Language Learning and Development

ISSN: 1547-5441 (Print) 1547-3341 (Online) Journal homepage: www.tandfonline.com/journals/hlld20

Word associations in Mexican school children

Natalia Arias-Trejo, Julia B. Barrón-Martínez, Francisco Abelardo Robles Aguirre & Aline Minto-García

To cite this article: Natalia Arias-Trejo, Julia B. Barrón-Martínez, Francisco Abelardo Robles Aguirre & Aline Minto-García (22 Sep 2025): Word associations in Mexican school children, Language Learning and Development, DOI: 10.1080/15475441.2025.2560806

To link to this article: https://doi.org/10.1080/15475441.2025.2560806

LANGUAGE LEARNING AND DEVELOPMENT
https://doi.org/10.1080/15475441.2025.2560806

Routledge
Taylor & Francis Group

Word associations in Mexican school children

Natalia Arias-Trejo[a], Julia B. Barrón-Martínez[b], Francisco Abelardo Robles Aguirre[c], and Aline Minto-García[d]

[a]Facultad de Psicología, Universidad Nacional Autónoma de México, Ciudad de México, México; [b]Universidad Internacional de La Rioja, La Rioja, España; [c]Centro Universitario de Ciencias Sociales y Humanidades, Universidad de Guadalajara, Guadalajara, México; [d]Instituto de Ciencias Sociales y Humanidades, Benemérita Universidad Autónoma de Puebla, Puebla, Mexico

ABSTRACT

Free Word Associations reflect how words are organized in the lexicon. They have been generally performed with young and elderly adults. However, very little is known about semantic organization in school-age children. The current research presents associations for 60 words acquired early in life with 484 children between the ages of 6 and 12, who attended either public or private schools. We provide eight association measures traditionally reported. A trajectory analysis identified that changes in associations are non-linear and more gradual in children attending public schools compared to those attending private schools. Public school students exhibit higher associative strength indices, indicating a more interconnected lexicon. Although the number of blank responses is small in both populations, idiosyncratic responses decrease among public school children but not among those from private schools, suggesting an increase in vocabulary. Analyses on the type of lexical relations and the type of grammatical responses (paradigmatic versus syntagmatic) showed that children preferred to provide taxonomic and paradigmatic responses. However, neither response type increased significantly in correlation with their level of education. This corpus serves to track the organization of noun knowledge during childhood and as an instrument for conducting research with Spanish-speaking children.

Knowledge of words and the relationship between them is organized in semantic memory and structured like a network (Tulving, 1983). Semantic memory has been studied using different techniques, such as free word associations, where participants respond to a cue word by saying or writing one or multiple single words (De Deyne & Storms, 2008; D. L. Nelson et al., 2004). Word association norms (WANs) are the common responses gathered through free associations. Until recently, little was known about children's organization of word knowledge through free word associations. Moreover, there is a lack of data on how word associations change within different stages of childhood throughout elementary school. The current research aims to present free word associations provided by Mexican Spanish-speaking children, considering both quantitative (eight associative measures) and qualitative analyses (type of semantic and grammatical response analyses) determined by three variables: age (6 to 12 years of age), socioeconomic status (SES, public versus private school) and educational level (first to sixth grade of elementary school). As a second aim, we created free word-associations used for young children in experimental studies with controlled material (priming, prediction, naming). Given that younger children are unable to read, we focused on concrete nouns that are identified through images.

CONTACT Aline Minto-García amintog@hotmail.com Instituto de Ciencias Sociales y Humanidades, Benemérita Universidad Autónoma de Puebla, Av. 2 Oriente no. 410, Centro Histórico, Puebla C.P. 72000, México

Supplemental data for this article can be accessed online at https://doi.org/10.1080/15475441.2025.2560806

In free word associations, the type of analysis selected depends on the research objective. For example, the frequency of responses and the associative strength between the cue and the response word can be measured through percentages. One such measure is the associative strength of the first associate, which is understood as the strongest connection between two words in memory (De Deyne & Storms, 2008; D. L. Nelson et al., 2000). According to the spreading activation model, the response time or the number of answers depends on the number of associates connected to the cue word (Collins & Loftus, 1975). Qualitative approaches measure the type of lexical relationship (e.g., taxonomic as in "dog-horse" or thematic as in "dog-bone") between the cue word and the response word (Hutchison, 2003), and whether they belong to the same (paradigmatic) or different grammatical categories (syntagmatic relationships) (e.g., Ervin, 1961; Minto-García et al., 2020). Another approach is a semantic network analysis, where words are nodes and their relationships with other words are links. The network structure is analyzed using graph measures such as centrality (number of connections a node has with other nodes), clusters (groups of related words), and edges (number of links between nodes) (Dubossarsky et al., 2017; Zortea et al., 2014). We analyze the organization of semantic memory using both quantitative and qualitative measures of free word associations.

Through free word associations, we can better understand the organization of the lexicon and how words are interconnected. They have also been used to evaluate language processing in priming or naming tasks (Alario et al., 2000); to select rigorously and systematically linguistic stimuli (Pérez Sánchez et al., 2001); to model memory retrieval (Steyvers & Tenenbaum, 2005), to study the trajectory of associative knowledge (Coronges et al., 2007; Macizo et al., 2000), to predict word learning (Hills et al., 2009), or to generate measures of semantic similarity (Cabana et al., 2024). Experimental studies typically use specific manipulations to capture word relationships. Nevertheless, free associations lack a semantic restriction that biases the results, generating a structure where salient links emerge independently of a specific context (Wojcik & Kandhadai, 2020; Zortea et al., 2014).

Word association norms with adults exist in languages such as English (De Deyne et al., 2019; D. L. Nelson et al., 2004), German (Schulte Im Walde & Borgwaldt, 2015), Dutch (De Deyne et al., 2013), French (Thérouanne & Denhière, 2004), European Spanish (Fernandez et al., 2004, 2012), Argentina (Cabana et al., 2024; Luna et al., 2016; Manoiloff et al., 2010; Vivas et al., 2017), and Mexico (Arias-Trejo et al., 2022; Barrón-Martínez & Arias-Trejo, 2014). Changes in the lexicon across the lifespan have also been documented (Cosgrove et al., 2021; Dubossarsky et al., 2017; Zortea et al., 2014). However, little is known about how concept knowledge changes throughout childhood using free word associations.

Free word associations in children

Efforts have been made to create WANs with children to understand the structure of the lexicon during this stage: Coronges et al. (2007); K. Nelson (1977); Palermo (1971); Wojcik and Kandhadai (2020) in English; Carneiro et al. (2004) and Comesaña et al. (2014) in European Portuguese; De La Haye (2003) in French; Macizo et al. (2000) in European Spanish; and Salles et al. (2009); Zortea and de Salles (2012) in Brazilian Portuguese. Currently, there is no corpus with children whose native language is Latin American Spanish; therefore, the available databases may not reflect the words used in a particular linguistic context or age. The Mexican variant is the largest in the world, representing 21% of the world's 595 million Spanish speakers (Eberhard et al., 2022).

As vocabulary increases, the connections between words change not only in number but also in their accessibility and representation (Carneiro et al., 2004; Macizo et al., 2000; Zortea & de Salles, 2012). Vocabulary growth influences variations in the strength of association (probability of generating the same response to a cue word). Changes in the strength of association are the product of a learning process in which children acquire new meanings and, therefore, new associations arise. Macizo et al. (2000) collected word associations for Spanish children aged 8–9, 10–11, and 12–13 with 58 nouns. Their findings showed that with age, there was an initial decrease in the strength of

association (in the first two groups) followed by an increase as children developed (from 11.08 for 8-year-olds to 13.36 for 13-year-olds). An increase in the number of idiosyncratic (unique) responses with age was also observed until reaching its lowest level in adulthood. Comesaña et al. (2014) collected a corpus with 139 Portuguese nouns with 7 to 8-, 9- to 10-, and 11 to 12-year-olds and reported a decrease in the percentage of associates, an increase in strength of association, and a decrease in idiosyncratic responses, based on these results, the authors of the study interpreted them as indicative of an increase in vocabulary size. The results did not show a linear function of age. They first indicated the addition of new information and secondly, the restructuring of the network later in development (as in Carneiro et al., 2004, with 16 Portuguese nouns). De La Haye (2003) found that in French, there was an increase in the strength of association with age when children wrote the first word that came to mind (as in Comesaña et al., 2014). Additionally, Coronges et al. (2007), using 16 English nouns, reported a change with age where 12- and 13-year-olds had a greater number of associates, and a larger number of idiosyncratic responses compared to university adults in D. L. Nelson et al. (2000). Using 65 words (nouns, adjectives, and verbs), with 60 younger English-speaking children from 3- to 8-year-olds (divided into younger and older children) and 60 adults, Wojcik and Kandhadai (2020) found that: 1) variability in responses was higher for children than adults (percentage of associates), 2) the strength of the first associate was stronger for children than adults and stronger for older children than younger ones (like a U shape), and 3) younger children had a higher number of idiosyncratic responses compared to older children and adults. As can be seen, drawing comparisons across studies is challenging due to differences in participant ages, methods, and grammatical categories of cue words. Together, the studies mentioned suggest a change in the organization of semantic knowledge.

