English Lexical Productivity and Diversity in Spanish-English Bilingual Children in Australia

Milena Hernández Gallego[1], *Gloria Pino Escobar*[1], *Weicong Li*[1] and *Paola Escudero*[1]

[1] MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia

m.hernandezgallego@westernsydney.edu.au, g.pinoescobar@westernsydney.edu.au, weicong.li@westernsydney.edu.au, paola.escudero@westernsydney.edu.au

Abstract

In English-speaking countries such as Australia, the English proficiency of bilingual children, who also speak a heritage language (HL), has persistently been a matter of concern. Research indicates that bilingual children may initially show weaker vocabulary skills than monolingual peers. However, increasing evidence indicates that this gap is not due to bilingualism, but to individual learning experiences. We aimed at contributing to this debate by comparing the lexical productivity of 4 monolingual (English) and 5 simultaneous bilingual (Spanish-English) preschool children. Bayesian analysis revealed similar performance for the two groups, suggesting that bilingualism does not hinder English lexical development. Bilinguals can therefore achieve similar lexical productive and density outcomes as monolingual children before starting school. Implications for models of bilingual language acquisition will be discussed.

Index Terms: Bilingual children, lexical productivity, lexical density, Spanish-English bilinguals, simultaneous bilinguals.

1. Introduction

Acquiring a heritage language (HL) alongside a societal language is common around the world, including in Australia where about 30% of households speak an HL other than English [1]. Children from these households naturally become bilingual. There are concerns about whether these HL children develop an adequate expressive vocabulary [2], which is a crucial skill that predicts later vocabulary growth [3], school readiness, reading skills and academic success for monolingual and bilingual children [4]. Specifically, studies have shown that a child's early vocabulary size in both English and their HL predicts school readiness [5], as well as later reading skills [6].

When tested in one of their languages, bilingual children typically score lower on vocabulary tests than monolingual peers [7,8]. There is, however, some evidence showing that bilinguals catch up with monolingual norms starting at around 8 years of age [9] and by the mid-school years [10]. Additionally, some studies [11], using the American English and Spanish version of the CDI [12] have looked at bilingual children's lexical production and diversity in each language compared to monolinguals and have found comparable results. Other studies [13] further controlled for SES and found that bilingual children from middle-class families showed comparable receptive and expressive vocabulary to monolinguals. However, the studies mentioned above suggest that current findings are contradictory, without a clear indication of whether bilingualism yields substantial and important differences in expressive vocabulary when children transition to primary school.

Traditional views suggest that differences stem from bilinguals receiving limited exposure in each of their languages, which can result their achievement of developmental milestones at a different pace (usually later) than monolinguals of either language [14]. Bilinguals must split their exposure between the two languages, and some accounts hold that lexical representations in bilingualism are therefore weaker and have higher activation thresholds [15].

Indeed, bilingualism takes place along a continuum that implies more individual variability than in monolingual development [16, 17]. Within this continuum, studies of early bilingual development have consistently found that the relative amount of speech addressed to children is a strong predictor of children's skill development in both languages [18,19], including a larger vocabulary size [20]. For instance, the simultaneous bilingual children in [14] had higher within-group variation than monolinguals, but those with predominant English exposure compared well with monolingual peers.

Regarding the development of expressive vocabulary in context, monolingual children start to retell simple stories with adult guidance at 3 years [21], and at the age of 4, their narratives show basic story structure and a better understanding of the main events [22]. Due to the high variability in bilingual children linguistic experience [16, 17], it has not been confirmed whether these age-related milestones also apply to them [8].

Most studies looking at children's expressive vocabulary have focussed on HL children younger than three years old [8]. Many of the studies with children above 3 have been conducted within programs such as the US Head Start for children from low-income families [6,23]. However, it is still unknown how their results translate to the Australian context, that contrary to other English-speaking countries like the U.S., does not have a clear dominant HL [24]. Additionally, many studies on bilingual children lexical development have used parental reports or have used productive vocabulary tests [11, 13, 14]. Few studies have investigated word retrieval within narratives, as this discourse skill requires a different complexity in retrieval, as words must be related to a topic [25] rather than just producing labels for images.

Here we measure children's story retelling productions at the microstructure level to understand how bilingualism affects

the lexical development required for more sophisticated oral discourse skills. The microstructure of a narrative includes lexical, morphosyntactic, and syntactic knowledge that is frequently operationalized in terms of story length or lexical productivity (e.g., total number of words and utterances) and lexical diversity (e.g. number of different words) [26]. Numerous studies have demonstrated variations in microstructure between bilingual children's two languages (e.g., Spanish and English [25]).

To measure children's lexical productivity, we used the number of words and number of utterances (TNW and NU) because one measures word frequency and the other longer utterances involved in dialogue and communication, which can be used as indicators language development [3, 27]. We also used the number of different words (NDW) as an indicator of vocabulary breadth and richness, to quantify the lexical diversity of the children's retelling productions [28]. Previous studies have used these measures to investigate lexical productivity and diversity of bilingual children, how they differ across languages and the impact of exposure or dominance over them [25, 29], agreeing that a higher level of language proficiency typically involves greater lexical productivity and diversity in the children's output.

