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Confrontation naming and semantic relatedness judgements in Spanish/English bilinguals

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Background: The results of many current studies on naming in bilingualism have provided converging evidence for a semantic representation common to both languages within a bilingual individual. However, the interaction between lexical access and semantic representation in bilinguals is relatively unclear.
Aims: To further understand this relationship in normal bilingual individuals, we asked the following questions: (1) Is there homogeneity in naming accuracy for both languages across subjects? We predicted that naming accuracy would differ across subjects based on their proficiency levels in each language. (2) After separating subjects into groups based on their proficiency levels (balanced, Spanish dominant, English dominant), is there a difference in their mean ratings of the semantic similarity of word pairs across proficiency groups? According to the mixed model (De Groot, Dannenburg, & van Hell, 1994), it was predicted that similar mean ratings would be observed across all groups.
Methods & Procedures: A total of 23 Spanish/English bilinguals (average age = 35.5 years) completed a confrontation naming task and a semantic relatedness questionnaire in both languages. The same set of stimuli, controlled for various factors, was used for each task in both languages and counterbalanced by language across two sessions. Based on naming performances, participants were assigned to the balanced bilingual ($N = 10$), English dominant ($N = 10$), or Spanish dominant ($N = 3$) group (Kohnert, Hernandez, & Bates, 1998).
Outcomes & Results: Overall English mean correct was 94.29%; Spanish was 88.19%. Significant differences in naming were seen between groups, $F(2, 85) = 4.3$, $p = .01$, and within the language dominant groups across subjects ($p < .05$) and items ($p < .05$). On the semantic relatedness task, no significant difference was observed between the ratings of word pairs in each language across participants or items in any group.
Conclusions: Despite differences in lexical access, participants in all proficiency groups rated word pairs similarly, indicating a shared semantic representation for both languages. The mixed model (de Groot et al., 1994) can explain the findings for all groups. Results of this study have clinical implications for bilingual aphasic patients. It is imperative to ascertain a patient's pre-morbid language use prior to brain damage in order to gauge pre-morbid proficiencies. Treatment should consider proficiency levels in both languages, with consideration that the strength of connections between each lexicon and from each lexicon to semantic memory may differ.

As the number of Spanish/English bilinguals in the United States increases, it is imperative that research be focused on the fundamental aspects of cognition and language in bilingualism. This information is necessary to assess and treat acquired disorders of language and cognition in bilingual adults, especially among the elderly Hispanic

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population, which is the fastest growing ethnic minority in the United States (ASHA, 1989, 1991). Naming deficits are the most common characteristic in all types of aphasia (Goodglass, 1998), and they are often the first language deficit detected in early Alzheimer's disease. In order to assess and treat naming deficits, it is crucial to understand the organisation, relationship, and processing within and between the lexicons of bilingual adults.

Evidence from numerous experimental sources reveals that the two languages of a bilingual individual access a common semantic network (Francis, 1999). Semantic comparisons between words of different languages have been shown to take *no longer* than comparisons between words in the same language, suggesting integration of semantic information between languages (Dufour & Kroll, 1995; Potter, So, vonEckardt, & Fedlman, 1984). Similarly, cross-language categorisation experiments have found that bilinguals show no difference in reaction times within and across language conditions (Caramazza & Brones, 1980; Potter et al., 1984). It has also been demonstrated through picture–word interference studies that words in the non-target language are active during production of words in the target language (Herman, Bongarts, De Bot, & Schreuder, 1998).

In addition to behavioural studies, neuroimaging studies utilising various semantic processing paradigms have demonstrated similar cortical localisation of activation for L1 and L2 languages (e.g., Chee, Tan, & Thiel, 1999; Hernandez, Dapretto, Mazziotta, & Bookheimer, 2001; Illes et al., 1999; Klein, Milner, Zatorre, Meyer, & Evans, 1995; Perani et al., 1996; Wartenburger, Heekeren, Abutalebi, Cappa, Villringer, & Perani, D., 2003).

While there appears to be converging evidence for a semantic representation that is common to both languages in a bilingual individual, the mechanism of phonological access of lexical items across two languages appears less evident (but see Roelofs, 2003, for a detailed investigation of phonological planning in Dutch/English unbalanced bilingual adults, and Pallier, Colomé, & Sebastián-Gallés, 2001, for a discussion of the influence of native-language phonology on lexical access in highly fluent Catalan/Spanish bilinguals).

