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Imageability effects in normal Spanish–English bilingual adults and in aphasia: Evidence from naming to definition and semantic priming tasks

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Background: Whereas the effect of imageability on lexical access has received attention in normal monolingual individuals and in individuals with aphasia, its effect on normal bilingual access and in bilingual aphasia has not been systematically addressed.
Aim: The goal of the present experiment was to examine the effects of imageability in normal bilingual adults and in one patient with bilingual aphasia by addressing the following questions: (a) Is there a difference in language performance in early L2 bilinguals? (b) Is there a difference between concrete and abstract words across both languages? (c) Is there a difference between accuracy on a naming to definition task and semantic priming task across language and imageability?
Methods & Procedures: A total of 15 normal Spanish–English bilingual adults and 1 bilingual aphasic individual performed two tasks – a naming to definition task and a semantic priming task in English and in Spanish. The targets in both tasks were either concrete or abstract nouns and the words were translation equivalents in the two languages. Naming accuracy in both languages and for both levels of imageability was measured during the naming to definition task. Mean reaction times and accuracy rates to judge relatedness of word pairs on the semantic priming task were also measured.
Results: Results indicated that across tasks, performance was better in English than in Spanish, indicating an English dominance in the normal bilingual adults, although performance was the same across languages in the aphasic patient. Across tasks and languages, responses were faster and more accurate for concrete words than abstract words. Finally, retrieval of abstract words was significantly more difficult during naming to definition than during semantic priming, reflecting a processing difference between concrete and abstract words in retrieval of their respective phonological forms.
Conclusions: These results highlight differences between concrete and abstract words in conceptual/semantic representations and phonological retrieval that are notably consistent across both languages in a bilingual individual. Data from the one bilingual aphasic individual suggest the possibility of a systematic deterioration of the normal bilingual language system.

Bilingual language representation has received much attention over the years. There is emerging consensus that in fluent bilinguals, picture naming and word translation are conceptually mediated in both the dominant language (L1) and the nondominant language (L2) (de Groot, 1992; Kroll & Stewart, 1994; Potter, So, von Eckardt, & Feldman, 1984; Sholl, Sankaranarayanan, & Kroll, 1995). Alternatively, connections between L1 and the semantic system are stronger than connections between L2 and the semantic

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system in late bilinguals (Dufour & Kroll, 1995; Kroll & Stewart, 1994; Potter et al., 1984; Sholl et al., 1995) but see de Groot and Poot (1997). A number of contrasting models have been proposed to detail the difference in bilingual lexical access (de Groot, 1992, 1993; Kroll & Stewart, 1994; Potter et al., 1984). All of these models concur that ease and accuracy of lexical access are affected by several variables including word frequency, word familiarity, word length, cognate status, and word imageability (Costa, Caramazza, & Sebastian-Galles, 2000a; Costa, Colome, & Caramazza, 2000b; de Groot, Borgwaldt, Bos, & van den Eijnden, 2002; de Groot, Dannenburg, & van Hell, 1994). Of these, imageability/concreteness of lexical items appears to determine the speed and accuracy of lexical access in a process similar to what has been observed in monolingual lexical processing (Jin, 1990; Paivio, Clark, & Lambert, 1988; Van Hell & De Groot, 1998).

For instance, Paivio et al. (1988) examined French–English bilinguals who performed free recall of concrete and abstract word lists repeated at different lag times. Results revealed that for repetitions involving the same words, translation equivalents, or same-language synonyms, recall of concrete words was superior to that of abstract words. Further, recall of translations was superior to recall of same language synonyms. Likewise, Jin (1990) investigated crosslinguistic semantic priming in Korean–English bilinguals and found that concrete words primed their translational equivalents more than abstract words. Van Hell and de Groot (1998) investigated within- and between-language word association in Dutch–English bilinguals and found that associations for concrete words were more often translations of one another than those for abstract words. Also, retrieving associates for concrete words was easier to perform than the same for abstract words both within and between languages. Finally, in a recent systematic analysis of 18 different factors affecting bilingual lexical decision and word naming, de Groot et al. (2002) found that, among other things, concrete words were judged and named faster than abstract words in both Dutch and English.

Theories explaining monolingual imageability effects have been extended to explain effects in bilingual individuals. For instance, the dual coding theory (Paivio, 1986, 1991), which proposes that concrete words are stored and accessed through verbal and image associations whereas abstract words possess only verbal associations, was expanded by Paivio and Desrochers (1980) to include bilingual lexical systems. In this theory, a nonverbal imagery system and verbal systems in L1 and L2 function separately but are interconnected. Both concrete and abstract words have verbal representations in L1 and L2 but only concrete words have an additional imagery referent that is shared by translation pairs in the two languages. Therefore, concrete words can be translated directly between the two verbal systems or indirectly through the shared image system, whereas abstract words can be translated only between the verbal systems.