Changes in any direction are thought to be a consequence of development since this process involves the reconfiguration of meaning. During the early stages of formal schooling, the information children associate with a word may expand. As children restructure existing knowledge to incorporate new information, these changes are likely to influence semantic memory processes by increasing the repertoire and lexical storage (Schneider & Bjorklund, 2003). Furthermore, children's conceptual knowledge is highly influenced by their environment during elementary school (Coley, 2012).

Types of lexical responses

As suggested by McRae et al. (2012), free associations are a product of semantic relations and serve as a useful metric for understanding the relationship between lexical concepts. The comparison between the generation of taxonomic (e.g., dog-horse) and thematic associations (e.g., dog-bone), particularly how they contrast, taps into lexical organization (Yee et al., 2009). Free associations reflect meaningful relationships that are established in space and time co-occurrence, relationships that occur daily and frequently, rather than only feature overlap (McRae et al., 2012). It has been suggested that thematic associations reflect automatic links as one word is likely to co-occur with another (Sadeghi et al., 2015). In contrast, taxonomic links encompass mental constructs that unify two members perceived as similar enough – shared features – to be part of a category (Mirman & Graziano, 2012). This coincides with Sass et al. (2009), who affirm that taxonomic relationships, due to overlap in features, require more effort to process than thematic ones. However, Wojcik and Kandhadai (2020) report an increase in taxonomic responses with children's age, which may be explained by the fact that free associations mirror the speech children are exposed to in their environment (Fourtassi, 2020). Also, García Coni and Vivas (2018) report that 6- to 11-year-old children prefer to describe objects and furniture thematically but describe fruits and animals taxonomically based on shared features. Thus, it seems that the category drives the selection of taxonomic or thematic traits. This study includes an analysis of nine types of lexical responses provided by children across six elementary school grades (see Table 5); however, we focus on the contrast between taxonomic and thematic associations in groups formed by education level (entry, middle, or advanced).

Grammatical responses

The types of responses that children provide in free associations have been previously studied by analyzing paradigmatic – same grammatical category as in 'cat-lion'– versus syntagmatic relations – different grammatical categories as in 'cat-eat'– (Clark, 1970; Ervin, 1961; Mattheoudakis, 2011). Children tend to produce more syntagmatic relations than paradigmatic ones, but the production of paradigmatic relations increases with age, and with educational experience or an increase in their vocabulary (Ervin, 1961; Masters, 1969; Palermo, 1971). This shift from producing syntagmatic to paradigmatic responses occurs between the ages of 6 and 8 (McNeill, 1970. However, evidence demonstrates that paradigmatic responses are already present by the age of 3, and their production increases from ages 3 to 8 (Wojcik & Kandhadai, 2020). However, Mattheoudakis (2011), who studied word associations in native speakers of Greek, found different results than those previously reported: children (between 7 and 8 years old) produced more paradigmatic responses than adults (between 18 and 23 years old). Studies are, therefore, necessary to identify the possible shift from syntagmatic to paradigmatic responses in Spanish. While some studies have shown that the type of grammatical response is influenced by the grammatical category of the stimulus (e.g., Nissen & Henriksen, 2006), our focus is on nouns as children – including Mexican children – tend to acquire them more frequently compared to other grammatical categories (e.g., Bornstein et al., 2004; Dhillon, 2010). In this context, our initial interest is to observe whether nouns reflect this shift from syntagmatic to paradigmatic relations.

Type of school in terms of socioeconomic status effects on free associations

In Mexico, elementary school curricula are regulated by the Ministry of Education. Although education in public and private schools should be similar, public schools are associated with low- to middle-income households, lower mathematics scores, and fewer academic or artistic activities compared to private schools, which have longer schedules and children from families with a higher socioeconomic status (SES) (Santibañez et al., 2021).

Since the seminal studies of Coleman (1967), Graves (1986), and Hart and Risley (1995), there has been an increasing amount of evidence that low-SES background children underperform on vocabulary growth measures compared to their middle and high-SES peers (Fernald et al., 2013; Pace et al., 2017). These differences emerge early and have been linked to a word exposure gap, which between high and low-SES groups reaches up to 4 million words by the age of 4 (Gilkerson et al., 2017). Even though contemporary research has related SES to measures of parental occupation, education, and family income (Oakes & Rossi, 2003), the aggregated SES of the student body, known as school SES, has been highly correlated not only to individual SES but also to academic achievement in students' test scores (Rumberger & Palardy, 2005; Sirin, 2005). Rumberger and Palardy's (2005) analysis of achievement growth from grades 8–12, based on a sample of 14,217 students from the National Education Longitudinal Survey, showed that both students' individual SES and the average school SES had a significant effect on student learning. Their results revealed that effect sizes for school SES were almost as large overall, and larger in certain subject areas, than the effect sizes for student SES measured by achievement through test scores in math, science, reading, history, and the composite test scores for all areas. This finding seems to indicate that an increase in school SES is associated with an increase in students' academic achievement, as measured by the test scores from the Program for International Student Assessment (PISA), regardless of individual SES. Similar findings have also been reported in the Australian (Perry & McConney, 2010) and Danish contexts (Andersen, 2008). Even after controlling SES covariates, several studies have found that children in private schools only marginally outperform those in public schools in standardized assessments of subject areas such as mathematics, science, reading, or writing (Ashley et al., 2014; Donkers & Robert, 2008; Tooley et al., 2010).

In summary, research suggests that children's word-word relationships change with age as they acquire more vocabulary and knowledge. Our study includes three analyses within the context of age, type of school (SES), and education level: 1) eight measures to track potential changes in associations; 2) type of semantic relationship; and 3) grammatical response. Based on the academic differences outlined in the Introduction, we hypothesized that peculiarities between school types exist. Additionally, we expected to observe a more interconnected lexicon with increasing age.

Method

Participants

A total of 484 children with typical development participated in this study. Participants included boys ($n = 239$) and girls ($n = 245$) from public and private elementary schools across grades 1 to 6. The inclusion criteria were: (a) Mexican; (b) monolingual and native speakers of Spanish; (c) between 6 to 12 years of age; (d) no reported visual or hearing impairments, as indicated by parents or teachers; (e) no language delays or other developmental disorders, as indicated by parents or teachers. The present research was conducted under strict adherence to the Official Mexican Standard NOM-012-SSA3 -2012 (Secretaría de Salud, 2012), which establishes the ethical regulations as outlined by the American Psychological Association.

Stimuli

Sixty stimulus words were taken from the *MacArthur Inventario del Desarrollo de Habilidades Comunicativas Palabras y Enunciados Inventario CDI-II* (MacArthur Communicative Development Inventory Words and Sentences Inventory II) for 16- to 30-month-old toddlers (Jackson-Maldonado et al., 2003). This Spanish version, adapted and validated for Mexican Spanish, includes 680 words potentially known by toddlers. All selected words had at least 32% production familiarity for Mexican 30-month-olds ($M = 64.95$; $SD = 12.86$) and 27% understanding familiarity for 18-month-olds ($M = 71.83$; $SD = 15.14$) (Wordbank database, Frank et al., 2016; data obtained in April 2024). The words selected belong to categories such as animals, people, body parts, among others (see Table A1 for the full list).

Free word association task

The task consisted of asking the participants to produce orally or in writing the first word that came to mind. The oral modality was incorporated after conducting a pilot study, which showed that first-grade children (approximately 6 to 7 years old) were either unable to read or write or had limited writing abilities. This modality ensured that their performance on the task would not be influenced by their limited ability to read and write. The rest of the participants, that is, children in second grade and above, wrote their answers on paper (written modality).

The instructions (originally in Spanish) that were provided in the oral modality were the following: "*Tell me the first word that comes to mind when you hear the word that I am going to say to you. Remember that you only have to say one word. There are no correct or incorrect answers.*" In the written modality: "*Write on the line to the right, the first word that comes to mind when reading the one on the left. There are no correct or incorrect answers. If you're not quite sure how to write it, don't worry, write it as you can*." Three extra practice words were included at the beginning of the task to familiarize the participant with the task.

Procedure

For data collection, authorization was requested by the directors of the elementary schools and their parents. The schools were in Mexico City and the State of Mexico. Participants' data remained anonymous. In the oral modality, the participants were only asked their age, and then the task was carried out. Each cue word was read by an experimenter clearly and loudly, and the responses were written on a laptop. The average time per participant, after the practice round in which the experimenter could provide feedback, was around 15–20 minutes. This modality was carried out in a separate and empty room to prevent noise and distractions. In the written modality, the task was carried out in the classroom. The experimenter provided the instructions orally and answered students' questions, then participants were provided with a sheet in which they had to first select their sex, write their age, and then complete the word association task. The average time for group sessions, after the practice round in which the experimenter could provide feedback, was around 20–30 minutes. The classroom sessions were exempt from as much external noise as possible.

Coding and data analysis

Eight measures of association were calculated (Table A2 contains the conceptual and operational definitions). Most of these measures, though not all of them, have been previously reported in free association studies (Carneiro et al., 2004; Comesaña et al., 2014; Luna et al., 2016; Macizo et al., 2000; D. L. Nelson et al., 2000).

