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Lexical Frequency in Heritage Speakers of Spanish: The Role of Language Exposure

Dámaris Mayans
Colby College
Waterville, Estados Unidos

Abstract
This study examines the impact of lexical frequency on grammatical agreement in heritage speakers of Spanish and a Spanish monolingual control group. Research has provided evidence of frequency effects when accessing nouns and this effect was proven to be more prominent in bilingual speakers. This investigation expands on the antecedent psycholinguistic research on lexical access through agreement operations carried out on monolingual speakers of Spanish by examining this effect in two populations of heritage speakers of Spanish that differ in relation to their dominance in Spanish. Experiment 1 was a Elicit Production Task and Experiment 2 was a Picture Description Task. Retrieval of grammatical gender features is needed in both tasks; therefore, lexical frequency plays a role in accessing this information. Reaction times analysis showed frequency effects in both bilingual populations and, as predicted by the Frequency-Lag Hypothesis, larger frequency effects in the less Spanish-dominant group. Results contribute to the understanding of processing mechanisms in adult bilingualism, particularly in heritage speakers of Spanish in the United States.
Key words: heritage speakers of Spanish; heritage languages; Frequency-lag Hypothesis; lexical frequency effects; lexical access.

Resumen
Frecuencia léxica en hablantes de español como lengua de herencia: el papel de la exposición lingüística
Este estudio examina el impacto de la frecuencia léxica en la concordancia de género en los hablantes de herencia y un grupo control de hablantes monolingües de español. La investigación previa ha constatado efectos de frecuencia cuando se accede al léxico nominal y se ha demostrado que este efecto es más prominente en hablantes bilingües. Este estudio amplía los resultados previos en la investigación psicolingüística sobre el

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acceso léxico en operaciones de concordancia de género que se ha realizado con monolingües de español examinando este efecto en dos poblaciones de hablantes de herencia del español que difieren en el nivel de dominio lingüístico de dicha lengua. El experimento 1 se trató de una tarea oral de producción inducida y el experimento 2, una tarea oral de descripción de imágenes. Dado que el acceso a las características de género es necesario en ambas tareas, la frecuencia léxica jugó un papel importante cuando se accedió a la información léxica de género. El análisis de los tiempos de reacción mostró efectos de frecuencia en ambas poblaciones bilingües y, como se predijo por la hipótesis *Frequency-Lag*, los efectos de frecuencia léxica fueron más prominentes en el grupo bilingüe menos dominante en español. Los resultados contribuyen al entendimiento del mecanismo de procesamiento en adultos bilingües y particularmente en los hablantes de herencia de español en los Estados Unidos.
Palabras clave: hablantes de español como lengua de herencia; lenguas de herencia; hipótesis *Frequency-Lag*; efectos de la frecuencia léxica; acceso léxico.

Résumé

Fréquence lexicale chez des locuteurs d'espagnol comme langue d'héritage : le rôle de l'exposition linguistique

La présente étude examine l'impact de la fréquence lexicale sur l'accord grammatical chez des locuteurs de langue d'origine espagnol et un groupe témoin monolingue espagnol. La recherche psycholinguistique antérieure a démontré des effets de fréquence lors de l'accès au lexique nominal. Cet effet s'est avéré plus important chez les locuteurs bilingues. Les résultats de la recherche antérieure sur l'accès lexique nominal avec opération d'accord de genre ont été élargis dans cette investigation à deux groupes de deux populations de locuteurs d'origine espagnole qui diffèrent par leur maîtrise de l'espagnol. L'expérience 1 consistait dans une production induite et l'expérience 2 dans une description d'image. La récupération des caractéristiques de genre grammaticales est nécessaire dans les deux expériences ; par conséquent, la fréquence lexicale joue un rôle dans l'accès à cette information. L'analyse des temps de réaction a montré des effets de fréquence dans les deux populations bilingues et, comme le prédit l'hypothèse de *Frequency-lag*, des effets de fréquence plus importants dans le groupe moins dominant en espagnol. Les résultats contribuent à la compréhension des mécanismes de traitement dans le bilinguisme adulte, en particulier chez les locuteurs de langue d'origine espagnole aux États-Unis.
Mots-clés : locuteurs de langue d'espagnole comme langue d'héritage ; langues d'héritage ; l'hypothèse de *Frequency-lag* ; fréquence lexicale ; l'accès lexical.