The context availability theory (Schwanenflugel, Harnishfeger, & Stowe, 1988; Schwanenflugel & Stowe, 1989) was also proposed to explain monolingual imageability effects. This theory argues that a word's context availability is more predictive of its ease of access than its imageability or familiarity. Schwanenflugel et al. (1988) showed that concreteness effects disappeared when the amount of contextual information was matched for concrete and abstract words, indicating that concrete words have a more easily available context (typically derived from prior world knowledge or the stimulus environment) than abstract words. This theory was extended to bilingual speakers by Van Hell and de Groot (1998) in an investigation contrasting the validity of the dual coding theory with the context availability theory. In three lexical decision experiments involving Dutch–English bilinguals, Van Hell and de Groot found an advantage for lexical access

of concrete words when stimuli were not matched for context availability. The advantage was not present when the concrete and abstract words in the experiments were matched for their context availability.

Most of the aforementioned studies have focused mainly on the conceptual/semantic level differences in imageability (using tasks such as lexical decision and semantic priming) although a few have examined imageability in the context of lexical access (such as word association and delayed naming). Few studies have sought to determine whether the difference between concrete and abstract words lies at the conceptual/semantic level or at the lexical access level (phonological access). We know from patients with monolingual aphasia that selective impairments in imageability can occur at the semantic level (Franklin, Howard, & Patterson, 1994) or at the word retrieval level (Franklin, Howard, & Patterson, 1995). This issue is even more relevant in the context of bilingual aphasia, given the current debate regarding whether word forms in both languages are active during lexical retrieval in normal bilingual individuals (Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, De Bot, & Schreuder, 1998). Further, it is likely that the nature and characteristics of various lexico-semantic factors influencing lexical access in bilingual individuals may vary as a function of language proficiency and need systematic examination (Grosjean, 1998). In fact, apart from case reports comparing impairments across languages (Dronkers, Yamasaki, Ross, & White, 1995; Stadie, Springer, de Bleser, & Burk, 1995; Vaid & Genesee, 1980; Vaid & Pandit, 1991) investigation of lexical access in bilingual aphasia has been limited to the quality of verbal output across the two languages (Munoz & Marquardt, 2003; Roberts & Le Dorze, 1998) and the influence of certain variables such as cognate status (Lalor & Kirsner, 2001; Roberts & Deslauriers, 1999; Roberts & Le Dorze, 1998).

THE PRESENT EXPERIMENT

As a preliminary attempt to address imageability effects in normal bilingual adults and in bilingual aphasia, a naming to definition task (NTD) and a semantic priming task (SP) were conducted in both Spanish and English. First, we wanted to examine differences, if any, in the overall language performance across English and Spanish tasks in the bilingual participants. We predicted that any difference noted between performance in Spanish and English, irrespective of task or imageability, would relate directly to the participants' reported proficiency across languages.

A second goal of the experiment was to examine the imageability effect across languages. While an advantage for concrete words over abstract words was expected to occur, of particular interest was the observation of comparable effects of imageability across both languages in the bilingual individual. We predicted that if the advantage concrete words had over abstract words were due to a difference in their conceptual/semantic representations, then concrete words should be named more accurately as well as primed faster than abstract words and this effect should be similar across both languages tested.

A third goal of the study was to explore differences between conceptual/semantic processing and phonological retrieval of concrete and abstract words by comparing accuracy levels across NTD and SP tasks. We hypothesised that accuracy levels that were disproportionately worse on the NTD task compared to SP task would reflect differential phonological access for concrete/abstract words. Conversely, no difference between NTD and SP accuracy levels may indicate that the difference between concrete and abstract

words lies at the level of conceptual/semantic processing following the theoretical assumption semantic attributes such as imageability are specified at the semantic level.

Finally, we explored the effects of imageability on lexical processing in one bilingual aphasic adult.

