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Lexical Availability and Semantic Networks in L1 and L2: A Systematic Review Based on the PRISMA Method

La disponibilidad léxica y las redes semánticas en L1 y L2: una revisión sistemática basada en el método PRISMA

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Abstract

This systematic review synthesises the evolving landscape of research on lexical availability and semantic network studies across various languages, focusing both on L1 and L2 contexts. Originating from the need to optimize language acquisition efficiency, this fields has evolved to explore the complex cognitive processes underlying lexical selection and organisation. Following PRISMA guidelines to ensure methodical rigour, this review critically assesses the contributions of 26 studies conducted globally, employing diverse methodologies and focusing on a wide array of populations and linguistic contexts. Key findings highlight the dynamic nature of lexical networks, which are significantly influenced by factors such as language, age, proficiency, educational stages, and sociocultural milieu. Innovations in computational tools like DispoGrafo, LexMath, and LexPro have propelled forward our understanding of semantic networks, offering sophisticated analyses of how lexical items interconnect within the mental lexicon. Despite these advances, the review identifies methodological limitations, including the need for greater consistency in sample sizes across comparative studies and for careful consideration of the stimulus variability in lexical activation. The move towards online lexical availability tests, while a milestone, warrants cautious implementation to ensure methodological integrity. The review advocates for broader and more in-depth analyses of semantic networks and urges researchers to expand inquiry beyond the predominantly examined languages to enhance our understanding of lexical processing across different linguistic and cultural landscapes. This comprehensive examination highlights the significance of lexical availability research in cognitive linguistics and language education, and outlines pathways for future inquiry,

emphasising the potential for technological innovations to unravel the complexities of the human lexicon.

Keywords: lexical availability, semantic networks, graph theory, L1, L2

Resumen

Esta revisión sistemática sintetiza el panorama evolutivo de los estudios sobre disponibilidad léxica y redes semánticas en diversos idiomas, con un enfoque en contextos de lengua materna (L1) y segunda lengua (L2). Surgida de la necesidad de optimizar la adquisición lingüística, esta área de investigación ha evolucionado para explorar los complejos procesos cognitivos que subyacen a la selección y organización léxica. Siguiendo las directrices PRISMA para garantizar el rigor metodológico, esta revisión evalúa críticamente las contribuciones de 26 estudios realizados a nivel mundial, empleando metodologías diversas y centrándose en una amplia variedad de poblaciones y contextos lingüísticos. Los hallazgos clave destacan la naturaleza dinámica de las redes léxicas, influenciada significativamente por factores como el idioma, la edad, el nivel de competencia, las etapas educativas y el entorno sociocultural. Las innovaciones en herramientas computacionales como DispoGrafo, LexMath y LexPro han impulsado nuestra comprensión de las redes semánticas, proporcionando análisis sofisticados sobre cómo los elementos léxicos se interconectan en el lexicón mental. A pesar de estos avances, la revisión identifica limitaciones metodológicas, entre ellas la necesidad de una mayor consistencia en el número de participantes en los estudios comparativos y la consideración del impacto de la variabilidad de los estímulos en la activación léxica. Aunque el desarrollo de pruebas en línea de disponibilidad léxica representa un hito significativo, su implementación requiere precaución para preservar la integridad metodológica. La revisión aboga por análisis más amplios y profundos de las redes semánticas, e insta a ampliar la investigación más allá de los idiomas predominantemente estudiados, con el fin de comprender mejor el procesamiento léxico en diferentes contextos lingüísticos y culturales. Este examen exhaustivo subraya la importancia de los estudios sobre disponibilidad léxica en la lingüística cognitiva y la educación lingüística, y traza caminos para futuras investigaciones, destacando el potencial de las innovaciones tecnológicas para desvelar las complejidades del lexicón humano.

Palabras clave: disponibilidad léxica, redes semánticas, teoría de grafos, L1, L2

INTRODUCTION

The history of lexical availability dates back to 1951, when the French Ministry of National Education commissioned a group of researchers to create a list of basic vocabulary in order to ensure the rapid and effective acquisition of the language by the inhabitants of previous French colonies. Gougenheim et al. (1964) expanded upon this by incorporating available lexicon, words that come to mind immediately and naturally when needed (Michéa, 1953), into the fundamental vocabulary of a language. This foundational work inspired López Morales (1973) to initiate the Panhispanic Project of Lexical Availability, catalysing a robust sociolinguistic movement primarily in Spain and Latin America.

It was in this context of Spanish that the relationship of lexical availability with cognitive sciences was established. Aware of the fact that this word association test

activates and gives crucial information on the internal organisation and relationship of the words activated (Bahar & Hansell, 2000), in 1991, Cañizal Arévalo (1991) analysed the semantic networks of body parts and indicated that words are organised in clusters forming networks or constellations with a similar availability index. In 1993, López Chávez and Meza Canales attempted to understand how the mental lexicon was organised at different ages. Furthermore, Echeverría (1991) became interested in the relationship between words and created the cohesion index, which indicates if a topic is closed or diffuse. He also contributed to the creation of *DispoGrafo* (Echeverría et al., 2008), an essential tool for analysing word connection and cognitive processes in lexical availability. Urrutia (2001) also discussed the complexity of lexical availability retrieval and related theories of semantic networks models. Other authors with the same approach are Galloso (2002), who developed a taxonomy of associative relations observed in a lexical availability corpus, and Gómez-Devís (2003) who also referred to the network theory and the fact that words are related to each other through nodes.

