HHS Public Access
Author manuscript
Biling (Camb Engl). Author manuscript; available in PMC 2019 May 01.

Published in final edited form as:
Biling (Camb Engl). 2018 May ; 21(3): 479–488. doi:10.1017/S1366728917000694.

Why is Lexical Retrieval Slower for Bilinguals? Evidence from Picture Naming*

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Abstract

Proficient bilinguals demonstrate slower lexical retrieval than comparable monolinguals. The present study tested predictions from two main accounts of this effect, the frequency-lag and competition hypotheses. Both make the same prediction for bilinguals but differ for trilinguals and for age differences. 200 younger or older adults who were monolingual, bilingual, or trilingual performed a picture naming task in English that included high and low frequency words. Naming times were faster for high than for low frequency words and, in line with frequency lag, group differences were larger for low than high frequency items. However, on all other measures, bilinguals and trilinguals performed equivalently, and lexical retrieval differences between language groups did not attenuate with age, consistent with the competition view.

Keywords

Multilingualism; Aging; Picture naming; Word frequency; Lexical retrieval

One of the central paradoxes in bilingualism research is that this linguistic experience improves performance on nonverbal cognitive tasks but makes language processing more effortful (for review, Bialystok, Craik, Green, & Gollan, 2009). Bilinguals show poorer performance than monolinguals on picture naming (for adults: Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, Slattery, Goldenberg, van Assche, Duyck, & Rayner, 2011; Ivanova & Costa, 2008; for children: Poarch & Van Hell, 2012a) and verbal fluency tasks (for adults: Bialystok, Craik, & Luk, 2008a; Gollan, Montoya, & Werner, 2002; Pelham & Abrams, 2014; Portocarrero, Burright, & Donovick, 2007; Rosselli et al., 2000; Sandoval, Gollan, Ferreira, & Salmon, 2010; for children: Friesen, Luo, Luk, & Bialystok, 2015) that require rapid lexical retrieval. Moreover, bilingual children (Bialystok, Luk, Peets, & Yang, 2010) and adults (Bialystok & Luk, 2012) typically have smaller vocabularies than monolingual speakers of each language.

*This research was supported by grant R01HD052523 from the US National Institutes of Health and grant A2559 from the Natural Sciences and Engineering Council of Canada to EB, and grant 91506561 from the German Academic Exchange Service (DAAD) to GJP. We thank Cari Bogulski, Ashley Etherington, Zehra Kamani, Yolanda Prescott, Devora Goldberg, Jazmine Rei Que, Ryan Barker, and Mira Aminuddin for their assistance with the study, as well as all of our participants.

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It is not clear how smaller vocabulary for bilinguals would lead to slower retrieval times. Verbal fluency studies that equate monolinguals and bilinguals for vocabulary level have found that both language groups perform equivalently on category fluency, supporting the role of vocabulary size in performance, but bilinguals *outperform* monolinguals on letter fluency (Bialystok, Craik, & Luk, 2008b; Luo, Luk, & Bialystok, 2010). Therefore, vocabulary size cannot explain why lexical retrieval is more effortful for bilinguals than monolinguals.

Two explanations have been proposed to account for the robust effects of slower bilingual lexical retrieval: the frequency-lag account (originally "weaker links"; Gollan et al., 2005, 2008, 2011) and the competition account (Abutalebi & Green, 2007; Green, 1998; Kroll & Gollan, 2014). According to frequency-lag, lexical retrieval is slower for bilinguals because they use words from each language less frequently than monolinguals, making concept-word connections less automatic or "weaker" (Gollan et al., 2008, p. 788). Greater experience with using a language should increase overall frequency of access over time, and in theory reduce lexical retrieval differences between bilinguals and monolinguals. Thus, the frequency-lag account explains slower lexical retrieval primarily in terms of a linguistic experience.

The competition account is based on the finding that both languages are jointly activated in bilingual minds, a claim supported by behavioral (Beauvillain & Grainger, 1987; Francis, 1999; Hermans, Bongaerts, de Bot, & Schreuder, 1998), eye-tracking (Marian, Spivey, & Hirsch, 2003), ERP (Martin, Dering, Thomas, & Thierry, 2009), and fMRI evidence (Rodriguez-Fornells, Rotte, Heinze, Nösselt, & Münte, 2002). On this view, slower word retrieval in bilinguals is caused by the need to resolve conflict between cross-language competitors. Although the mechanism for selection is still a matter of debate, it is likely rooted in domain-general attention (for discussion, see Bialystok, 2015). Thus, the competition for production account explains slower lexical retrieval primarily in terms of a cognitive experience.

Identifying the source of differences in lexical retrieval is essential to understanding the mechanism underlying cognitive differences attributable to bilingualism (for review, Bialystok, 2017). The explanation from frequency-lag is inherent to linguistic processing, but the explanation from competition provides a bridge between linguistic and cognitive processing. Such a link could potentially explain nonverbal cognitive differences between language groups.