To analyze the type of lexical relations, we created a classification system focusing on the contrast between taxonomic and thematic associations. Thus, the lexical responses were classified into nine types: taxonomic, when cue and response words belonged to the same semantic category (e.g., *pato-león* [duck-lion]); thematic, when both appeared in the same context of occurrence (e.g., *plato-mesa* [plate-table]); descriptive, the response described or qualified the stimulus (e.g., *zapato-morado* [shoe-purple]); functional, indicating actions linked with the cue word (e.g., *cama-dormir* [bed-to sleep]); part-contents, the response referred to a part of a whole or an element or container (e.g., *carro-asiento* [car-seat]); phonological, identified as sharing the first phoneme or having a rhyme (e.g., *dedo-dado* [finger-dice]); shape, similar visual form (e.g., *pelota-manzana* [ball-apple]); idiosyncratic responses were unique (e.g., *zapato-de Emilio* [shoe- of Emilio]); and anomalous responses were coded as repetitions and non-answers. The authors trained four linguists, who, after various training sessions, randomly coded ten percent of the data; this data was first analyzed before they were allowed to code the rest of the data. The inter-rater agreement was high, with an average Cohen's kappa of 0.96 (range 0.81 to 1.00). The confidence interval for Cohen's kappa extended from 0.92 (range 0.62 to 1.00) to 1.00 (range 0.95 to 1.00). These values indicate a remarkably high level of consistency among the four linguists, suggesting that the evaluation process was both reliable and valid across different raters. Although our primary focus in this qualitative classification was on the taxonomic versus thematic distinction (as in other studies), we also classified other types of responses to conduct a detailed analysis of the lexical relations generated by children.

A third classification of the lexical relations was performed based on the type of grammatical response. Following Clark (1970), two trained linguists coded relations as paradigmatic when the response and stimulus belonged to the same grammatical category (e.g., *cama-mesa* [bed-table]) and as syntagmatic when the stimulus and response were from different grammatical categories (e.g., *cama-dormir* [bed-to sleep]). They also identified non-answers and idiosyncratic responses as anomalous. In this coding, the linguists had a 98% agreement rate, and any discrepancies were resolved through common agreement.

The classification of responses is proposed based on an extensive review of the most common measurements used in free association studies (De Deyne et al., 2019; Fernandez et al., 2004; Schulte

Im Walde & Borgwaldt, 2015; Vivas et al., 2017; Zortea et al., 2014). It includes both quantitative measurements (for frequency comparisons) and qualitative classifications (based on the relationship between the stimulus word and the response word). Both categorizations homogenize and facilitate comparisons between previous and future studies.

Results

Cleaning and inclusion criteria

Participants´ responses to the stimuli were orthographically corrected and standardized as described in Barrón-Martínez and Arias-Trejo (2014): grammatical gender was unified to masculine (e.g., *perra* to *perro*, female dog to male dog); grammatical number to singular (e.g., apples to apple as in Dubossarsky et al., 2017); and verb tense to the infinitive form (e.g., playing to play). Out of a total of 484 participants, 19 were excluded from the analysis because they had fewer than 60% of the responses (fewer than 36 answers), and three participants were excluded because their age exceeded the range of the inclusion criteria. The first criterion applied because participants with a few responses repeatedly answered with the same word to different cue words, used undefined terms such as "cosa" (thing), provided the same word but in another gender as "niño-niña" (child), or decided not to complete the task due to fatigue. Similar criteria were reported in Cabana et al. (2024). Thus, a total of 462 children were included in the analysis: boys ($n = 224$) and girls ($n = 238$) with a mean age of 8.16 years ($SD = 1.84$); they attended public (120 boys and 120 girls) or private (104 boys and 118 girls) schools. Table A3 presents the number of participants by age in each school grade.

Association measures

The eight associative measures described above in the Coding and Data Analysis section were calculated (see Table A2). After finding that six association measurements from the general sample were not normally distributed (see Table B1), comparative analyses were performed using non-parametric tests in IBM SPSS Statistics Software (IBM Corp., 2019, Version 26). Table 1 shows the statistical comparisons between the two types of schools regardless of their level of education or age. Differences showed that children from public schools in general had a higher Associative Strength of the Most Frequent Associate (FA) than their peers from private schools, but children from private schools provided a greater Number of Different Associates (NA) (FA for public was 22.73 and NA was

Table 1. Means, standard deviations (SD), and *p*-values of the association measures.

No.	Measure	General Mean (SD)	Public Schools' Mean (SD)	Private Schools' Mean (SD)	*z*-value (*p*-value)
1	Associative Strength of the Most Frequent Associate (FA%)	21.17 (9.16)	22.73 (9.12)	19.61 (8.97)	−3.732 (.0001)*
2	Associative Strength of the Second Most Frequent Associate (SA%)	10.97 (3.81)	12.56 (4.00)	9.57 (3.55)	−4.548 (.001)*
3	Sum of Associative Strength of FA and SA (SM%)	32.85 (10.84)	35.52 (10.48)	30.17 (10.55)	−5.111 (.0001)*
4	Difference of Associative Strength between FA and SA (DF%)	9.503 (9.19)	9.94 (9.49)	9.05 (8.90)	−.460 (.646)
5	Number of Different Associates (NA)	32.98 (10.99)	30.91 (8.75)	35.066 (12.54)	−2.170 (.030)*
6	Blank Responses (BLR%)	4.68 (7.39)	4.96 (7.85)	4.67 (7.05)	−1.798 (.072)
7	Idiosyncratic Responses (IR%)	31.46 (9.62)	27.61 (8.79)	35.32 (8.87)	−8.121 (.0001)*
8	Cue Validity of the Most Frequent Associate (CV)	0.766 (0.292)	0.7833 (0.304)	0.766 (0.283)	−.473 (.636)

Note. *p*-values were calculated with the non-parametric Mann-Whitney *U*-test. * $p < .05$.

30.91, while for private FA was 19.61 and NA 35.066). The percentage of idiosyncratic responses also differed: 27.61 for public and 35.32 for private school children. In fact, idiosyncratic responses increased in private school children and decreased in public school children. The item that produced the largest number of different responses for both types of schools was *casa* ([house], NA for public schools = 108, NA for private = 104). Among public school children, the first associate was *vivir* ([to live], $n = 25$), whereas for private school children, it was *grande* ([big], $n = 17$).

To analyze differences by level of education, we divided participants into three groups: entry level (1st grade; participants who performed the task orally), medium level (2nd and 3rd grade), and advanced level (4th to 6th grade). The Mexican educational system divides elementary school into lower elementary (1st to 3rd grade) and upper elementary (4th to 6th grade); however, we decided to treat children in 1st grade as a separate group because they performed the task with a variation in the data collection method. Looking for an interaction between the two factors (Type of school and Level of education), a non-parametric Scheirer-Ray-Hare test (Scheirer et al., 1976), which is a reliable alternative for a two-way ANOVA (2x3), was performed in the R Statistical Software (v4.2.3; R Core Team, 2023). We found interaction effects between factors in SA ($H(2, 354) = 15.16$, $p < .001$), SM ($H(2, 354) = 8.66$, $p = .013$), IR ($H(2, 354) = 36.23$, $p < .001$), and NA ($H(2, 354) = 86.24$, $p < .001$). Main effects for education level were found in FA ($H(2, 354) = 9.33$, $p = .009$), SA ($H(2, 354) = 5.98$, $p = .050$), SM ($H(2, 354) = 11.66$, $p = .002$), BLR ($H(2, 354) = 28.29$, $p < .001$), IR ($H(2, 354) = 44.63$, $p < .001$), and NA ($H(2, 354) = 156.89$, $p < .001$) with significant differences between entry and advanced levels (see Tables B5 and B6). Main effects for type of school were found in FA ($H(1, 354) = 13.92$, $p < .001$), SA ($H(1, 354) = 29.11$, $p < .001$), SM ($H(1, 354) = 26.11$, $p < .001$), IR ($H(1, 354) = 65.94$, $p < .001$), and NA ($H(1, 354) = 4.711$, $p = .029$).

The associative measures were also calculated by age group. Table 2 presents these calculations for the seven age groups. The changes seen with age are non-linear. As expected, we observed a decrease in BLR as children provided a word for almost all cue words, an increase in IR, and an increase in cue validity.

To explore if these differences were more related to the children's age than to the level of education (e.g. if differences were present when students aged, for example, from ages 6 to 7 or from 8 to 9, more so than from 1st to 4th grade), we performed another Scheirer-Ray-Hare test. So, the factors considered were the Type of school (private and public) and the Age within the sample (ages 6 to 12). We found interaction effects between age and type of school in FA ($H(6, 826) = 25.62$, $p < .001$), SA ($H(6, 826) = 20.355$, $p = .002$), SM ($H(6, 826) = 29.56$, $p < .001$), NA ($H(6, 826) = 464.93$, $p < .001$), BLR ($H(6, 826) = 24.09$, $p < .001$), and IR ($H(6, 826) = 257.27$, $p < .001$). Interestingly, main effects in age were only found in NA ($H(6, 826) = 145.87$, $p < .001$), BLR ($H(6, 826) = 104.09$, $p < .001$), and IR ($H(6, 826) = 23.47$, $p < .001$). Post-hoc comparisons with the Dunn (1964) test showed that age differences were scarce between consecutive years in BLR and IR and, more often, reached significance when comparing nonconsecutive years. This was not the case for NA, where differences were commonly observed between consecutive age comparisons (7–8 ($p < .0009$), 8–9 ($p < .0004$), and 10–11 ($p < .0001$), but not for 9–10 ($p = .07$) and 11–12 ($p = .99$)). Likewise, no differences were found between nonconsecutive years of age (for example, 6–9 ($p = .41$), 6–10 ($p = .35$), 8–11 ($p = .14$), 8–12 ($p = .15$)). This might be due to the non-linear increase in NA, particularly evident for children from private schools (see Figure 1C).