SOBRE LA AUTORA

Doctora en Lingüística Hispánica por la Universidad de Florida (Gainesville, USA) y profesora de lingüística y español en Colby College (Estados Unidos). Áreas de docencia: sociolingüística. Áreas de investigación: Hablantes de herencia del español, adquisición bilingüe y el español en contacto con otras lenguas.
Correo electrónico: dmayans@colby.edu

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INTRODUCTION

According to Valdés (2005), *Heritage speakers* (henceforth HSs) are "individuals raised in homes where a language other than English is spoken and who are to some degree bilingual in English and the heritage language" (p. 381). HSs and heritage languages differ in many ways from their monolingual norm. One of the factors studied in the present investigation that accounts for this difference between adult bilingualism and monolingualism is the level of exposure or input that speakers receive from the heritage language (henceforth HL). According to Grosjean (2008), the more domains in which a bilingual uses the HL and the more frequently they use and are exposed to the HL will lead to greater fluency. However, the domains in which HSs are exposed to the HL tend to decrease according to the generation they are born in, bilingualism in their community, education and governmental support of the HL. With regard to the generation they are born in, bilinguals born in the US from immigrant parents (second generation HSs) tend to have more monolingual input from their parents and/or grandparents and, thus, more linguistic domains than third generation HSs. This situation might differ when bilinguals are born from other bilingual speakers of Spanish (third generation HSs) since the shift of language use, from the HL to the societal language, might have occurred in that generation, thus reducing the number of domains or exposure to the HL for the children of those speakers.

The motivation of this study is to provide evidence of how language is processed when the input in the heritage language is reduced, in comparison to other bilingual contexts where both languages are functional in society (non-diglossic contexts). The present research uses psycholinguistic methodology to aid understanding of the interaction between language exposure and use of the HL in two bilingual populations and the effects of lexical frequency through agreement operations. In summary, this study tested two groups of bilingual HSs of Spanish born in the United States (whose parents or grandparents immigrated to the USA) who had different levels of exposure to Spanish while growing up and lexical frequency was the linguistic variable selected to study the effects of language exposure. Predictions and outcomes of these two bilingual populations will be discussed under the Frequency-Lag Hypothesis (Gollan et al., 2011) which assumes that bilingual patterns of language use, more or less exposure and use of the minority language, determine lexical effects in bilingual speakers in production tasks and consequently lexical accessibility.

Research on Monolinguals, Bilinguals and Frequency Effects

There is no extensive psycholinguistic research on the role of noun frequency in the retrieval of grammatical features in agreement operations with monolingual or bilingual speakers of Spanish. However, Navarrete et al. (2006) used two production experiments

to test access to gender with different noun frequencies. Experiment 1 was a picture description task where speakers had to describe the image that appeared on the screen using the following structure: demonstrative determiner + copula '*es*'+ adjective, e.g., *este/a es nuevo/a* ('this-DET.M/F.SG. (one) is new'-ADJ.M/F.SG.). The images that appeared on the screen were high frequency (henceforth HF) and low frequency (henceforth LF) nouns selected for the experiment, and they used two adjectives throughout the experiment ('new'/'old'). Response latencies were measured from picture presentations on the screen. Results indicated that the naming latency of the target sentence was affected by the frequency of the noun; that is, low frequency nouns elicited slower responses. Experiment 2 was a gender decision task in which participants had to decide the gender of a picture by pressing a button box. Results from Experiment 2 found frequency effects similar to those found in Experiment 1. Researchers interpreted these results as evidence of the role of lexical frequency in agreement operations, particularly in tasks where the lexico-syntactic information (gender of the noun) is necessary but without the production of the noun itself (lexeme retrieval).

With respect to bilingual speakers and frequency effects, Gollan et al. (2008) proposed the Weaker Links Hypothesis, more recently renamed as the Frequency-Lag Hypothesis (Emmorey et al., 2012; Gollan et al., 2011), which proposes that bilinguals do not perform as well as monolinguals in production tasks because they divide frequency-of-use between two languages. Bilinguals necessarily speak each language less often than monolinguals do, which results in frequency effects (slower and faster naming times) in both languages and particularly in their non-dominant language. The researchers based this account on production and comprehension models (despite only testing their model in production) that explain frequency effects by assuming that lexical representations store basic levels of activation with increased use (i.e., exemplar-based models). As mentioned in Gahl and Yu (2006), exemplar-based models suggest that "mental representations consist of memory traces of specific tokens" (p. 213). This concept is different from other models, such as the Underspecification Theory (Chomsky, 1993, 1995), that try to develop extremely simple, non-redundant representations as a way to economize "their conception of the lexicon and its grammatical interfaces" (Gahl & Yu, 2006, p. 213). Therefore, due to these levels of activation promoted by increased use, the Frequency-Lag Hypothesis predicts that monolinguals will exhibit the highest activation levels, and among bilinguals, the activation level will be higher in the speaker's dominant language than non-dominant language. In other words, the hypothesis predicts faster/slower noun retrieval according to language dominance in bilinguals and that monolinguals will exhibit the fastest retrieval since their level of activation will be the highest. Gollan et al. (2008) tested the Frequency-Lag Hypothesis in two production tasks, with the first task being of particular interest for the current investigation. They tested 57 English monolinguals and 73 Spanish-English bilinguals (57 bilingual speakers dominant in English and 16 bilingual speakers dominant in Spanish) using a picture naming task

that included high and low frequency nouns in English. Bilinguals showed overall slower naming time differences than monolinguals. The bilingual cost was greater for low-frequency words than for high-frequency words (even for bilingual speakers dominant in English). There was an interaction between language dominance and frequency category such that bilinguals showed larger frequency effects in the non-dominant language than in the dominant language. The results of this task provided direct support for the Frequency-Lag Hypothesis by showing that bilinguals are slower to name pictures than monolinguals and showing that the difference between groups is more pronounced for low-frequency words. That is, bilinguals showed larger frequency effects in picture naming because reduced language use affects low-frequency nouns more than high-frequency nouns.