A few studies have investigated lexical access in bilingual adults using naming tasks. Roberts and Deslauriers (1999) investigated naming of cognates and noncognates in French/English normal and aphasic bilinguals, with the hypothesis that phonetic similarity of cognates would facilitate naming across languages. However, in general, they did not find significantly higher naming of cognates over noncognates. Kohnert, Bates, and Hernandez (1999) conducted timed naming tasks on Spanish/English bilinguals from age 5 through college. All subjects had learned English as a second language at school between ages 4 and 6. Based on accuracy and reaction times in naming, they found a gradual dominance shift to English culminating by college age. Kohnert et al. (1998) also tested 100 young, educated Mexican-American Spanish/English bilingual adults who learned both languages before age 8 on the Boston Naming Test (BNT) (Kaplan, Goodglass, & Weintraub, 1983). They found that 75% of their participants named fewer pictures in Spanish than in English, and the progression of difficultly on the BNT normally seen in English monolinguals was not evident in Spanish. In both of these studies, the authors argue that age of acquisition is less important a factor in proficiency than use, and that the critical period theories for language learning may be over-simplified. In an attempt to evaluate the performance of other bilingual groups on the BNT, Roberts, Garcia, Desrochers, and Hernandez (2002) tested English monolingual, Spanish/English bilingual, and French/English bilingual groups. The English group served as a control group that the Kohnert et al. (1998) study did not have. They found that the bilingual groups scored significantly lower than the monolingual group in English.

Most naming studies with bilingual adults aim to establish normative data (e.g., Kohnert et al., 1998; Kremin et al., 2003; Roberts et al., 2002), and they are not directed at answering theoretical questions about naming. Further, interpretation of the data is occasionally difficult based on what authors have reported. For example, Roberts et al. (2002) did not report within-group differences in naming across languages. Roberts and Deslauriers (1999), unlike Kohnert et al. (1998), did not separate the bilingual groups into categories of dominance, as the authors assumed a certain degree of equal proficiency based on questionnaires given to the participants regarding language use. Further, the authors did not report how each bilingual group performed across languages, and they only tested two semantic categories of words.

Numerous models have been proposed to explain semantic representation and access of lexical items between two languages (L1 and L2). The word association model, first described by Potter et al. (1984), assumes that second language words (L2) gain access to concepts only through first language mediation (L1). This model predicts that translation from L1 to L2 will be faster than picture naming in L2, because translation from L1 to L2 relies on the lexical links and can thus bypass conceptual access. In contrast, the concept mediation model (Potter et al., 1984) proposes that second language words directly access concepts, and predicts that translation from L1 to L2 and picture naming in L2 should be similar because both require conceptual access prior to the retrieval of L2 lexical items. Potter et al. (1984) investigated translation and picture naming in a group of fluent Chinese/English bilinguals and found that the times to translate from L1 to L2 and to name pictures in L2 were very similar, thus providing support for the concept mediation model. However, application of these models to groups of bilingual adults depends on respective proficiency in each language. For instance, Kroll and Curley (1988) performed a similar task as Potter et al. (1984) with bilinguals with low and high L2 proficiency, and they observed evidence for the word association model in the low-proficiency bilinguals as well as evidence for the concept mediation model in the high-proficiency bilinguals.

The revised hierarchical model proposed by Kroll and Stewart (1990, 1994) includes connections between both L1 and L2 and the central concept. However, the links differ in their strengths as a function of proficiency in L1 relative to L2. Therefore, L1 presumably has a larger lexicon than L2, and lexical associations from L2 to L1 are assumed to be stronger than those from L1 to L2. Further, the links between words and concepts are assumed to be stronger for L1 than for L2. Kroll and Stewart provide support for the revised hierarchical model from observations of increased latencies when translating from L1 to L2 than vice versa, and shorter latencies when translating categorised lists versus randomised lists from L1 to L2. They infer from the data that a longer latency implies that the translation is being moderated by conceptual memory, whereas shorter latencies imply a direct translation between lexicons.

Finally, de Groot (1992) proposed the mixed model, which combines the word association and concept mediation models. This model argues that the lexicons of a bilingual are directly connected to each other as well as indirectly connected by way of a shared semantic representation. However, de Groot (1992) based her theory on forward translation (L1 to L2) only in L1 dominant subjects. Therefore, in a follow-up study De Groot et al. (1994) examined forward and backward translation with six predictor variables (imageability, context availability, definition accuracy, familiarity, word frequency, and length) in two Dutch/English bilingual groups that differed in L2 proficiency. Results revealed a significant effect of imageability on forward translation, implying semantic mediation, and a smaller effect of imageability on backward translation. Therefore, while de Groot et al. (1994) agree that the data support a weak version of the asymmetrical model (direct and strong L2 to L1 link in backward translation without concept mediation), they argue for the mixed model since this model predicts concept mediated backward translation, but with less ''strength'' in the link from L2 to conceptual memory than L1 to conceptual memory.

In order to further understand the relationship between lexical access and semantic representation in bilingual adults, the present study investigated the relationship between oral confrontation naming and semantic representation in bilingual adults by using the same set of stimuli for both tasks. Semantic representation was evaluated by semantic relatedness ratings of pairs of words in English and Spanish in order to discern if there are differences in how bilinguals ''conceptualise'' word pairs in each of their respective languages. This task was chosen because we believed that there would be a ceiling effect in a semantic categorisation task and because a semantic relatedness judgement task would require the subjects to extract features from pairs of items being compared. Although both experiments were untimed, we predicted the results to be accounted for by the general predictions of de Groot's mixed model (de Groot et al., 1994). Further, the results of our experiment were expected to provide a theoretical basis to guide treatment methods for bilingual individuals with aphasia.