Both accounts make similar predictions for bilingual picture naming but diverge for trilinguals. Trilinguals use each of their languages less than bilinguals because usage is divided across three languages, so connections should be weaker than for bilinguals and, therefore, retrieval even slower. However, the need to resolve conflict between competing options is likely similar for bilinguals and trilinguals, so there should be no difference between groups; studies comparing monolingual, bilingual, and trilingual children performing executive function tasks have found that both multilingual groups outperform monolinguals with no difference between bilinguals and trilinguals (Poarch & Bialystok, 2015; Poarch & Van Hell, 2012a, 2012b). If anything, trilinguals may have more efficient selection mechanisms than bilinguals because of the need to select among three jointly-activated languages rather than two, although there is no evidence at present to decide if this is the case. Therefore, trilinguals provide critical evidence for deciding between competing accounts for bilingual lexical retrieval, a resolution that contributes to understanding bilingual language and cognitive processing more broadly.

Empirical evaluation of these two accounts requires considering two further factors that affect picture naming latencies: word frequency and aging. For monolinguals, word retrieval is slower for low than high frequency words (Almeida, Knobel, Finkbeiner, & Caramazza, 2007; Forster & Chambers, 1973; Oldfield & Wingfield, 1965), an effect that may be exacerbated for multilinguals. Gollan et al. (2008) asked younger and older Spanish-English bilinguals and English monolinguals to name pictures with high and low frequency names. Both bilingualism and aging resulted in slower naming, with larger language group differences for low frequency items than high and this frequency effect was consistent across age groups. Ivanova and Costa (2008) reported corroborating evidence using a group of Spanish-Catalan bilinguals and Spanish monolinguals, again demonstrating that there was a larger language group difference for low frequency items than for high. Therefore, in both studies, low-frequency words were retrieved more slowly than high-frequency words, with larger word frequency differences for bilinguals than monolinguals (reviews by Runnqvist, Strijkers, Sadat, & Costa, 2011; Sadat, Martin, Magnuson, Alario, & Costa, 2016, for the contribution of additional variables to slower bilingual lexical access).

With aging, older adults take longer to name pictures (Britt, Ferrara, & Mirman, 2016; Gordon & Cheimariou, 2013; Verhaegen & Poncelet, 2013), independently of changes in speed of processing (Verhaegen & Poncelet, 2013), and are more error-prone (Feyereisen, 1997; Kavé, Samuel-Enoch, & Adiv, 2009; Newman & German, 2005) than younger adults. Older adults tend to show similar effects of word frequency as young adults for picture naming accuracy (Newman & German, 2005) and latency (LaGrone & Spieler, 2006), and for lexical decision tasks (Allen, Madden, Weber, & Groth, 1993; Bowles & Poon, 1981; Tainturier, Tremblay, & Lecours, 1989). Mixed results are shown when older and younger adults are asked to read words out loud, with frequency effects found in younger but not in older adults (Morrison, Hirsh, Chappell, & Ellis, 2002) or stronger frequency effects with aging (Balota & Ferraro, 1993; Spieler & Balota, 2000). Stronger frequency effects with aging have also been reported for spoken word recognition (Revill & Spieler, 2012). Older adults also experience increased tip of the tongue states (TOT, Burke, MacKay, Worthley, & Wade, 1991). To explain this, Burke and colleagues proposed the Transmission Deficit model (TDM, Burke et al., 1991; Burke, 1999) arguing that with age, there are weaker connections between lexical and phonological nodes resulting in inadequate priming between the two systems and subsequent problems with word retrieval. Burke (1999) points out, however, that reduced lexical access may also reflect age-related problems with inhibitory control (Hasher & Zacks, 1988) resulting in inadequate suppression of interfering words.

These two factors help to distinguish between the frequency lag and competition accounts in explaining slower lexical retrieval in bilinguals. For aging, both accounts predict slower performance by older adults but different outcomes for language background. In the frequency-lag account, accumulated experience by older adults will lead to an attenuation of language group differences because concept-word associations would have reached a threshold of automaticity; in the competition account, there will continue to be language group differences across age because the need for selection and conflict resolution does not erode with years.

Predictions for word frequency are also different under the two accounts. For the frequency-lag view, the combination of low word frequency and low practice in retrieval should make low frequency words disproportionately more difficult to retrieve for bilinguals and trilinguals than high frequency words, leading to a word frequency by language group interaction. In the competition view, the additional retrieval time required for selection between jointly activated alternatives should not vary with word frequency. Therefore, there will be slower retrieval for low than high frequency words, but no interaction between word frequency and language group. Regarding accuracy, language group differences in vocabulary should be reflected as better performance by monolinguals than the other two language groups. Older adults are expected to show lower accuracy than younger adults (cf., Feyereisen, 1997). However, because older adults consistently show higher vocabulary scores than younger adults (cf., Verhaegen, 2003), the expected age-related declines in lexical production accuracy do not reflect vocabulary knowledge but rather correspond to increased rates of word finding failures with aging (Burke et al., 1991; see also Ramscar, Hendrix, Shaoul, Milin, & Baayen, 2014).

