study 2 (transitive verbs), and the Study 5.b. (prepositional locutions) to the Study 5.a. (prepositions).

First of all, regarding the studies on comprehension of the verbal morphology of number (Studies 2 and 3), it can be verified that Study 3 (verbs in intransitive form) has a lower level of difficulty compared to Study 2 (transitive verbs). This lies on the fact that the non-canonical sentence structure in the Study 3 (e.g. "Camina... la niña"; in English, "The girl... walks") contains less grammatical elements than the sentence structure in the Study 2 (e.g. "Bebe agua... el caballo"; in English, "The horse... drinks water"). In fact, the statistical values of the average fixation onto the target (correct answer), as it can be seen in the graphs (Figure 2/Study 2 and Figure 3/Study 3), show that the comprehension task of Study 3 (verbs in intransitive form) is easier than the task in Study 2 (transitive verbs) for all groups (SLI, AGE, MLU-w and Adults).

Secondly, in relation to the studies on the comprehension of prepositions and prepositional locutions, it can be verified that Study 5.b (prepositional locutions) is less difficult than Study 5.a (prepositions), since the prepositional locutions in Spanish (e.g. "al lado de"; in English, "next to") are phonologically more prominent than the prepositions (e.g. "encima"; in English, "above"). Once again, if we check the statistical values of the average fixation onto the target (Figure 5/Study 5.a and Figure 6/Study 5.b) it is clear for all groups that the task of study 5.b (prepositional locutions) is easier than that of study 5.a (prepositions).

It is particularly interesting that, throughout all the experimental tasks of this work, the differences with greater weight appear in two of the tasks that entail a relatively lower difficulty. Both in Study 3 (verbs in intransitive form) and Study 5.b

(prepositional locutions) the SLI group presents a good level of comprehension, since they clearly differentiate the target from the competitor. In fact, in absolute terms, the SLI group shows a considerable higher level in the two aforementioned tasks (Study 3 and Study 5.b), compared to the values obtained in the tasks related to the other two, that is, Study 2 (transitive verbs) and Study 5.a (prepositions).

This apparent paradox may have a rather simple explanation: the significant effect between the SLI group and the Age control group appears in the easiest tasks (Study 3 and Study 5.b) because, most probably, the linguistic advantage that the children without a linguistic impairment have over the children with SLI becomes evident in those tasks. In other words, in the relatively more difficult tasks (Study 2 and Study 5.a) there are less significant differences between the SLI group and the Age group, since the main complexity of these tasks is reflected in a more homogeneous comprehension pattern between the two groups. Conversely, when the complexity of the task reduces, the pattern of comprehension is more heterogeneous and more statistically significant differences are recorded in the time-windows of analysis. In this sense, in the two comprehension tasks where more effects have been recorded (Study 3 and Study 5.b), it can be argued that the SLI group responds relatively well, and that the AGE group responds significantly better.

The four levels of statistical analysis lay out a quantitative image regarding the SLI group's comprehension, which is recorded as less atypical than what is generally considered. This, in turn, allows us to introduce the central idea of this thesis:

The accumulation of difficulty in quantitative terms provokes an impact in qualitative terms, which is expressed as a lower comprehension.

In the vast majority of the analysed windows (24/38), in inter-group terms, the SLI group presents a comprehension which does not significantly differ from the comprehension in the Age group. However, when we analyse the overall value of these same analyses, a significant effect appears in half of the experimental tasks (6/12), a marginal difference in a third part (4/12) and finally we observe absence of differences in only few time-windows (2/12). The explanation of this phenomenon is expressed in the evolution curves of the values of comprehension, and it becomes evident in the statistical effects and in the graphs. In this sense, the mostly non-significant differences between the SLI group and the Age group accumulate in quantitative terms, until a qualitative change appears (a statistically lower comprehension).This pattern, probably, characterizes the nature of linguistic comprehension of children with SLI, since the difficulty might be more related to the accumulation of difficulty in the general processing of language, as shown throughout our work, and less due to specific linguistic elements (such as verbal morphology marks and function words).

Other evidence that argues in favour of the possibility of a less atypical comprehension in the case of children with SLI appears through the corroborations between the SLI group and the MLU-w group. More specifically, in the third window of Study 2 (transitive verbs, Figure 4) and at the end of the task (the last 1000 ms) in Study 4 (articles, Figure 10), the SLI group has a significantly higher comprehension in relation to the MLU-w group, an effect that is due to the higher level of understanding by the older children with SLI (SLI2, average age: 9;07) compared to the older children of MLU-w (MLU-w2, average age: 8;02). A similar effect, although not statistically significant, also appears at the end of Study 3 (verbs in intransitive form, Figure 5). These differences between the older children from the SLI group and the older children from the MLU-w group can probably be explained by the 15-month distance that

separates the two subgroups (SLI2 and MLU-w2), an issue that may suggest an evolutionary pattern when it comes to explain the differences found between the two subgroups.

Finally, it is important to note the presence of a relatively isolated processing speed effect. In Study 2 (transitive verbs) and in Study 3 (verbs in intransitive form) we find a clear speed effect, precisely in the time-windows where the subject appears and the sentence is disambiguated (e.g. “Drink water (silence) the horse (final silence)”/ “Walks (silence) the girl (final silence)”). More specifically, in the third time-window of Study 2 (“horse”) and in the second time-window of Study 3 (“girl”), we register the highest differences (between SLI group and Age control group) of the whole study. This statistical effect are due to the significant differences between the older children of the SLI group (SLI2) and the older children of the Age control group (AGE2). However, in the following time-windows (the 1000 ms of the final silence window) the statistical effect disappears. The SLI group reaches a similar level of comprehension with the Age control group. It is particularly interesting, since in Study 4 (articles) also the sentence is disambiguated with the appearance, in this case, of the direct object (e.g. “Grandma touches the (silence) tree (final silence)”). However, in this case in the time-window of interest (“tree”) there are not any significant differences between the SLI group and the Age control group, since the children with SLI show a processing speed similar to that of the children of the Age control group. Perhaps the explanation of this phenomenon is the additional difficulty of the tasks of verbal number morphology (Study 2 and Study 3) that introduces the non-canonical structure of the sentence. In this sense, perhaps the differences in speed, found in the tasks of verbal number morphology, is due to the question of the irregular order of the sentence that complicates the comprehension of SLI group. Nevertheless, in the following 1000 ms (last time-window) they reach a

level of comprehension similar to the Age control group. Contrarily, when the sentence structure is canonical (Study 4) the speed effect does not appear.

The presented results allow us to argue in favour of a comprehension by children with SLI that is less atypical than what is generally thought. In all experimental tasks, the SLI group can clearly distinguish between the correct and incorrect answers. It is true that there are some differences between two groups (especially in Study 3 and Study 5.b). There are also some differences in terms of processing speed and also in terms of fixation on the target (Study 2 and Study 3). However, the main reason that probably explains the differences between the two groups (SLI and AGE) is the accumulation of difficulty throughout the sentence of each task. There are clear statistical differences when we compare the global contrast (significant differences between the two groups in 6/12 time-windows of interest) with the particular contrast (significant differences between the two groups in 14/38 time-windows of interest).