All of the participants learned both languages before age 10 and described themselves as functionally bilingual. However, due to the existing nature of variability within bilinguals, we categorised our participants into three dominance groups based on their naming performance in each language using the methods of Kohnert et al. (1998). We then examined the relationship between lexical access (through oral naming) and semantic processing (through semantic relatedness ratings) across the three groups. The following were our research questions and predictions.

1. Is there homogeneity in naming accuracy for both languages across subjects? We predicted that naming accuracy would not be homogeneous between subjects based on their proficiency levels in each language. Based on their naming accuracy in both languages, subjects would be assigned to one of three groups: balanced bilingual, English dominant, or Spanish dominant (Kohnert et al., 1998).

2. Is there a difference in semantic relatedness judgements across languages as measured by mean ratings of word pairs in English and Spanish in any of the proficiency groups? According to the mixed model, it was predicted that similar mean ratings on word pairs would be observed across all groups since L1 and L2 both have links to a shared conceptual memory. However, if differences between word pair ratings are observed, we would predict these differences to occur in the language dominant groups, since the strengths of the links between L1 and conceptual memory and L2 and conceptual memory would theoretically be different in these groups. Any significant differences in mean ratings of word pairs across languages for the dominant groups would have to be reconciled by alternative bilingual language processing models, such as the asymmetrical model (Kroll & Stewart, 1990, 1994).

METHOD

Participants

A total of 23 Spanish/English normal bilingual individuals ranging in age from 22 to 71 years (average = 35.5; *SD* = 14.2) participated in the study. All participants had normal or corrected to normal vision and normal hearing. They all had at least a high-school degree with a mean education of 15.6 years (*SD* = 2.01). Exclusionary criteria included neurological disorders such as stroke, transient ischaemic attacks, Parkinson's disease, Alzheimer's disease, psychological illness, learning disability/dyslexia, seizures, and attention deficit disorder. All participants learned English (*Mean* = 3.3 years; *SD* = 3.3) and Spanish (*Mean* = 0.6; *SD* = 1.7) before the age of 10 years and described themselves as ''functionally bilingual''. In order to characterise language use and proficiency further, participants filled out a language usage questionnaire (Muñoz, Marquardt, & Copeland, 1999) during their first session that asked questions about usage and self-evaluation of their language skills. See Table 1 for further description of participants.

Stimuli

Oral naming and semantic relatedness judgement tasks were developed for this experiment. We expected the participants to perform at near 100% accuracy levels on a semantic processing task such as semantic matching, which would make it difficult to discern differences in semantic processing within the different proficiency groups.

TABLE 1
Participant information

Subject	*Gender*	*Age*	*Years ed*	*Age learned English*	*Age learned Spanish*	*Eng-S*	*Eng-C*	*Span-S*	*Span-C*
1	F	22	15	0	0	7	7	6	6
2	F	23	17	0	0	7	7	6	7
3	F	33	15	3	0	7	7	7	7
4	F	46	16	4	0	7	7	6	6
5	F	38	16	0	0	7	7	7	7
6	F	24	15	6	0	7	7	7	7
7	F	24	18	3	0	7	7	6	7
8	M	29	12	0	5	7	7	6	6
9	F	37	14	3	0	7	7	6	7
10	F	59	12	4	0	7	7	7	7
11	M	35	16	8	0	5	6	7	7
12	F	23	17	10	0	7	7	6	7
13	F	22	16	5.5	0	7	7	7	7
14	F	71	16	8.5	0	7	7	7	7
15	F	50	18	0	0	7	7	7	7
16	F	23	17	9	0	6	6	7	7
17	F	49	16	0	5	7	7	7	7
18	F	21	14	5	0	6	7	5	6
19	M	58	12	0	5	7	7	7	7
20	F	23	17	0	0	5	5	7	7
21	F	42	20	0	0	7	7	6	7
22	M	35	14	0	0	7	7	7	7
23	F	30	17	6	0	5	5	7	7
	Average	35.52	15.65	3.26	0.65	6.65	6.74	6.56	6.83
	SD	14.17	2.01	3.35	1.68	0.71	0.62	0.59	0.39

Eng-S = Self-ratings of English speaking in informal situations. Eng-C = Self-ratings of English comprehension in informal situations. Span-S = Self-ratings of Spanish speaking in informal situations. Span-C = Self-ratings of comprehension of Spanish informal situations.

Further, we wanted the subjects to engage in a task that involved extracting semantic information and using it to make semantic decisions. Finally, the results of our experiment were expected to provide a theoretical basis to guide treatment methods for bilingual individuals with aphasia. Therefore, we administered a semantic relatedness judgement task in each language to investigate the degree to which participants rated the similarity in meaning of two related items.