Method

Participants

The final sample[1] of 200 participants included 106 young adults (40 monolinguals, 44 bilinguals, and 22 trilinguals), and 94 older adults (52 monolinguals, 20 bilinguals, and 22 trilinguals). Young adults were recruited from an undergraduate participant pool and older adults from the community.

Participants completed the Language and Social Background Questionnaire[2] (LSBQ; Anderson, Mak, Keyvani Chahi, & Bialystok, 2017) to assess background experience and language use. The non-English languages of the bilingual and trilingual participants included a range of languages with no one language over-represented[3]. All bilinguals and trilinguals reported high levels of fluency and regular use of all their languages (See Table 1

[1]In total 223 participants completed the task, of whom 23 were excluded from analyses due to unclear language background (9 older adults), intelligence score < 70 (2 young monolinguals, 1 young bilingual), verbal score < 70 (1 older monolingual, 5 young bilinguals, 2 young trilinguals), missing background data (1 young adult, 1 older adult), or severe vision problem (1 older adult).

[2]In the present study an earlier version of the LSBQ was used than that described in Anderson et al. (2017). The scales are slightly different but comparable.

[3]The non-English languages of the bilingual group included Albanian (3), Arabic (2), Cantonese (3), Farsi (6), Finnish (1), French (7), German (4), Greek (2), Gujarati (1), Guyanese (1), Hindi (2), Hungarian (1), Korean (1), Maltese (1), Mandarin (3), Patois (1), Polish (2), Portuguese (2), Punjabi (3), Romanian (1), Russian (2), Serbian (1), Singhalese (1), Spanish (8), Tagalog (2), Twi (1), and Urdu (2). The first non-English language of the trilingual group included Afrikaans (1), Albanian (1), Armenian (1), Cantonese (6), Dutch (1), Estonian (1), Farsi (3), French (3), Fukien Chinese (3), Hebrew (2), Hungarian (1), Mandarin (2), Marathi (2), Polish (1), Portuguese (1), Romanian (1), Russian (1), Sindhi (1), Spanish (2), Swiss German (1), Tagalog (2), Tamil (1), Ukrainian (1), Urdu (4), and Yiddish (1). The second non-English language of the trilingual group included Azerbaijani (1), Cantonese (2), French (6), German (3), Greek (1), Hebrew (1), Hiligaynon (1), Hindi (4), Hungarian (1), Italian (2), Mandarin (6), Punjabi (1), Russian (2), Sinhalese (1), Spanish (6), Swedish (1), Tagalog (3), Turkish (1), and Yiddish (1).

for age of acquisition (AoA), proficiency ratings, and English usage ratings; Table 2 for frequency of English as L1 and contexts where languages were used). As the picture naming task was performed in English, two-way ANOVAs for age group and language group were conducted on English AoA and English proficiency ratings. For English AoA, there was a main effect of language group, $F(2, 194) = 58.45$, $p < .0001$, $\eta^2_p = .38$, in that monolinguals learned English significantly earlier than bilinguals or trilinguals, with no difference between the multilingual groups. There was no effect of age group, $F < 1$, or interaction of age and language group, $F < 2.9$. For English proficiency ratings, there was a main effect of language group, $F(2, 194) = 15.65$, $p < .0001$, $\eta^2_p = .14$, in that monolinguals had higher ratings than both bilinguals and trilinguals, with no difference between the multilingual groups. Note, however, that all English proficiency ratings were at 90 or higher for all groups. There was no main effect of age, $F < 1.9$, or interaction of age and language group, $F < 2.9$. Finally, to assess whether bilinguals and trilinguals had differential usage of English, English usage with family, friends, and community were examined using two-way ANOVAs for age group and language group. For English usage with family, there was a main effect of age group, $F(1, 104) = 44.65$, $p < .0001$, $\eta^2_p = .30$, in that older adults indicated using English more with family than younger adults, but no main effect of language or interaction with age, Fs < 1. There were no main effects or interactions for English usage with friends, Fs ≤ 1, or for English usage in the community, Fs < 3.9. These values indicate that all groups were highly proficient in English and used English extensively in their daily lives. However, by the logic of the frequency lag account, multilinguals had to divide their language usage across more languages than bilinguals who in turn used less of each language than monolinguals.

Tasks[4]

Background measures—Younger participants completed the PPVT-III (Dunn & Dunn, 1997) and KBIT-2 (Kaufman & Kaufman, 2004) to assess English receptive vocabulary and nonverbal fluid intelligence. Older adults completed the Shipley-2 Institute of Living Scale Verbal and Blocks (Shipley, Gruber, Martin, & Klein, 2009).