This also allows us to lay out the central idea of the thesis, in the sense that the apparent difficulty of the comprehension by children with SLI follows a pattern where the accumulation of difficulty in quantitative terms leads to a change in qualitative terms, which is manifested as a lower comprehension. Therefore, and despite the evident affectation in language production, the comprehension of these children seems to be more typical compared to our initial hypothesis, as well as compared to what is indicated in the theoretical corpus. If this question is proved to be true, it may have a considerable importance in speech therapy interventions.

2. General Discussion

There is an ample amount of literature which indicates that the main problem that children with SLI have with their language production is related to the aspects of verbal morphology **(**Bishop, 1997; Conti-Ramsden, Botting & Faragher, 2001; Conti-Ramsden & Jones, 1997; Grinstead, et al., 2009; Hoover, Storkel & Rice, 2012; Leonard, 2014; Leonard, Eyer, Bedore & Grela, 1997; Rice et al., 1995; Rice & Wexler, 1996; Sanz-Torrent et al. 2008; Sanz-Torrent et al., 2011) and function words (Anderson & Souto, 2005; Auza & Morgan, 2013; Bedore & Leonard, 2001, 2005; Bortolini, Caselli & Leonard, 1997; Chondrogianni & Marinis, 2015; Cipriani, Chilosi, Bottari, Pfanner, Poli & Sarno, 1991; Leonard & Bortolini, 1998; Leonard, Bortolini, Caselli, McGregor & Sabbadini, 1992; Polite, Leonard & Roberts, 2011). Along these lines, Leonard (2014) supports that problems with morphology are notorious in SLI, both in terms of production and comprehension. In a similar way, Mendoza (2012, 2016) considers that children with SLI have the most severe difficulties producing and understanding morphological marks. However, despite this perspective, which considers that the problems with morphology (especially verbs and function words) that characterize their linguistic production, also characterize their linguistic comprehension, very few studies tried to clarify this question. In fact, Muñoz, Carballo, Fresneda and Mendoza (2014) emphasized on the limited number of empirical studies that assess the language comprehension in SLI. According to these authors, most of the research focuses on language production.

For this reason the present thesis, through the *visual world paradigm*, assesses the comprehension in SLI throughout a series of different experimental tasks. In further detail, this study evaluates the comprehension of the most affected morphological marks

in the linguistic production of SLI, in real time and using a simple sentence structure. Starting from the empirical knowledge that children with SLI have a great difficulty regarding the morpho-syntactic dimension in linguistic production, the experimental tasks are fostered to be sentence structures as least complex as possible. The objective is to study the morphological marks and function words in the Spanish language with the smallest possible amount of distraction, reducing the lexical difficulty to the minimum, in order to observe, as clearly as possible, their capacity to process the morphological marks and function words under consideration.

Below are the hypotheses of this thesis, set against the results obtained:

1. If the morphological characteristics of linguistic stimuli guide the comprehension of sentences and the visual analysis of an event, then the deficits in morpho-syntactic processing will be reflected in the conduct and in the pattern of eye movements during comprehension tasks.

Throughout the experimental tasks, as well as in the previous studies with eye tracking technology (e.g**.** Altman & Haywood, 2003; Altmann & Kamide, 1999; Altmann & Kamide, 2009; Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Trueswell, 2013; Boland, 2005; Kamide, Knoeferle & Crocker, 2006; Knoeferle & Crocker, 2007; Knoeferle, Crocker, Scheepers & Pickering, 2005) it becomes evident that the morphological characteristics of the linguistic stimuli guide the language comprehension and visual analysis of a scene. In fact, in one of the most relevant works in this context, Altmann and Kamide (2009) the study results demonstrate the capacity of language when mediating in the update of the mental representation of a scene, and how this mental representation is constituted as a basis for where the direction of attention goes afterwards and as a guide to our behaviour.

However, children with SLI, despite presenting some difficulties in certain tasks, show a pattern of eye movements which is more typical than our central research hypothesis. In this sense, the results of the study suggest a more preserved processing in morpho-syntactic comprehension compared to what is considered in the bibliographic corpus.

2. If children with SLI have difficulty in producing studied linguistic elements (verbal morphology and function words), then they will show difficulties in the speed and/or the conduct of comprehension tasks of those elements.

The different online comprehension tasks that this work is composed of have been arranged thinking specifically of the most problematic areas of language production in SLI. As indicated in the bibliographic corpus, morphological difficulties become clear in different languages. In English, for example, in the verbal inflection of the third person singular (-s), inflection of past tense (-ed), and inflection of present continuous tense (-ing) (Conti-Ramsden, Botting & Faragher, 2001; Hoover, Storkel & Rice, 2012; Leonard, Eyer, Bedore & Grela, 1997); in Spanish or in Catalan, in the verbal inflection of time, number and person, as well as in the use of infinitives, (Bedore & Leonard, 2001; Grinstead et al., 2009; Sanz-Torrent et al., 2008). Other studies show similar results regarding the significant difficulty in the production of verbal morphology in SLI in languages like Arabic, German, French and Greek (Abdalla & Crago 2008; Jakubowicz et al., 1999; Paradis & Crago 2001; Stavrakaki, 2005). However, the results of this research indicate that, despite the difficulty with the aforementioned elements in linguistic production, children with SLI are capable comprehending them; on the other hand, the expression of this difficulty is not concentrated on the task execution or in their processing speed, but the overall accumulation of difficulty causes a certain linguistic collapse. This perspective could follow a similar line to the previous studies which highlighted the importance of

phonological working memory (verbal working memory) in the consolidation of linguistic difficulties in SLI (Ellis, Weismer, Evans & Hesketh, 1999; Fresneda & Mendoza, 2005; Gardner & Petersen, 2011; Montgomery & Evans, 2009). According to Bishop (1994) the morphological and syntactic problems of children with SLI are not always the same and they don't occur in all contexts. In this sense, they cannot be considered as a result of a modular alteration, or a lack of grammatical competence. It seems rather a problem of execution of certain grammatical structures in certain conditions, especially when the processing demands are excessively high.

3. If children with SLI follow not only a delayed, but also a deviant language acquisition pattern, then there will be differences in the speed and/or the conduct of comprehension tasks when compared with the control group matched by linguistic level.

It is important to state that the children with SLI (average age: 7;08) not only show a similar level to the children they are matched to by linguistic level (average age: 6;08) but also, as exhibited in the previous section, in some occasions they show a significantly or marginally higher level of comprehension. In fact, it can be verified by the graphs that throughout all experimental tasks (with the exception of Study 5/prepositions) in the last window, the SLI group shows the highest percentages of fixation onto the target, compared to the percentages of the MLU-w group. In this sense, it becomes clear that the pattern of language acquisition in terms of comprehension by children with SLI cannot be considered deviant.

4. We expect children with SLI to have the worst results, compared to their control groups. In the case that the hypotheses of the study are not confirmed, and children with SLI do not have significantly different comprehension levels from the control groups, it may be suggested that there is a possibility of a greater capacity when processing studied linguistic elements and, consequently, of a less atypical comprehension than what is generally thought.