From an original corpus of 200 words that varied across semantic categories, 150 were selected based on the following criteria. Cognates (e.g., *elephant* and *elefante*) and words with at least 50% phonetic similarity (e.g., *cat* and *gato*) were eliminated from the set to avoid facilitation of naming across languages. Words between one and four syllables (English average = 1.53; Spanish = 2.58) were then chosen. Finally, high to moderate frequency words were selected in each language (English = 5 or higher, Spanish = 3 or higher; Frances & Kučera, 1982; Juilland & Chang-Rodriguez, 1964; respectively) such that the average frequency for both languages (English = 53.86, *SD* = 107.35; Spanish = 58.50, *SD* = 126.47) was matched as determined by a paired *t*-test ($t = 0.707$; $p = .480$). Colour pictures were chosen from Art Explosion Software® (NOVA Inc), modified to equal approximately 4 × 6 inches, and centred on 8 × 11 inch white paper. Two sets of stimuli were prepared, one for each language, and placed in a binder with the pictures in a pseudorandomised order controlled to avoid more than two consecutive examples from the same category (e.g., *table* could not follow *chair*).

The semantic relatedness task employed the same stimuli as the oral naming task. Each of the 150 words was paired with another word from the same list. The word pairs were either category coordinates (e.g., *apple* and *orange*) or word associations (e.g., *soap* and *razor*), so were intended to be similar in meaning. In order to create more semantic variation in pairs, some words were used more than once, resulting in 157 pairs of words. All word pairs were typed onto a sheet and a 4-point rating scale where ''1'' (indicating ''very similar'') and ''4'' (indicating ''not similar'') was typed beneath each word pair. The questionnaire was 11 pages long with approximately 1.5 spaces between each pair of words.

Procedures

Both the naming and the semantic relatedness tasks were conducted across two sessions that were at least 1 day apart, with the order of language counterbalanced across participants. First the naming task was conducted. Participants were required to name each picture with no feedback provided. After naming the pictures, each participant completed a semantic relatedness questionnaire in the same language as the naming task to avoid cross-linguistic interference. For this task, participants were required to rate how similar they considered the meanings of pairs of words on a scale of 1 (''very similar'') to 4 (''not similar'') by circling the appropriate number. The directions written on the top of the first page were as follows: ''*For this task, you need to make decisions about pairs of words. Please look at each pair of words and decide how similar the words are in meaning. If you do not know a word, cross it out and do not do anything else with that pair of words*.'' The Spanish version had a translation of these directions. The directions were also provided verbally with an example, and participants were instructed to ask questions if they did not understand the task.

Scoring

For the naming task, the total number of pictures named correctly in each language was calculated. Responses were considered incorrect if they could not be found in an English or a Spanish dictionary with an appropriate definition or in a bilingual dictionary with an appropriate translation. Further, alternative responses reflecting dialectal or acceptable lexical variations in Spanish were credited (e.g., *cerillas* and *fósforos* were both accepted for *matches*). For the semantic relatedness task, only word pairs that were rated were calculated.

RESULTS

Grouping of participants

Based on their naming performances, participants were divided into three groups: balanced bilingual ($N = 10$), English dominant ($N = 10$), and Spanish dominant ($N = 3$). Dominance for each subject was calculated by comparing the difference between their naming performance in both languages against the mean difference in naming for all of the participants (*Mean* = 6.1) (Kohnert et al., 1998). Participants more than one standard deviation from the mean were deemed dominant in the language with the higher naming score. For example, participant 13 was deemed English dominant because she achieved 98% accuracy in English and 90.6% accuracy in Spanish, a difference of 7.4. See Table 2 for groupings and scores.

Naming accuracy

A 3×2 ANOVA on the naming accuracy revealed a significant main effect only for group, $F(2, 85) = 4.3$, $p = .01$. A Bonferroni post-hoc analysis across groups revealed a significant difference between the balanced bilingual and the Spanish dominant group ($p < .001$) and the English dominant and Spanish dominant group ($p < .001$). These results were expected, since groups were composed based on the naming performance of the participants. Interaction effects were not pursued because the interaction between the groups was not the point of this study.

Data for the groups were then separated and analysed with paired *t*-tests to determine if there were differences in naming across participants and items (subject and item analyses). No significant difference was found between English and Spanish naming on the subject analysis in the balanced bilingual group ($t = 1.60$; $p = .130$), but there was a significant difference between English and Spanish naming in the English dominant ($t = 5.69$; $p < .001$) and Spanish dominant groups ($t = 4.74$; $p = .009$, see Figure 1a). Next, paired *t*-tests were performed on each group to see if there were any differences in naming across items for both languages. The results showed that naming accuracy across both languages was significantly different across items for the English dominant, $t(149) = 8.13$, $p < .05$, and Spanish dominant groups, $t(149) = 5.64$, $p < .05$. These results are consistent with the naming across participants results for each group. There was also a significant difference across items for the balanced bilingual group, $t(149) = 2.59$, $p < .05$. Given that the overall means for naming accuracy were close (English *Mean* = 96.25; *SD* = 9.19, Spanish *Mean* = 94.14, *SD* = 11.36), this inconsistent finding appears to be due to a few items consistently named incorrectly in Spanish.