Picture Naming Task—The task consisted of 132 black-and-white drawings (66 low frequency and 66 high frequency) from the IPNP database (Székely et al., 2004). Stimuli from the two frequency lists were matched on number of syllables, number of letters, percent name agreement, visual complexity, imageability, number of phonemes, and initial phoneme type (plosive versus non-plosive), but differed on noun subtlex frequency, CELEX frequency (Brysbaert & New, 2009; Brysbaert, New, & Keuleers, 2012), and age-of-acquisition (Table 3). The task was programmed using E-prime software (version 2.0, Psychology Software Tools). For each trial, a black fixation cross (+) appeared against the white background for 1000 ms, followed by the picture for 3000 ms or until the participant responded; afterwards a black minus sign appeared in the center of the screen until the experimenter coded the accuracy of the participant's response using a Serial Response Box (Psychology Software Tools, Inc.). Inaccurate/timed out trials and trials with RTs faster than 300 ms were excluded from analyses. Within-subject relative trimming using a threshold of

[4]The picture naming task was incorporated into ongoing studies, so participants also completed other cognitive tasks.

2.5 *SD*s was performed on RTs[5]. Voice-key error trials on which the microphone was prematurely triggered prior to the production of a response were included in accuracy analyses but excluded from RT analyses. The number of voice-key errors did not differ by group, *F*s < 3.0.

Results

Background measures are presented in Table 4. Two-way ANOVAs for age group and language group were conducted on each measure. For English vocabulary, older adults scored higher than younger adults, $F(1, 194) = 34.93$, $p < .0001$, $\eta^2_p = .15$, and monolinguals scored higher than bilinguals and trilinguals, $F(2, 194) = 7.95$, $p < .0006$, $\eta^2_p = .08$, who did not differ from each other, with no interaction, $F < 1$.

For nonverbal intelligence, there were no main effects, *F*s < 1, but a significant interaction of age group and language group, $F(2, 194) = 8.93$, $p < .0003$, $\eta^2_p = .08$. For young adults, monolinguals scored lower than the other two groups, $F(2, 103) = 6.66$, $p < .002$, $\eta^2_p = .11$, but there was no difference between language groups for older adults, $F(2, 91) = 2.81$, n.s. Years of education indicated more education by older adults, $F(1, 194) = 97.9$, $p < .0001$, $\eta^2_p = .34$, and an effect of language group, $F(2, 194) = 4.29$, $p < .02$, $\eta^2_p = .04$, in which bilinguals ($M = 13.9$, $SD = 2.0$) had fewer years of education than trilinguals ($M = 14.9$, $SD = 2.1$), with no difference between monolinguals ($M = 14.2$, $SD = 2.2$) and the other two groups, and no interaction, $F < 1$. Due to group differences in nonverbal intelligence and education, a correlation was run between these variables and average RT and average accuracy on picture naming. None of the correlations was significant ($\text{range}_{\text{absolutevalue}}$ $r = .01$ to $r = .10$) so no further adjustment was made in the analyses.

Accuracy scores from picture naming are presented in Table 4 and RT results are displayed in Figure 1. Scoring was carried out using both an exact method where only the pre-designated picture name was considered correct and a liberal method where synonyms were also accepted. There were no differences between these methods in RT outcomes, but the liberal method produced higher accuracy scores. Therefore, all data are reported using the exact method since it is more objective.

A three-way ANOVA on accuracy for age group, language group, and word frequency showed main effects of age group, $F(1, 194) = 17.97$, $p < .0001$, $\eta^2_p = .08$, and language group, $F(2, 194) = 29.20$, $p < .0001$, $\eta^2_p = .23$, with no interaction, $F = 0.54$. Contrasts indicated that young adults were more accurate than older adults and monolinguals were more accurate than bilinguals or trilinguals, with no difference between the multilingual groups. There was a main effect of word frequency, $F(1, 194) = 59.17$, $p < .0001$, $\eta^2_p = .23$, that interacted with age group, $F(1, 194) = 7.27$, $p < .008$, $\eta^2_p = .04$, and language group, $F(2, 194) = 11.07$, $p < .0001$, $\eta^2_p = .10$, but the three-way interaction was not significant, $F < 1.4$. To understand the 2-way interactions, word frequency effects were examined separately by age and language group. For age group, both younger, $F(1, 105) = 49.61$, $p < .0001$, η^2_p

[5]Within-subject relative trimming resulted in the removal of 1.4% trials for young monolinguals, 2.3% trials for young bilinguals, 1.6% trials for young trilinguals, 1.0% trials for old monolinguals, 2.4% trials for old monolinguals, and 2.3% for old trilinguals.

= .32, and older adults, $F(1, 93) = 5.99$, $p < .02$, $\eta^2_p = .06$, were more accurate on high than low frequency words, but the effect was larger in younger adults. For language group, there was no effect of word frequency for monolinguals, $F = 1.71$, but bilinguals, $F(1, 63) = 32.23$, $p < .0001$, $\eta^2_p = .34$, and trilinguals, $F(1, 43) = 27.82$, $p < .0001$, $\eta^2_p = .39$, were more accurate on high frequency words.

