Dual-Dimension Naming Speed and Language-Dominance Ratings by Bilingual Hispanic Adults

Henriette W. Langdon
San José State University

Elisabeth H. Wiig
Boston University (Emerita)

Niels Peter Nielsen
Department of Psychiatry, Hvidovre Hospital,
Copenhagen, Denmark

Abstract

This study compared the efficacy of measures of naming speed, verbal fluency and self-ratings for establishing language dominance in 25 bilingual English–Spanish adults with college degrees. Naming speed was measured by total naming times (in seconds) for five *Alzheimer's Quick Test* tasks (Wiig, Nielsen, Minthon & Warkentin, 2002) and verbal fluency with the *Word Listing by Domain* (Lambert, Havelka, & Crosby, 1958; Fishman & Cooper, 1969). Self-ratings of English–Spanish competence (listening, speaking, reading, and writing) and frequency of use of each spoken language served as standards for comparisons. For the aggregate sample, color–form, color–animal, and color–object naming times were significantly shorter for English than Spanish ($p < .01$). There was 100% agreement in language-dominance judgments between self-ratings of language competence and frequency of use, and color–form, color–animal, and color–object naming-time differences in the two languages. *Word Listing by Domain* quotients for language dominance showed a lower degree of agreement (52%) with self-ratings and naming-time differences. The findings suggest that cross-linguistic comparisons of naming times for color–form, color–animal, and color–object naming may be helpful in screening adults for language dominance for psychoeducational assessment purposes.

Introduction

Many factors influence language dominance in multilingual speakers. Among them are the timing of learning each language (simultaneous or sequential), the duration and frequency with which each language is being used, the language used in the home and/or professional setting, and the facility with which a given speaker acquires a new language (Baker, 2001; Cummins, 1984; Romaine, 1995). Therefore, it is not a simple task to establish which of two or more languages available to a speaker maintains the dominant position. The objectives of this study were to compare the efficacy of naming speed for repeated visual stimuli, verbal fluency, and self-ratings of language dominance for English or Spanish by bilingual and biliterate adults**.** We used test results and self-ratings to evaluate which measures would best identify the dominant language. We were especially interested in exploring relationships between measures of (a) naming and cognitive speed (attention, working memory, verbal automaticity), validated to be mediated by temporal–parietal lobe activation (Wiig, Nielsen, Minthon, & Warkentin, 2002), (b) verbal fluency and language-dominance ratios (Fishman & Cooper, 1969; Lambert, Havelka, & Crosby,1958), and (c) self-ratings of competence and frequency of use of English and Spanish.

Assessment of Language Dominance

Language dominance is a common construct, used to determine the language in which special testing needs to be carried out to assess academic, cognitive, or language performance (Kayser, 1995; Langdon, 1992). *Word Listing by Domain (WLD)* (Fishman & Cooper, 1969; Lambert et al., 1958) is a classic and commonly used measure for assessing language dominance in bilingual speakers. In the context of *WLD*, the term *language dominance* is used to indicate the language in which retrieval of words from different semantic classes is most fluid when specific domains (e.g., home, school, street) are used for elicitation. Language dominance is, however, not a static concept, and it may vary depending on the specific domain or function considered or the context for acquiring the languages. Thus, Lambert and associates suggest that a bilingual speaker achieves greater ability to separate languages when they are learned in different cultural and linguistic contexts as compared to a more homogeneous environment (i.e., within the same context only separated by time or person).

The *WLD* language-dominance quotient, one of the experimental measures in this study, is obtained with procedures that are similar to those of verbal fluency and word association tests. As an example, the FAS verbal fluency test (Benton & Hamsher, 1977) elicits lexical words that begin with given letters (F, A, and S). In comparison, the *WLD* test elicits names for items found

in four common, culturally familiar contexts. Both the FAS and *WLD* provide timed measures of the quantity of different words produced within a given time period. The *WLD* requires an active search of the stored vocabulary for members from given semantic classes within a minute time period for each category, and this search is mediated by frontal and left temporal–parietal lobe activation (Frith, Friston, Liddle, & Frakowick, 1991; Hillyard, 2000). The FAS verbal fluency test requires an active search of the stored lexicon for words that begin with given letters. The word search is mediated by activation of prefrontal regions of the brain, and the FAS is classified as an executive function test (Benton & Hamsher, 1977; Delis, Kaplan, & Kramer, 2001; Warkentin, Risberg, Nilsson, Karlson, & Graae, 1991). Because the *WLD* is a word fluency test for members of semantic classes and broader cortical regions mediate performance, it can be considered to be a combination executive and verbal function test. *WLD* primarily captures the size of the internalized vocabulary and the ability to conduct an accurate and speedy internal search for semantic class members. Differences in the quantity of production in two languages form the bases for calculating the *WLD* language-dominance quotient.