METHOD

Participants

A total of 15 normal bilingual adults (10 female and 5 male) recruited from central and southern Texas took part in this study. Participants ranged in age from 20 to 55 years (mean age = 32 years, *SD* = 11.6). All participants: (a) had learned both Spanish and English prior to 10 years of age, (b) were literate in both languages, (c) had no history of brain damage, Parkinson's disease, or Alzheimer's disease, (d) had at least a high-school degree, and (e) had normal or corrected to normal vision and normal hearing as measured by a pure tone hearing screening at 40 db HL bilaterally at 500, 1000, and 2000 Hz and a visual screening using the Snellen chart. Each participant completed a language use survey (Munoz, Marquardt, & Copeland, 1999) indicating their use of Spanish and English with various conversational partners and in various contexts (Edmonds & Kiran, 2004). Each participant also rated his or her proficiency in both languages across various situations. The language proficiency rating used a 7-point scale where 1 = nonfluent (only knows several words or a few simple sentences) and 7 = fluent (completely comfortable like a native speaker with skills). Each participant reported proficiency of 3.4 or higher in both Spanish and English, although overall abilities were rated higher in English (M = 6.70, SD = 0.536) than in Spanish (M = 5.24, SD = 1.13), indicating that the majority (12/15) of the participants were English dominant (see Table 1). An additional 10 bilingual participants were recruited for various stimuli development tasks using the same exclusionary criteria.

One bilingual (English–Spanish), 53-year-old female individual with aphasia also participated in the experiment. This patient had suffered a single left hemisphere stroke in the distribution of the middle cerebral artery confirmed by a CT/MRI scan approximately 9 months prior to initiation of the experiment. She was born in Mexico, and had learned Spanish as her native language and received 10 years of education. At 21 years of age, she moved to the US and subsequently married a monolingual English-speaking individual. Results from ratings of her language-use survey revealed equal levels of proficiency in English (Mean = 6) and Spanish (Mean = 7, see Table 1). The diagnosis of aphasia (AQ = 67.9) was determined by administration of the *Western Aphasia Battery* (Kertesz, 1982) administered in English. Additionally, the *Bilingual Aphasia Test* (Paradis, 1989) administered in English and Spanish revealed generally similar performance levels in both languages on naming (English = 60%, Spanish = 93% accuracy), semantic opposites (English = 20%, Spanish = 10% accuracy), comprehension of simple commands (English = 100%, Spanish = 100% accuracy), comprehension of complex commands (English = 100%, Spanish = 75% accuracy), semantic categorisation (English = 80%, Spanish = 100% accuracy), repetition (English = 93%, Spanish = 96% accuracy), and sentence construction (English = 0%, Spanish = 0% accuracy). Patient MT obtained similar scores (41% and 40% accuracy) on the *Boston Naming Test* (Goodglass, Kaplan, & Weintraub, 1983) administered in English and Spanish respectively. Based on her self-reported proficiency and performance on the above tests, patient MT did not show a preference for either language before or following her stroke.

TABLE 1
Language proficiency data

			Spanish									*English*								
Subject	*Age*	*Language dominance*	*SCC*	*LCC*	*SFS*	*LFS*	*Read*	*Write*	*OA*	*Spanish average*	*Spanish SD*	*SCC*	*LCC*	*SFS*	*LFS*	*Read*	*Write*	*OA*	*English average*	*English SD*
S1	51	English	4	6	4	6	4	4	5	4.71	0.88	7	7	7	7	7	7	7	7.00	0.00
S2	23	English	7	7	7	7	7	7	7	7.00	0.00	7	7	6	6	7	6	7	6.57	0.53
S3	40	English	4	4	4	4	4	4	5	4.14	0.35	7	7	7	7	7	7	7	7.00	0.00
S4	24	English	6	7	5	6	6	5	5	5.71	0.70	7	7	7	7	7	7	7	7.00	0.00
S5	38	Spanish	7	7	7	7	7	7	7	7.00	0.00	6	6	6	6	6	6	7	6.14	0.38
S6	27	English	4	6	4	5	4	3	4	4.29	0.88	7	7	6	6	7	6	6	6.43	0.53
S7	32	English	6	7	6	7	6	6	6	6.29	0.49	7	7	7	7	7	7	7	7.00	0.00
S8	21	English	4	7	4	7	7	6	5	5.71	1.28	7	7	7	7	7	7	7	7.00	0.00
S9	22	English	5	5	4	4	7	6	5	5.14	0.99	7	7	6	6	7	7	7	6.71	0.49
S10	20	Both	5	5	5	5	5	5	5	5.00	0.00	5	5	5	5	5	5	5	5.00	0.00
S11	24	English	7	7	5	5	6	7	6	6.14	0.83	7	7	7	7	7	6	7	6.86	0.38
S12	24	English	6	7	6	7	5	5	6	6.00	0.76	7	7	6	7	7	6	7	6.71	0.49
S13	47	English	4	5	4	5	4	3	4	4.14	0.64	7	7	7	7	7	7	7	7.00	0.00
S14	55	English	4	6	2	3	3	3	3	3.43	1.18	7	7	7	7	7	7	7	7.00	0.00
S15	28	English	3	6	2	5	5	3	3	3.86	1.36	7	7	7	7	7	7	7	7.00	0.00
MT	53	Both	7	7	7	7	7	7	7	7.00	0	6	7	5	6	7	7	6	6.28	0.75