Despite our initial hypotheses, children with SLI had mostly similar levels of comprehension in relation to the comprehension levels of the children from the Age group, and on some occasions, they had higher levels compared to the children from the MLU-w group. These empirical results demonstrate a greater capacity in morphological comprehension by children with SLI, at least in the circumstances of the online experimentation and in simple sentence structures, which, in turn, suggest a possibility of a less atypical comprehension than what is generally thought.

In general terms, the six experimental tasks can be conceptualised within the Vygotskyan theoretical framework, which deals with the interaction between thought and language (Vygotsky, 1986). Thought and language are two nuclear dimensions of human consciousness, the study and interpretation of which may allow a greater knowledge regarding the nature and the possible causes of dysfunctional language. In turn, a greater knowledge allows the certainty of a more adequate approach regarding the developmental and clinical needs of the children who experience the disadvantages of an atypical language. On that matter, the interaction between thought and language (Vygotsky, 1986, 1995; Wygotski, 1964) can be considered nuclear in the theoretical and empirical perspective, from which this research has been developed. Stated in other words, throughout the different experimental tasks, we can see that linguistic stimulus works as a key that disambiguates the different possibilities of graphic representation, guiding the glances towards the correct answer. To investigate in greater depth, it is important to place a special emphasis on the idea posed by Chomsky (2014) that introduces the present work:

> "It seems that language is evolved and it's designed as a mode of creating and interpreting thought. It's a system of thought basically".

This idea raised by Chomsky is presented in the theoretical perspective of the Vygotskyan cognition. Vygotsky, one of the most emblematic figures in the history of Psychology, demonstrated in his notorious work (*Thought and Language*, 1986) the limitations of Piaget's theoretical perspectives, coming to the parallel conclusion that:

> Thought is not merely expressed in words; it comes into existence through them [...]. An analysis of the interaction of thought and word must begin with an investigation of the different phases and planes a thought traverses before it is embodied in words. (pag. 218).

According to Vygotsky (1986), thought comes into existence through words, or said in a different way, it materializes in words. His idea is illustrated by his classic example:

> *When I wish to communicate the thought that today I saw a barefoot boy in a blue shirt running down the street, I do not see every item separately: the boy, the shirt, its blue color, his running, the absence of shoes. I conceive of all this in one thought, but I put it into separate words.* (pag. 251).

As Chomsky (2014) indicates, language seems to be a system of creation and interpretation of thought. Vygotsky (1986) defends, along a similar line, that:

> A speaker often takes several minutes to disclose one thought. In his mind the whole thought is present at once, but in speech it has to be developed successively. (pag. 251).

This question does not have a mere theoretical interest, in fact it introduces the possibility to materialize this notion in specific elements of psycholinguistic intervention, to be able to further and better approach the various needs of the children who experience a language impairment. In this sense, language comprehension, the central phenomenon of this research, cannot be conceptualized in *exclusively linguistic terms* (phonemes/words/sentences), nor in *exclusively psychological terms* (thoughts

through the associative activation; Khaneman, 2011). The phenomenon of comprehension consists of both linguistic (language) and psychological (thought) reality since, according to Vygotsky (1986) meaning is the union of word and thought. In further detail, from the aforementioned theoretical point of view, the comprehension consists of understanding both words and thoughts. In different occasions of human interaction, motivation and thought happen to be clearly reflected in the verbalized message. On these occasions, and even in very early stage of language acquisition, a child can understand (represent in their mind) a sentence which they are not yet able to produce (through their language).

Cuetos, Gonzalez and De Vega (2015) give the follow examples: a) *"Put the cookie on the table"; b) "Put the ball on the chair".*

One-year-old children can understand these sentences despite the fact that they cannot yet produce them. Their capacity to understand seems to carry an important advance compared to their capacity to produce, in a way that thought already appears when a proper speech is not yet available. Following this line we can see that, in very early stages of language acquisition, the child is able to understand the meaning of a message, like the presented ones, since the words manage to transmit specifically the desired intention. Although the child cannot produce the message, the words that form the speaker's sentence manage to create the thought corresponding to reality, which is manifested in the receiver's response (the child puts down the cookie/ball).

Essentially, the different experimental tasks deal with the interaction between thought (the specific concept) and language (morphological marks). In that sense, the word functions as a "linguistic key" which eliminates the ambiguity between the different images, and guides the fixation of glances to the correct answer. For example,

in the sentence: “La niña subió al árbol” (in English, “The girl climbed the tree”) (Figure 1/Study 1), we observe that, after hearing the linguistic key (“subió”; en English, “climbed”), both the SLI group and the three control groups (chronological, linguistic, adults) fix their gaze onto the correct image (the girl on top of the tree), eliminating the wrong image (the girl under the tree).

According to Leonard (2014):

> Problems with morphosyntax are notorious in SLI, and it is therefore no surprise that many accounts of this disorder are centered around grammar. Of the various accounts that focus on grammar, several treat grammatical deficits as a knowledge problem. That is, it is assumed that the weaknesses seen in the production and comprehension of grammatical details by children with SLI are the result of incomplete knowledge of particular rules, principles, or constraints (pag. 241).

If the aforementioned lack of grammatical knowledge existed, the SLI group could not have distinguished between the correct and incorrect answers. The results of the six experimental tasks demonstrate that in the present circumstances (simple sentence, online task, graphic representation), the linguistic comprehension by children with SLI is less atypical than what is generally thought. The coherence in the data throughout different tasks and the theoretical foundations of Vygotskyan cognition allow us to argue a more preserved state of comprehension than what is generally thought, and they pose the possibility to study language impairments in general, and SLI in particular (also known as Development Language Disorder, DLD), from a psycholinguistic perspective - that is to say, both in linguistic (language) and psychological terms (thought).

CHAPTER 11

CONCLUSSIONS

1. Conclussions

The findings of the present study provide empirical evidence of a less atypical language comprehension in children with SLI in relation with what is generally considered in the psycholinguistic community. In general terms, children with SLI present a capacity to comprehend verbal morphology and function words (which is the main difficulty in their language production) not statistically different in comparison to children of the chronological control group. Our results may can be interpreted in a similar way to Leonard's view (2014) that Spanish-speaking children with SLI show a higher capacity in language comprehension than in language production.

The statistical differences between the SLI group and the Age control group seem less to be the consequences of isolated linguistic elements, such us verbal inflection marks or function words, and more to an accumulation of the difficulty among the experimental sentence. In other words, we suggest the existence of a pattern where the accumulation of the difficulty in quantitative terms, produce a change in qualitative terms, which is manifested as a lower general comprehension. Our interpretation could follow a similar line with the perspective of previous studies that emphasize the vulnerability of the verbal working memory of children with SLI, especially when the difficulty of the task increases (Ellis, Weismer, Evans & Hesketh, 1999; Montgomery & Evans, 2009).

Finally, we support that language comprehension should conceptualize inseparably in linguistic and psychological terms. According to the Vygotskyan

cognition (Vygotsky, 1986) words and thoughts maintain a profound interconnection, where one cognitive phenomenon is mainly possible in the presence of the other cognitive phenomenon.