As will be discussed later, these differences between the groups become more pronounced at medium and advanced levels than for entry-level grades (see Tables B2 to B4). Figure 1 illustrates the percentages and the number of associates from public and private schools for each level of education.

Type of lexical responses

When classifying the type of lexical responses, taxonomic responses (e.g., *pato-león* [duck-lion]) were the most frequently produced, followed by thematic (e.g., *vaso-agua* [glass-water]), descriptive (e.g., *zapato-*

Table 2. Means, standard deviations (SD) of the association measures per age.

No.	Measure	6 years Mean (SD)	7 years Mean (SD)	8 years Mean (SD)	9 years Mean (SD)	10 years Mean (SD)	11 years Mean (SD)	12 years Mean (SD)
1	Associative Strength of the Most Frequent Associate (FA%)	21.78 (8.63)	17.36 (7.21)	20.20 (8.31)	21.42 (9.10)	21.18 (8.27)	20.83 (8.84)	23.95 (11.47)
2	Associative Strength of the Second Most Frequent Associate (SA%)	12.02 (4.37)	10.32 (3.09)	11.29 (3.39)	11.75 (3.77)	11.87 (3.80)	12.33 (4.60)	12.63 (4.62)
3	Sum of Associative Strength of FA and SA (SM%)	33.81 (10.15)	27.69 (8.77)	31.49 (9.30)	33.18 (10.46)	33.05 (9.60)	33.17 (10.83)	36.59 (13.17)
4	Difference of Associative Strength between FA and SA (DF %)	9.76 (9.10)	7.03 (6.74)	8.90 (8.57)	9.67 (9.13)	9.30 (8.43)	8.48 (8.83)	11.31 (11.51)
5	Number of Different Associates (NA)	35.22 (6.62)*	35.22 (5.51)*	27.73 (4.29)*	33.58 (5.51)	36.85 (6.73)	25.68 (4.82)*	14.73 (2.88)*
6	Blank Responses (BLR%)	6.44 (8.91)*	4.78 (7.80)	6.89 (9.43)	4.09 (8.88)*	4.15 (7.05)*	2.06 (3.41)*	2.63 (6.58)*
7	Idiosyncratic Responses (IR%)	29.76 (7.35)*	31.42 (7.12)*	34.16 (7.41)*	30.95 (6.72)	28.76 (6.32)	32.74 (8.23)*	46.25 (13.49)*
8	Cue Validity of the Most Frequent Associate (CV)	0.6649 (0.367)	0.7533 (0.314)	0.7499 (0.342)	0.7833 (0.289)	0.8499 (0.252)	0.8027 (0.285)	0.9083 (0.193)

Note. *p*-values were calculated with the post-hoc non-parametric Dunn test. * $p < .05$.

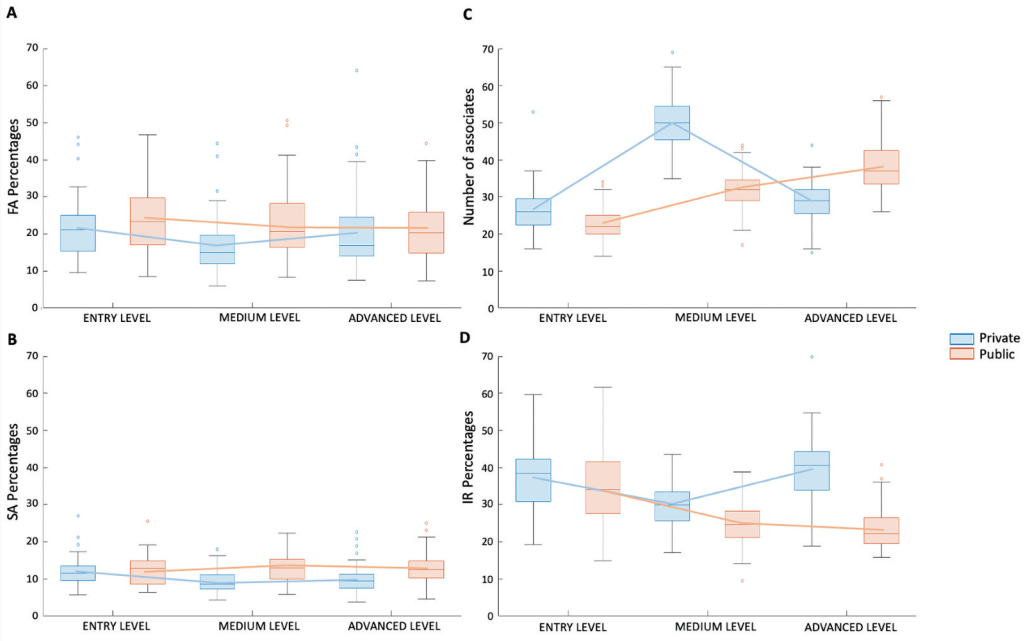

Figure 1. Graphs illustrating the percentages and the number of associates from private and public children for each of the education levels. A) shows the percentages of FA: Associative Strength of the Most Frequent Associate, B) depicts the percentages of SA: Associative Strength of the Second Most Frequent Associate, C) displays NA: Number of Different Associates, and D) shows the percentages of IR: Idiosyncratic responses.

morado [shoes-purple]), and functional responses (e.g., *escoba-barrer* [broom-sweep]). There were significant differences in the frequency of all types of responses (X^2 [8, $N = 462$] = 19945.87, $p < .001$).

A Kruskal-Wallis test to examine differences by age in the production of each of the four most common types of responses found non-significant differences between the seven age groups (from 6 to 12 years old) in the production of taxonomic responses ($X^2(6) = 5.6$, $p = .469$), thematic responses ($X^2(6) = 7.54$, $p = .274$), descriptive responses ($X^2(6) = 3.2$, $p = .783$), and functional responses ($X^2(6) = 5.25$, $p = .511$). These results show that children's production of the four most common types of responses does not change significantly with age.

To analyze differences by level of education, we once again divided participants into the three established groups: entry level, medium level, and advanced level. Table B7 presents the frequency of production for each type of lexical response and the percentage of total responses.

Kruskal – Wallis tests found non-significant differences between these three groups in the production of taxonomic responses ($X^2(2) = 3.714$, $p = .156$), thematic responses ($X^2(2) = 3.429$, $p = .18$), descriptive responses ($X^2(2) = 3.714$, $p = .156$, and functional responses ($X^2(2) = 0.074$, $p = .964$). These results indicate that children's production of the four most common types of responses does not change significantly with each level of education.

We analyzed the differences between the four most frequent types of lexical responses across each of the three levels of education to identify preferences for any of these lexical responses. For the entry level group, a Friedman test showed significant differences in the four most frequent types of lexical responses (X^2 [3] = 66.95, $p < .001$), and post-hoc analyses with a Wilcoxon signed-rank test indicated a significant difference between the taxonomic and descriptive responses ($z = -5.90$, $p < .001$), between thematic and descriptive responses ($z = -7.25$, $p < .001$), as well as between descriptive and functional responses ($z = -7.25$, $p < .001$). These results indicate an equal production of taxonomic, thematic, and functional responses. For the medium level group, a Friedman test showed significant differences in the four most frequent types of lexical responses (X^2 [3] = 82.49, $p < .001$). Post-hoc analyses with

a Wilcoxon signed-rank test indicated a significant difference between the taxonomic and thematic responses ($z = -5.09$, $p < .001$), between taxonomic and descriptive responses ($z = -2.43$, $p = .015$), as well as between taxonomic and functional responses ($z = -6.97$, $p < .001$), with taxonomic responses being more frequent in this group. Finally, for the advanced level group, a Friedman test also showed significant differences in the four most frequent types of lexical responses (X^2 [3] = 34.42, $p < .001$). Post-hoc analyses with a Wilcoxon signed-rank test indicated a significant difference between the taxonomic and functional responses ($z = -2.73$, $p = .006$), between thematic and descriptive responses ($z = -2.28$, $p = .022$), as well as between thematic and functional responses ($z = -3.41$, $p = .001$), with taxonomic and thematic responses being more frequent in this group.

A comparative analysis of the production of taxonomic (most frequent type of responses) and thematic responses (second most frequent type of responses) was performed using a Mann-Whitney *U*-test; there were non-significant differences between children of private and public schools ($z = -1.96$, $p = .05$, $z = -.09$, $p = .92$, respectively).