Significant contributions by Hernández Muñoz (2005) and Ferreira (2006) shed important light on the significant role of psycholinguistics, neurolinguistics, the philosophy of language or artificial intelligence in understanding the complex cognitive task of retrieving available vocabulary in both Spanish and English (Hernández Muñoz, 2005; Ferreira, 2006). Therefore, by looking at seminal works on the concept of mental lexicon, such as Aitchison (1994), Altmann (1995, 1999) or Levelt (1999), it became obvious that this task offered important information about the way speakers of a language codify the surrounding world, they store it and then are able to reconstruct it when given a verbal stimulus (Hernández Muñoz, 2005). In a quest to find an answer to the question regarding the way information flows from the semantic memory to the mental lexicon and then to our mouth or hand (Hernández Muñoz, 2005), researchers in the field have reported significant findings regarding the difference between this process in L1 and L2.

As explained by Hernández Muñoz and Tomé Cornejo (2017), the available lexicon in L1 is produced once the semantic category is recognised. The identification of the stimulus triggers the activation of several conceptual representations, either because they are interconnected or because they share some features. These conceptual representations activate their corresponding lexical nodes. In a lexical availability task, there can be several possible answers to the topic *Animals*. Words such as 'dog', 'cat', 'pig', 'elephant' and their lexical nodes can be equally activated, and yet research in the field has shown that the availability of a word can be predicted according to its familiarity, typicality and age of acquisition, that is, the more familiar and typical a word is and the earlier it is learned, the more available it is (Hernández Muñoz et al., 2006).

When the production of the available lexicon takes place in L2, the process is different and the L1 plays an essential role even in the case of bilingual participants.

The lexical availability task has cast some more light on this process and put forward that the available lexicon in Spanish as a Foreign Language (SFL) is determined by typicality, age of acquisition, and cognateness (Hernández Muñoz et al., 2014). According to Hernández Muñoz and Tomé Cornejo (2017), these findings are in line with the Revised Hierarchical Model, which indicates that once the L1 word is activated, the stimulus triggers its L2 equivalent. If lexical representations are formally similar, those L2 words obtain a high degree of activation, which makes cognates more available. When the research was carried out in English as a Foreign Language (EFL) (Ferreira et al., 2019), age of acquisition and frequency stood out as significant predictors of lexical availability, as well as that, the regression model run with frequency and familiarity as predictors showed that they both explained lexical availability.

1. Graph theory

Empirical evidence from participants and data gathered from other lexical resources (e.g., corpus, thesauri) have demonstrated that language can be represented as a network (Borge-Holthoefer & Arenas, 2010). A network is a graph that contains nodes and links between the nodes. In language studies, researchers have studied semantic networks, which are graphs in which vertices denote words, whereas links represent association relations. The importance of these networks is that they help understand the dynamics and organisation of cognitive and behavioural phenomena. Semantic networks can be built from many sources, for instance, text corpora, thesauri, or experimental data (Borge-Holthoefer et al., 2011).

A task that is commonly used in neuropsychology is verbal fluency. It consists of producing spoken words based on a specific letter (Phonemic Verbal Fluency) or a category of knowledge (Semantic Verbal Fluency). The latter is the most commonly used task to assess language and semantic memory skills in older adults (Bertola et al., 2014). Semantic verbal fluency can predict future cognitive and functional impairments in the elderly (e.g., Aretouli et al., 2010; Salmon et al., 2002) and predict the progression from mild cognitive impairment to Alzheimer's disease (Saxton et al., 2004).

In a similar vein, linguistic researchers have used a similar task to measure words that children or adults know or are most available in a given category (Ferreira & Echeverría, 2010, 2014). Some researchers have also used the graph theory or semantic networks to analyse results of lexical availability tasks (e.g., Echeverria et al., 2008; Ferreira & Echeverría, 2010; Henríquez Guarín et al., 2016; Morais et al., 2013; Salcedo et al., 2013). The aim has been to understand how words relate to each other and how strongly interconnected they are. They assume that words which end up with close connections are more semantically related than those with weak connections, which provides insights into the accessibility of lexical units and the way they are

organised in the mental lexicon. Researchers have demonstrated that the semantic network organisation in lexical availability varies as a function of factors such as age, proficiency or socio-economic status (Agustin-Llach, 2022; Valenzuela Castellanos et al., 2018).

As can be seen, lexical availability studies have made a significant contribution to the understanding of the complex cognitive process of lexical selection and have provided valuable insights into how words are processed in both L1 and L2. Researchers have shown increasing interest in exploring semantic networks through lexical availability tasks, leading to the development of various tools, such as *DispoGrafo* (Echeverría et al., 2008) or *LexMath* (Salcedo Lagos et. al., 2015; Salcedo Lagos et. al., 2019), designed to process lexical data provided by participants. Another recent and sophisticated software is *LexPro* (Hernández Muñoz et al., 2023), which integrates functions from earlier programmes and reflects the ongoing evolution of network analysis methodological approaches in the field. The present systematic review aims to synthesise findings from studies that investigate lexical availability and semantic networks in L1 and L2.