Semantic relatedness judgements

Participants were instructed to avoid rating word pairs for which they did not recognise one or both words, resulting in elimination of less than .1% of the word pairs from the data set. A 3×2 ANOVA on the remaining ratings indicated an overall significant main effect only for group, $F(2, 892) = 8.00$, $p = .0001$. A Bonferroni post hoc analysis

TABLE 2
Naming accuracy for all three groups

Balanced bilingual group				*English dominant group*				*Spanish dominant group*			
Subject #	*English naming %*	*Spanish naming %*	*/E/-/S/*	*Subject #*	*English naming %*	*Spanish naming %*	*/E/-/S/*	*Subject #*	*English naming %*	*Spanish naming %*	*/E/-/S/*
5	98.6	98.6	0	1	98	63.3	34.7	11	76	90.6	14.6
6	92.6	90	2.6	2	96.6	70.6	26	20	82	96.6	14.6
9	98.6	96.6	2	3	98.6	84.6	14	23	83.3	95.3	12
12	96	90	6	4	99.3	91.3	8				
14	91.3	90	1.3	7	95.3	80	15.3				
15	98.6	97.3	1.3	8	93.3	75.3	18				
16	94	93.3	0.7	10	96	86.6	9.4				
17	98.6	96	2.6	13	98	90.6	7.4				
19	96.6	94	2.6	18	96	81.3	14.7				
22	95.3	93.3	2	21	98	83.3	14.7				
Average	96.02	93.91	2.11	Average	96.91	80.69	16.22	Average	80.43	94.17	13.73
SD	2.70	3.19	0.49	*SD*	1.81	8.83	7.02	*SD*	3.89	3.16	0.74