Runnqvist et al.'s (2013) research also provides evidence of frequency effects on syntactic structures. In their study, researchers tested passive and active structures and pre- and post-modified possessive noun phrases in two groups of bilinguals (Spanish-English and Chinese-English). Findings were in line with previous results under the Frequency-Lag Hypothesis; that is, more frequent syntactic structures produced faster naming times than less frequent syntactic structures (Gollan et al. 2008; Gollan et al. 2011).

Recent off-line research has also focused on the effects of lexical frequency as a source of variability in heritage speakers of Spanish. Hur et al. (2020) tested the effects of lexical frequency in gender agreement and gender assignment in production and comprehension tasks. Participants in this study were heritage speakers of Spanish dominant in English, 22 were born in the United States and 17 were born in a Spanish speaking country and later immigrated to the US. Researchers administered an oral production task, specifically an elicited production task, where participants saw a picture and had to orally describe what they saw (e.g., *arroz blanco*, "white rice"). The second experiment, more metalinguistic in nature, was a forced choice task where participants saw a picture and had to orally choose between two given answers. Researchers used the Multilingual Naming Task (MINT) as a proficiency measure; that is, participants' vocabulary range as an index of proficiency in Spanish. Accuracy results showed that heritage speakers performed better with high frequency nouns than low frequency nouns in both gender assignment and gender agreement. Moreover, those participants who scored higher in the MINT and therefore were categorized as having greater proficiency, also had higher accuracy rates in the elicited production task. Surprisingly, these results were not extended to the forced choice task; that is, higher proficiency did not predict higher accuracy rates in the forced choice task. An additional recent study by Perez-Cortes (2020) investigated verbal frequency in mood selection. Results in this investigation, although statistically not significant, also indicated that heritage speakers were numerically more accurate when the matrix verb was lexically more frequent.

As presented above, psycholinguistic research on bilingual speakers and frequency effects has focused on access to lexico-semantic properties in noun retrieval

(Gollan et al., 2008; Gollan et al., 2005; Gollan et al., 2011) or lexico-syntactic information in sentence production (Runnqvist et al. 2013). Research using off-line methodologies has also investigated frequency effects in heritage speakers of Spanish in both syntactic structures (Perez-Cortes, 2020), and agreement operations (Hur et al., 2020) finding frequency effects in their accuracy results. However, frequency effects on the retrieval of lexico-syntactic features in agreement operations, as measured by participants reactions times, appears only to have been studied in monolinguals (Navarrete et al. 2006). The present investigation tested frequency effects in determiner-noun and noun-adjectival agreement using high- and low-frequency nouns in two bilingual populations that experienced reduced exposure of their heritage language, Spanish, while growing up (i.e. Heritage Speakers of Spanish).

The Present Study: Research Questions and Predictions

As stated above, the purpose of this study is to determine whether there is a bilingual cost, or frequency effect, in two distinct populations of heritage speakers of Spanish when accessing lexico-syntactic information in grammatical gender processing. The research questions and hypothesis are formulated as follows:

(1) What is the effect of noun lexical frequency in agreement operations?

As observed in the findings of Navarrete et al. (2006), faster response times for high frequency (HF) than low frequency (LF) nouns will be expected in both groups in both experiments. As in Experiment 2, in the present study, frequency effects will be observed in adjectival agreement, that is, gender information of the noun (lexico-syntactic information) will be accessed without naming the agreement source (the lexeme), expanding the results found in Navarrete et al. (2006).

(2) Does heritage speakers' language dominance impact the retrieval of lexico-syntactic information in agreement operations?

In line with previous research on monolingual and bilingual speakers that studied lexical access in oral production and with the Frequency-Lag Hypothesis (Gollan & Silverberg, 2001; Gollan et al., 2002; Gollan et al., 2008; Gollan et al., 2005; Sandoval et al., 2010), different frequency effects in the retrieval of gender features will be found between both bilingual groups (more and less Spanish-dominant speakers) and the monolingual group. Monolinguals will show the fastest naming times with HF and LF words and the smallest magnitude difference between HF and LF words. Among the bilingual groups, both bilingual groups will show greater difference with LF nouns than the monolingual control group. Within the bilingual groups, the more Spanish-dominant bilingual group will show the fastest naming times with HF and LF nouns and consequently the smaller

difference between HF and LF nouns. Accordingly, the less Spanish-dominant bilingual group will show smaller activation of HF nouns than the more Spanish-dominant bilingual group, leading to slower naming times.