2. Clinical implications and future studies

The results of this research may have an impact at a clinical level. An inadequate morpho-syntactic processing regarding the use of verbal marks of time and number, as well as the use of function words (articles and prepositions), probably keeps a central role in the reduced capacity of children with SLI when it comes to understanding and properly producing the language. A clinical intervention should focus on transmitting the morpho-syntactic knowledge of verbs, while working on function words in parallel. A good integration and use of these linguistic elements can be the essential basis for the development of simple sentences and the key to achieve a more complex grammar and a more fluid language production. This intervention can be very beneficial regarding the errors that children with SLI commit, and consequently, it can significantly improve their linguistic abilities through the creation of pedagogical material specifically aimed at these problems and, in parallel, for the adaptation of curricular contents in schools. A psycholinguistic intervention that is more substantial and more adjusted to the reality of these children will give a greater emphasis, on the one hand, to correct the typical mistakes they make, and on the other, to encourage the correct use of verbal marks of time and number and function words. The possibility of a less atypical comprehension of verbal morphology and function words raises the presence of a better prognosis and underline the importance of an early intervention.

The findings of the research introduce more empirical evidence, in a relatively recent perspective which points out the possibility of a less atypical comprehension in

relation to what is generally thought. In greater detail, Andreu and col. (Andreu, Sanz-Torrent, Guardia & MacWhinney, 2011; Andreu, Sanz-Torrent & Rodriguez-Ferreiro, 2016; Andreu, Sanz-Torrent & Trueswell, 2013) by means of eye movement tracking methodology, has presented empirical data which indicates a more preserved comprehension of language by children with SLI. However, it would be essential to corroborate the stated perspective with a different point of view, consolidated through a series of studies, recent also, in which opposing results are presented (Coloma, Maggiolo & Pavez, 2013; Coloma, Mendoza & Carballo, 2017; Coloma & Pavez, 2017). Coloma and col. (2013, 2017, 2017), studied the comprehension by children with SLI using a narrative discourse protocol (Pavez, Coloma & Maggiolo, 2008) which measures the natural character of language. The findings of this line of research indicate that children with SLI have a lower level of comprehension in relation to children from the chronological control group. Different reasons can be involved in this apparent antithesis between the two lines of investigation presented here. On the one hand, studies suggesting a less atypical comprehension by children with SLI are based on simpler structures of language, through eye tracking methodology, which does not require linguistic production by children with SLI, in order to indicate the level of understanding, and the language is always held in visual scenes. On the other hand, studies that suggest a more atypical comprehension do not have visual support, the comprehension is evidenced through verbal responses of the children with SLI and the characteristics of the studied language are much closer to the real-world circumstances of day-to-day linguistic communication, since complex sentences of narration are used. The possibility of integrating the results of these two empirical and theoretical perspectives considerably enriches the study of linguistic comprehension by children with SLI and allows the formulation of different hypotheses that future studies will have

to answer, in search of greater clarity regarding the nature of comprehension mechanisms within this linguistic disorder.

In this sense, the proposal that this thesis raises regarding the future studies calls for the possibility to assess the comprehension by children with SLI in circumstances that integrate elements of these two lines of research. In other words, by means of an online methodology that can ideally capture the cognitive processes of linguistic comprehension in SLI, and without the limitations inherent in the complexity of human communicative interaction, it would be necessary to assess more complex sentence structures that come closer, more objectively, to the intricate linguistic reality that surrounds the children with SLI in their natural communication context. Thus, through psycho-physiological techniques, future studies will have to find out to what extent the processing of language is dynamic and variant, and to what extent it depends on the circumstances and the characteristics surrounding it.

From previous researches it is known that the children with SLI have considerable difficulties when the linguistic complexity increases (Evans, Saffran & Robe-Torres, 2009; Montgomery, 2004; Montgomery & Evans, 2009). Furthermore, the existence of social stress, emotional problems and greater presence of anxiety and depression symptomatology in children and adolescents with SLI is also known (Andreu & Sanz-Torrent, 2013; St Clair, Pickles, Durkin & Conti-Ramsden, 2011; Wadman, Botting, Durkin & Conti-Ramsden, 2011; Wadman, Durkin & Conti-Ramsden, 2011). It would not be wrong, therefore, to think that children with SLI experience linguistic difficulties with an important discomfort, and their problems with language probably increase their emotional discomfort, and vice versa.

This issue allows considering the importance of emotional implication in the process of comprehension and production of language, since it is an observable reality that the children with SLI experience their linguistic difficulties with significant psychological distress. Possibly, this emotional spiral is directly related to the mentioned difficulties, in a way that both dimensions grow in the same direction and nourish one another.

Therefore, perhaps, the problems that characterise the language of children with SLI, both in terms of production and comprehension, are less due to isolated linguistic elements (such as verbal morphology and function words) and more due to a difficulty in the overall processing of language, the complexity of which leads to a collapse. A collapse, according to our perspective, in terms of *a quantitative accumulation* (accumulation of difficulty), *which is manifested as a qualitative impact* (a lower comprehension). The window that the psycholinguistic perspective opens to the reality of children with SLI raises the possibility of a study which should be not only linguistic but also psychological, that is, both in terms of thought and emotion.

To conclude this work, with great respect and humility, here is the final idea of Lev Vygotsky's work (1986), whose importance indelibly marks this thesis:

> We cannot close our study without mentioning the perspectives that our investigation opens up. This is even more momentous a problem than that of thinking; what I mean is the problem of consciousness. [...]. We attempted to study experimentally the dialectics of transition from perception to thinking, and to show that a generalized reflection of reality is the basic characteristic of words. This aspect of the word brings us to threshold of a wider and deeper subject, i.e., the problem of the relation between word and consciousness. [...]. *Though and speech turn out to be the key to the nature of human consciousness.* (pag. 256).

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APPENDIX

Appendix 1.

The 30 sentences of the LIST A[1] used in the first study are:

1.La niña pondrá la sopa en el plato

(TARGET: plato vacío; COMPETIDOR: plato lleno; DISTRACTORS: casa, coche)

[The girl will put the soup in the plate

(TARGET: empty plate; COMPETITOR: full plate; DISTRACTORS: house, car)].

2. El niño comió el pastel de cumpleaños

(T: pastel comido; C: pastel entero; D: pila, libro)

[The boy ate the birthday cake

(T: eaten cake; C: entire cake, D: battery, book)].

3. El avión aterrizará en el aeropuerto

(T: avión en el aire, C: avión en el aeropuerto; D: edificio, radio)

[The plane will land at the airport

(T: flying plane, C: landed plane; D: building, radio)].

4. Mi abuela encendió la chimenea

(T: chimenea con fuego; C: chimenea sin fuego; D: pelota, zapato)

[My grandmother lit the fireplace

(T: lighted fireplace; C: fireplace without fire; D: ball, shoe)].

5. La niña subirá al árbol

(T: niña delante del árbol; C: niña encima del árbol; D: plátano, botella)

[The girl will climb the tree

(T: girl in front of the tree; C: girl on the tree; D: banana, bottle)].