We used five dual-dimension naming tasks from the *Alzheimer's Quick Test: Assessment of Parietal Function (AQT)* (Wiig, Nielsen, Minthon, & Warkentin, 2002) to obtain timed measures of naming speed for English and Spanish. The *AQT* tasks are objective, highly reliable, independent of habituation and learning, and free of gender, Western cultural, or educational biases after Grade 6 (Wiig, Nielsen, Minthon, & Warkentin; Wiig, Nielsen, Minthon, McPeek, Said, & Warkentin, 2002). Age is a minimal factor, as naming time increases only 1 second per decade below age 60 (Jacobson, Nielsen, Minthon, Warkentin, & Wiig, 2004).

AQT color–form naming (e.g., red circle, blue square) is associated with increased bilateral activation of the posterior temporal and parietal regions. Thus, parametric statistical comparisons between regional cerebral blood flow (rCBF) patterns in normal adults during *AQT* color–form naming and open-eyed rest indicate significant bilateral increases in blood-flow values in the temporal–parietal–occipital regions and suppressed blood flow in the frontal cortex (Wiig, Nielsen, Minthon, & Warkentin, 2002; Wiig, Nielsen, Minthon, McPeek, Said, & Warkentin, 2002). The "normal" rCBF pattern for color–form naming concurs with neuroimages during performance of visual input tasks that require implicit working memory (Baddeley, 1986; Downing, 2000; Engle, 2001, 2002; Fockert, Rees, Rith, & Lavie, 2001; Furey, Pietrini, & Haxby, 2000; Robbins, Mehta, & Sahakian, 2000). The pattern is recognized as a hallmark of the involvement of attention, speed and efficiency of processing, and working memory for visual input and engagement of the "visual-spatial sketchpad" (Baddeley). *AQT* color–form naming also measures automaticity of word retrieval, mediated by the posterior temporal cortex.

The established brain-behavior relationship for color–form naming and the statistical characteristics suggested that the *AQT* naming tasks may provide objective measures of language dominance and/or equivalence in bilingual adults. We hypothesized that one or more of the *AQT* naming-time measures might complement currently used word association and other measures of language dominance.

Rationale of the Study

The notion of using dual-dimension naming measures, which elicit bilateral activation of the temporal–parietal regions, to evaluate and compare naming speed and estimates of levels of language dominance in adults may at first glance appear farfetched. However, this notion is supported by research discussed by Goldberg (2001). Goldberg suggests that both cerebral hemispheres are involved in cognitive processes and that "hemispheric specialization is but two parallel variations of the same basic theme" (p. 53). In support of this notion, Goldberg cites research that supports that the right hemisphere is involved in pattern recognition during early learning of, among other things, language when stimuli and tasks are novel. The left hemisphere gets involved when stimuli and patterns are familiar and serves to establish automaticity (routinization) of the task. This transfer from right to left is considered to continue throughout life, according to the "novelty-routinization principle" (Goldberg, pp. 40–52).

Goldberg's (2001) *novelty-routinization transfer* theory and rCBF observations of bilateral cortical activation of the temporal–parietal regions during color–form naming supported the use of the *AQT* for objective evaluation of language dominance (Wiig, Nielssen, Minthon, & Warkentin, 2002; Wiig, Nielsen, Minthon, McPeek, Said, & Warkentin, 2002). We hypothesized that total time for naming familiar, early acquired stimuli (colors, forms, numbers, letters, animals, and/or objects) in the two languages of bilingual adults may differ as a function of the relative degree of novelty (right hemisphere) versus established automaticity (left hemisphere) of each language. This hypothesis received additional support from recent research of the laterality of languages in bilingual adults (Evans, Workman, Mayer, & Crowley, 2002). The research was conducted with four groups of English–Welsh bilingual adults, who differed in the ages and environments for the acquisition of the secondary language. By using a split visual field paradigm, the researchers obtained results that supported the notion of right-hemisphere processing of the later learned and left hemisphere processing of the earlier learned language. In other words, the study supported Goldberg's novelty-routinization transfer principle for language processing. It also suggested that a verbal measure such as the *AQT*, which is associated with bilateral cortical activation, might

differentiate processing speed and efficiency (i.e., attention, perceptual speed, working memory, and verbal automaticity) and competence in two languages spoken by bilingual adults.