METHODOLOGY

In order to test these hypotheses, two experimental tasks were carried out. The first experiment was a picture naming task where participants had to name in Spanish what appeared on the screen using the correct determiner. Experiment 2 was similar to the first experiment by Navarrete et al. (2006) and consisted of a picture description task where participants had to describe what appeared on the screen using only two adjectives agreeing with the noun referent. Further details on the experimental tasks, proficiency measures and screening tasks are provided in the next section.

Proficiency tests and background information

Self-reported Proficiency Measures: LEAP-Q and Language Background Questionnaire

Participants completed the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al. 2007) in Spanish. This questionnaire elicits self-reported information about the participant's linguistic background, such as age of acquisition or history of past and present language exposure and participant's self-reported language proficiency. As well as the LEAP-Q, participants also completed a short language background questionnaire (henceforth LBQ) that was designed by the experimenter to elicit additional information that the LEAP-Q did not prompt, such as self-reported dominance in the heritage language and usage of Spanish in writing, speaking and reading.

Standard Proficiency Measures: DELE, MELICET and MINT

Participants also completed several standard proficiency measures since self-reported proficiency can be unreliable for heritage speakers of Spanish. Therefore, to further assess proficiency in Spanish, monolinguals and bilinguals completed the DELE (*Diploma de Español como Lengua Extranjera;* Ministry of Education, Sports and Culture, Spain), a standardized Spanish grammar exam usually administered to second language learners of Spanish. The DELE version that was used in the experiment is an adapted test that consists of three sections, all multiple choice, with a total of 50 items that test grammar and vocabulary. The results of this test can be seen in Tables 2 and 3 in the participants' section.

English proficiency in the bilingual population was also measured via an adapted version of the standardized Michigan English Language Institute College English Test (MELICET; English Language Institute. University of Michigan). The version that was

used in the experiment consists of two parts, all multiple choice, with a total of 50 items that test grammar and vocabulary. The results of this test can be seen in Table 2.

Also, to determine Spanish dominance, the Multilingual Naming Task (MINT) (Gollan et al., 2012) was administered to bilingual speakers. This test is similar to the Boston Naming Task (BNT; Kaplan et al., 1983), but it was designed for bilingual speakers. The MINT has been shown to be a better evaluation of bilingual performance than the BNT; it avoids cognates, maximizes proficiency in language-specific knowledge, and diminishes influence from the non-target language (Gollan et al. 2012). The MINT scores were used to classify the bilingual participants into a more Spanish-dominant bilingual group (D+) based on a score higher than 34 in the MINT, and a less Spanish-dominant bilingual group (D-) based on a score lower than 34 in the MINT (See Table 2 for MINT mean scores and p-values). Results from the MINT determined that, among the HSs, 24 were more dominant in Spanish than the other 20 HSs in Spanish who scored lower than 34.

Experimental tasks

In experiment 1, participants were instructed to name the pictures with the corresponding definite article *el*-DET.M.SG or *la*-DET.F.SG (the) as quickly as possible using only the determiner and the noun. Experiment 2 was a picture description task similar to the one designed by Navarrete et al. (2006). Participants were presented with a picture stimulus on the screen and were instructed to use *borroso/borrosa* ('blurry'-*ADJ.M.SG* /'blurry'-ADJ.F.SG) or *claro/clara* ('clear'- *ADJ.M.SG* /'clear'- *ADJ.F.SG*) to describe each image that appeared on the screen. The adjective *borroso/a* was only used with the fillers. For both experiments, participants completed a 10-item practice set.

Vocabulary Test Experiment 2

This vocabulary test consists of providing the names with the corresponding article of the experimental pictures that appear in Experiment 2. The vocabulary test was carried out because Experiment 2 is a Picture Description Task, and participants did not provide the name of the item that they saw on the screen but were instructed to use *claro/a* ('clear'-masculine or feminine according to the stimulus presented) or *borroso/a* ('blurry'-masculine or feminine according to the stimulus presented). Therefore, participants needed to provide the name and the corresponding article of the experimental pictures to verify that they were familiar with the name of the picture and gender properties of the nouns. The results of this vocabulary test were considered during data coding to discard the noun trials where the speakers did not know the target referent or provided the incorrect article.

Participants

A total of 34 monolingual Spanish-speaking undergraduate students from Pontificia Universidad Católica Madre y Maestra (PUCMM) in the Dominican Republic (14 men, mean age= 20.8 years) voluntarily took part in the study. A total of 44 Spanish-English bilingual speakers from the University of Florida (17 men, mean age=19.8 years) participated for class credit. Monolingual and bilingual speakers were not significantly different in mean age (p = 0.06). As mentioned above, the Multilingual Naming Test (Gollan et al. 2012) was used to divide the bilingual group in two linguistic groups: a more dominant Spanish-speaking bilingual group (D+) and less dominant Spanish-speaking bilingual group (D-).