2. Method

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The methodology adhered to the PRISMA Statement, originally published in 2009, and followed the updates provided in the PRISMA 2020 Statement (Page et al., 2021). The PRISMA 2020 enhances transparency and reporting quality by offering a detailed checklist of 27 items for the review process and an additional 12 items specifically for the structuring of the title and abstract. Furthermore, a flow diagram was utilised to visually represent the study selection process, including the identification, screening, eligibility assessment, and inclusion of studies. This approach ensured a systematic, reproducible, and transparent review process, facilitating the identification of relevant studies, assessment of their quality, and synthesis of their findings.

2.1 Research strategies

To systematically explore the international literature on lexical availability, we conducted a comprehensive search using the Scopus and Web of Science databases. Our focus was on identifying articles and book chapters published in journals that employ a blind peer-review process, ensuring the credibility and rigor of the included studies. The search was performed without imposing restrictions on the country of origin or language of the publications, thereby broadening the scope to include diverse perspectives and methodologies. Similarly, we did not limit the sample characteristics used in the reviewed reports, aiming to capture a wide range of research contexts and findings.

The search strategy was meticulously designed to capture the most relevant literature. We employed Boolean combinations (OR, AND) of keywords to query the title, abstract, and keywords of potential publications. The search terms included "lexical availability," "available lexicon," "network," "graph," "cognit*" in English, and their Spanish equivalents "disponibilidad léxica," "léxico disponible," "red," "graf," and "cogni*". This dual-language approach was essential for inclusivity and comprehensiveness, considering the bilingual nature of the research topic.

The initial search yielded a total of 112 reports. Seven additional reports were identified through citation searching, bringing the total to 119; these seven reports were published in journals indexed in Scopus and Web of Science, but also Scielo and Emerging Source Citation Index. To streamline the review process and ensure accuracy, we utilised the systematic review web-tool Rayyan (Ouzzani et al., 2016). This tool facilitated the removal of duplicates and assisted in the initial screening phase. Both authors of this review independently screened each report identified in the search. Subsequent discussions were held to reach a consensus on the inclusion of each study, ensuring that all decisions were jointly made and reflective of our collective judgment.

This methodical approach, last updated on 20 March 2024, underpins our commitment to conducting a thorough and unbiased review of the literature on lexical availability. The comprehensive search and selection process is expected to provide a solid foundation for understanding the current state of research in this field.

2.2 Eligibility criteria

We included studies that met the following criteria: research focusing on lexical availability in either first language (L1) or second language (L2) that employed graph theory or network analysis methodologies. This inclusion criterion was aimed to ensure that the studies were directly relevant to our research question, specifically addressing the organisational structure and accessibility of lexical items within the mental lexicon using quantitative and qualitative analysis techniques.

2.3 Data collection

In alignment with the Population, Intervention, Comparison, Outcomes, and Study Design (PICOS) framework (Liberati et al., 2009), we extracted pertinent data from each selected study. The extracted information encompassed author(s) and year of publication, the country where the study was conducted, participant characteristics (including age, language proficiency, grade/level of education, and sex), prompts used in the lexical availability (LA) task, the timing of the LA task, methods of data editing, and the software programmes utilised for analysis. These details are succinctly summarised in Table 1, providing a comprehensive overview of the study characteristics and facilitating cross-study comparisons.

3. Results

3.1 Selection of studies

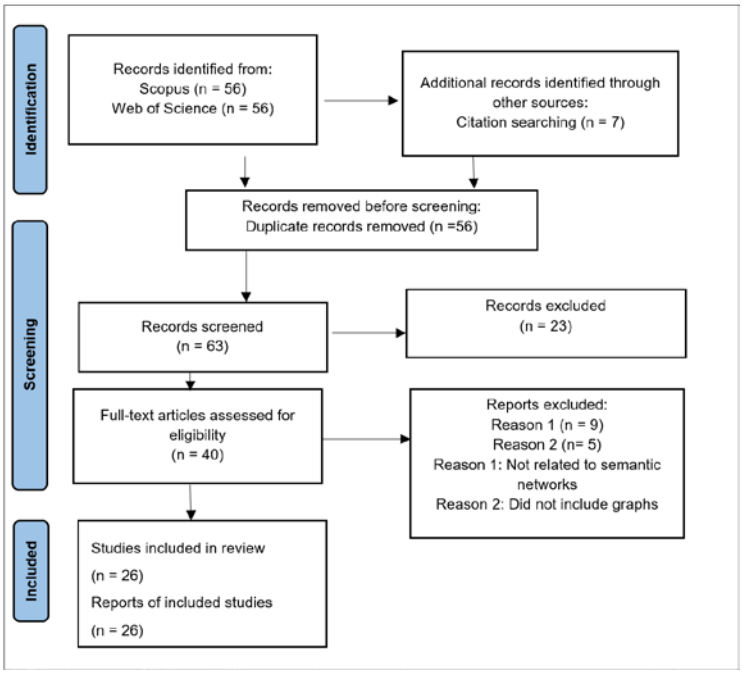
The flow diagram (Figure 1) shows the number of studies collected from the databases and the number of research studies examined by the authors for eligibility. The reasons regarding exclusion are indicated.