Grammatical responses: paradigmatic versus syntagmatic

Paradigmatic responses (e.g., *gato-perro* [cat-dog]) were the most frequently produced, followed by syntagmatic responses (e.g., *gato-maullar* [cat-to mew]). There were significant differences in the frequency of these types of responses (X^2 [1, $N = 462$] = 1884.63, $p < .001$). A Kruskal-Wallis test to examine differences by age in the production of each type of grammatical response found non-significant differences among the seven groups (from 6 to 12 years old). This result indicates that children's production of paradigmatic and syntagmatic responses does not increase significantly with age. Likewise, a Kruskal-Wallis test showed non-significant differences between children of private and public schools in the production of both paradigmatic and syntagmatic responses. Table B8 shows the frequency and percentage of total grammatical responses for the three levels of education.

Discussion

In this study, we present free associations for 60 stimulus words collected from 484 Spanish-speaking children aged 6–12 years, attending public and private schools. Except for first-grade children, who completed the task orally, all free word associations were collected in a written modality (children wrote the first word that came to mind), consistent with previous studies with children (De Deyne et al., 2013; De La Haye, 2003). We offer three main analyses. First, we calculated eight measures: Associative Strength of the Most Frequent Associate (FA), Associative Strength of the Second Most Frequent Associate (SA), Sum of Associative Strength of FA and SA (SM), Difference of Associative Strength between FA and SA (DF), Number of Different Associates (NA), Blank Responses (BLR), Idiosyncratic Responses (IR) and Cue Validity of the Most Frequent Associate (CV) – all commonly reported in free association studies (Barrón-Martínez & Arias-Trejo, 2014; Callejas et al., 2003; Macizo et al., 2000; McRae et al., 2005). Secondly, we analyzed the types of lexical relations that children produced between a cue word and the FA. Third, we differentiated responses grammatically, distinguishing between paradigmatic and syntagmatic responses.

Association measures

Our findings reveal a pattern of free associations during childhood that varies with the type of school, level of education, or age. The results do not indicate a progressive pattern; instead, except for BLR, a U-shaped curve is observed across all measures. We will revisit this issue shortly. First, we present the results by type of school. As outlined in the Introduction, our hypothesis suggested that due to the academic differences, peculiarities between the types of schools could be expected. Children from private schools were expected to exhibit higher FA (a more connected lexicon), less IR, and more NA (more words). We only partially obtained these results (see Table 1). Significant

differences were found in five measures: FA, SA, and SM were larger for public schools, whereas NA (mean public school 30.91 vs 35.066 for private) and IR were larger for private schools (mean public school 27.61 vs 35.32 for private). FA, SA, and SM for private schools suggest a less connected lexicon than their peers in public schools. Personal word-word relations in private schools could explain a less connected lexicon. However, this interpretation is misleading, considering that more NA and IR reflect a larger vocabulary and therefore various responses for the same cue word. Thus, children's lexicons in private schools may be as connected as those of their public-school peers but have a broader range of lexical options (words) to select from. Lower FA indexes reflect more words associated with a cue word, and so the association strength is distributed among more relations. We did not measure reaction times, but it would be interesting to see if the lower values of FA in private schools are associated with longer response times, potentially due to increased interference from having many possible associates.

Focusing on responses from public school children, three measures follow a linear pattern (see Table B5): NA increases, and BLR, along with decreases in IR; FA does not change significantly. In private school children, only BLR decreased linearly. This fluctuation does not delineate a progressive pattern of changes but rather reflects a lexicon that is constantly adjusting.

Our results also detail the significant interactions between level of education and type of school. The differences in the lexicon between children from private and public schools seem to become more pronounced as they advance in their education. At the entry level of education, the two types differ only in NA (private school children have a greater number). These differences extend to include FA, SA, SM, and IR as children reach the medium level, and these differences persist through the advanced level, except for FA (see Tables B2 to B4). Although some of these differences were not significant in younger children (entry level at 6–7 years old) (Table B2), almost all the associative measures reached significance at the medium (i.e., second and third grade, Table B3) and the advanced level of schooling (i. e., fourth through sixth grade, Table B4). As previously noted, these differences suggest that the private school children's lexicon was probably broader and more diverse than the public schoolers' (e. g., NA for public schools was 30.91 and 35.06 for private schools in general, see Table 1). In contrast, public school children's lexicon, though smaller, seems to be more interconnected and characterized by stronger associations (see the differences between the two groups in FA, SA, and SM in Table 1). In terms of education level and age, we expected to see gradual progression as more abstract knowledge was incorporated, leading to an expansion of vocabulary. This developmental progression was expected to mirror age. Overall, we observed changes that confirm our hypothesis.

As noted, free association tendencies reflecting the changes in associative networks of words related to child development (decrements in FA, IR, and BLR, accompanied by an increase in NA) were not necessarily linear (Macizo et al., 2000, see Figure 1A for FA, 1D for IR, and 1C for NA). This is striking when comparing public and private school trajectories, with public schoolers showing a much more linear tendency when going from entry to advanced level of education (Entry FA = 24.11, Medium FA = 22.80, Advanced FA = 21.29, see Figure 1 and Table B6 in Appendix B), whereas, children in private schools follow the previously reported partial U-shape decrease for FA and IR (diminishing from 6–10 years old, Entry FA = 21.6, Medium FA = 16.76, and partially recovering from 10–12 years old at the Advanced level FA = 20.45, see Table B5 and Figure 1A for FA measure and 1D for IR). This is a phenomenon that Macizo et al. (2000) found only when comparing young children to adults. This partial U-shape decrease perhaps indicates that private schools' curricula could be accelerating word learning processes, similar to how high school SES reportedly enhances student learning (Rumberger & Palardy, 2005) or how the type of educational approach, even when SES is controlled, seems to influence concept organization (Denervaud et al., 2021). Considering the previously reported variations in the increase of the percentage of associates (i.e., a fast growth between ages 8–10, followed by a plateau from 10–12, and a slight decrease afterward, see Macizo et al., 2000), when compared to the educational level in private schools, we found a slight increase for NA, describing an inverted U-shape (see Figure 1 and Table B6). This curve has been reported in cognitive development (Carlucci & Case, 2013). Initially, as children acquire new knowledge, their performance improves; however,

performance may temporarily decline as this new knowledge is incorporated into the learning process and children are introduced to rules or exceptions.

A similar pattern emerges in the data when observing the responses given by age, revealing a fluctuating rather than a consecutive trajectory of changes. When Age was a factor instead of Level of education, FA and BLR were also significant, indicating that BLR decreased with age – more drastically in private schools – while FA significantly decreased only in private schools (see Table B6). This non-linear evolution in the strength of FA, NA, and the percentage of IR seems to culminate in a higher FA and NA, and a lower number of IR around young adulthood (as shown by Arias-Trejo et al., 2022). These results align with the established process of vocabulary accretion, the tuning and adjusting of lexical entries and their meaning in memory, and the restructuring of weak and strong associative and semantic relations between words (Rumelhart & Norman, 1978). In line with Beckage et al. (2011) and Hills et al. (2009), vocabulary changes with age during infancy; these early changes are likely to continue with schooling, as categories known by children become more populated, potentially resulting in a temporal decrease in association strength. Stella et al. (2017) state that words have multiple connections, such as phonological, co-occurrence, feature similarity, and associative relationships. Thus, while changes occur with age, there is wide variability in the lexicon.

Previous research reports that a higher degree of strength of association in the FA is found in adults; for instance, Arias-Trejo et al. (2022) reported an FA of 29.27% for older adults and Barrón-Martínez and Arias-Trejo (2014) of 29.38% for young adults. We found a similar total FA in 6 to 11-year-olds, which then increases at age 12 to 23.95%. This outcome, along with an increase in Cue validity from .66 at 6 years of age to .90 at 12 years (being .766 in general), suggests that the relationships between words are in a consolidation process.

The comparisons we can make with previous studies on children's free associations are very limited due to differences in age, number of cue words, and sample sizes. Our study shows divergences and similarities with their findings. Like Comesaña et al. (2014), but in contrast to Macizo et al. (2000), we found an increase in FA with age that fluctuates around similar values until it dramatically increases in the last age group and last grade of elementary school. In terms of NA and aligned with Comesaña et al. (2014), we observed a pronounced decrease among 11- and 12-year-olds only in public schools. Conversely, in private schools, we found an increase, consistent with the findings of Macizo et al. (2000). Additionally, the increase in IR observed in our private school sample coincides with the findings of Macizo et al. (2000) while the decrease observed in public schools is consistent with Comesaña et al. (2014). As Comesaña et al. (2014) indicate, the responses given by children do not show a linear function of age or education level, but changes in their responses reflect shifts in their conceptual organization. As children's vocabulary and knowledge broaden, they develop richer and more sophisticated networks, evidenced by a larger NA with higher education levels observed in our data. However, this may also reflect children's vocabulary expansion, and therefore, individual differences in how they experience certain words are indicated by the higher IR. Stella (2019) suggests the need to consider individual differences (related to age) when testing representation hypotheses, particularly free associations in early word learning, as word representations undergo significant changes during this period.