According to the information provided in the LBQ and LEAP-Q, all monolingual participants were born in the Dominican Republic and have lived there for their entire life. The monolingual data was collected in the Dominican Republic as the Caribbean Spanish spoken there is closer to that spoken by the bilingual participants who were tested in Florida. Bilingual participants were all born in the United States. Following Silva-Corvalan's (1994) criteria for classifying generation in HSs, 27 bilingual participants were second generation HSs since they were born in the US but not their parents. Seventeen bilingual participants were categorized as third generation HSs because they were born in the US as were their parents. Most of the Spanish-dominant bilinguals (D+) (as determined by Multilingual Naming Test) were second generation HSs (21) and only three bilingual speakers were third generation HSs. In the less dominant group (D-), there were 10 second generation HSs and 10 third generation HSs.

The monolingual control group self-reported to be dominant in Spanish, even when they self-reported to have some proficiency in English or another language. All bilingual participants reported to be dominant in English. In the LBQ, monolingual and bilingual participants assessed their Spanish and English frequency of use on a scale of 1 to 8 (where 1 was "everyday" and 8 was "never"). As expected, self-assessed Spanish usage was greater in the monolingual speaker group. In the LEAP-Q, the monolingual group self-reported to have a higher competence in Spanish than the HSs (both groups). Monolingual and bilingual participants also self-reported their exposure to Spanish in different linguistic contexts (family, friends, watching TV and listening to music, radio etc.). As anticipated, monolingual mean rates were higher in all linguistic contexts. Results from the DELE showed that monolingual speakers scored higher (=46.55), than HSs (both groups) (=24.45). DELE results correlated with the self-reported competence results (in comprehension, speaking and reading) for both monolinguals and heritage speakers of Spanish (both groups).

Below, Table 1 summarizes the monolingual and both HS groups' characteristics drawn from the LBQ, the LEAP-Q and DELE as well as p-values from the two-sample t-

tests carried out to determine whether mean rates were statistically different from each other.

Table 1. Mean averages and *p*-values for MSs' and HSs' results in the LEAP, LBQ and DELE

LBQ	MSs	HSs	*p*-value
Age	20.8	19.8	0.06
Self-reported dominance	Spanish	English	n/a
Spa. frequency of use (writing) 1-8 scale*	1.02	2.7	<0.001***
Spa. frequency of use (speaking) 1-8 scale*	1.05	2.1	<0.001***
Spa. frequency of use (reading) 1-8 scale*	1.7	3.6	<0.001***
LEAP			
Spa. self-rated prof. (speaking) 1-10 scale	9.2	8.1	<0.001***
Spa. self-rated prof. (comprehen.) 1-10 scale	9.2	8.7	<0.001***
Spa. self-rated prof. (reading) 1-10 scale	9.2	8.3	<0.001 ***
Spa. exposure/usage (family) 1-10 scale	9.96	8.4	<0.001***
Spa. exposure/usage (friends) 1-10 scale	9.5	4.9	<0.001***
Spa. exposure (watching TV) 1-10 scale	8.02	3.8	<0.001***
Spa. exposure (music/radio) 1-10 scale	8.1	4.6	<0.001***
Objective proficiency measures			
Prof. In Spa. (DELE) (out of 50)	46.55	24.45	<0.001***

*1=frequent, 8=infrequent (see paragraph above for details on this test)

Table 2 also provides the LBQ, LEAP-Q and MELICET results for the two bilingual groups (D+ and D-). In the LBQ, bilingual participants assessed their frequency of usage of Spanish and English and results showed that the more Spanish-dominant bilingual group (D+) self-reported a higher frequency of use of Spanish than the less Spanish-dominant bilingual group (D-) Spanish group. In the LEAP-Q, heritage speakers (D+) self-reported as having a higher competence in Spanish than the HSs (D-) group. As per exposure of Spanish in different contexts, HSs (D+) mean rates were also higher in all linguistic contexts than the HSs (D-). The DELE results show that mean rates of the more Spanish-dominant HSs (D+) were numerically higher than the less Spanish-dominant group (D-), but *p*-values showed no statistical significance between the bilingual groups. It is worth pointing out that in Table 2 there is a correlation between the MINT results and self-reported proficiency measure (LBQ and LEAP-Q), self-reported exposure and use of Spanish. In other words, those heritage speakers classified as more Spanish-dominant self-reported to have grown up using the minority language in more contexts as well as self-reported as having greater proficiency in the minority language than the less Spanish-dominant bilingual group. The Multilingual Naming Task (MINT; Gollan et al., 2012) proved to be a reliable tool in determining fluency as results correlated with the

self-reported proficiency measures as well as the self-reported exposure and frequency of use of Spanish. MELICET scores were numerically slightly higher for less Spanish-dominant group, but *p*-values showed no statistical significance between the bilingual groups.