3.2 Results and discussion of the selected studies

Of the 26 studies identified, ten were conducted in America (seven in Chile and three in Colombia), and twelve in Europe (one in Poland, one in Greece, and ten in Spain). Ferreira and Echeverría (2010), Gómez-Devís (2021), Gómez-Devís and Cepeda Guerra (2022), and Gómez-Devís et al. (2023) included participants from the two continents.

Figure 1

Studies selection flow diagram (PRISMA flow chart)



3.3 Semantic networks and developmental milestones across age and proficiency

Research studies carried out by Agustín-Llach (2022), Gómez-Devís and Cepeda Guerra (2022), Henríquez Guarín et al. (2016), and Manjón-Cabeza Cruz (2010) offer

a nuanced understanding of how age and/or proficiency impact lexical availability and organisation across different language learners.

With regard to L2 studies, Agustín-Llach (2022) highlights that older and more proficient EFL learners exhibit a broader range of lexical production, which indicates not only a growing vocabulary size, but also enhanced lexical diversity, suggesting that learners' semantic networks become more intricate as they age and gain proficiency. These findings are in line with Sánchez-Saus Laserna (2022), who explores proficiency in SFL. Furthermore, Agustín-Llach (2022) broadens this finding by showing that associations among words in learners' mental lexicon differ from one age and level group to the other, as younger learners tend to focus on core vocabulary with few very interconnected words, while older and more proficient learners also link words more distant in the network.

In L1 Henríquez Guarín et al. (2016) add to this picture by examining the lexical activation mechanisms related to the human body in Spanish L1, demonstrating a more complex network of lexical units, with more nodes, links, and relationships among older students. This complexity is associated with a predominance of semantical-cognitive mechanisms, suggesting that as learners progress, they not only accumulate a larger number of lexical items, but also employ a wider range of mechanisms to organise and access their lexicon, although the type of mechanisms does not vary. Manjón-Cabeza Cruz (2010) further enriches this understanding by examining the semantic configurations across four age groups, emphasising the unique lexical repertoires and network structures that characterise different age groups. The study reveals significant variation in lexical repertoires across age groups, with distinct words being exclusive to children and the elderly. This brings to light the necessity of considering the unique lexical items and semantic configurations that distinguish different age groups and suggests that the evolution of the lexicon is not only a matter of increasing size and diversity, but also involves significant changes in how lexical items are organised and connected within individuals' semantic networks across their lifespan. Gómez-Devís, et al. (2022) also seek to enlarge these findings by concluding that Spanish L1 primary school participants activate less frequent networks, and that these seem to be weaker and show fewer connections.

3.4 Semantic networks and language learning

Research studies exploring lexical organisation in language learning reveal critical insights into the structure, development, and educational implications of lexical networks across different languages and learning contexts.

The analysis of the types of prompts used in LA studies according to inclusivity and internal structure criteria might be of paramount importance when it comes to language learning as it provides information on the quantity of words they could contain, how they are distributed and connected to each other or their degree of

openness, among other characteristics (López González, 2014). In addition, being knowledgeable about prototypes and the semantic networks (Manjón-Cabeza Cruz, 2008) theories might lead to a better understanding of the mechanisms used to activate and connect words in order to apply them to the learning process. López González (2014) offers a comprehensive view of these concepts and theories in LA and applies them to two centres of interest in SFL which show important differences in terms of taxonomy.

Ferreira and Echeverría (2010), Hernández Muñoz and Tomé Cornejo (2017), Santos Díaz (2017), and Agustín-Llach and Palapanidi (2024) examined the semantic networks of native and foreign language speakers. Ferreira and Echeverría (2010) found that both English L1 and advanced EFL participants activated a great number of connections when words with a high lexical availability index were analysed. However, English L1 students included very specialised words, which were well-connected to other lexical items. According to these authors, a more scattered image of the organisation of the vocabulary in EFL might stem from the lack of knowledge of the meaning and use of these words. The authors employ a metaphor that likens words to people and assert that "[m]uchos de los términos que para los hablantes nativos son 'amigos' o 'familia', para los alumnos son sólo 'conocidos' o 'perfectos desconocidos'" (Ferreira & Echeverría, 2010, p. 150). The likelihood of transforming those "acquaintances" into "close friends" or "family members" lies in using these findings when teaching or learning a foreign language. Hernández Muñoz and Tomé Cornejo (2017) offer further insight into the strategies used by L1 and L2 learners to retrieve the necessary words most effectively and state that native speakers have a significantly superior ability to create clusters and switch from one cluster to a different one, even when compared with bilinguals. This might be due to the fact that native speakers' mental dictionary is broader and more strongly connected with corresponding conceptual representations. Furthermore, when switching is required, native speakers seem to possess more effective search mechanisms and higher cognitive flexibility. In a study with the same number of Spanish L1 and SFL participants, based on Tomé Cornejo (2015) and using a similar methodology, they show that, indeed, L2 speakers with an intermediate level struggle more to categorise words in well-defined clusters, while native speakers' lexical availability is larger and better interconnected. Santos Díaz (2017) confirms these results with Spanish L1, as well as EFL and French as a Foreign Language (FFL) undergraduate students. Moreover, graphs in Spanish L1 and EFL showed more nodes with stronger links than those in FFL. Furthermore, phonological priming was attested, underscoring different types of connections in L1 and FL. In an attempt to gain further insight into the nature of L1 and FL mental lexicon and the influence of native language and culture, Agustín-Llach and Palapanidi (2024) examined category organisation and typicality in taxonomic versus slot-filler categories with Spanish L1, Greek B1 SFL, and C1 SFL undergraduate participants. They found that typicality effects do not