A three-way ANOVA for age group, language group, and word frequency for RTs showed main effects of age group, $F(1, 194) = 6.24$, $p < .02$, $\eta^2_p = .03$, with faster performance by young adults, and language group, $F(2, 194) = 12.37$, $p < .0001$, $\eta^2_p = .11$, with faster performance by monolinguals than the other two groups, who did not differ from each other. There was no interaction of age group and language group, $F < 1.3$. There was a main effect of word frequency, $F(1, 194) = 155.71$, $p < .0001$, $\eta^2_p = .45$, with high frequency words producing faster RTs than low frequency words, and an interaction of word frequency and language group, $F(2, 194) = 4.91$, $p = .008$, $\eta^2_p = .05$, that is plotted in Figure 1. The difference between frequency levels was significant for monolinguals, $F(1, 91) = 67.45$, $p < .0001$, $\eta^2_p = .43$, bilinguals, $F(1, 63) = 53.54$, $p < .0001$, $\eta^2_p = .46$, and trilinguals, $F(1, 43) = 64.66$, $p < .0001$, $\eta^2_p = .60$, so the interaction is likely due to the difference in effect size for language group for the high, $F(2, 197) = 7.25$, $p < .001$, $\eta^2_p = .07$, and low frequency items, $F(2, 197) = 13.90$, $p < .0001$, $\eta^2_p = .12$. In both cases, the contrasts showed faster times for monolinguals than the other two groups, but there is a wider gap between groups for low frequency words. No other interactions were significant, *F*s < 1.

Although the 3-way interaction was not significant, it appears visually in Figure 1 that older bilinguals and trilinguals performed more similarly to each other than did the younger bilinguals and trilinguals. Therefore, we re-analyzed the data separately by age group. For young adults, there was a main effect of language group, $F(2, 103) = 4.49$, $p < .01$, with monolinguals responding faster than bilinguals and trilinguals between them and not significantly different from either. For older adults, there was a main effect of language group, $F(2, 91) = 7.13$, $p < .001$, with monolinguals responding faster than bilinguals and trilinguals and no difference between these latter two groups. Typically, however, the results of the whole model should take precedence in the interpretation.

Discussion

The goal of the present study was to adjudicate between the frequency-lag and competition accounts of lexical retrieval to understand the links between linguistic and cognitive processing in bilinguals. The crucial evidence is whether trilinguals have a greater deficit than bilinguals due to reduced frequency of usage across languages, as predicted by frequency lag, or a comparable or smaller deficit than bilinguals, as predicted by competition. The frequency lag view further predicts an interaction between word frequency and language group, and an interaction between age and language group whereas the competition view does not.

For both accuracy and reaction time, monolinguals outperformed bilinguals and trilinguals with no difference between these two groups. In a follow-up analysis of RT, young trilinguals performed partway between monolinguals and bilinguals, with no significant difference to either. Thus, aging did not attenuate lexical access for multilinguals through accumulated experience, as predicted by frequency lag. This pattern is consistent with the conflict account.

Regarding word frequency, accuracy data conformed to the frequency lag view in that there was an interaction between word frequency and language group. Word frequency did not affect monolingual accuracy but both multilingual groups were more accurate on high than low frequency items, with no difference between the bilinguals and trilinguals. These language group differences in accuracy likely reflect stronger English vocabulary in monolinguals than multilinguals.

All three language groups demonstrated word frequency effects for RT showing faster naming times for high frequency words, although the magnitude of the difference changed across groups. However, the effect was similar for bilinguals and trilinguals, a finding in line with the competition view. Moreover, differences in lexical retrieval between language groups did not attenuate with age, supporting competition.

The finding that low frequency items elicited larger language group differences than high frequency items means that linguistic processing is fundamental to understanding multilingual word retrieval. Nonetheless, competition provided a stronger account of the data and was in line with the majority of the outcomes. Therefore, the current data provided support for both models, indicating an interaction between linguistic and cognitive processing in lexical retrieval. Although the involvement of linguistic factors on a language task is not surprising, evidence for the substantial role of cognitive processing has great consequence, not only in terms of providing a more complete description of the phenomenon but also in terms of providing a link to help identify the mechanism by which bilingualism affects cognitive outcomes.