In the present study, we aim to bridge the gap in our understanding of how chronological age, linguistic input, and lexical productivity and diversity interrelate in Spanish-English bilingual children. Specifically, we used NU, TNW & NDW to compare bilingual to monolingual lexical development for oral discourse skills.

2. Method

2.1 Corpus and participants

The recordings used in the present study are part of a large database of child language speech in bilingual and monolingual children, as part of a longitudinal project on HL language maintenance and enhancement in Australia [30, 31]. The data presented here is part of the first wave of data collection that included Spanish-English bilingual children' linguistic and cognitive assessments in their two languages. Linguistic proficiency was measured with a battery of psycholinguistic tasks, two of which targeted their ability to understand and retell the story conveyed in a colourful and engaging audio-visual eBook. Data collection took place via Zoom with an experimenter conducting a session where children participated in the tasks with the help of a parent for session set up [for details on the online testing protocol see [18, 32]. The story comprehension and retelling component of the session lasted for approximately 10 minutes, including the presentation of the 12-page eBook.

Here we report on speech data from a subset of 9 children who participated in the first session of the longitudinal project. Table 1 shows the number of children in the monolingual and bilingual groups together with demographics information, including children's age and language input. This information was gathered using a Qualtrics survey form sent to parents together with the electronic consent form and study information sheet. Data collection was approved by the Western Sydney University human ethics committee (ethics approval number: H11022).

Table 1: *Participants demographic information*

	Spanish- English bilingual	English Monolingual
n	5	4
Females (n)	3	3
Mean Age (range)	4.44 (4.0-4.9)	4.30 (4.1-5.2)
Mean English exposure % (range)	40.00 (14-75)	100
Mean Spanish exposure % (range)	59.20 (25-86)	0
Median Principal Carer Relati	Mother (n=5)	Mother (n=3)
Median Principal Carer Education	University degree (n=5)	University degree (n=3)

As shown in the table all bilingual participants received a minimum of 40% of English input and 59% of Spanish input. From the 5 bilingual children, 3 reported Spanish to be their main language. Socioeconomic status (SES) was accounted for using parents/carers education as a proxy, with all the participants principal carer having completed a university degree.

2.2 Data processing

Initially, audio WAV files were extracted from Zoom video recordings. These files underwent orthographical transcription at the utterance level using OpenAI's Whisper [33], an automatic speech recognition (ASR) system that is trained on approximately 680,000 hours of diverse, multilingual data sourced from the internet. The text transcriptions and time information were then converted into Praat TextGrid files using MATLAB scripts. The first author manually reviewed and refined these transcriptions for accuracy. Compared with transcribing audio manually, the use of Whisper for ASR followed by manual review substantially decreases human resource required for transcription and improves efficiency. Further, forced alignment can be applied after ASR to provide annotation at phoneme level. We believe that employing such methodology would speed up various types of linguistic research projects.

2.3 Statistical analysis

To examine lexical density and diversity, the number of utterances, words and different words from the used speech were annotated into a dataset. The dataset included a total of 485 children's utterances, 1570 words and 539 unique words. JASP [34] was used for data visualization and statistical analyses. We conducted two Bayesian independent sample T-Tests to investigate the probability of the groups (Spanish-English bilingual vs English monolingual) differing in number of utterances (NU) and number of different words (NDW), and a Bayesian Mann-Whitney test to explore what the probability of the groups differing in number of words (TNW) was, as the data for the TNW variable was not normally distributed.

We chose a Bayesian t-test over its frequentist analogue because Bayesian statistics offer a more intuitive and comprehensive analysis in estimating the probability of an effect. Specifically, Bayesian t-tests estimate the full distribution of credible values for parameters and use Bayes factors to quantify evidence for or against hypotheses. This approach allows for more nuanced conclusions than the binary reject/accept decision based on p-values [35].

3. Results

Figures 1-3 show descriptive intervals for the mean of each variable (NU, TNW, and NDW). The mean of the NU (monolingual M=47.8, SD=9.8, bilingual M=53.3, SD=13.9) and the TNW (monolingual M=152.6, SD=44.8, bilingual M=167.5, 85.5) is higher for the bilingual group, and higher for the monolingual group in the NDW variable (monolingual M=58.6, SD=18.7, bilingual M=53, SD=32.3). However, it can be observed that the standard deviation (SD) is higher for the bilingual group for the three variables.