Type of lexical responses

Overall, children produced preferentially taxonomic, thematic, descriptive, and functional responses (as in García Coni & Vivas, 2018; Mirman & Graziano, 2012; Yee et al., 2009). Taxonomic responses were significantly more abundant than the other three types of responses; however, differences were found in individual educational levels rather than among groups of educational level (entry, medium, and advanced levels). This result aligns with García Coni and Vivas (2018), who reported that children prefer to describe objects taxonomically based on shared characteristics. We suggest that children generate a coordinate that activates another member of the same category. On the one hand, we could assume that a system of lexical relations is built through semantic categories (for example, animals or

body parts); every time a new element is learned, it is grouped into its category, thus, the category is strengthened. On the other hand, we could also assume that thematic relationships, being the second most frequent category, represent a link that is nourished by the daily experience of each individual (for instance, the games they play or the scenes of their daily life). With this information and as previously suggested, we can understand the lexical mechanisms, taxonomic and thematic, that aid in the construction of the mental lexicon of school-age children. For instance, Wojcik and Kandhadai (2020) propose that the increase in taxonomic relationships reflects the speech of the environment children are exposed to. Regarding thematic relationships, we may be capturing links that are formed due to word-word co-occurrence as proposed by Sadeghi et al. (2015). Likewise, the predominance of taxonomic and thematic relationships in children could be analyzed through the influence exerted by different cognitive or educational elements (obtained by the teaching-learning process). The school stage is characterized by the continuous acquisition of information related to language, reading, and writing, which influences how the links between words are formed. Additionally, descriptive responses reveal that children provide characteristics of an item, while functional responses demonstrate that they link items by utility.

Our outcome indicates that children's production of the four most common types of responses does not change significantly with age, that is, from 6 to 12 years old. This suggests that age does not affect the types of connections formed between nodes in their networks. It appears that lexical relationships within this age range remain consistent.

Grammatical responses: paradigmatic versus syntagmatic

Children at all levels of education produced more paradigmatic than syntagmatic responses. This result contradicts those found in English-speaking children (e.g., Ervin, 1961; McNeill, 1970), but coincides with Mattheoudakis (2011), who studied Greek children. This preference for paradigmatic responses can be explained in different ways. First, the syntagmatic-paradigmatic shift may occur at an earlier age in Spanish-speaking children, and such a change could be linked to the structure of language. The second explanation relates to the characteristics of stimulus words. Specifically, it has been identified that in children (but not in adults), words of higher frequency elicit mostly paradigmatic responses (Mattheoudakis, 2011). Moreover, the tendency to provide a paradigmatic response to a noun stimulus is considerably higher than for any other grammatical category (Palermo, 1971). Both characteristics are features of the stimuli used in our study, indicating that the type of response is influenced by both the frequency and grammatical category of the stimulus used in the task. Another possible explanation is that the preference for paradigmatic responses observed in Spanish-speaking children may be influenced by the rich morphological structure of the Spanish language. Spanish, as a highly inflected language, offers a wide range of grammatical markers that facilitate the recognition and manipulation of word forms within paradigmatic sets (e.g., conjugations, gender, and number agreements). In contrast, the more lexicalized nature of English, with its relatively limited morphological marking, may make it more difficult for English-speaking children to group words by grammatical type. As a result, they may find it challenging to generate paradigmatic responses and instead rely heavily on syntagmatic or surface-level lexical relations.

Likewise, the analysis of the type of grammatical response evidenced that children's production of both paradigmatic and syntagmatic responses does not increase significantly with age or level of education, which is different from what was found in other studies (e.g., Ervin, 1961; Masters, 1969; Palermo, 1971). This finding reinforces our idea that for children, the characteristics of the stimulus have a greater influence than other factors in determining their preference for a particular type of grammatical response. Our results on the type of grammatical response are consistent with those of other studies with young and older adult speakers of Mexican Spanish (Arias-Trejo et al., 2022; Minto-García et al., 2020). A preference for paradigmatic relationships in school-age children was also identified in our data, indicating that Mexican Spanish-speakers in elementary school can produce this type of response that is indicative of a more developed semantic system. Although paradigmatic

relations are more common in adults (K. Nelson, 1977), our data showed that children can establish relationships between words that involve a higher level of cognitive processing.

Research suggests that early word learning could be partially driven by words that highly co-occur in caregiver speech or that have associations with a greater number of words (Hills et al., 2010). Fourtassi (2020) analyzed the corpus of Wojcik and Kandhadai (2020) and found that co-occurrence in child-directed speech (as in CHILDES corpus, MacWhinney, 2000) predicted children's free associations. This co-occurrence indicates a linguistic environment that highly influences conceptual development; therefore, it is possible that the school context, where the categorization of elements is persistently emphasized in child-directed speech, influences the preference for paradigmatic (or taxonomic) associations. Similarly, parents often use words from taxonomies regardless of their similarity, and through repeated co-occurrence, children come to associate them. This could partially explain why Wojcik and Kandhadai (2020) found that in a free association task, children responded with referents that were not necessarily perceptually similar, such as "dog-fish," demonstrating a shift from syntagmatic to paradigmatic or taxonomic relationships. In this sense, the linguistic environment of our participants could play a relevant role in the production of responses in free word associations.

Limitations

One of the limitations of the present study is that each level of education group was made up of a different number of participants, which could have reduced the comparative homogeneity between groups. We also recognize that not measuring children's linguistic skills is a limitation, as this information could have helped explain the differences found. Even if the 6- to 7-year-olds produced their answers orally and teachers confirmed that the 7- to 8-year-olds could write, we are unable to determine the influence of the literacy process on the generation of associates. It is possible that reading or writing difficulties partially account for the pronounced and non-linear changes observed in the 7-year-old children. Thus, future studies could consider measuring cognitive skills such as reading and writing, and even verbal or written fluency skills. Finally, future work could include other grammatical categories to perform a deeper exploration of the lexicon in childhood. We were restricted to using only nouns, as one of our main goals was to create visual representations of word associations that can be used with toddlers.

Conclusion

We present word associations for 60 Spanish nouns, collected from 484 children between the ages of 6 to 12 years, attending public and private schools. This study draws a picture of how word associations change with age and SES. The results showed an increase in the degree of strength of association with the level of education and a reduction in blank responses. A predominance of taxonomic and paradigmatic responses across education levels was also identified. We found differences, although non-linear, in terms of the type of school children attended; the associative strength of the first associate was significantly higher for children in public schools than for those in the private system. As a result, the number of different associates was higher in private compared to public schools, probably reflecting vocabulary growth. This corpus represents a contribution to psycholinguistic research with Spanish-speaking children and is a useful methodological and systematic resource for designing verbal stimuli in experimental tasks with children, such as priming, naming, and memory retrieval tasks, among others.

Acknowledgments

We extend our gratitude to all the children who participated in this research. We would also like to express a special thank you to Hillary López Santillán for her help in generating the database, as well as to Leonardo Solís Morales for his assistance in extracting the data to perform the statistical analyses.

Disclosure statement

The authors all declare they have no commercial or financial conflicts of interest.

Funding

This work was supported by the Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT), UNAM. [Proyecto PAPIIT IG300224].

Data availability statement

The data used in this study are in the Open Science Framework repository, https://osf.io/cwfg3/?view_only=a2fa49fcbeba4b3c8a23399ae1705468

References

Alario, X. F., Segui, J., & Ferrand, L. (2000). Semantic and associative priming in picture naming. *The Quarterly Journal of Experimental Psychology Section A*, *53*(3), 741–764. https://doi.org/10.1080/713755907

Andersen, S. C. (2008). Private schools and the parents that choose them: Empirical evidence from the Danish school voucher system. *Scandinavian Political Studies*, *31*(1), 44–68. https://doi.org/10.1111/j.1467-9477.2008.00195.x

Arias-Trejo, N., Bel-Enguix, G., Barrón-Martínez, J. B., Minto-García, A., Arias-Carrión, O., & González-González, M. M. (2022). Word association norms in Mexican older adults. *The Mental Lexicon*, *17*(2), 155–177. https://doi.org/10.1075/ml.22001.ari

Ashley, L. D., Mcloughlin, C., Aslam, M., Engel, J., Wales, J., Rawal, S., Batley, R., Kingdon, G., Nicolai, S., & Rose, P. (2014). *The role and impact of private schools in developing countries: A rigorous review of the evidence*. Department for International Development.

Barrón-Martínez, J. B., & Arias-Trejo, N. (2014). Word association norms in Mexican Spanish. *The Spanish Journal of Psychology*, *17*, 1–13. https://doi.org/10.1017/sjp.2014.91

Beckage, N., Smith, L., Hills, T., & Perc, M. (2011). Small worlds and semantic network growth in typical and late talkers. *PLOS ONE*, *6*(5), e19348. https://doi.org/10.1371/journal.pone.0019348

Bornstein, M. H., Cote, L. R., Maital, S., Painter, K., Park, S. Y., Pascual, L., Pêcheux, M. G., Ruel, J., Venuti, P., & Vyt, A. (2004). Cross-linguistic analysis of vocabulary in young children: Spanish, Dutch, French, Hebrew, Italian, Korean, and American English. *Child Development*, *75*(4), 1115–1139. https://doi.org/10.1111/j.1467-8624.2004.00729.x

Cabana, Á., Zugarramurdi, C., Valle-Lisboa, J. C., & De Deyne, S. (2024). The "Small world of words" free association norms for Rioplatense Spanish. *Behavior Research Methods*, *56*(2), 968–985. https://doi.org/10.3758/s13428-023-02070-z

Callejas, A., Correa, Á., Lupiáñez, J., & Tudela, P. (2003). Normas asociativas intracategoriales para 612 palabras de seis categorías semánticas en español. *Psicológica*, *24*(2), 185–201.