Table 2. Mean averages and p-values for the two bilingual groups in the LEAP, LBQ, MINT, MELICET and DELE

LBQ	HSs (D+)	HSs (D-)	*p*-value
Age	19.9	19.75	0.463
Self-reported dominance	English	English	
Spa. frequency of use (writing) 1-8 scale*	2.04	3.55	<0.001***
Spa. frequency of use (speaking) 1-8 scale*	1.58	2.8	<0.001***
Spa. frequency of use(reading) 1-8 scale*	2.8	4.7	<0.001***
Eng. frequency of use (writing) 1-8 scale*	1.45	1.25	0.32
Eng. frequency of use (speaking) 1-8 scale*	1	1.1	0.16
Eng. frequency of use (reading) 1-8 scale*	1.54	1.4	0.54
LEAP			
Spa. self-rated prof. (speaking) 1-10 scale	8.7	7.4	<0.001***
Spa. self-rated prof. (comprehen.) 1-10 scale	9.5	7.8	<0.001***
Spa. self-rated prof. (reading) 1-10 scale	9.1	7.4	<0.001***
Eng. self-rated prof. (speaking) 1-10	9.7	9.8	0.49
Eng. self-rated prof. (comprehend.) 1-10 scale	9.9	9.95	1
Eng. self-rated prof. (reading) 1-10 scale	9.75	9.95	0.18
Spa. Exposure/usage (family) 1-10 scale	9.25	7.4	0.01*
Spa. Exposure/usage (friends) 1-10 scale	5.6	2.2	<0.001***
Spa. Exposure (watching TV) 1-10 scale	5.2	2.15	<0.001***
Spa. Exposure (music/radio)1-10 scale	6.25	2.8	<0.001***
Exposure to Eng. (family) 1-10 scale	1.91	5.55	<0.001***
Exposure to Eng. (friends) 1-10 scale	7.3	9.8	<0.001***
Exposure to Eng. (watching TV) 1-10 scale	7.8	9.2	0.03*
Exposure to Eng. (music/radio) 1-10 scale	7.75	9.15	0.02*
Objective proficiency measures			
Prof. In Spa. (DELE) (out of 50)	25.3	23.35	0.07
Prof. In Eng. (MELICET) (out of 50)	44.41	44.55	0.62
Dominance in Spa. (MINT) (out of 68)	45.6	28.3	<0.001***

*1=frequency, 8=infrequency (see paragraph above for details on this test)

Materials and Design

The materials for the two experiments consisted of 142 color drawings depicting the stimuli selected for the experiment. All experimental pictures were color pictures obtained from Google. In experiment 2, 36 pictures were blurred using an online photo

editor. Only the filler pictures were blurred. Prior to administering the actual experiments, a pilot study with the stimuli and images was carried out with 10 bilingual speakers of Spanish to ensure that the pictures chosen for the experiments were representative of the referent, as well as to avoid dialectal variation and remove (and replace) items that did not produce the target response.

The stimuli consisted of two experimental lists, with each list containing 44 experimental items, 88 fillers and 10 practice pictures, resulting in a total of 142 pictures. Half of the experimental noun items were feminine (22) and half masculine (22) and the lists were balanced in the number of nouns with opaque and transparent endings. The lists were controlled for noun frequency, word length (number of letters), noun morphology, gender, imageability and concreteness. Two-tailed t-tests corroborated that there were not significant differences between the two lists of experimental items with regard to word length (p =.69), imageability (p =.85) and concreteness (p =.32). Likewise, a two-tailed t-test with the lists of fillers was carried out to ensure that there were not significant differences. Lexical frequency was obtained from the ESPAL database[1] (Duchon et al., 2013). High Frequency nouns were those nouns that had a frequency of more than 30 per million occurrences and low frequency nouns had fewer than 30 per million occurrences. Mean frequency from all HF and LF items in each list was subtracted to ensure that there were no overlapping frequencies between the HF and LF items. A two-tailed t-test corroborated that there was a significant difference between HF and LF items in each list, verifying that there was not an overlap in frequency between HF and LF nouns.

Procedure

Participants filled in and signed the consent form at the beginning of the session. Then, the two background questionnaires were administered followed by the experimental tasks. Pictures from both experimental tasks were presented using E-Prime 2.0 (SP1, Psychology Software Tools, Pittsburgh, PA). Naming times were recorded using an Audio-Technica AT1200 microphone connected to a response box. Both groups of participants completed the tasks using the same experimental set up. Correct and incorrect responses were verified manually. Each test began with a 500 ms. fixation cross (+) in the middle of the screen immediately followed by the picture. The pictures appeared in color at the center of the screen. Participants started the experiment by pressing the space bar. Reactions times were recorded when participants provided an oral response to the stimuli that appeared on the screen.

Instructions were given in Spanish and the experimenter used Spanish throughout the session. After completing the two experimental tasks, monolingual participants

[1] http://www.bcbl.eu/databases/espal/index.php.

completed the vocabulary test and the DELE. HS participants completed the vocabulary test, the MELICET and the MINT test.

RESULTS

The independent variables reported in both experiment analyses are Frequency (within-subject variable) and Group (between-subject variable) with Monolingual speakers, more Spanish-dominant bilinguals (D+ bilinguals) and less Spanish-dominant bilinguals (D- bilinguals). Frequency was treated as a categorical variable since, as mentioned in the methods section, the stimuli (high frequency and low frequency nouns) did not overlap in frequency distribution. A repeated measures ANOVA was carried out to obtain the statistical significance of the data. The following sections outline the results for the RT analysis.