Based on this prior research, we hypothesized that among bilingual speakers, any dominant language (e.g., English, Spanish) would be established with a greater degree of automaticity than a non-dominant language. We also assumed that differences in the degree of automaticity for two spoken languages could be measured indirectly by comparing total naming times (in seconds) for the *AQT* tests, especially those in which colors were combined with forms, numbers, letters, animals, or objects for dual-dimension naming.

Method

Participants

There were 25 bilingual adults in the sample. All used English and Spanish in professional contexts, were literate in both languages, and resided in California. Their ages ranged from 23 to 40 years (mean 29.8 years), and participants had completed a college education. Based on biographical information, the participants formed a heterogeneous group with regard to perceived language dominance (English or Spanish). This was intended due to the exploratory nature of the study.

Materials and Performance Criteria

The five rapid-naming tasks in the *AQT* (Wiig, Nielsen, Minthon, & Warkentin, 2002) were the primary experimental tasks. Each naming task consists of three separate tests, and each task takes about 3 minutes to administer and score. The two first tests in each task require rapid naming of 40 repeated single-dimension visual stimuli from the same semantic category (e.g., color or form). They measure perceptual speed (attention and verbal automaticity) and serve as priming for the dual-dimension tests. The visual stimuli for Test 1 in each task are randomized, repeated colors (black, blue, red, and yellow). For Test 2 of each task, the visual stimuli are: Task A, forms (circle, line, square, and triangle); Task B, numbers (2, 4, 5, and 7); Task C, letters (a, b, e, k, m, o, p, and t); Task D, animals (bird, cat, fish, rat, snake, and spider); and Task E, objects (bed, chair, shoe, table, and pencil). The third test in each task requires rapid naming of 40 repeated stimulus combinations (e.g., colors combined with forms, numbers, letters, animals, or objects) and measures cognitive speed, that is, perceptual speed + cognitive overhead (cognitive shifting between semantic categories and working memory for visual stimuli). All visual stimuli are prototypical, highly familiar, and applicable across Western cultures.

A priori, a criterion of 10 or more seconds between parallel test (English and Spanish) naming times was set to indicate a significant difference. This criterion was determined based on means and standard deviations (*SD*s) for normative data from monolingual samples of adult speakers of English ($n = 135$) and related Scandinavian languages (Danish, Norwegian, Swedish) ($n = 30$) (Wiig, Nielsen, Minthon, & Warkentin, 2002). In the normative samples, a naming-time difference of 10 seconds reflected a separation of 1.5 *SD* or more in naming speed. Accordingly, 10 or more seconds in favor of either English or Spanish resulted in judging the language with the shortest total naming time (in seconds) to be dominant. The speaker's verbal automaticity for English and Spanish was considered to be equivalent and to reflect balanced language dominance, if the difference was 9 or fewer seconds.

The second experimental task was the *WLD* (Lambert et al., 1958; Fishman & Cooper, 1969), a timed word-association test. The *WLD* requires rapid retrieval and naming of associated words from within four contexts: (a) the kitchen, (b) the street, (c) a church, and (d) a school, within a minute (see Appendix A). A formula is used to determine a ratio or language-dominance quotient. A speaker is considered to be a balanced bilingual if the ratio lies between .4 and .6. Ratios below .4 are considered to indicate dominance in English, while ratios above .6 indicate dominance in Spanish.

A personal data questionnaire for bilingual speakers (Langdon, 2002) was also administered (see Appendix B). The questionnaire asks for (a) information about the participant's bilingual history; (b) self-ratings on a 5-point Likert scale of language competence in English and Spanish for comprehension, speaking, reading, and writing; and (c) estimates of the percentages of time spent in comprehension, speaking, reading, and writing English and Spanish during a typical week.