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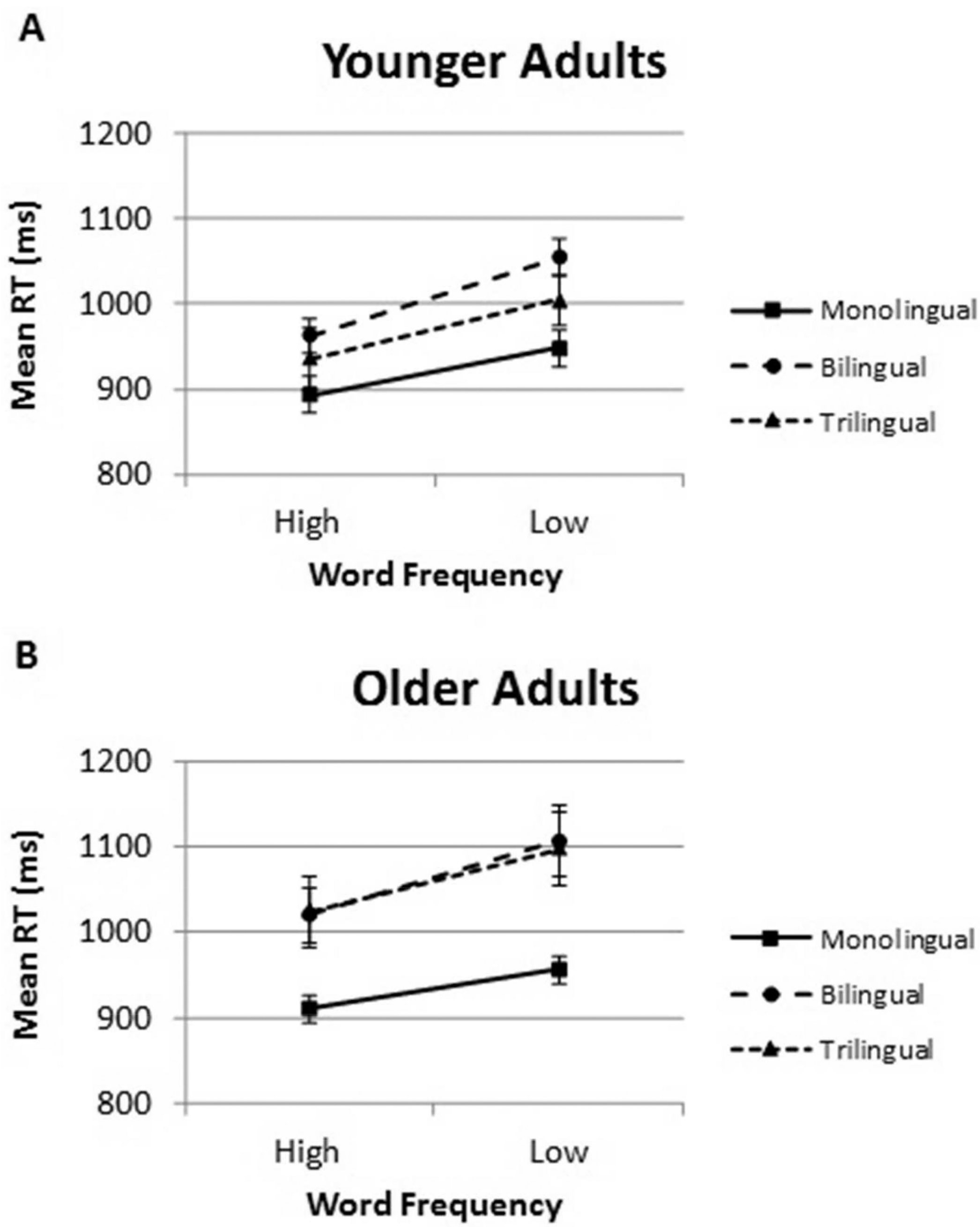

Figure 1.
Mean RT (and standard error) for naming high and low frequency words by language group for (A) younger adults and (B) older adults.

Table 1

Language background measures by age group and language group.

	Younger Adults						Older Adults					
	ML (*N* = 40)		BL (*N* = 44)		TL (*N* = 22)		ML (*N* = 52)		BL (*N* = 20)		TL (*N* = 22)	
	n	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**	***n***	***M* (*SD*)**
English AoA	40	0.8 (1.3)	44	6.1 (5.3)	22	5.8 (4.1)	52	0.5 (1.2)	20	5.5 (4.7)	22	8.3 (4.8)
Non-English Language 1 AoA	10	9.8 (5.4)	44	0.8 (2.2)	22	1.9 (2.3)	33	16.7 (15.4)	20	1.7 (3.7)	22	2.3 (3.7)
Non-English Language 2 AoA	4	10.0 (5.9)	7	9.6 (6.9)	22	6.4 (6.7)	12	20.5 (19.5)	10	18.1 (13.6)	22	8.7 (8.6)
Non-English Language 3 AoA	0	.	0	.	7	11.4 (8.0)	2	38.0 (32.5)	6	23.8 (14.5)	16	14.8 (13.6)
English Proficiency	40	99.8 (1.0)	44	93.1 (9.6)	22	90.1 (13.3)	52	98.7 (3.8)	20	93.3 (9.3)	22	95.7 (7.7)
Non-English Language 1 Proficiency	13	12.9 (11.0)	44	90.3 (13.6)	22	93.2 (9.1)	33	13.6 (11.0)	20	86.3 (14.0)	22	97.0 (4.8)
Non-English Language 2 Proficiency	3	1.7 (2.9)	7	23.2 (6.1)	22	79.1 (15.8)	12	7.7 (8.5)	10	26.6 (12.7)	22	82.0 (16.7)
Non-English Language 3 Proficiency	0	.	0	.	9	36.7 (30.5)	2	16.3 (12.4)	6	15.8 (9.6)	16	57.6 (29.9)
English Usage with Family	40	1.1 (4.6)	44	67.8 (25.7)	22	67.2 (26.9)	52	0.8 (3.8)	20	25.1 (32.0)	22	31.7 (33.9)
English Usage with Friends	40	0.4 (2.4)	44	26.0 (21.6)	22	33.2 (21.1)	52	0.3 (1.4)	20	29.1 (24.0)	22	31.3 (27.3)
English Usage in the Community	40	2.8 (2.6)	44	10.0 (5.3)	22	9.8 (4.4)	52	0.1 (0.2)	20	9.7 (13.6)	22	20.5 (26.3)