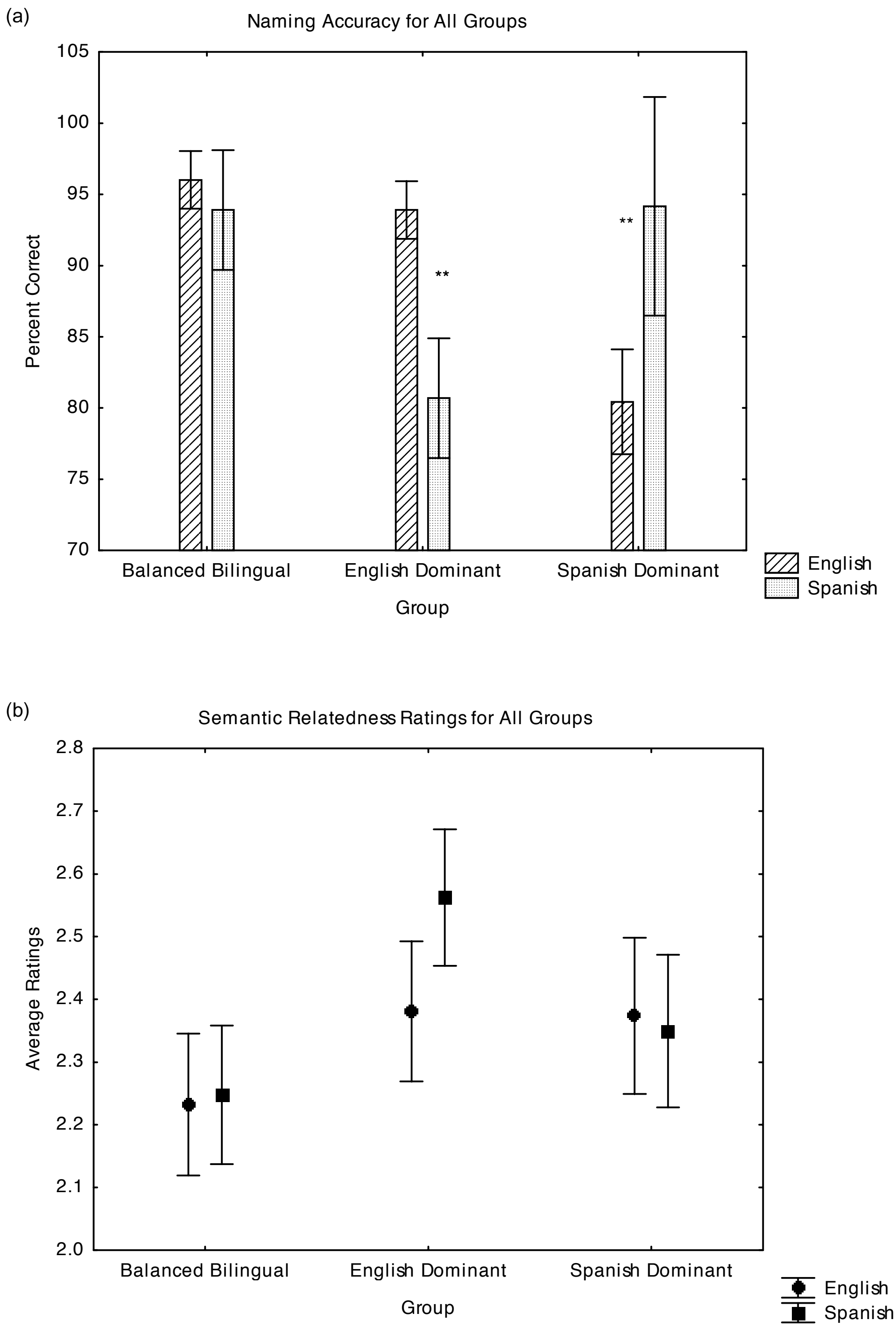

Figure 1. (a) Naming accuracy for all groups across participants. ** indicates $p < .0001$ significance. (b) Semantic relatedness judgements across items for all groups.

revealed that there was a significant difference in rating between the balanced bilingual group and the English dominant (p = .00421) and balanced bilingual group and Spanish dominant group (p < .001). In other words, the balanced bilingual group rated word pairs in English and Spanish significantly lower (more alike) than both the English and Spanish dominant groups. Implications for these findings will be explored in the Discussion.

Data for the three groups were then separated and analysed with a paired t-test to determine if there was a difference in ratings between languages across participants and items (subject and item analysis). The results showed that there was no significant difference between languages on the subject analysis in any group—balanced bilingual: $t(9) = 0.48$, $p = .64$; English dominant: $t(9) = 0.39$, $p = .71$; Spanish dominant: $t(2) = 1.57$, $p = .26$. Further, on the item analysis, no significant difference between English and Spanish semantic ratings was noted within any group—balanced bilingual: $t(138) = 0.77$, $p = .44$; English dominant: $t(123) = 0.65$, $p = .51$; Spanish dominant: $t(136) = 0.85$, $p = .39$; see Figure 1b. Assuming that the semantic relatedness judgements are a reflection of semantic representation (albeit a less sensitive measure than online measures), non-significant differences in ratings across participants within each group seem to indicate that semantic representation of both languages is shared across participants.

Self-rating across groups

The self-rating scores that the participants gave themselves on their speaking and comprehension abilities in both languages were also analysed. Two 3×2 ANOVAs across groups revealed overall significant main effects for group differences in self-ratings for production, $F(4, 38) = 19.13$, $p < .001$, and comprehension, $F(4, 38) = 15.21$, $p < .001$. A Bonferroni post-hoc analysis for both production and comprehension revealed a significant difference in ratings between the balanced bilingual and Spanish dominant group ($p < .001$) and the English dominant and Spanish dominant group ($p < .001$). Thus, the subjects' self-ratings reflected their naming abilities in both languages. This appears to indicate that naming tasks may be a good indicator of overall language proficiency, and also that bilingual adults provide accurate information regarding their linguistic abilities in both languages.

DISCUSSION

The present experiment investigated the relationship between oral picture naming and semantic relatedness judgements on the same set of stimuli across two languages in normal bilingual adults. Based on naming performance, three groups with significantly different proficiency profiles emerged: balanced bilingual, English dominant, and Spanish dominant. Overall, the balanced bilingual group showed no difference in naming across languages. However, the English dominant group named better in English than in Spanish, and the Spanish dominant group named better in Spanish than in English.

On the semantic rating task, there was a significant difference in ratings between the balanced bilingual group and both other groups, with the balanced bilingual group rating word pairs as more alike in both English and Spanish as compared to the English and Spanish dominant groups. A notable finding was that, unlike the naming results within each group, no significant differences were observed between English and Spanish word-pair ratings for any group across participants or items. These results are particularly striking because they seem to indicate that the participants conceptualised the items in both languages similarly. Assuming that the semantic relatedness judgement task measures semantic representation, since participants were forced to extract semantic information about the two words that they were instructed to compare, then the results seem to indicate that there is a shared semantic representation for both languages for all groups *despite* differences in naming abilities (lexical access) and proficiency in each language. Further, the self-rating scores that the participants gave themselves on their English and Spanish speaking abilities revealed a significant difference in ratings between the three groups. These differences reflected the dissimilarity observed in naming abilities across groups. Thus, self-rating questionnaires may provide useful information related to proficiency.

To summarise, findings from this study indicate that despite differential access for naming of L1 and L2 across languages, semantic representation (concepts) is the same in English and Spanish for normal adult bilinguals. Specifically, we found that the English dominant group demonstrated superior naming in English compared to Spanish, while the Spanish dominant group demonstrated superior naming in Spanish compared to English. However, despite these differences, we found no significant difference in rating the semantic relatedness of word pairs within any group. Therefore, it can be surmised that even though there may be a wide variation in proficiency within bilinguals who learn both languages before age 10, this variation does not seem to affect a shared semantic representation between their two lexicons.