Criteria for dominant-language competence and frequency of use of English and Spanish were developed a priori. Self-rating values for competence were calculated by summing the ratings (between 1 and 5) for English and Spanish comprehension, speaking, reading, and writing separately. The maximum total rating score for each language was therefore 20 points. A total score between 15 and 20 points was assigned as showing "competence" for the given language. Ratings between 10 and 14 were considered to show "relative competence," between 5 and 9 "partial competence," and between 1 and 4 "inadequate competence." If the two overall ratings of English and Spanish differed by one or more competence levels, the language with the highest overall rating was considered dominant. As an example, a rating of 18 for English, indicating competence, and 11 for Spanish, indicating relative competence, was judged to indicate dominance for English. On the other hand, if the overall ratings for English and Spanish language competence were within the same competence level, the speaker would be considered to

show balanced language dominance. None of the participants rated his or her overall competence in English or Spanish as "inadequate."

The estimates of frequency of use in percentages were also categorized to reflect relative differences. Thus, estimates of between 75% and 100% use were judged to indicate "prevalent use." Estimates between 50% and 74% were judged as "frequent use," between 25% and 49% as "intermittent use," and estimates between 1% and 24% as "infrequent use." Again, if the frequency of use estimates fell within the same category, the use was judged as balanced. If the estimates differed by one or more frequency categories, the use was judged to be unbalanced, and the language with the highest use estimate was considered dominant. None of the participants gave frequency of use estimates between 1% and 24% (i.e., infrequent use). Furthermore, the language-dominance estimates based on ratings of competence and frequency of use concurred for all but one participant.

Administration and Data Analyses

Licensed, bilingual speech-language pathologists or educational specialists administered the *AQT* naming tests (Wiig, Nielsen, Minthon, & Warkentin, 2002), *WLD* word association test (Lambert et al., 1958; Fishman & Cooper, 1969), and self-rating questionnaires individually. The instructions for the *AQT* tests were to name each of the 40 visual stimuli on a test plate as fast and accurately as possible, as if reading from a page (Wiig, Nielsen, Minthon, & Warkentin, pp.15–18, pp. 63–68). The total naming time for each test plate was timed digitally, beginning at voice onset and ending after the last spoken syllable. For the *WLD*, the instructions were to name as many examples from each given context within a timed minute (Fishman & Cooper, p. 277). The order of test administrations in English and Spanish was alternated among participants to minimize order effects.

The significance of mean differences in naming times (in seconds) between English and Spanish was evaluated with paired-sample *t*-tests. Subsequently, correlation coefficients (Pearson *r*) were calculated between English and Spanish naming times for each test. Paired-sample tests of differences in *AQT* naming-times for parallel tests in English and Spanish were performed to obtain time-difference measures. A priori criteria for time differences considered to reflect English-, Spanish-, or balanced language dominance were then applied, as were criteria for judging self-ratings of language competence and frequency of use. The self-ratings of competence and frequency of use for English or Spanish were subsequently used as standards for determining the degree of agreement with dominance assignments based on *WLD* quotients or *AQT* naming-time differences.

Results

Descriptive statistics, significance of mean differences between English and Spanish naming times (in seconds), and English–Spanish paired time differences for the aggregate sample are reported in Table 1. Paired-sample *t*-tests for mean differences indicated significantly shorter naming times (in seconds) in English than in Spanish for colors, forms, numbers, letters and animals ($p < .05$), but not for objects. English and Spanish naming times differed significantly for color–form, color–letter and color–object combinations ($p < .01$), and color–number and color–animal combinations ($p < .05$). The significant differences were in the direction that *AQT* dual-dimension stimuli were named with greater speed and automaticity in English than in Spanish. However, individual naming-time differences, and therefore

Table 1

Alzheimer's Quick Test (AQT) Descriptive Statistics, Paired Sample t-Tests, and Paired Time Differences (English–Spanish) (in seconds) (N = 25)

AQT	English		Spanish		*t*	English–Spanish differences	
	Mean	*SD*	Mean	*SD*		Mean	*SD*
Color	23.50	4.60	27.23	5.71	-2.67*	-3.72	6.54
Form	25.45	5.46	29.42	7.05	-2.20*	-4.27	9.09
Color–form	50.40	12.28	59.76	14.29	-3.25**	-9.36	14.41
Number	15.23	3.24	18.14	4.12	-2.82*	-2.91	4.84
Color–number	43.82	10.94	46.09	9.74	-0.97*	-2.27	11.02
Letter	15.68	3.00	19.45	6.31	-2.77*	-3.78	6.38
Color–letter	47.36	9.40	52.59	9.80	-2.90**	-5.23	8.47
Animal	31.00	6.96	36.14	9.74	-2.80*	-5.14	1.83
Color–animal	55.24	15.38	62.48	11.92	-2.56*	-7.24	14.12
Object	30.55	6.34	31.95	5.62	-1.01ns	-1.41	6.57
Color–object	42.48	15.03	65.40	15.56	-3.79**	-12.92	17.07