[1] The sentences used in LIST B had exactly the opposite Targets and Competitors, for example: *"La niña puso la sopa en el plato"; "The girl put the soup in the plate".*

6. El hombre cortó la leña

(T: leña cortada; C: leña no cortada; D: teléfono, tacones)

[The man cut the wood

(T: cut wood; C: uncut wood; D: telephone, heels)].

7. El niño saltará a la piscina

(T: niño fuera de la piscina; C: el niño dentro de la piscina; D: mesa, hilo)

[The boy will jump in the swimming pool

(T: boy outside the pool; C: boy inside the pool; D: thread)].

8. El niño cogió la pelota

(T: niño con la pelota; C: niño sin la pelota; D: sofá, árbol)

[The boy caught the ball

(T: boy with the ball; C: boy without the ball; D: sofa, tree)].

9. El pájaro atrapará al gusano

(T: gusano en el suelo suelo; C: gusano en la boca del pájaro; D: maceta, llave)

[The bird will catch the worm

(T: worm on ground; C: worm in the mouth of the bird; D: flowerpot, key)].

10. El niño metió un mensaje dentro de una botella

(T: botella con mensaje; C: botella vacía; D: camiseta, sillón)

[The boy put a message inside the bottle

(T: bottle with the message; C: empty bottle; D: t-shirt, armchair)].

11. La niña decorará el árbol de navidad

(T: árbol sin decoración; C: árbol con decoración; D: vaso, manzana)

[The girl will decorate the Christmas tree

(T: undecorated tree; C: decorated tree; D: glass, apple)].

12. La maestra mordió una manzana en el descanso

(T: manzana mordida; C: manzana entera; D: flor, cama)

[The teacher bit an apple during the break

(T: bitten apple; C: entire apple; D: flower, bed)].

13. Mi abuela encenderá una vela

(T: vela apagada; C:vela encendida; D: bicicleta, plato)

[My grandmother will light a candle

(T: candle off; C: lighted candle; D: bicycle, plate)].

14. Mi abuelo bebió un vaso de agua

(T: vaso vacío; C: vaso con agua; D: cinturón, silla)

[My grandfather drank a glass of water

(T: empty glass; C: glass with water; D: belt, chair)].

15. El niño recogerá sus juguetes

(T: juguetes en el suelo; C: juguetes en la caja; D: pantalla, limón)

[The boy will pick up his toys

(T: toys on the floor; C: toys in the box; D: screen, lemon)].

16. La niña abrió su regalo

(T: regalo abierto; C: regalo cerrado; D: botón, hoja)

[The girl opened her present

(T: opened present; C: wrapped present; D: button, leaf)].

17. El chico atará sus zapatos

(T: zapatos desatados; C: zapatos atados; D: ordenador, nevera)

[The boy will tie his shoes

(T: shoes untied; C: tied shoes; D: computer, fridge)].

18. El niño rompió la ventana

(T: ventana rota; C: ventana intacta; D: calcetín, queso)

[The boy broke the window

(T: broken window; C: window unbroken; D: sock, cheese)].

19. El señor abrirá la puerta

(T: puerta cerrada; C: puerta abierta; D: guitarra, pastel)

[The gentleman will open the door

(T: closed door; C: opened door; D: guitar, cake)].

20. El niño subió las escaleras

(T: niño al final de las escaleras; C: niño al inicio de las escaleras; D: botella, lápiz)

[The boy went up the stairs

(T: boy at the top of the stairs; C: boy at the bottom of the stairs; D: bottle, pencil)].

21. Joan escribirá una carta

(T: hoja en blanco; C: carta escrita; D: peluche, mandarina)

[Joan will write a letter

(T: blank paper; C: written paper; D: teddy, mandarin)].

22. La niña comió un helado

(T: vaso sin helado; C: vaso con helado; D: lámpara, estrella)

[The girl ate the ice cream

(T: glass without ice cream; C: glass with ice cream; D: lamp, star)].

23. El señor pintará la pared

(T: pared blanca; C: pared pintada; D: moneda, bocadillo)

[The gentleman will paint the wall

(T: white wall; C: painted wall; D: coin, sandwich)].

24. El hombre baño al perro

(T: perro bañado; C: perro manchado; D: helicóptero, uvas)

[The man bathed the dog

(T: bathed dog; C: filthy dog; D: helicopter, grapes)].

25. El niño manchará su ropa

(T: niño con camiseta limpia; C: niño con camiseta manchada; D: patata, maleta)

[The boy will stain his clothes

(T: boy with clean T-shirt; C: boy with stained T-shirt; D: potato, suitcase)].

26. El hombre construyó el muro

(T: muro construido; C: muro en construcción; D: moneda, bocadillo)

[The man constructed the wall

(T: constructed wall; C: wall under construction; D: coin, sandwich)].

27. La niña dibujará en una hoja

(T: hoja blanca; C: hoja con dibujos; D: melón, palmeras)

[The girl will draw on a paper

(T: white paper; C: paper with drawings; D: melon, palm trees)].

28. El cartero entregó un paquete

(T: cartero sin el paquete; C: cartero con el paquete; D: bolígrafo, fresa)

[The postman delivered the package

(T: postman without package; C: postman with the package; D: *pen, strawberry)]*.

29. El chico tirará la pelota

(T: chico con la pelota; C: chico sin la pelota; D: tijeras, cochecito de bebé)

[The boy will throw the ball

(T: boy with the ball; C: boy without the ball; D: scissors, baby carriage)].

30. La planta creció en la maceta

(T: planta grande; C: planta en crecimiento; D: barril, cuchara)

[The plant grew in the pot

(T: big plant; C: growing plant; D: barrel, spoon)].

Appendix 2.

The 32 sentences of the LIST A[1] used in the Study 2 are:

1.Recoge las olivas el chico

(TARGET: chico; COMPETIDOR: chicos; DISTRACTORS: sierra, altavoces)

[Collects the olives the boy

(TARGET: boy; COMPETITOR: boys; DISTRACTORS: wood saw, speakers)]

2. Abre la puerta la niña

(T: niña; C: niñas; D: avión, peras)

[Opens the door the girl

(T: girl; C: girls; D: plane, pears)].

3. Pintan un dibujo los niños

(T: niños, C: niño; D: raquetas, bus)

[Draw a picture the children

(T: children, C: child; D: rackets, dinosaur)].

4. Venden castañas las abuelas

(T: abuelas; C: abuela; D: templos, tractor)

[Sell nuts the grandmothers

(T: grandmothers; C: grandmother; D: temples, tractor)].

5. Bebe agua el caballo

(T: caballo; C: caballos; D: cojines, cepillo)

[Drinks water the horse

(T:horse; C: horses; D: pillows, toothbrush)].

[1] The sentences used in LIST B had exactly the opposite Targets and Competitors, for example: *"Recogen las olivas los chicos"; "Collect the olives the boys".*

6. Tira papeles la niña

(T: niña; C: niñas; D: pan, flores)

[Throws papers the girl

(T: girl; C: girls; D: bred, flowers)].

7. Plantan tomates los abuelos

(T: abuelos; C: abuelo; D: mochila, corbatas)

[Plant tomatoes the grandparents

(T: grandparents; C: grandparent; D: backpack, ties)].