change according to proficiency level, but are influenced by language and culture, and the type of semantic category, with taxonomic categories producing more typical answers. Furthermore, they observed that native semantic networks were denser and contained strongly connected nodes, which "are more easily learned, robustly stored, highly organised and consequently more easily accessed" (Agustín-Llach & Palapanidi, 2024, p. 29), while both B1 and C1 learner networks projected external chains of lexical items, which "points to lexico-semantic organisation being a function of vocabulary size rather than proficiency differences" (p. 29).

Agustín-Llach and Rubio (2024) addressed the semantic network of Spanish EFL learners in an attempt to identify "graph metrics and mathematical regularities in the learners' mental lexicon" (p. 7). The use of sophisticated mathematical tools led to compelling insights as they proved that high centrality words are as relevant to the EFL mental lexicon as they are to the L1 semantic network for children and adults, and that these "key players or anchor words [...] are relevant for the navigation of the mental lexicon" (p. 20). Yet, they admit that lexical availability graphs "are an imperfect approximation to try to replicate the structure of the mental lexicon" (p. 24), which is why they describe a diverse array of tools, hence suggesting the adoption of a more comprehensive approach in future research.

Agustín-Llach (2023) has further expanded the analysis of lexical availability and network theory as she explores the way monolingual and bilingual participants access and retrieve lexicon. Three cohorts participated in the study, namely, monolinguals, environmental bilinguals, and educational bilinguals. Although most of the data analysed revealed non-significant variances, educational bilinguals showed higher levels of lexical organisation and stronger connections among the nodes, which might mean that their mental lexicon is more efficiently structured, more compact and more stable; this could also signify that their capacity for broadening their vocabulary is greater. Environmental bilinguals, however, show more idiosyncratic connections, "which points to L2 lexicons as less well-organised and to L2 networks where words are less likely to group into identifiable subcategories" (p. 9).

Studies focusing on young learners (Gómez-Devís, 2019, 2021; Gómez-Devís & Cepeda Guerra, 2022; Gómez-Devís et al., 2023) highlight the impact of age and mother tongue on lexical organisation. Young learners exhibit distinctive patterns of lexical organisation that reflect developmental stages and linguistic exposure. For instance, Chilean students display different mechanisms, which might lead to a more reduced lexical repertoire compared to Valencian peers, emphasising the influence of linguistic environment and educational practices on lexical development (Gómez-Devís & Cepeda Guerra, 2022).

3.5 Semantic networks and cognitive and linguistic mechanisms

Research conducted by Mateus-Ferro and colleagues (Henríquez Guarín et al., 2016; Mateus-Ferro et al., 2018; Mateus Ferro & Mahecha Mahecha, 2020) contributes to the field by identifying the cognitive and linguistic mechanisms that influence the organisation and retrieval of lexical items in a lexical availability test, based on the semantic networks theory (Aitchinson, 2012; Lehman, 1992; Shapiro & Woddmansee, 1969; Sowa, 1999; Quillian, 1968), and supported by *DispoGrafo* (Echeverría et al., 2008), which enables them to display graphically the relationships established between words. Through a comprehensive analysis of graphs obtained in different semantic fields, in their last proposal, the authors (Mateus Ferro & Mahecha Mahecha, 2020) establish two general types of association mechanisms and twelve final mechanisms, namely, semantical-cognitive (coordination, functional association, special association, part-whole association, emergent cultural association, general association, hyponymy and hyperonymy, synonymy, antonymy) and linguistic-formal (syntagmatic composition, derivation, and phonetic association) and discuss each type through examples and graphs. They also show that 94% of the mechanisms activated by participants were semantical-cognitive, with 89.2% belonging to the cognitive category, which refers to individuals' capacity to categorise the information perceived in their reality in clusters which belong together according to general principles (Mateus Ferro & Mahecha Mahecha, 2020). These cognitive mechanisms which seem to be so frequent in native speakers should be further explored with other groups of participants, as the authors themselves suggest, it would be interesting to investigate if these cognitive mechanisms are also common in the L2 and what type of pedagogical implications and applications these findings can have.