Experiment 1 Results: Determiner + Noun Agreement

In this experiment, reaction time (RT) analyses were conducted on correct responses only. A response was accepted as correct if participants could name the picture that appeared on the screen with the correct article *el* or *la* before the picture disappeared from the screen (3000 ms.). Responses with *un* or *una* ('a'/'an') were also accepted. Correct responses after self-correction were not accepted. Answers that were not clear due to lack of audibility or unclear pronunciation were discarded.

RTs Analysis: Monolinguals, D+ and D- Bilinguals

Mean picture naming times indicated that monolinguals were on average faster than the two bilingual groups with both high and low frequency nouns. Between the bilingual groups, the more Spanish-dominant bilingual group (D+ bilinguals) was on average faster than the less Spanish-dominant bilingual group (D- bilinguals) who showed, on average, the slowest naming times. Also, numerically, the greater difference in naming times between high and low frequency nouns was shown by the less Spanish-dominant group. Below, Table 3 shows the mean picture naming times and standard error (SE) for Experiment 1 RTs analysis.

Table 3. Experiment 1 mean RTs in ms. and SE split by frequency

Group	Freq.	Means	SE
Mono	High	847.5	8.08
Mono	Low	1177	14.0
D+	High	951.46	10.3
D+	Low	1654.03	13.9
D-	High	1058.20	14.5
D-	Low	1889.25	32.1

To assess the statistical significance of the results, a repeated-measures ANOVA using R (R core team, 2015, version 3.1.3) was conducted with a 2 x 3 factorial design with the within-subject factor of Frequency (High versus Low) and the between-subjects factor of Group (Monolinguals, D+ Bilinguals, D- Bilinguals). Results of this model are presented in Table 4.

Table 4. Experiment 1 three-groups 2 x 3 repeated-measures ANOVA output

Effect	DFn	DFd	F	*p*
Group	2	70	89.645	<0.001***
Frequency	1	70	532.791	<0.001***
Group:Frequency	2	70	42.457	<0.001***

As the output shows, there was a main effect for Group ($F(2,70) = 89.645$, $p = 0.001$) and Frequency ($F(1,70) = 532.791$, $p = 0.001$). There was also an interaction by Group x Frequency ($F(2,70) = 42.457$, $p = 0.001$).

Given this interaction, a separate analysis of the monolingual and the bilingual group comparison was conducted. Specifically, a repeated-measures ANOVA was carried out with a 2 x 2 factorial design with the within-subject factor of Frequency (High versus Low) and the between-subjects factor of Group (Bilinguals D+, Bilinguals D-). Below are the results of this model (Table 5).

Table 5. Experiment 1 bilingual group comparison 2 x 2 x 2 repeated-measures ANOVA output

Effect	DFn	DFd	F	*p*
Group	1	38	19.987	<0.001***
Frequency	1	38	690.656	<0.001***
Group:Frequency	1	38	6.882	<0.001***

As the output shows and looking at the direction of the results in Table 3, Group was significant ($F(1,38) = 19.987$, $p = 0.001$) indicating that the more Spanish-dominant

group (D+ bilinguals) were faster than the less Spanish-dominant group (D- bilinguals). Also, Frequency was significant ($F(1,38) = 690.636$, $p = 0.001$) indicating a frequency effect in all participants. Also, the interaction between Group and Frequency ($F(1,38) = 6.882$, $p = 0.001$) was significant indicating that frequency effects were greater in the less Spanish-dominant group. In addition, a separate analysis of each bilingual group was conducted to observe the effect individually and the output showed a main effect of Frequency in both bilingual groups.

Experiment 2 Results: Adjectival Agreement

This experiment was a picture description task. Participants were presented with a picture stimulus on the screen and were instructed to use *borroso*/*borrosa* ('blurry'-*ADJ.M.SG.* /'blurry'-ADJ.FEM.SG.) or *claro*/*clara* ('clear'- *ADJ.M.SG.* /'clear'- *ADJ.F.SG.*) to describe what appeared on the screen, using only the adjective. Only responses with the target referent were included in the analysis. In experiment 2, RTs analyses were also conducted on correct responses. A response was accepted as correct if participants could describe the picture that appeared on the screen using *claro*/*a* ('clear'-ADJ. M/F. SG.) according to the agreeing referent. Correct responses after self-correction were not accepted. Answers which were not clear due to lack of audibility or unclear pronunciation were discarded.

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RTs Analysis: Monolingual, D+ and D- Bilingual Group

Overall mean average times (Table 6) showed that high frequency conditions were responded to faster than low frequency conditions. Both bilingual groups had greater differences in RTs between high frequency and low frequency nouns than the monolingual group and, among the bilingual groups, the D- bilingual group showed the greatest difference. Numerically, among the bilingual groups, the D- bilinguals had the slowest naming times naming adjectives for low frequency nouns. The greater magnitude difference between high frequency and low frequency noun trials was produced by both bilingual groups.