8. Ponen la mesa las niñas

(T: niñas; C: niña; D: palmera, cometas)

[Put on the table the girls

(T: girls; C: girl; D: palm tree, kites)].

9. Arregla la bicicleta el hombre

(T: hombre; C: hombres; D: manzana, nubes)

[Fixes the bicycle the man

(T: man; C: men; D: apple, clouds)].

10. Lee las letras la abuela

(T: abuela; C: abuelas; D: acordeón, macetas)

[Reads the letters the grandmother

(T: grandmother; C: grandmothers; D: accordion, flowerpots)].

11. Escuchan la radio los abuelos

(T: abuelos; C: abuelo; D: granja, acelgas)

[Listen to the radio the grandfathers

(T: grandfathers; C: grandfather; D: farm, celgas)].

12. Envían cartas las abuelas

(T: abuelas; C: abuela; D: plancha, coches)

[Send letters the grandmothers

(T: grandmothers; C: grandmother; D: iron, cars)].

13. Mira a las hormigas el chico

(T: chico; C: chicos; D: jarra, sombreros)

[Looks at the ants the boy

(T: boy; C: boys; D: jug, hats)].

14. Construye un castillo la niña

(T: niña; C: niñas; D: teléfono, tacones)

[Builds a castle the girl

(T: girl; C: girls; D: phone, heels)].

15. Buscan huesos los perros

(T: perros; C: perro; D: manija, alcachofas)

[Search the bones the dogs

(T: dogs; C: dog; D: handle, artichokes)].

16. Venden la televisión las chicas

(T: chicas; C: chica; D: casita de perro, champiñones)

[Sell the television the girls

(T:girls; C: girl; D: dog house, mushrooms)].

17. Corta un melón el chico

(T: chico; C: chicos; D: estrella, edificios)

[Cuts a melon the boy

(T: boy; C: boys; D: star, buildings)].

18. Canta canciones la chica

(T: chica; C: chicas; D: barco, montañas)

[Sings the songs the girl

(T:girl; C: girls; D: boat, mountains)].

19. Saludan a sus amigos los abuelos

(T: abuelos; C: abuelo; D: sobre, gafas)

[Greet their friends the grandfathers

(T:grandfathers; C: grandfather; D: envelope, glasses)].

20. Tiran la basura las mujeres

(T: mujeres; C: mujer; D: molino, neumáticos)

[Throw the garbage the women

(T: women; C: woman; D: mill, tires)].

21.Persigue a las cucarachas el gato

(T: gato; C: gatos; D: vestido, pinceles)

[Persues the cockroaches the cat

(T:cat; C: cats; D: dress, brushes)].

22. Dibuja un árbol la niña

(T: niña; C: niñas; D: lechuga, semáforos)

[Draws a tree the girl

(T:girl; C:girls; D: lettuce, traffic lights)].

23. Sacan el bocadillo los niños

(T: niños; C: niño; D: piña, patines)

[Take out the sandwich the children

(T:children; C: child; D: pineapple, skates)].

24. Escriben los números las niñas

(T: niñas; C: niña; D: enchufe, botellas)

[Write the number the girls

(T:girls; C:girl; D: plug, bottles)].

25. Recorta el papel el niño

(T: niño; C: niños; D: roca, árboles)

[Cuts the paper the child

(T:child; C: children; D: rock, trees)].

26. Tira la pelota la niña

(T: niña; C: niñas; D: fábrica, grifos)

[Throws the ball the girl

(T:girl; C: girls; D: factory, taps)].

27. Ordenan los juguetes los niños

(T: niños; C: niño; D: llave, plantas)

[Put in order the toys the children

(T:children; C: child; D: key, plants)].

28. Abrazan los peluches las niñas

(T: niñas; C: niña; D: ancla, lápices)

[Hug the teddys the girls

(T:girls; C: girl; D: anchor, pencils)].

29. Barre los papeles el chico

(T: chico; C: chicos; D: faro, vasos)

[Sweeps the papers the boy

(T:boy; C: boys; D: lighthouse, glasses)].

30. Come lechuga la tortuga

(T: tortuga; C: tortugas; D: bastón, cerillas)

[Eats the lettuce the turtle

(T:turtle; C: turtles; D: cane, matches)].

31. Compran un póster los niños

(T: niños; C: niño; D: zapato, cohines)

[Buy a poster the children

(T:children; C: child; D: shoe, pillows)].

32. Regalan unos caramelos las niñas

(T: niñas; C: niña; D: trofeo, globos)

[Give out candies the girls

(T:girls; C: girl; D: trophy, balloons)].

Appendix 3.

The 32 sentences of the LIST A[1] used in the Study 3 are:

1.Toca el chico

(TARGET: chico; COMPETIDOR: chicos; DISTRACTORS: fuego, nubes)

[Touches the boy

(TARGET: boy; COMPETITOR: boys; DISTRACTORS: fire, clouds)].

2. Escribe la abuela

(T: abuela; C: abuelas; D: silla, coches)

[Writes the grandmother

(T: grandmother; C: grandmothers; D: chair, cars)].

3. Trabajan los chicos

(T: chicos, C: chico; D: cuadro, agujas)

[Work the boys

(T: boys, C: boy; D: painting, needles)].

4. Flotan las chicas

(T: chicas; C: chica; D: botella, bolígrafos)

[Float the girls

(T: girls; C: girl; D: bottle, pens)].

5. Corre el chico

(T: chico; C: chicos; D: cuchara, baúles)

[Runs the boy

(T: boy; C: boys; D: spoon, trunks)].

[1] The sentences used in LIST B had exactly the opposite Targets and Competitors, for example: *"Tocan los chicos"; "Touch the boys".*

6. Duerme la niña

(T: niña; C: niñas; D: chocolate, burbujas)

[Sleeps the girl

(T: girl; C: girls; D: chocolate, bubbles)].

7. Comen los ratones

(T: ratones; C: ratón; D: muro, televisiones)

[Eat the mouses

(T: mouses; C: mouse; D: wall, televisions)].

8. Cantan las niñas

(T: niñas; C: niña; D: mantequilla, vasos)

[Sing the girls

(T: girls; C: girl; D: butter, glasses)].

9. Dibuja el niño

(T: niño; C: niños; D: camión, montañas)

[Draws the boy

(T: boy; C: boys; D: truck, mountains)].

10. Conduce la mujer

(T: mujer; C: mujeres; D: planta, contenedores)

[Drives the woman

(T: woman; C: women; D: plant, containers)].

11. Vuelan los pájaros

(T: pájaros; C: pájaro; D: magdalena, espejos)

[Fly the birds

(T: birds; C: bird; D: cake, mirrors)].

12. Ladran los perros

(T: perros; C: perro; D: pozo, cortinas)

[Bark the dogs

(T: dogs; C: dog; D: well, curtains)].

13. Llora el bebé

(T: bebe; C: bebes; D: pizza, móviles)

[Cries the baby

(T: baby; C: babies; D: pizza, mobiles)].

14. Habla la chica

(T: chica; C: chicas; D: fresa, sombreros)

[Talks the girl

(T: girl; C: girls; D: strawberry, hats)].