*$p < .05$. **$p < .01$.

language-dominance estimates, were obscured by the heterogeneity within the sample, as indicated by large *SD*s. In other words, this group of bilingual adults showed the expected heterogeneity with respect to their English–Spanish language competence, as measured by single- and dual-dimension naming-times.

The paired English-Spanish mean differences were relatively small for single-dimension (color, form, number, letter, animal, and object) naming, ranging from -1.41 to -5.14. Paired English-Spanish mean differences were largest for dual-dimension color–object, followed by color–form, color–animal, color–letter, and color–number naming (see Table 1). The relatively small mean differences for color–number and color–letter led us to exclude these color–number and color–letter tests when estimating language dominance.

Correlation coefficients (Pearson *r*) were calculated between paired English and Spanish naming times. Correlations (*r*) between paired color, form, number, letter, and object naming were not significant (range -.04 to .40), but significant for animal naming (.51, $p < .05$). Correlations (*r*) between paired dual-dimension English and Spanish naming tests were low-to-moderate in degree for color–form (.42, $p < .05$), color–letter (.62, $p < .01$), and color–animal (.49, $p < .05$) naming, but not significant for color–number (.41) and color–object naming (.38).

Correlation coefficients (*r*) were calculated separately between naming times for the various tests spoken in English and Spanish. In English, all correlations (*r*) between dual-dimension naming test pairs were significant and moderate to high (range .54 to .93, $p < .01$). In Spanish, correlations (*r*) between the dual-dimension naming tests, except between color–number and color–animal, were significant but low to moderate in degree (range .47 to .74, $p < .05$).

Speaker-by-speaker comparisons between the English and Spanish naming times for color–form, color–animal, and color–object combinations indicated a fair degree of differentiation when a criterion of 10 or more seconds' difference on two of the three dual-dimension naming tests was applied. Based on a difference of +/– 10 seconds in total naming time on two of three combination naming tests (color–form, color–animal, or color–object), 15 participants were identified as English- and five as Spanish-language dominant, while five participants showed equivalence (i.e., balanced dominance).

The *WLD* quotients identified six participants as English-language dominant (range .202 to .380), two as Spanish-language dominant (ratios .615 and .645, respectively), and 17 as having balanced dominance (range .405 to .564). All participants identified by the *WLD* as English-language dominant were also identified by naming-time differences of 10 or more seconds in favor of English on two or three *AQT* tests. Two participants identified as Spanish-language dominant by the *WLD* also obtained differences of 10 or more seconds

in *AQT* dual-dimension naming time in favor of Spanish. Of the 17 participants identified by the *WLD* quotients as showing balanced dominance, only nine showed balanced performance based on *AQT* dual-dimension naming-time differences (i.e., less than 10 seconds). Of the remaining eight, identified by the *WLD* as having balanced dominance, five showed differences of 10 or more seconds in favor of English, and three differences in favor of Spanish on two or three of the *AQT* dual-dimension naming tests.

Self-ratings of competence and frequency of use identified 15 participants as English-language dominant, five as balanced dominant, and five as Spanish-language dominant. A comparison of the numbers identified by self-ratings as having English- Spanish-, or balanced language dominance to the number similarly identified by *AQT* naming-time differences (+/– 10 seconds) for color–form, color–animal, and/or color–object combinations indicated 100% agreement. A comparison of the number of participants identified similarly by self-ratings of competence and frequency of use and the *WLD* quotients indicated that 52% of the judgments concurred, while 48% conflicted. The largest number of participants for whom the judgments did not concur showed balanced dominance based on their *WLD* quotients.

Color–form, color–animal, and color–object naming times in English by participants judged to be English-language dominant were compared to normative data from monolingual English-speaking adults (n = 135) (Wiig, Nielsen, Minthon, & Warkentin, 2002). Of the 15 speakers identified as English-dominant, 13 obtained total naming times on the dual-dimension naming tests that fell within the typical range (i.e., below 60 seconds). Two speakers scored in the slower than typical range on color–form (i.e., between 61 and 70 seconds), but within typical limits on color–animal and color–object naming (i.e., below 60 seconds). These results indicate typical average naming speeds among the bilingual speakers identified as English-language dominant by the naming-time difference criterion (i.e., 10 seconds or more in favor of English).