As hypothesised in the introduction, the findings of this experiment can be explained by de Groot's mixed model (1994). This model predicts that each lexicon is connected directly to a shared representation in conceptual memory as well as by a direct connection between the two lexicons. Further, the model predicts that the strength of the weight from L2 to conceptual memory is weaker than that from L1. This premise would explain both the findings of the current study—namely (a) lexical access or naming is weaker in L2 than in L1 and (b) semantic representations from a shared conceptual memory (as measured by semantic feature extraction and similarity ratings for word pairs) are similar between L2 and L1 for all bilingual groups. Further, the model would also account for the non-significant but notable differences in the mean ratings between English (*Mean* = 2.38) and Spanish (*Mean* = 2.56) in the English dominant group. In other words, the English dominant group rated word pairs more similarly in their dominant language (L1) than in L2, suggesting a ''stronger'' connection between L1 to conceptual memory than from L2 to conceptual memory.

An alternative explanation for the results can be provided by the asymmetrical model proposed by Kroll and Stewart (1994). This model argues for a stronger link from L2 to L1 and a weak connection between L2 and the shared conceptual system, and thus would predict that semantic relatedness judgements would be mediated by L1 for both languages. This premise would account for the similar semantic judgements in the dominant groups but may imply that participants in the dominant groups translated the word pairs in the weaker language into their stronger language in order to make judgements (since the link from L2 to L1 is stronger than that between L2 and conceptual memory in this model). However, this model cannot satisfactorily explain the findings of the balanced bilingual group, where mean semantic ratings for English (*Mean* = 2.23) and Spanish (*Mean* = 2.24) were almost identical.

A more parsimonious explanation for all three subject groups can be obtained from de Groot's mixed model (1992, 1994), since this model would suggest the weighted connection between L2 and conceptual memory falls along a continuum determined by L2 proficiency. Therefore, in balanced bilingual individuals, L2 and L1 connections to conceptual memory are equally weighted, whereas in L1 dominant groups, the L2 connections to conceptual memory can be weighted lesser than the L1 connections to conceptual memory.

The data in the current study provide further empirical support for the increasing notion that the frequency of usage, and not age of acquisition, more accurately describes bilingual proficiency. For example, the three Spanish dominant participants in the present study were born in Spanish-speaking countries and spoke Spanish at home, but learned English in school and used English in addition to Spanish on a fairly regular basis. These participants are currently students and have been in the United States for 2–3 years. This profile is distinctly different from the subjects in the English dominant group, who were primarily born and educated in the United States, so their English usage has been much higher than their Spanish usage despite using Spanish at home as children. The majority of the participants in the balanced bilingual group, by contrast, were professional translators and bilingual teachers whose work involves switching between both languages simultaneously on a regular basis. Therefore, it seems that language proficiencies are clearly on a continuum and are not static, and one of the strongest factors influencing proficiency is language usage. Support for this premise also comes from Kohnert et al. (1998, 1999) who propose that continued language use may be more important for L1 and L2 proficiency than factors such as age of acquisition, which is often of main concern in critical period theories of second language learning.

Further investigation is needed on other groups of bilingual adults, including proficient bilinguals that learned L2 after age 10. In addition, the present study was restricted to high- to mid-frequency concrete words. Less frequent and abstract words also need to be evaluated in order to have a more complete picture of the relationship between lexical access and semantic representation. Finally, other measures of semantic representation, including online measures, are needed to replicate the present findings.

Results of the present study have clear clinical implications for bilingual patients with aphasia. First, during the case history it is imperative to ascertain a patient's amount of usage in each language *immediately prior* to brain damage in order to gauge pre-morbid proficiency in each language. In addition, interpretation of test results should account for prior proficiency so that a lower score in one language is not necessarily interpreted as a deficit due to brain damage. Further, treatment should take into account proficiency level in both languages, with consideration that both lexicons most likely share a semantic representation but the strengths of the connections between each lexicon and semantic representation may differ based on proficiency. Therefore, a semantic approach to naming may improve the target in both languages if it were only remediated in one, assuming that the strength of the connection between semantic memory and the untreated language is strong enough to support the generalisation. If not, direct translation treatment may be needed in order to mediate through the dominant language. We recognise that this method is not the most efficient, and are currently investigating the most efficient manner in which to treat naming deficits in bilingual people with aphasia.

REFERENCES

American Speech-Language-Hearing Association. (1989). *Office of minority concerns newsletter*, *10*(1). Rockville, MD: American Speech-Language-Hearing Association.

American Speech-Language-Hearing Association. (1991). Cultural diversity in the elderly population. *ASHA*, 33. *66.10* (1). Rockville, MD: American Speech-Language-Hearing Association.

Caramazza, A., & Brones, I. (1980). Semantic classification by bilinguals. *Canadian Journal of Psychology*, *34*, 77–81.