Carlucci, L., & Case, J. (2013). On the necessity of U-shaped learning. *Topics in Cognitive Science*, *5*(1), 56–88. https://doi.org/10.1111/tops.12002

Carneiro, P., Albuquerque, P., Fernandez, A., & Esteves, F. (2004). Normas de associação livre de 16 palavras portuguesas para crianças de diferentes faixas etárias. *Laboratório De Psicologia*, *2*(1), 49–76. https://doi.org/10.14417/lp.777

Clark, H. H. (1970). Word associations and linguistic theory. *New Horizons in Linguistics*, *1*, 271–286. https://web.stanford.edu/~clark/1970s/Clark, H.H. _Wordassociations and linguistic theory_ 1970.pdf.

Coleman, J. S. (1967). Toward open schools. *The Public Interest*, *9*, 20–27. https://www.nationalaffairs.com/storage/app/uploads/public/58e/1a4/a61/58e1a4a61a1d8166394049.pdf

Coley, J. D. (2012). Where the wild things are: Informal experience and ecological reasoning. *Child Development*, *83*(3), 992–1006. https://doi.org/10.1111/j.1467-8624.2012.01751.x

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, *82*(6), 407–428. https://doi.org/10.1037/0033-295X.82.6.407

Comesaña, M., Fraga, I., Moreira, A. J., Frade, C. S., & Soares, A. P. (2014). Free associate norms for 139 European Portuguese words for children from different age groups. *Behavior Research Methods*, *46*(2), 564–574. https://doi.org/10.3758/s13428-013-0388-0

Coronges, K. A., Stacy, A. W., & Valente, T. W. (2007). Structural comparison of cognitive associative networks in two populations 1. *Journal of Applied Social Psychology*, *37*(9), 2097–2129. https://doi.org/10.1111/j.1559-1816.2007.00253.x

Cosgrove, A. L., Kenett, Y. N., Beaty, R. E., & Diaz, M. T. (2021). Quantifying flexibility in thought: The resiliency of semantic networks differs across the lifespan. *Cognition*, *211*, 104631. https://doi.org/10.1016/j.cognition.2021.104631

De Deyne, S., Navarro, D. J., & Storms, G. (2013). Better explanations of lexical and semantic cognition using networks derived from continued rather than single-word associations. *Behavior Research Methods*, *45*(2), 480–498. https://doi.org/10.3758/s13428-012-0260-7

De Deyne, S., Navarro, D., Perfors, A., Brysbaert, M., & Storms, G. (2019). The small world of words: English word association norms for over 12,000 cue words. *Behavior Research Methods*, *51*(3), 987–1006. https://doi.org/10.3758/s13428-018-1115-7

De Deyne, S., & Storms, G. (2008). Word associations: Network and semantic properties. *Behavior Research Methods*, *40*(1), 213–231. https://doi.org/10.3758/BRM.40.1.213

De La Haye, F. (2003). Normes d'associations verbales chez des enfants de 9, 10 et 11 ans et des adultes. *L'Année Psychologique*, *103*(1), 109–130. https://doi.org/10.3406/psy.2003.29627

Denervaud, S., Christensen, A. P., Kenett, Y. N., & Beaty, R. E. (2021). Education shapes the structure of semantic memory and impacts creative thinking. *NPJ Science of Learning*, *6*(1), 35. https://doi.org/10.1038/s41539-021-00113-8

Dhillon, R. (2010). Examining the 'noun bias': A structural approach. *University of Pennsylvania Working Papers in Linguistics*, *16*(1), 7.

Donkers, J., & Robert, P. (2008). Differences in scholastic achievement of public, private government-dependent, and private independent schools: A cross-national analysis. *Educational Policy*, *22*(4), 541–577. https://doi.org/10.1177/0895904807307065

Dubossarsky, H., De Deyne, S., & Hills, T. T. (2017). Quantifying the structure of free association networks across the life span. *Developmental Psychology*, *53*(8), 1560–1570. https://doi.org/10.1037/dev0000347

Dunn, O. J. (1964). Multiple comparisons using rank sums. *Technometrics*, *6*(3), 241–252. https://doi.org/10.1080/00401706.1964.10490181

Eberhard, D. M., Simons, G. F., & Fennig, C. D. (2022). *Ethnologue: Languages of the world* (25th ed.). SIL International. https://www.cia.gov/the-world-factbook/countries/mexico/#people-and-society

Ervin, S. M. (1961). Changes with age in the verbal determinants of word-association. *The American Journal of Psychology*, *74*(3), 361. https://doi.org/10.2307/1419742

Fernald, A., Marchman, V. A., & Weisleder, A. (2013). Ses differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science*, *16*(2), 234–248. https://doi.org/10.1111/desc.12019

Fernandez, A., Diez, E., & Alonso, M. Á. (2012). Normas de asociación libre en castellano de la Universidad de Salamanca [online database]. https://iblues-inico.usal.es/iblues/nalc_home.php

Fernandez, A., Diez, E., Alonso, M. Á., & Beato, M. S. (2004). Free-association norms for the Spanish names of the Snodgrass and Vanderwart pictures. *Behavior Research Methods Instruments & Computers*, *36*(3), 577–583. https://doi.org/10.3758/BF03195604

Fourtassi, A. (2020). Word co-occurrence in child-directed speech predicts children's free word associations. *Proceedings of the Workshop on Cognitive Modeling and Computational Linguistics*, Mexico City, Mexico (pp. 49–53). Online. Association for Computational Linguistics.

Frank, M. C., Braginsky, M., Yurovsky, D., & Marchman, V. A. (2016). Wordbank: An open repository for developmental vocabulary data. *Journal of Child Language*, *44*(3), 677–694. https://doi.org/10.1017/S0305000916000209

García Coni, A., & Vivas, J. (2018). Diferencias en la categorización de seres vivos y objetos Estudio en niños de edad escolar. *Suma Psicológica*, *25*(1), 62–69. https://doi.org/10.14349/sumapsi.2018.v25.n1.7

Gilkerson, J., Richards, J. A., Warren, S. F., Montgomery, J. K., Greenwood, C. R., Kimbrough Oller, D., Hansen, J. H. L., & Paul, T. D. (2017). Mapping the early language environment using all-day recordings and automated analysis. *American Journal of Speech-Language Pathology*, *26*(2), 248–265. https://doi.org/10.1044/2016_AJSLP-15-0169

Graves, M. F. (1986). Vocabulary learning and instruction. *Review of Research in Education*, *13*, 49–90. https://doi.org/10.2307/1167219

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Paul Brookes.

Hills, T. T., Maouene, J., Riordan, B., & Smith, L. B. (2010). The associative structure of language: Contextual diversity in early word learning. *Journal of Memory and Language*, *63*, 259–273. https://doi.org/10.1016/j.jml.2010.06.002

Hills, T. T., Sheya, J., Maouene, M., Maouene, A., & Smith, L. (2009). Longitudinal analysis of early semantic networks: Preferential attachment or preferential acquisition? *Psychological Science*, *20*(6), 729–739. https://doi.org/10.1111/j.1467-9280.2009.02365.x

Hutchison, K. A. (2003). Is semantic priming due to association strength or feature overlap? A microanalytic review. *Psychonomic Bulletin & Review*, *10*(4), 785–813. https://doi.org/10.3758/BF03196544

IBM Corp. (2019). IBM SPSS Statistics for Windows (Version 26.0). Computer software.

Jackson-Maldonado, D., Thal, D., Marchman, V., Newton, T., Fenson, L., & Conboy, B. (2003). *Inventarios MacArthur del desarrollo de habilidades comunicativas. User´s guide and technical manual.* Brooks Publishing.

Luna, F. G., Marino, J., Silva, J. D., & Mesas, A. A. (2016). Normas de asociación léxica e índices psicolingüísticos de 407 palabras en español en una muestra latinoamericana [Lexical associative norms and psycholinguistic indexes of 407 Spanish words in a Latin American sample]. *Psicológica*, *37*(1), 1–14. https://doi.org/10.2478/psicolj-2018-0001

Macizo, P., Gómez-Ariza, C., & Bajo, M. T. (2000). Associative norms of 58 Spanish for children from 8 to 13 years old. *Psicológica*, *21*(2), 287–300.

MacWhinney, B. (2000). The CHILDES project: Tools for analyzing talk. In *Transcription format and programs* (Vol. 1). Psychology Press.