Five participants were identified by the naming-time difference criterion (i.e., 10 seconds or more in favor of Spanish) as Spanish-language dominant. The same speakers were identified as Spanish-language dominant by self-ratings of competence and use estimates or by one of these. This indicates 100% agreement between the self-rating and *AQT* naming-time difference criteria. The participant whose self-ratings of competence and use did not concur rated competence in Spanish highest, and a judgment call was made, based on *AQT* naming-time differences and high competence rating, to categorize this speaker as Spanish-language dominant. Only one of the five speakers identified by both self-ratings and naming-time differences to be Spanish-language dominant was so identified by the *WLD* quotient (.645).

Five participants were judged to show balanced language dominance, based on the naming-time difference criteria (i.e., less than 10 seconds) and self-ratings of competence and use. All scored within the range considered

normal (60 seconds or below) on both the English and Spanish dual-dimension naming tests. The *WLD* quotients classified two of these speakers as Spanish-language dominant rather than as balanced dominant.

Discussion

This study was exploratory in nature and therefore has limitations in design and interpretation. First, the bilingual group was heterogeneous with regard to perceived and rated competence and frequency of use of English and Spanish. Because all participants were volunteers, stricter sampling procedures were precluded. Second, the heterogeneity resulted in relatively small samples rated as having English-, Spanish-, or balanced language dominance. This limited the application of statistical procedures to test for mean differences in dual-dimension naming times by dominance category. In future validation studies, this limitation can be removed by testing equal-sized samples of bilingual speakers with predetermined self-ratings of language competence and frequency of use.

Comparisons of paired means for each *AQT* dual-dimension naming tests indicated that, for the group as a whole, the English rendition was significantly faster than the Spanish rendition on four of the five tests. The exception occurred for the time difference between English and Spanish color–number naming, which was not significant. This suggested that the bilingual adults in the study had acquired similar competence for using numbers in the two languages and therefore similar degrees of speed and efficiency in naming. This was not the case for naming the dual-dimension color–letter stimuli in the two languages. The difference in favor of English may reflect phonetic or phonological interference or the fact that all participants were exposed to and read more English at this time.

The correlations between dual-dimension naming tests in English, as compared to Spanish, were of interest, because similar measures of interrelationships exist for the normative data from monolingual English speakers ($n = 135$) (Wiig, Nielsen, Minthon, & Warkentin, 2002). In English, correlations (r) between color–form, color–animal, and color–object naming were moderate to high in degree for the bilingual speakers in this study. The corresponding correlations for monolingual speakers of English between color–form and color–animal ($r = 0.84$) and between color–form and color–object naming ($r = 0.79$) were similar in size and degree. In contrast, correlations between Spanish color–form and color–animal, and color–form, and color–object naming were low to moderate in degree. It remains to be tested whether the relations between the Spanish naming times, observed in this study, would be similar or greater in degree for monolingual Spanish speakers.

Speaker-by-speaker comparisons of time differences for English and Spanish color–form, color–animal, and color–object naming were made and

subsequently a priori criteria for judging language dominance were applied. Criteria for estimating language dominance based on self-ratings of competence and frequency of use of English and Spanish were applied independently, and the classifications served as standards for comparisons. The *AQT* dual-dimension naming tests (i.e., color–form, color–animal, and color–object) differentiated English and Spanish naming-time differences to the same degree as self-ratings of competence and frequency of use. In other words, these measures provided 100% correct identification of English-, Spanish-, or balanced language dominance, when compared to self-ratings. A comparison of judgments of dominance based on (a) *AQT* naming-time differences, self-ratings of competence and frequency of use, and (b) *WLD* quotients indicated 52% agreement. Thus, close to half the speakers were misclassified for dominance based on their *WLD* quotients when self-ratings were used as the standard for comparison. This makes the *WLD* quotients for language dominance appear of limited sensitivity to small differences in perceived language competence between English and Spanish among well-educated bilingual adults. This study did not evaluate whether or not the observed inadequacy of *WLD* quotients in differentiating language dominance extends to speakers with minimal education, or to typical bilingual children, adolescents, or young adults in public school or college settings.