15. Leen los hombres

(T: hombres; C: hombre; D: botella, macarrones)

[Read the men

(T: men; C: man; D: bottle, pasta)].

16. Abrazan las niñas

(T: niñas; C: niña; D: bañera, pepinos)

[Hug the girls

(T: girls; C: girl; D: bath, cucumbers)].

17. Da el abuelo

(T: abuelo; C: abuelos; D: tenedor, monedas)

[Gives the grandfather

(T: grandfather; C: grandfathers; D: fork, coins)].

18. Pone la niña

(T: niña; C: niñas; D: bus, lámparas)

[Puts the girl

(T: girl; C: girls; D: bus, lamps)].

19. Gritan los abuelos

(T: abuelos; C: abuelo; D: monedero, espadas)

[Shout the grandfathers

(T: grandfathers; C: grandfather; D: purse, swords)].

20. Crecen las niñas

(T: niñas; C: niña; D: brújula, huesos)

[Grow up the girls

(T: girls; C: girl; D: compass, bones)].

21.Cae el niño

(T: niño; C: niños; D: alfombra, silbatos)

[Falls the boy

(T: boy; C: boys; D: carpet, whistles)].

22. Pasa la mujer

(T: mujer; C: mujeres; D: libro, zanahorias)

[Passes the woman

(T: woman; C women; D: book, carrots)].

23. Lanzan los chicos

(T: chicos; C: chico; D: regadera, martillos)

[Throw the boys

(T: boys; C: boy; D: watering can, hammers)].

24. Construyen las niñas

(T: niñas; C: niña; D: piña, periodicos)

[Build the girls

(T: girls; C: girl; D: pineapple, newspapers)].

25. Regala el chico

(T: chico; C: chicos; D: relámbago, flores)

[Gives the boy

(T: boy; C: boys; D: flash of lightning, flowers)].

26. Enseña la chica

(T: chica; C: chicas; D: dulce, copas)

[Teaches the girl

(T: girl; C: girls; D: sweet, glasses)].

27. Caminan los hombres

(T: hombres; C: hombre; D: patata, helicópteros)

[Walk the men

(T: men; C: man; D: potato, helicopters)].

28. Nadan las chicas

(T: niñas; C: niña; D: cometa, motos)

[Swim the girls

(T: girls; C: girl; D: kite, motorbikes)].

29. Sale el abuelo

(T: abuelo; C: abuelos; D: templo, árboles)

[Leaves the grandfather

(T: grandfather; C: grandfathers; D: temple, trees)].

30. Entra la mujer

(T: mujer; C: mujeres; D: sol, perchas)

[Enters the woman

(T: woman; C: women; D: sun, hangers)].

31. Beben los osos

(T: osos; C: oso; D: avión, botas)

[Drink the bears

(T: bears; C: bear; D: plane, boots)].

32. Abren las chicas

(T: chicas; C: chica; D: escalera, auriculares)

[Open the girls

(T:girls; C: girl; D: stair, headphones)].

Appendix 4.

The 32 sentences of the LIST A[1] used in the Study 4 are:

1.El padre da un regalo

(TARGET: regalo; COMPETIDOR: flor; DISTRACTORS: árboles, neveras)

[The father gives a present

(TARGET: present; COMPETITOR: flower; DISTRACTORS: trees, fridges)].

2. El padre da unos regalos

(T: regalos; C: flores; D: barril, montaña)

[The father gives some presents

(T: presents; C: flowers; D: barrel, mountain)].

3. El padre da una flor

(T: flor, C: regalo; D: árboles, neveras)

[The father gives a flower

(T: flower, C: present; D: trees, fridges)].

4. El padre da unas flores

(T: flores; C: regalos; D: barril, montaña)

[The father gives some flowers

(T: flowers; C: presents; D: barrel, mountain)].

5. La chica muerde la manzana

(T: manzana; C: plátano; D: patines, sartenes)

[The girl bites the apple

(T: apple; C: banana; D: roller skates, skillets)].

[1] The sentences used in LIST B were completely different, for example: *"La niña pinta un sol"; "The girl draws a sun"/"La niña pinta una luna";"The girl draws a moon", etc.*

6. La chica muerde las manzanas

(T: manzanas; C: plátanos; D: acordeón, lámpara)

[The girl bites the apples

(T: girl; C: girls; D: accordion, lamp)].

7. La chica muerde el plátano

(T: plátano; C: manzana; D: patines, sartenes)

[The girl bites the banana

(T: banana; C: apple; D: roller skates, skillets)].

8. La chica muerde los plátanos

(T: plátanos; C: manzanas; D: acordeón, lámpara)

[The girl bites the bananas

(T: bananas; C: apples; D: accordion, lamp)].

9. La niña tira una piedra

(T: piedra; C: piedras; D: molino, estufas)

[The girl throws a rock

(T: rock; C: rocks; D: windmill, stoves)].

10. La niña tira unas piedras

(T: piedras; C: piedra; D: molino, estufas)

[The girl throws some rocks

(T: rocks; C: rock; D: windmill, stoves)].

11. La niña tira un bolígrafo

(T: bolígrafo; C: bolígrafos; D: chimenea, ventana)

[The girl throws a pen

(T: pen; C: pens; D: chimney, window)].

12. La niña tira unos bolígrafos

(T: bolígrafos; C: bolígrafo; D: chimenea, ventana)

[The girl throws some pens

(T: pens; C: pen; D: chimney, window)].

13. La madre llena el vaso

(T: vaso; C: vasos; D: bicicleta, puertas)

[The mother fills the glass

(T: glass; C: glasses; D: bicycle, doors)].

14. La madre llena los vasos

(T: vasos; C: vaso; D: bicicleta, puertas)

[The mother fills the glasses

(T: glasses; C: glass; D: bicycle, doors)].

15. La madre llena la jarra

(T: jarra; C: jarras; D: fuego, relámpagos)

[The mother fills the jar

(T: jar; C: jars; D: fire, lightings)].

16. La madre llena las jarras

(T: jarras; C: jarra; D: fuego, relámpagos)

[The mother fills the jars

(T: jars; C: jar; D: fire, lighting)].

17. El abuelo compra una naranja

(T: naranja; C: huevo; D: guantes, botellas)

[The grandfather buys an orange

(T: orange; C: egg; D: gloves, bottles)].

18. El abuelo compra unas naranjas

(T: naranjas; C: huevos; D: guantes, botellas)

[The grandfather buys some oranges

(T: oranges; C: eggs; D: gloves, bottles)].

19. El abuelo compra un huevo

(T: huevo; C: naranja; D: olla, cepillo)

[The grandfather buys an egg

(T: egg; C: orange; D: pot, brush)].

20. El abuelo compra unos huevos

(T: huevos; C: naranjas; D: olla, cepillo)

[The grandfather buys some eggs

(T: eggs; C: oranges; D: pot, brush)].

21.La abuela toca el árbol

(T: árbol; C: flor; D: calcetines, botellas)

[The grandmother touches the tree

(T: tree; C: flower; D: socks, bottles)].

22.La abuela toca los árboles

(T: árboles; C: flores; D: banco, pantalla)

[The grandmother touches the trees

(T: trees; C: flowers; D: bench, screen)].