Table 6. Experiment 2 mean picture naming times and SE split by frequency

Group	Freq.	Means	SE
Mono	High	1052.88	6.92
Mono	Low	1331.27	13.8
D+	High	1028.02	6.94
D+	Low	1758.49	10.6
D-	High	1189.92	10.1
D-	Low	2120.39	28.5

Statistical analysis was also carried out. To assess the statistical significance of the results, a repeated-measures ANOVA using R (R core team, 2015, version 3.1.3) was conducted with a 2 x 3 factorial design with the within-subjects factor of Frequency (High versus Low) and the between-subjects factor of Group (Monolinguals, D+ bilinguals, D- bilinguals). Below the results of this analysis (Table 7).

Table 7. Experiment 2 three-groups 2 x 3 repeated-measures ANOVA output

Effect	DFn	DFd	F	*p*
Group	2	73	43.071	<0.001 ***
Frequency	1	73	545.040	<0.001 ***
Group:Frequency	2	73	57.908	<0.001***

As the output shows and based on the numerical patterns of Table 6, the Group factor was significant (F (2,73) = 43.071, p = 0.001). Frequency was also significant as was the interaction between Group and Frequency (F(2,73) = 57.908, p = 0.001). This indicates that the impact of Frequency was different between the groups.

Given this interaction, a separate analysis of the subgroups was conducted. Specifically, a repeated-measures ANOVA was conducted with a 2 x 2 factorial design with the within-subject factor of Frequency (High versus Low) and the between-subjects factor of Group (D+ bilinguals, D- bilinguals). Below the results of this analysis (Table 8).

Table 8. Experiment 2 bilingual group comparison 2 x 2 repeated measures ANOVA output

Effect	DFn	DFd	F	*p*
Group	1	40	13.800	<0.001***
Frequency	1	40	375.352	<0.001***
Group:Freq.	1	40	9.485	<0.001***

In this model and based on the direction of the results from Table 6, there was a main effect for Group (F(1,40) = 13.800, p = 0.001) indicating an advantage in naming times for D+ bilinguals. Frequency (F(1,40) = 375.352, p = 0.001) was also significant, along with

Group x Frequency interaction ($F(1,40) = 9.485$, $p = 0.001$) indicating that the D+ bilinguals were faster than the less Spanish-dominant group (D-). A separate analysis of the monolingual group also indicated that Frequency was significant ($F(1,33) = 195.238$, $p = 0.001$).

DISCUSSION

The results of both experiments clearly support the predictions of our first research question. Frequency effects were present overall in the three group RTs analysis of Experiment 1 (Determiner-noun agreement) and Experiment 2 (noun-adjective agreement). Monolingual speakers of Spanish, as well as the bilingual groups, showed faster naming times with high frequency nouns than low frequency nouns, as seen in Navarrete et al. (2006), expanding these results out to two different agreement operations not previously tested using on-line methods. Additionally, further evidence was provided that the lexico-syntactic information (noun gender information) is activated in cases such as in Experiment 2 (adjectival agreement), where the agreement source (the noun) is not part of the speech production.

Regarding our second research question, as predicted by the Frequency-Lag Hypothesis (Gollan & Silverberg, 2001; Gollan et al., 2002; Gollan et al., 2008; Gollan et al., 2005; Sandoval et al., 2010), a larger frequency effect was observed in bilingual speakers than monolingual speakers of Spanish. Results from Experiments 1 and 2 indicated that both bilingual groups were slower than monolingual speakers, and that this effect was more prominent with low frequency nouns. These results confirmed the so-called bilingual lexical frequency 'disadvantage' in lexical access. Furthermore, a highest magnitude frequency effect in the less Spanish-dominant group was predicted and, in line with the prediction, the less Spanish-dominant group showed larger frequency effects, with the effect larger for low frequency nouns. More importantly, the Frequency-Lag Hypothesis states that patterns of language use determine lexical accessibility. As seen in our findings, the group that showed decreased lexical accessibility (the less Spanish-dominant bilingual group) was also the group that self-reported to have been exposed to Spanish less frequently and in fewer contexts. Accordingly, the more Spanish-dominant group self-reported to have grown up with greater exposure to the heritage language and more linguistic domains in which Spanish was used, than the less Spanish-dominant group, leading to more lexical accessibility.

CONCLUSION

The present investigation found frequency effects in gender processing, expanding the findings of Navarrete et al. (2006) to pre-nominal and post-nominal agreement operations previously only investigated in heritage speakers using off-line methodologies (Hur et

al., 2020). Our results support the Frequency-Lag Hypothesis (Emmorey et al., 2012; Gollan et al. 2012), revealing that bilingual performance differs from the monolingual norm but also differs within bilingual groups, providing evidence for the variability of linguistic skills among bilingual speakers. By comparing two groups of heritage speakers of Spanish with different language dominance, this study provided evidence of the cognitive factors (frequency effects and word activation) that vary between bilinguals due to societal factors such as levels of exposure to the minority language while growing up bilingual.

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