Note. Self-report ratings of proficiency range from 0 = “no proficiency” to 100 = “fully fluent” and usage from 0 = Always English to 100 = Always Non-English. Proficiency averages are based on ratings of speaking and understanding. Participants were classified into their respective language group based on proficiency profiles of: one, two, or three languages, using a cut-off criterion of 50 as the LSBQ allows participants the option to provide ratings based on any language exposure throughout one’s lifetime. Monolingual Proficiency Ranges: English (Min = 80, Max = 100), Non-English Language 1 (Min = 0, Max = 35), Non-English Language 2 (Min = 0, Max = 30), Non-English Language 3 (Min = 7.5, Max = 25). Bilingual Proficiency Ranges: English (Min = 62.5, Max = 100), Non-English Language 1 (Min = 50, Max = 100), Non-English Language 2 (Min = 5, Max = 45), Non-English Language 3 (Min = 0, Max = 30). Trilingual Proficiency Ranges: English (Min = 60, Max = 100), Non-English Language 1 (Min = 75, Max = 100), Non-English Language 2 (Min = 50, Max = 100), Non-English Language 3 (Min = 5, Max = 100).

Table 2

Language background frequency measures by age group and language group.

	Younger Adults						Older Adults					
	ML (*N* = 40)		BL (*N* = 44)		TL (*N* = 22)		ML (*N* = 52)		BL (*N* = 20)		TL (*N* = 22)	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Indicated English as L1[a]	40	100.0	28	63.6	14	63.6	52	100.0	15	75.0	13	59.1
Learned English: Home	39	97.5	14	31.8	4	18.2	50	96.2	8	40.0	6	27.3
Learned English: School	25	62.5	41	93.2	21	95.5	29	55.8	19	95.0	16	72.7
Learned English: Community	12	30.0	16	36.4	2	9.1	22	42.3	3	15.00	6	27.3
Learned English: Other	0	0.0	1	2.3	1	4.6	0	0.0	0	0.0	0	0.0
Use English: Home	40	100.0	22	50.0	12	54.6	52	100.0	16	80.0	14	63.6
Use English: School	39	97.5	41	93.2	21	95.5	51	98.1	20	100.0	19	86.4
Use English: Community	25	62.5	8	18.2	6	27.3	48	92.3	16	80.0	16	72.7
Use English: Other	14	35.0	34	77.3	13	59.1	4	7.7	5	25.0	5	22.7
Learned Non-English Language 1: Home	2	5.0	43	97.7	20	90.9	2	3.9	17	85.0	15	68.2
Learned Non-English Language 1: School	9	22.5	24	54.6	8	36.4	29	55.8	6	30.0	10	45.5
Learned Non-English Language 1: Community	0	0.0	13	29.6	4	18.2	0	0.0	4	20.0	8	36.4
Learned Non-English Language 1: Other	0	0.0	3	6.8	1	4.6	2	3.9	1	5.0	0	0.0
Use Non-English Language 1: Home	1	2.5	43	97.7	20	90.9	3	5.8	16	80.0	16	72.7
Use Non-English Language 1: School	5	12.5	14	31.8	9	40.9	23	44.2	10	50.0	9	40.9
Use Non-English Language 1: Community	0	0.0	7	15.9	0	0.0	3	5.8	11	55.0	10	45.5
Use Non-English Language 1: Other	1	2.5	30	68.2	17	77.3	9	17.3	8	40.0	8	36.4
Learned Non-English Language 2: Home	1	2.5	2	4.6	9	40.9	3	5.8	0	0.0	11	50.0
Learned Non-English Language 2: School	4	10.0	2	4.6	11	50.0	8	15.4	8	40.0	10	45.5
Learned Non-English Language 2: Community	0	0.0	1	2.3	2	9.1	0	0.0	1	5.0	7	31.8
Learned Non-English Language 2: Other	0	0.0	1	2.3	5	22.7	2	3.9	1	5.0	1	4.6
Use Non-English Language 2: Home	1	2.5	1	2.3	8	36.4	2	3.9	1	5.0	7	31.8
Use Non-English Language 2: School	4	10.0	2	4.6	9	40.9	5	9.6	7	35.0	9	40.9