23.La abuela toca la flor

(T: flor; C: árbol; D: calcetines, botellas)

[The grandmother touches the flower

(T: flower; C: tree; D: socks, bottles)].

22.La abuela toca las flores

(T: flores; C: árboles; D: banco, pantalla)

[The grandmother touches the flowers

(T: flowers; C: trees; D: bench, screen)].

25. El chico mira el portátil

(T: portátil; C: portátiles; D: casa, nubes)

[The boy looks at the portable

(T: portable; C: portables; D: house, clouds)].

26. El chico mira los portátiles

(T: portátiles; C: portátil; D: casa, nubes)

[The boy looks at the portables

(T: portables; C: portable; D: house, clouds)].

27. El chico mira la pizarra

(T: pizarra; C: pizzaras; D: árbol, extintores)

[The boy looks at the blackboard

(T: blackboard; C: blackboards; D: tree, fire extinguishers)].

27. El chico mira las pizarras

(T: pizarras; C: pizzara; D: árbol, extintores)

[The boy looks at the blackboards

(T: blackboards; C: blackboard; D: tree, fire extinguishers)].

29. El chico rompe una ventana

(T: ventana; C: ventanas; D: teléfono, huevos)

[The boy brokes a window

(T: window; C: windows; D: telephone, eggs)].

30. El chico rompe unas ventanas

(T: ventanas; C: ventana; D: teléfono, huevos)

[The boy brokes some windows

(T: windows; C: window; D: telephone, eggs)].

31. El chico rompe un jarrón

(T: jarrón; C: jarrones; D: televisión, lámparas)

[The boy brokes a vase

(T: vase; C: vases; D: television, lamps)].

32. El chico rompe unos jarrones

(T: jarrones; C: jarrón; D: televisión, lámparas)

[The boy brokes some vases

(T: vases; C: vase; D: television, lamps)].

Appendix 5.

The 10 sentences of the LIST A[1] used in the Study 5.1/ Prepositions are:

1.El coche está ante la casa

(TARGET: coche ante la casa; COMPETIDOR: coche detrás de la casa; DISTRACTORS: banco, farolito)

[The car is in front of the house

(TARGET: car in front of the house; COMPETITOR: car behind the house; DISTRACTORS: bench, small lantern)]

2. El chico grita tras el árbol

(T: chico tras el árbol; C: chico ante el árbol; D: nube, globo)

[The boy shouts behind the tree

(T: boy behind the tree; C: boy in front of the tree, D: cloud, balloon)]

3. El gato está bajo la mesa

(T: gato bajo la mesa, C: gato encima de la mesa; D: reloj, papelera)

[The cat is under the table

(T: cat under the table, C: cat on the table; D: clock, basket)]

4.El libro está sobre la cama

(T: libro sobre la cama; C: libro bajo la cama; D: espejo, radio)

[The book is on the bed

(T: book on the bed; C: book under the bed; D: mirror, radio)]

5. El perro está con la oveja

(T: oveja al lado del perro; C: oveja en frente del perro; D: montaña, árbol)

[The dog is with the sheep

(T: the sheep on the side of the dog; C: the sheep opposite the dog; D: mountain, tree)]

[1] The sentences used in Study 5.1/Preposition LIST B had exactly the opposite Targets and Competitors, for example: *"El coche está detrás de la casa"; "The car is behind the house".*

6. La señora va sin sombrero

(T: señora sin sombrero; C: señora con sombrero; D: ventana, sofá)

[The lady goes without a hat

(T: lady without a hat; C: lady with a hat; D: window, sofa)]

7. El chico está en el autobús

(T: chico en el autobús; C: chico fuera del autobús; D: planta, cochecito de bebé)

[The boy is on the bus

(T: boy in the bus; C: boy outside the bus; D: plant, baby carriage)]

8. El niño canta junto a la escuela

(T: niño junto a la escuela; C: niño dentro de la escuela; D: semáforo, contenedor)

[The boy sings next to the school

(T: boy next to the school; C: boy inside the school; D: traffic lights, container)]

9. Los árboles están alrededor de los columpios

(T: árboles alrededor de los columpios; C: árboles entre los columpios; D: quiosco, bicicleta)

[The trees are around the swings

(T: trees around the swings; C: trees between the swings; D: kiosk, bicycle)]

10. La niña va por el parque

(T: niña por el parque; C: niña para el parque; D: edificio, roca)

[The girl goes through the park

(T: girl in the park; C: girl towards the park; D: building, rock)]

The 10 sentences of the LIST A[1] used in the Study 5.2/Prepositional locutions are:

11. El gato está debajo de la ventana

(T: gato debajo de la ventana; C: gato encima de la ventana; D: árbol, taburete)

[The cat is under the window

(T: cat under the window; C: cat on top of the window; D: tree, stool)]

12. El regalo está encima de la mesa

(T: regalo encima de la mesa; C: regalo debajo de la mesa; D: ventana, libro)

[The present is on the table

(T: present on the table; C: present under the table; D: window, book)]

13. La niña corre delante de la granja

(T: niña delante de la granja; C: niña detrás de la granja; D: montaña, barril)

[The girl runs in front of the farm

(T: girl in front of the farm; C: girl behind of the farm; D: mountain, barrel)]

14. La pelota está detrás del árbol

(T: pelota detrás del árbol; C: pelota delante del árbol; D: nube, bicicleta)

[The ball is behind the tree

(T: ball behind the tree; C: ball in front of the tree; D: cloud, bicycle)]

15. La bicicleta está en frente de la casa

(T: bicicleta en frente de la casa; C: bicicleta detrás de la casa; D: árbol, papelera)

[The bicycle is in front of the house

(T: bicycle in front of the house; C: bicycle behind the house; D: tree, bin)]

[1] The sentences used in Study 5.2/Prepositional locutions LIST B had exactly the opposite Targets and Competitors, for example: *"El gato está encima de la ventana"; "The cat is on the top of the window".*

16. El autobús para al lado de la tienda

(T: autobús al lado de la tienda; C: autobús en frente de la tienda; D: farolito, contenedor)

[The bus stops next to the store

(T: bus next to the store; C: bus in front of the store; D: small lantern, container)]

17. El ratón está dentro de la taza

(T: ratón dentro de la taza; C: ratón fuera de la taza; D: maceta, caramelo)

[The mouse is inside the cup

(T: mouse inside the cup; C: mouse out of the cup; D: pot, candy)]

18. El peluche está fuera de la caja

(T: peluche fuera de la caja; C: peluche dentro de la caja; D: estufa, teléfono)

[Teddy is out of the box

(T: teddy out of the box; C: teddy inside the box; D: stove, telephone)]

19. El avión está cerca de la nube

(T: avión cerca de la nube; C: avión lejos de la nube; D: edificio, moto)

[The plane is near the cloud

(T: plane near the cloud; C: plane away from the cloud; D: building, motorcycle)]

20. La niña está lejos de la nevera

(T: niña lejos de la nevera; C: niña cerca de la nevera; D: jarra, alacena)

[The girl is far from the fridge

(T: girl far from the fridge; C: girl near the fridge; D: jar, cupboard)].

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