Participants rated their proficiency in each language on a 7-point scale where 1 = nonfluent, only knows several words or a few simple sentences, to 7 = fluent, completely comfortable with skills like a native speaker. Participants were also asked to state which language they were most comfortable using, which is listed here as the stated language dominance. SCC = speaking in casual conversation, LCC = listening in casual conversation, SFS = speaking in formal situations, LFS = listening in formal situations, OA: overall ability.

Stimuli

The stimuli consisted of 120 words (English $N = 60$; Spanish $N = 60$). In each language, 30 of these were abstract (concreteness rating of < 344) and 30 were concrete (concreteness rating of >538; *MRC psycholinguistic database*, University of Western Australia, 1988). Words were matched for frequency by language (Frances & Kucera, 1982; Juilland & Chang-Rodriguez, 1964) and by imageability (concrete $M = 152$, $SD = 210$; abstract $M = 171$, $SD = 152$). A 2 × 2 ANOVA on written frequency of items revealed no significant effects for language, $F(1, 119) = 2.4701$, or imageability, $F(1, 119) = 0.17315$. While we recognised the influence of cognate status on bilingual lexical retrieval, especially on concrete nouns (Costa et al., 2000a; Lalor & Kirsner, 2001; Roberts & Deslauriers, 1999) we felt it more important to balance stimuli for word frequency and imageability across languages in lieu of cognate status. Hence, many items on the abstract word lists were cognates in English and Spanish (e.g., *responsibilidad/responsibility*) and this issue was addressed during data analysis through an analysis of covariance with cognate status entered into the analysis as a covariate.

For the NTD task, a one-sentence definition that was the most frequent definition describing each word was selected from *Merriam-Webster's Collegiate Dictionary* (1996) for English stimuli and its respective translation equivalent was selected for Spanish stimuli. Average length of definition was 9.2 words in English ($SD = 3.46$) and 8.4 words in Spanish ($SD = 2.8$).

For the SP task, the same 60 words were used in each language as in the naming to definition task. Semantic relatedness judgements were obtained from 10 participants for the abstract words in Spanish and English by conducting a relatedness survey. The 60 words were pseudorandomly matched with semantically related words or unrelated words (approximately 10% of the pairs) for each language. Participants were asked to rate the similarity of pairs on a scale of 1 to 4 (1 = very similar in meaning, 4 = not similar in meaning). Semantic relatedness data for the concrete words in Spanish and English were obtained from a previous study (Edmonds & Kiran, 2004). Concrete word relatedness ($M = 1.84$, $SD = 0.34$) and abstract word relatedness ($M = 1.68$, $SD = 0.40$) were compared using a 2 (Spanish × English) × 2 (abstract × concrete) ANOVA. No significant effect was found for language, $F(1, 59) = 3.8437$, or imageability, $F(1, 59) = 2.9809$, suggesting that the word pairs were matched for semantic relatedness.

For the priming task, 30 word pairs on the semantic relatedness survey that were rated 2.4 or less were selected as targets. Once the target pairs were created, each word was pseudorandomly matched with another imageability-matched word on the list to create the filler pairs. Therefore, there were 60 word pairs (30 target pairs, 30 filler pairs) in each language. A Dell (PC) computer loaded with Superlab® (Cedrus Corporation, Phoenix, Arizona) was used to display stimuli and collect data (reaction time and errors). The order of presentation of word pairs was randomised for each participant. For each pair, the first word was presented for 750 ms, followed by a 200-ms interstimulus interval (ISI), while the second word was presented until the participant made the semantic relatedness decision. The intertrial interval (ITI) was 1500 ms. To summarise, two priming experiments were created, one in English ($n = 60$) and one in Spanish ($n = 60$).

Procedures

The experiment was divided into two sessions, each consisting of two tasks. Each participant was presented first with the NTD task and then with the SP task. This order was followed to avoid prior exposure to the phonological representations of target items in the

NTD task. The order of presentation by language was counterbalanced across participants. Participants were presented with the tasks in the environment most convenient for them (research lab, participant's home/workplace) and the tasks were completed in a quiet environment with only the researcher and the participant present.