Chee, M. W. L., Tan, E. W. L., & Thiel, T. (1999). Mandarin and English single word processing studied with functional magnetic resonance imaging. *The Journal of Neuroscience*, *19*, 3050–3056.

De Groot, A. M. B. (1992). Determinants of word translation. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *18*, 1001–1018.

De Groot, A. M. B., Dannenburg, L., & van Hell, J. G. (1994). Forward and backward word translation by bilinguals. *Journal of Memory and Language*, *33*, 600–629.

Dufour, R., & Kroll, J. (1995). Matching words to concepts in two languages: A test of the concept mediation model of bilingual representation. *Memory and Cognition*, *23*(2), 166–180.

Frances, N., & Kučera, J. (1982). *Frequency analysis of English usage*. Boston: Houghton Mifflin & Company.

Francis, W. S. (1999). Cognitive integration of language and memory in bilinguals: Semantic representation. *Psychological Bulletin*, *125*, 193–222.

Goodglass, H. (1998). Stages of lexical retrieval. *Aphasiology*, *12*(4), 287–298.

Herman, D., Bongarts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: Can speakers prevent interference from their first language? *Bilingualism: Language and Cognition*, *1*, 213–229.

Hernandez, A., Dapretto, M., Mazziotta, J., & Bookheimer, S. (2001). Language switching and language representation in Spanish-English bilinguals: An fMRI study. *NeuroImage*, *14*, 510–520.

Illes, J., Francis, W. S., Desmond, J. E., Gabriele, J. D., Glover, G. H., Poldrack, R. et al. (1999). Convergent cortical representation of semantic processing in bilinguals. *Brain and Language*, *70*(3), 347–363.

Juilland, A., & Chang-Rodriguez, E. (1964). *Frequency dictionary of Spanish words*. London: Mouton & Co.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *Boston Naming Test*. Philadelphia: Lea & Febiger.

Klein, D., Milner B., Zatorre, R., Meyer, E., & Evans, A. (1995). The neural substrates underlying word generation: A bilingual function-imaging study. *Proceedings of the National Academy of Sciences USA*, *92*, 2899–2903.

Kohnert, K. J., Bates, E., & Hernandez, A. E. (1999). Balancing bilinguals: Lexical-semantic production and cognitive processing in children learning Spanish and English. *Journal of Speech, Language, and Hearing Research*, *42*, 1400–1413.

Kohnert, K. J., Hernandez, A. E., & Bates, E. (1998). Bilingual performance on the Boston Naming Test: Preliminary norms in Spanish and English. *Brain and Language*, *65*(3), 422–440.

Kremin, H., Akhutina, T., Basso, A., Davidoff, J., De Wilde, M., Kitzing, P. et al. (2003). A cross-linguistic data bank for oral picture naming in Dutch, English, German, French, Italian, Russian, Spanish, and Swedish (PEDOI). *Brain and Cognition*, *53*, 243–246.

Kroll, J. F., & Curley, J. (1988). Lexical memory in novice bilinguals: The role of concepts in retrieving second language words. In M. Gruneberg, P. Morris, & R. Sykes (Eds.), *Practical aspects of memory* (Vol. 2, pp. 389–395). London: John Wiley & Sons.

Kroll, J. F., & Stewart, E. (1990). *Concept mediation in bilingual translation*. 31st Annual Meeting of the Psychonomic Society, New Orleans.

Kroll, J. F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language*, *33*, 149–174.

Muñoz, M., Marquardt, T., & Copeland, G. (1999). A comparison of the codeswitching patterns of aphasic and neurologically normal bilingual speakers of English and Spanish. *Brain and Language*, *66*, 249–274.

Pallier, C., Colomé, A., & Sebastián-Gallés, N. (2001). The influence of native-language phonology on lexical access: Exemplar-based versus abstract lexical entries. *Psychological Science*, *12*(6), 445–449.

Perani, D., Dehaene, S., Grassi, F., Cohen, L., Cappa, S., Dupoux, E. et al. (1996). Brain processing of native and foreign languages. *NeuroReport*, *7*, 2439–2444.

Potter, M., So, K., vonEckardt, B., & Fedlman, L. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior*, *23*, 23–381.

Roberts, P. M., & Deslauriers, L. (1999). Picture naming of cognate and non-cognate nouns in bilingual aphasia. *Journal of Communication Disorders*, *32*, 1–23.

Roberts, P. M., Garcia, L. J., Desrochers, A., & Hernandez, D. (2002). English performance of proficient bilingual adults on the Boston Naming Test. *Aphasiology*, *16*(4–6), 635–645.

Roelofs, A. (2003). Shared phonological encoding processes and representations of languages in bilingual speakers. *Language and Cognitive Processes*, *18*(2), 175–204.

Wartenburger, I., Heekeren, H. R., Abutalebi, J., Cappa, S. F., Villringer, A., & Perani, D. (2003). Early setting of grammatical processing in the bilingual brain. *Neuron*, *37*, 159–170.