Conclusions

In this study, *AQT* dual-dimension naming, which is mediated by bilateral temporal–parietal activation and probes attention, working memory, and automaticity of retrieval, differentiated dominance with greater efficacy than the *WLD*. These results suggest that these *AQT* tests may be used to complement self-ratings of dominance or currently used content measures (e.g., word associations) for judging language dominance in bilingual speakers.

The findings confirm that self-ratings provide valuable measures of language dominance among well-educated bilingual adults. Self-ratings should therefore be used as a first step and may be followed by the *AQT* naming-time tests to provide objective, quantitative measures to validate language-dominance ratings by adults. Self-ratings by children and teens may not prove as reliable as those by older adolescents or adults. For bilingual children and adolescents with normal development or language disorders and learning disabilities, *AQT* naming-time differences for color–form, color–animal, and/or color–object naming may indicate which language is primary and best developed, and therefore should be used for psychoeducational or academic assessments. Further studies may explore if the present findings can be replicated for (a) school-aged children, adolescents, and young adults with and without special needs and (b) bilingual speakers of languages other than

English and Spanish with combinations of languages that belong to different language families and are distant (e.g., English–Arabic, Spanish–Russian, Hungarian–Farsi, or Tagalog–Ilokano).

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Appendix A

Word Listing by Domain (WLD)

ADMINISTER THIS SECTION IN THE LANGUAGE IN WHICH YOU ARE GOING TO ADMINISTER THE AQT FIRST (for example, if you administer the AQT in Spanish, use Spanish for the WLD).

ENGLISH

Directions: I will give you one minute to name various things that are found in different places. Please name those items as fast as you can. Are you ready? (Use a stop-watch.) How many things can you name that are found in the

in the kitchen like spoon, salt, rice _____
in the street like car, tree, dog _____
in church like candle, priest, cross _____
in school like table, paper, pencil _____

SPANISH

Instrucciones: Le (te) voy a dar un minuto para que me nombre(s) todas las cosas que se hallan en varias partes. Por favor nombra(e) esos ítems lo más pronto que pueda(s), ¿ Está(s) listo(a)? ¿Cuántas cosas puede(s) encontrar?

en la cocina como cuchara, sal, arroz _____
en la calle como carro, árbol, perro _____
en la iglesia como vela, padre, cruz _____
en la escuela como mesa, papel, lápiz _____

Language Dominance Formula:

$$\frac{\frac{\text{Total Spanish words} - \text{Total English words}}{\text{Larger of the two}} + 1}{2}$$

For example:

(1) $\dfrac{\dfrac{65-55}{65}+1}{2} = 0.57$ (Balanced bilingual)

(2) $\dfrac{\dfrac{76-40}{76}+1}{2} = 0.73$ (Spanish dominant)

(3) $\dfrac{\dfrac{40-75}{75}+1}{2} = 0.26$ (English dominant)

(A value of .4 to .6 indicates balanced bilingualism; lower than .4 is English dominant; and larger than .6 is Spanish dominant)

Note. Adapted from Fishman, & Cooper, 1969; Lambert, Havelka, & Crosby, 1958.

Appendix B

Self-Rating Scales for English–Spanish Competence and Frequency of Use (Langdon, 2002)

Name: _____ No: _____

Age: _____ Date: _____

Assessor: _____

1- BILINGUAL HISTORY:

1. Simultaneous learner of Spanish–English (before 3) Y N
2. If you were not a simultaneous bilingual, how old were you when you began learning English? _____
3. How did you learn English? Home____ School____ Both____
   Comments: _____
4. If you are a second language learner of Spanish, at what age did you learn Spanish?_____
5. How did you learn Spanish? Home____ School_____ Both_____
   Comments:_____
6. On a scale of 1-5 please rate your skills in the following areas:

1- Poor 2-Below Average 3-Average 4-Above Average 5-Excellent

Area	English	Spanish
Comprehension		
Speaking		
Reading		
Writing		

During a typical week, include the percentage of time you spend (list percentages).

Area	English	Spanish
Comprehension		
Speaking		
Reading		
Writing		

Comments:

_____

_____

Acknowledgments

Lisa de Curtis, Ruth Fainswith, Dianna Lynn, Julie Urquidez, and Sonia Valdez collected the experimental data for this study. Their collaboration is gratefully acknowledged.