Gómez-Devís and Llopis Rodrigo (2016) identified and described semantic nodes and connections evoked by Valencian bilingual students in response to the prompt *"The city."* The data reveal that while lexico-statistical methods provide a general picture of lexical availability, tools like *DispoGrafo* enable a more nuanced understanding of associative relations. Both L1 and L2 groups demonstrate similar semantic clustering and associative relations and a high degree of lexical convergence (88%), which indicates shared conceptual frameworks. Although L1 speakers exhibit slightly richer and more integrated associative networks, with more stable connections among items, overall patterns suggest that at advanced proficiency, priming in L1 and L2 aligns closely.

3.6 Semantic networks across disciplines

Given the importance of mathematics in our lives, several scholars have sought to measure lexical availability in this specialised field, focusing on areas such as numbers, algebra, geometry, and probability, and statistics (Cerda Etchepare et al., 2021; Del Valle et al., 2016). However, the interpretation of the graphs and semantic networks is

succinct and not conclusive, and this limitation impedes a thorough understanding of the findings.

Blanco Correa et al. (2020) and Salcedo Lagos et al. (2021) explore lexical availability related to emotions, in an attempt to illustrate how domain-specific vocabulary develops and is organised. Blanco Correa et al. (2020) carried out a survey containing the prompts *rabia* (anger), *sorpresa* (surprise), *amor* (love), *alegría* (happiness), *miedo* (fear), *tristeza* (sadness), *asco* (disgust), and the results obtained through graphs show how these feelings are connected and also their direction, leading to the conclusion that they might be useful to design education policies related to emotional intelligence in order to foster social harmony and conflict prevention. Salcedo Lagos et al. (2021) elaborate on the emotions field during COVID-19 pandemic by examining teachers' perceptions of their students' emotions when using ICTs. The strongest lexico-semantic links are shown in different graphs, albeit the semantic networks are explored succinctly.

3.7 Semantic networks as a training tool for pre-service teachers

Some studies have used LA and semantic networks in an attempt to gauge future and current knowledge. For instance, Valenzuela Castellanos et al. (2018) explore pre-service teachers' knowledge of learning concepts during their training, which they assume has an impact both on their own learning and on the way they will approach teaching. As they learn new concepts, these participants also go through a process of transformation and personal growth. Valenzuela Castellanos et al. (2018) observe higher lexical availability and more complex relationships between concepts in the second phase, leaving the role of the teacher behind and bringing forward noteworthy learning concepts, such as change and construction, process and change, and motivation and teacher. Trigo Ibáñez and Santos Díaz (2023) also work with pre-service teachers and analyse the presence of digital tools in the concept of reading in Spanish L1, EFL, and FFL, in an attempt to seize opportunities to improve their training. Their findings revealed that reading continues to be understood in the traditional sense, with few words related to digital tools.

Montre Águila and Araneda-Machmar (2021) examine History, Geography, and Social Sciences teachers' vocabulary related to democracy, citizenship, and human rights due to the introduction of a new subject called *Formación ciudadana*. The results indicate that participants' vocabulary does not reflect important concepts promoted by the government of Chile in this subject teaching programme.

3.8 Limitations

The systematic review of the reports on lexical availability and semantic networks reveals that there are some limitations that must be addressed in future studies. For

instance, regarding the methodology, as Hernández Muñoz and Tomé Cornejo (2017) suggest, "para comparar grafos en L1 y L2, se necesita contar con el mismo número de sujetos en ambos grupos y aplicar unos principios metodológicos comunes" (p. 111). In some of the reports involving comparisons, the samples differed in size, whereas in others, the same sample size was employed. Apart from the number of participants, the name of the prompt might lead to the activation of different available words, therefore, this aspect ought to be considered when carrying out comparisons. Other aspects which must be contemplated are the two-minute time period of the task for each prompt, except when participants are children or senior citizens, or following the data editing criteria specifically created for L1 and L2. Addressing these limitations would lead to stronger conclusions.

Additionally, the literature reviewed shows there is a tendency in some studies to use online lexical availability tests. While this represents a milestone in the lexical availability research field, caution must be exerted as the presence of a teacher or a researcher who ensures the adoption of the right procedure is not always clear from the description of the methodology. This will have a significant impact on the relevance and magnitude of the findings reported.

In addition to the methodological aspects mentioned above, research might have benefitted from exploring graphs from a broader perspective, with more in depth analyses, either using graph metrics or retrieval mechanisms some authors have created, or both. Further research examining lexical availability and semantic networks in other languages other than Spanish, English or French would also broaden the view of retrieval mechanisms both in L1, L2, and even L3.

CONCLUSIONS

This systematic review has analysed the landscape of lexical availability studies, highlighting the global scope and diverse methodologies that characterise this vibrant area of research. The selected studies, spanning continents and engaging with a wide array of languages and populations, collectively affirm the complex nature of lexical availability and its underlying cognitive, linguistic, and educational dimensions. The utilisation and development of computational tools has significantly improved our understanding of semantic networks, demonstrating the potential of technology in mapping and analysing the intricate relationships within the lexicon. Educational stages and the effects of age, language and proficiency level on lexical organisation emerge as critical themes, revealing how lexical networks evolve and expand in complexity with age, education, and linguistic exposure. These insights have deepened our comprehension of language acquisition and cognitive development and have provided valuable pointers for language teaching and learning, suggesting that more targeted strategies cater to learners' specific needs and developmental stages. Furthermore, the exploration of novel prompts, reflecting current societal and

technological advancements, reveals the field's adaptability and its eagerness to remain relevant in a rapidly changing world. This adaptability is echoed in the methodologies adopted, transitioning from traditional paper-based questionnaires to digital platforms and online data collection, thereby expanding the research's reach and inclusivity.