	Younger Adults						Older Adults					
	ML (*N* = 40)		**BL** (*N* = 44)		**TL** (*N* = 22)		**ML** (*N* = 52)		**BL** (*N* = 20)		**TL** (*N* = 22)	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Use Non-English Language 2: Community	0	0.0	0	0.0	0	0.0	3	5.8	1	5.0	9	40.9
Use Non-English Language 2: Other	0	0.0	4	9.1	21	95.5	2	3.9	6	30.0	12	54.6
Learned Non-English Language 3: Home	.	.	.	.	0	0.0	0	0.0	1	5.0	2	9.1
Learned Non-English Language 3: School	.	.	.	.	4	18.2	2	3.9	4	20.0	11	50.0
Learned Non-English Language 3: Community	.	.	.	.	1	4.6	0	0.0	0	0.0	5	22.7
Learned Non-English Language 3: Other	.	.	.	.	3	13.6	0	0.0	1	5.0	2	9.1
Use Non-English Language 3: Home	.	.	.	.	1	4.6	0	0.0	1	5.0	1	4.6
Use Non-English Language 3: School	.	.	.	.	3	13.6	2	3.9	4	20.0	5	22.7
Use Non-English Language 3: Community	.	.	.	.	0	0.0	0	0.0	0	0.0	6	27.3
Use Non-English Language 3: Other	.	.	.	.	3	13.6	0	0.0	3	15.0	8	36.4

[a] *L1*. Language listed first when asked to list known languages in order of fluency.

Note. *Other* responses included: Family, Friends, Roommate, Work, Travel, Classes, Self-instruction, Prayer, Phone Use, Reading, Media, Music, CDs, Movies, and TV.

Table 3

Stimuli characteristics by frequency used in the picture naming task.

Variable	Low Frequency	High Frequency	*p*-value
Freq1 subtlex	247 (123)	5477 (6537)	$p < .001$
Freq2 CELEX	2.0 (0.8)	4.3 (1.1)	$p < .001$
AoA	5.3 (1.2)	4.5 (1.1)	$p < .001$
Syllables	1.6 (0.7)	1.5 (0.6)	$p = .35$
Letters	5.4 (1.7)	5.1 (1.2)	$p = .19$
Name agreement	0.9 (0.1)	0.9 (0.1)	$p = .60$
Visual complexity	16048 (7144)	18083 (9640)	$p = .17$
Imageability (100–700)	589 (32)	596 (34)	$p = .25$
Number of phonemes	4.3 (1.4)	4.0 (1.1)	$p = .15$
Initial phoneme (1=Plosive/2=Non-plosive)	1.6 (.5)	1.6 (.5)	$p = .38$

Note. Freq1 subtlex: The frequency of the word as noun in Brysbaert and New (2009); Brysbaert et al. (2012).
Freq2 CELEX: Natural logarithm of the Celex frequency, as reported in the original IPNP database.
AoA: Age-of-acquisition ratings in Kuperman, Stadthagen-Gonzalez, and Brysbaert (2012).
Name Agreement: Percent name agreement, as reported in the original IPNP database.
Visual Complexity: Estimates of objective visual complexity, as reported in the original IPNP database.
Imageability Rating: As reported in the MRC Psycholinguistic Database.

Table 4

Means score (and SD) on background measures and accuracy as % correct (and SD) for picture naming by age group and language group.

	Younger Adults				Older Adults			
	ML	BL	TL	Language Effect	ML	BL	TL	Language Effect
n	40	44	22		52	20	22	
Age	19.9 (3.0)	20.7 (3.1)	21.2 (3.8)	n.s.	72.6 (5.2)	74.1 (4.9)	71.6 (5.1)	n.s.
Vocabulary	102.0 (10.6)	96.6 (11.1)	93.8 (12.4)	ML > BL & TL	109.9 (7.1)	103.7 (10.7)	106.1 (10.4)	ML > BL & TL
Nonverbal IQ	95.6 (10.4)	103.9 (13.5)	106.2 (14.1)	ML < BL & TL	105.2 (13.9)	99.3 (15.2)	98.3 (8.9)	n.s.
Years of Education	12.6 (0.9)	13.1 (1.4)	13.7 (1.6)	BL < TL	15.4 (2.2)	15.6 (2.1)	16.1 (1.8)	BL < TL
High Frequency % Accuracy	90.3 (4.6)	84.8 (6.1)	82.2 (6.9)	ML > BL & TL	83.4 (4.7)	73.2 (15.8)	76.9 (15.2)	ML > BL & TL
Low Frequency % Accuracy	87.6 (7.4)	74.8 (13.6)	74.1 (14.6)	ML > BL & TL	83.9 (7.3)	69.8 (17.6)	69.8 (16.2)	ML > BL & TL

Note. Raw vocabulary and nonverbal scores were converted to standardized scores based on a population mean of 100 and a standard deviation of 15.