Manoiloff, L., Artstein, M., Canavoso, M. B., Fernández, L., & Segui, J. (2010). Expanded norms for 400 experimental pictures in an Argentinean Spanish-speaking population. *Behavior Research Methods*, *42*(2), 452–460. https://doi.org/10.3758/BRM.42.2.452

Masters, J. (1969). Word association and the functional definition of words. *Developmental Psychology*, *1*(5), 517–519. https://doi.org/10.1037/h0027976

Mattheoudakis, M. (2011). A word-association study in Greek and the concept of the syntagmatic-paradigmatic shift. *Journal of Greek Linguistics*, *11*(2), 167–197. https://doi.org/10.1163/156658411X599992

McNeill, D. (1970). *The acquisition of language*. Harper & Row.

McRae, K., Cree, G. S., Seidenberg, M. S., & McNorgan, C. (2005). Semantic feature production norms for a large set of living and nonliving things. *Behavior Research Methods*, *37*(4), 547–559. https://doi.org/10.3758/BF03192726

McRae, K., Khalkhali, S., & Hare, M. (2012). Semantic and associative relations in adolescents and young adults: Examining a tenuous dichotomy. In V. F. Reyna (Ed.), *The adolescent brain: Learning, reasoning, and decision making* (pp. 39–66). American Psychological Association.

Minto-García, A., Arias-Trejo, N., & Vargas-García, E. M. (2020). Lexical relations in Spanish-speaking older adults. *Journal of Psycholinguistic Research*, *49*(4), 663–716. https://doi.org/10.1007/s10936-020-09708-5

Mirman, D., & Graziano, K. M. (2012). Individual differences in the strength of taxonomic versus thematic relations. *Journal of Experimental Psychology General*, *141*(4), 601–609. https://doi.org/10.1037/a0026451

Nelson, D. L., McEvoy, C. L., & Dennis, S. (2000). What is free association and what does it measure? *Memory & Cognition*, *28*(6), 887–889. https://doi.org/10.3758/BF03209337

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (2004). The University of South Florida free association, rhyme, and word fragment norms. *Behavior Research Methods Instruments & Computers*, *36*(3), 402–407. https://doi.org/10.3758/BF03195588

Nelson, K. (1977). The syntagmatic-paradigmatic shift revisited: A review of research and theory. *Psychological Bulletin*, *84*(1), 93–116. https://doi.org/10.1037/0033-2909.84.1.93

Nissen, H. B., & Henriksen, B. (2006). Word class influence on word association test results. *International Journal of Applied Linguistics*, *16*(3), 389–408. https://doi.org/10.1111/j.1473-4192.2006.00124.x

Oakes, J. M., & Rossi, P. H. (2003). The measurement of SES in health research: Current practice and steps toward a new approach. *Social Science and Medicine*, *56*(4), 769–784. https://doi.org/10.1016/S0277-9536(02)00073-4

Pace, A., Luo, R., Hirsh-Pasek, K., & Golinkoff, R. M. (2017). Identifying pathways between socioeconomic status and language development. *Annual Review of Linguistics*, *3*(1), 285–308. https://doi.org/10.1146/annurev-linguistics-011516-034226

Palermo, D. S. (1971). Characteristics of word association responses obtained from children in grades one through four. *Developmental Psychology*, *5*(1), 118–123. https://doi.org/10.1037/h0031075

Pérez Sánchez, M. A., Campoy Menéndez, G., & Navalón Vila, C. (2001). Índice de estudios normativos en idioma español. *Revista Electrónica de Metodología Aplicada*, *6*(2), 85–105.

Perry, L. B., & McConney, A. (2010). Does the SES of the school matter? An examination of socioeconomic status and student achievement using PISA 2003. *Teachers College Record*, *112*(4), 1137–1162. https://doi.org/10.1177/016146811011200401

R Core Team. (2023). *R: A language and environment for statistical computing*. URL R Foundation for Statistical Computing. https://www.R-project.org/

Rumberger, R. W., & Palardy, G. J. (2005). Does segregation still matter? The impact of student composition on academic achievement in high school. *Teachers College Record*, *107*(9), 1999–2045. https://doi.org/10.1177/016146810510700905

Rumelhart, D. E., & Norman, D. A. (1978). Accretion, tuning and restructuring: Three modes of learning. In J. W. Cotton & R. L. Klatzky (Eds.), *Semantic factors in cognition* (pp. 37–53). Lawrence Erlbaum Associates.

Sadeghi, Z., McClelland, J., & Hoffman, P. (2015). You shall know an object by the company it keeps: An investigation of semantic representations derived from object co-occurrence in visual scenes. *Neuropsychologia*, *76*, 52–61. https://doi.org/10.1016/j.neuropsychologia.2014.08.031

Salles, J. F., Holderbaum, C. S., & Machado, L. L. (2009). Normas de associação semântica de 50 palavras do Português brasileiro para crianças: Tipo, força de associação e set size [Semantic association norms of 50 Brazilian Portuguese words for children: Type, association strength and target's set size]. *Revista Interamericana de Psicología*, *43*(1), 57–67.

Santibañez, L., Saavedra, J. E., Kattan, R. B., & Patrinos, H. A. (2021). Comprehensive private schooling for low-income children: Experimental case-study evidence from Mexico. *International Journal of Educational Development*, *87*, 102494. https://doi.org/10.1016/j.ijedudev.2021.102494

Sass, K., Sachs, O., Krach, S., & Kircher, T. (2009). Taxonomic and thematic categories: Neural correlates of categorization in an auditory-to-visual priming task using fMRI. *Brain Research*, *1270*, 78–87. https://doi.org/10.1016/j.brainres.2009.03.013

Scheirer, J., Ray, W. S., & Hare, N. (1976). The analysis of ranked data derived from completely randomized factorial designs. *Biometrics*, *32*(2), 429–434. https://doi.org/10.2307/2529511

Schneider, W., & Bjorklund, D. (2003). Memory and knowledge development. In K. J. Connolly & J. Valsiner (Eds.), *Handbook of developmental psychology* (pp. 370–403). Sage Publications.

Schulte Im Walde, S., & Borgwaldt, S. R. (2015). Association norms for German noun compounds and their constituents. *Behavior Research Methods*, *47*(4), 1199–1221. https://doi.org/10.3758/s13428-014-0539-y

Secretaría de Salud. (2012). *Norma Oficial Mexicana NOM-012-SSA3-2012, Que establece los criterios para la ejecución de proyectos de investigación para la salud en seres humanos.* Diario oficial de la federación [D.O.F.], 5 de noviembre de 2012, (México). https://dof.gob.mx/nota_detalle.php?codigo=5270637&fecha=28/09/2012

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, *75*(3), 417–453. https://doi.org/10.3102/00346543075003417

Stella, M. (2019). Modeling early word acquisition through multiplex lexical networks and machine learning. *Big Data and Cognitive Computing*, *3*(1), 10. https://doi.org/10.3390/bdcc3010010

Stella, M., Beckage, N. M., & Brede, M. (2017). Multiplex lexical networks reveal patterns in early word acquisition in children. *Scientific Reports*, *7*(1), 1–10. https://doi.org/10.1038/srep46730

Steyvers, M., & Tenenbaum, J. B. (2005). The large-scale structure of semantic networks: Statistical analyses and a model of semantic growth. *Cognitive Science*, *29*(1), 41–78. https://doi.org/10.1207/s15516709cog2901_3

Thérouanne, P., & Denhière, G. (2004). Normes d'association libre et fréquences relatives des acceptions pour 162 mots homonymes [free association norms and meaning frequencies for 162 ambiguous words]. *L'Année Psychologique*, *104*(3), 537–595. https://doi.org/10.3406/psy.2004.29679

Tooley, J., Dixon, P., Shamsan, Y., & Schagenb, I. (2010). The relative quality and cost-effectiveness of private and public schools for low-income families: A case study in a developing country. *School Effectiveness and School Improvement*, *21*(2), 117–144. https://doi.org/10.1080/09243450903255482

Tulving, E. (1983). Ecphoric processes in episodic memory. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, *302*(1110), 361–371.

Vivas, J., Vivas, L., Comesaña, A., Coni, A. G., & Vorano, A. (2017). Spanish semantic feature production norms for 400 concrete concepts. *Behavior Research Methods*, *49*(3), 1095–1106.

Wojcik, E. H., & Kandhadai, P. (2020). Paradigmatic associations and individual variability in early lexical-semantic networks: Evidence from a free association task. *Developmental Psychology*, *56*(1), 53. https://doi.org/10.1037/dev0000844

Yee, E., Overton, E., & Thompson-Schill, S. L. (2009). Looking for meaning: Eye movements are sensitive to overlapping semantic features, not association. *Psychonomic Bulletin & Review*, *16*(5), 869–874. https://doi.org/10.3758/PBR.16.5.869

Zortea, M., & de Salles, J. F. (2012). Comparative study of the semantic word associations between young and elderly adults/estudo comparativo das associacoes semanticas de palavras entre adultos jovens e idosos. *Psicologia: Teoria e Pesquisa*, *28*(3), 259–267. https://doi.org/10.1590/S0102-37722012000300001

Zortea, M., Menegola, B., Villavicencio, A., & de Salles, J. F. (2014). Graph analysis of semantic word association among children, adults, and the elderly. *Psicologia Reflexão e Crítica*, *27*(1), 90–99. https://doi.org/10.1590/S0102-79722014000100011