Research should also attempt to apply the mechanisms of lexical activation as well as the graph metrics to establish the exact process through which native learners store, organise, and access their available vocabulary. These findings could be utilised to build practical language learning strategies for L2 learners concerning clusters and switching in a given language for students to train and acquire these skills. Global collaborations among different countries and a more comprehensive approach would also benefit all key stakeholders as lexical availability dictionaries related to the most topical issues can be created and then examined in order to design such useful tools.

As Hernández Muñoz and Tomé Cornejo (2017) concluded, but for all the research studies carried out around the world "que van dotando de madurez el conocimiento sobre el léxico disponible" (p. 117), we would not have such an ambitious projection of the lexical availability psycholinguistics functioning.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

Bianca Manuela Sandu & Roberto A. Ferreira: conceptualisation of the review, literature search, writing of the original draft, revision, and editing of the manuscript. Both authors contributed to the article and approved the submitted version.

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Table 1

Main characteristics of the studies included

Author(s)	Country	N	Age	Language	Level/Grade	Sex	Prompts	LA task	LA task timing	Data editing	Programmes
Agustin-Llach (2022)	Spain	98 (A2) / 98 (B1) (total 196)	15-16 / 17-18	EFL	A2 (grade 10) / B1 (grade 12)	No	'food and drink', 'hobbies', 'animals', 'town', 'countryside'	On paper	2 min	According to Jiménez Catalán and Ojeda Alba (2009)	DispoGrafo, Gephi, SPSS 26.0
Agustin-Llach (2023)	Spain	14 / 14 / 14 (total 42)	17-18	EFL	B1 (grade 12)	No	'food and drink', 'hobbies', 'animals', 'town', 'countryside'	On paper	2 min	According to Jiménez Catalán and Ojeda Alba (2009)	DispoGrafo, Gephi, SPSS 26.0
Agustín-Llach and Palapanidi (2023)	Greece / Spain	22 (SFL-B1) / 28 (SFL-C1) / 45 SL1	+18	SFL	Undergraduates	No	*'comida y bebida', profesiones y oficios', 'el campo', 'la casa', 'amar', 'bonito/a', acciones cotidianas', 'celebraciones y fiestas'*	On paper	2 min	Criteria mentioned without reference to previous literature.	Dispogen, DispoGrafo, Gephi, SPSS 26.0
Agustín-Llach and Rubio (2024)	Spain	98 (B1)	17-18	EFL	B1 (grade 12)	No	'animals', 'countryside'	On paper	2 min	Criteria mentioned without reference to previous literature.	Dispogen, Gephi
Blanco Correa et al. (2020)	Chile	119	18-20	Spanish L1	Undergraduates	No	*'enojo', 'alegría', 'tristeza', 'miedo', 'sorpresa', 'amor', 'asco'*	Online (sent by email)	2 min	Criteria mentioned without reference to previous literature.	DispoGrafo
Cerda Etchepare et al. (2021)	Chile	635	No info.	Spanish L1	Final year of upper-secondary education	No	*'números, álgebra', 'geometría', 'datos y azar'*	Online	2 min	No info.	LexMath
Del Valle, M., et. al. (2016)	Chile	1557 / 228	No info.	Spanish L1	First graders of secondary education / Mathematics teaching students	Yes	First graders of secondary education: 'numbers', 'algebra', 'geometry', 'probability and statistics' / Mathematics teaching students: 'algebraic structures'	Online	2 min	Reference to spelling correction	Excel (Microsoft Office), LexMath, Gephi
Ferrerira and Echeverría (2010)	Chile / England	50 (English L1) / 50 (English FL)	16-18 / 21-22	English L1 / EFL)	Lower Sixth / C1 level	No	'body parts', 'pollution' and 'the environment'	On paper	2 min	No info.(data drawn from Ferreira, 2006)	DispoGrafo
Gómez-Devís and Llopis Rodrigo (2016)	Spain	253 (Valencian L1) / 211 (Valencian L2) (total 464)	No info.	Valencian L1 / Valencian L2	Final year of upper-secondary education	No	*'la ciutat'*	On paper (within the LAPP)	2 min	Within the LAPP	DispoGrafo
Gómez-Dévís (2019)	Spain	55	6-7	Spanish L1	Primary School	Yes	*'animales'*	Audio or video recording without taking notes	1 min	No info.	DispoGrafo