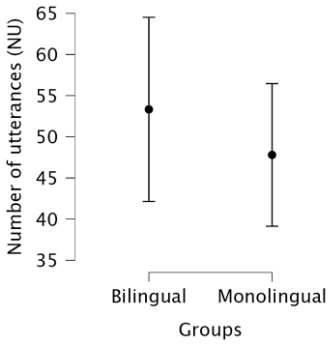

Figure 1: *Mean and standard deviation of the number of utterances for each group.*

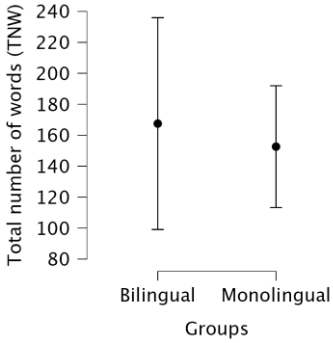

Figure 2: *Mean and standard deviation of the total number of words for each group.*

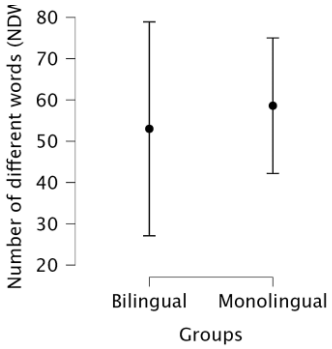

Figure 3: *Mean and standard deviation of the number of different words for each group.*

In Bayesian t-tests the null hypothesis (H_0) posits that there is no difference between the groups, while the alternative hypothesis (H_1) suggests that difference exists. The likelihood of the data under each hypothesis is calculated to provide Bayes factors, which indicate the strength of evidence for one hypothesis over the other [35]. Bayesian t-tests were used to compare the distributions of NU and NDW between the two groups, estimating the full range of credible values for the differences.

For the NU variable, the results showed that the data are 2.269 times more likely under the alternative hypothesis (H_1) than under the null hypothesis (H_0). According to the American Statistical Association (ASA) guidelines [36], a Bayes factor (BF_{10}) between 1 and 3 is considered to provide anecdotal evidence for H_1. This suggests weak evidence supporting a difference in the number of utterances between Spanish-English bilinguals and monolinguals.

Regarding the TNW, Bayesian Mann-Whitney test, a non-parametric alternative, compared the rank distributions of TNW between the two groups. Results indicated that the data are 0.594 times more likely under H_1 than under H_0, which translates to a Bayes factor of approximately 1.68 for H_0 (1/0.594) [36]. This indicates anecdotal evidence in favour of H_0, suggesting that there is little to no difference in the total number of words used between the two groups. Finally, regarding the NDW variable, the data are 0.513 times more likely under the H_1 than under H_0, corresponding to a Bayes factor of approximately 1.95 for H_0 (1/0.513). Like the TNW result, this provides anecdotal evidence favouring the null hypothesis, implying that there might not be meaningful difference in the number of unique words used between Spanish-English bilinguals and monolinguals.

4. Discussion and conclusion

The present study aimed at contributing to our understanding of how bilingualism influences lexical acquisition required for sophisticated oral discourse skills such as retelling a story. Bilingual and monolingual four-year-olds' lexical productivity and diversity when retelling an English story was compared by measure of their number of utterances (NU), total number of words (TNW) and number of different words (NDW). For all three measures, SD in the bilingual group was higher than that of the monolingual group, in line with previous studies [16,17] and the fact that bilingualism implies more variation than monolingualism. Despite the larger variation for bilinguals, we found anecdotal but not strong evidence suggesting a group difference for NU, while the evidence slightly favoured the null hypothesis for TNW and NDW, indicating no significant difference between the groups.

These findings suggest that bilinguals' limited exposure to each of their two languages compared to monolinguals does not necessarily lead to lower lexical productivity and diversity [20]. This is particularly the case of children growing up in high SES households [13], as is the case for the bilingual children included in the present study (Table 1). Our limited sample size, however, and our focus on measuring quantity rather than quality may have resulted in a less pronounced difference between bilingual and monolingual children.

Ongoing research includes a larger sample of children in both the monolingual and bilingual groups with more detailed information of their demographic background such as how SES and input exposure affect performance. We will consider a higher number of utterances by analysing the whole recording per child (45-60 minutes rather than the 10 minutes reported on in the present study), as well as an analysis of specific

grammatical categories (e.g., nouns, verbs, adjectives) and grammatical errors, which will improve our understanding of the effects of bilingualism on lexical acquisition for sophisticated oral discourse skills.

Further research should also aim at examining the effect of quantity and quality of the bilingual input, and whether enhancing HL input through HL enhancement and maintenance projects such as [18, 30, 31] yields positive results for bilinguals. Additionally, more research on establishing whether monolingual story retelling age-related milestones apply to bilinguals would be important to finally shift the current view of bilingualism as a deficit and toward embracing it as a distinct linguistic capability [16].

Despite the limitations acknowledged above, we believe the current findings support the benefits of bilingual education and reassure parents that maintaining a heritage language alongside English will not hinder their children's language development, as was proposed in [18]. Additionally, this study and future research, adopting an individual differences approach could have implications such as enhancing the accuracy of information accessible to clinicians regarding bilingual development (e.g., to avoid overlooking a bilingual child who exhibits delays in both languages, because clinicians incorrectly anticipate that delays in both languages are typical).

5. Acknowledgements

This study was supported Australian Research Council grants awarded to the fourth author (CE140100041, FT160100514, LP210300631). We thank all children who participated in the study and their parents who provided consent for their participation. Special thanks to Anthony Serrano for his assistance with preliminary data pre-processing and analysis within his summer research internship under the supervision of the second and fourth authors, funded by the Western Sydney University Summer Scholarship program. We also thank Deeahn Sako for her help with data collection.

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