Gómez-Dévís (2021)	Chile / Spain	51 (Chile) / 40 (Gran Canaria) / 55 (Valencia)	6	Spanish L1	Primary School	Yes	*'ropa', 'alimentos', 'escuela', 'animales', 'colores'*	Oral interviews: Gran Canaria (reseachers note down words elicited from students, who are further prompted from time to time) / Valencia (researchers record words) / Chile (reseachers note down words elicited from students)	2 min	Within the LAPP	DispoGrafo
Gómez-Devís and Cepeda Guerra (2022)	Chile / Spain	55 (Valencia) / 51 (Chile)	6	Spanish L1	Primary School	Yes	*'colores'*	Oral interviews	2 min	No info.	DispoGrafo, índice de connectividad
Gómez-Devís et al., (2023)	Chile / Spain	55 (Valencia) / 51 (Chile)	6	Spanish L1	Primary School	Yes	*'partes del cuerpo'*	Oral interviews	2 min	No info.	DispoGrafo
Henríquez Guarín, M. C., et. al. (2016)	Colombia	192	No info.	Spanish L1	11th / 5th	No	*'cuerpo humano'*	Framed within the projects *"Léxico Disponible en Bogotá"* and *"Análisis cognitivo de la disponibilidad léxica de los estudiantes bogotanos de 11º y 5º grado"*	No info.	No info.	DispoGrafo
Hernández Muñoz and Tomé Cornejo (2017)	Spain	75 B2 SFL / 80 SL1	SFL mean age - 20,21 / SL1 20	SFL / Spanish L1	B2	No	'partes del cuerpo'	Half written / half oral	4 min	According to Hernández Muñoz(2004)	DispoGrafo
López González (2014)	Poland	121	No info.	SFL	Upper-secondary school (3º liceo)	No	*'el cuerpo humano', 'la ciudad'*	No info.	No info.	No info.	DispoGrafo
Manjón-Cabeza Cruz (2010)	Spain	142	25 children (5-11) / 44 young people (12-25) / 49 adults (up to 65) / 25 senior citizens	Spanish L1	No info.	Yes	*'juegos y diversiones'*	Children between 5 and 8 y.o. & senior citizens: 1-min. oral interviews / the rest: on paper	1 min / 2 min.	No info.	DispoGrafo/ manual
Mateus Ferro, G. E., et. al. (2018)	Colombia	96	No info.	Spanish L1	No info.	No	*'animales', 'cuerpo humano', 'prendas de vestir', 'muebles', 'escuela y útiles escolares', 'cocina', 'profesiones y oficios', 'juegos y distracciones', 'trabajos del campo y del jardín'*	On paper (within the LAPP)	No info.	Within the LAPP	DispoGrafo
Mateus Ferro and Mahecha Mahecha (2020)	Colombia	192	No info.	Spanish L1	11th / 5th	Yes	*'partes del cuerpo', 'prendas de vestir', 'alimentos y bebidas', 'ciudad', 'profesiones y oficios', 'escuela y útiles escolares'*	No info.	No info.	No info.	DispoGrafo

Montre-Águila and Araneda-Machmar (2021)	Chile	36	No info.	Spanish L1	University teachers	No	*'democracia', 'derechos humanos', 'ciudadanía'*	Recorded and transcribed	No info.	No info.	Gephi version 0.9.1
Salcedo Lagos et. al (2021)	Chile	178	No info.	Spanish L1	Teachers	Yes	'ICTs in teachers' specialty', 'students' emotions perceived by teachers when using ICTs in class', 'emotions teachers want to modulate in their students during the class to improve involvement with the learning task'	Online (Lexical Availability Test (LAT) http://www.sacited.cl/encuesta/)	2 min	Criteria described	DispoGrafo
Salcedo Lagos, P. et. al. (2013)	Chile	150	No info.	Spanish L1	Upper-secondary school	No	'numbers', 'algebra', 'geometry', 'probabilities and chance', 'transportation', 'home', 'city'	Words written down (no more info.)	2 min	Criteria described	ELVIRA
Sánchez-Saus Laserna, M. (2022)	Spain	322	No info.[1]	Spanish FL	A, B, C according to the CEFR	No	*'el cuerpo humano', 'escuela y universidad', 'los animales'*	On paper	2 min	Within the LAPP	DispoGrafo
Santos Díaz (2017)	Spain	171	Adults	Spanish L1 / EFL / FFL	B1 or above postgraduate students	No	*'partes del cuerpo humano', 'la escuela: muebles y materiales', 'ordenadores e internet'*	On paper	2 min	Within the LAPP	DispoGrafo
Trigo Ibáñez and Santos Díaz (2023)	Spain	520	Mean age: 21.68	Spanish L1 / EFL / FFL	B1 or above postgraduate students	No	'reading'	On paper	2 min	Spanish L1 data according to Samper-Padilla, Bellón, and Samper-Hernández (2003) / EFL and FFL data according to De la Maya Retamar (2015), Mackey (1971), and Santos Díaz et al. (2020)	Dispogen II, DispoGrafo
Valenzuela Castellanos et. al. (2018)	Chile	97	18-31	Spanish L1	N/A	No	*'aprendizaje'*	On paper	2 min	No information	Software R, librereía iGraph, Gephi 0.8.2-beta

NOTE

[1] The author refers the reader to Sánchez-Saus Laserna (2016).