For the NTD task, participants were instructed that they would hear the definition of a word and they were to state the word that best matched the definition. The participants were instructed to say ''I don't know'' if they couldn't think of the word. The order of presentation of items was randomised. For the SP task, participants were seated in front of a computer with their nondominant hand placed on the keyboard, and instructed that they would see a word, followed by a short interval and then a second word, and they were to decide if they felt the two words were related in meaning or not. Participants were told to complete the task as quickly and as accurately as possible.

RESULTS

Naming to definition task (NTD)

Normal bilingual speakers. Error rates on NTD for the normal bilingual adults are summarised in Table 2 and percent accuracies are illustrated in Figure 1a. A 2 (Spanish × English) × 2 (concrete × abstract) ANCOVA with cognate status as a covariate was performed on the error data as an item analysis (F_1, averaged across subjects), and a separate 2 × 2 ANOVA was performed on the error data as a subject analysis (F_2, averaged across items). Results indicated that accuracy was better in English than in Spanish, $F_1(1, 115) = 8.59$, $MSe = .4441$, $p < .001$; $F_2\ (1, 54) = 30.7$, $MSe = .284$, $p < .0001$, and for concrete words than abstract words, $F_1(1, 115) = 145$, $MSe = 7.53$, $p < .0001$; $F_2\ (1, 54) = 575$, $MSe = 5.33$, $p < .0001$. No significant interaction effects or effects of cognate status were observed, $F_1(1, 115) = .36$.

Patient MT. Error rates on NTD task for the aphasic patient are summarised in Table 2 and percent accuracies are illustrated in Figure 1a. A 2 (Spanish × English) × 2 (concrete × abstract) ANCOVA performed on error proportion data indicated a significant main effect for imageability, $F(1, 115) = 72.56$, $MSe = .04$, $p < .0001$, with naming of concrete words more accurate than abstract words. No main effect for language, cognate status, or interaction effects was observed.

Semantic priming task (SP): Error analysis

Normal bilingual speakers. Error rates for normal bilingual adults and the bilingual aphasic patient are illustrated in Table 2. A 2 (Spanish × English) × 2 (abstract × concrete) × 2 (target × filler) ANCOVA with cognate status as a covariate was performed on the error data as an item analysis, and a separate 2 × 2 × 2 ANOVA was performed on the error data as a subject analysis. Results showed that accuracy in English was better than in Spanish, $F_1(1, 111) = 6.62$, $MS_e = 1289$, $p < .05$; $F_2\ (1, 112) = 7.6386$, $MS_e = 29.0083$, $p < .01$, concrete words were more accurate than abstract words, $F_1(1, 111) = 17.6$, $MS_e = 3427$, $p < .0001$; $F_2\ (1, 112) = 35.393$, $MS_e = 134.408$, $p < .0001$, and target pairs were more accurate than filler pairs, $F_1(1, 111) = 21.97$, $MS_e = 4276$, $p < .0001$; $F_2\ (1, 112) = 25.123$, $MS_e = 95.4083$, $p < .0001$. No effect of cognate status was observed, $F_1(1, 111) = .28$. Significant interaction effects were observed between imageability and target/filler status, $F_1(1, 111) = 39.141$, $MS_e = 761$, $p < .0001$; $F_2\ (1, 112) = 44.872$, $MS_e = 1704$, $p < .0001$, indicating that abstract filler pairs were less accurate than

TABLE 2.
Mean RTs (SD) and error percentages

	Semantic priming							
	Normal Bilingual Adults				*Patient MT*			
English	*Target*	*Error*	*Filler*	*Error*	*Target*	*Error*	*Filler*	*Error*
Concrete	1147.46 (*SD* = 881.73)	5%	1235.96 (*SD* = 1227.37)	6%	1891 (*SD* = 452)	57%	1973 (*SD* = 933)	0%
Abstract	1307.284 (*SD* = 1025.18)	7%	1884.116 (*SD* = 1943.13)	26%	2276 (*SD* = 614)	43%	2097 (*SD* = 794)	20%
Spanish	*Target*		*Filler*		*Target*		*Filler*	
Concrete	1372.147 (*SD* = 705.49)	15%	1459.142 (*SD* =1068.65)	6%	2055 (*SD* = 991)	20%	1622 (*SD* = 565)	25%
Abstract	1667.156 (*SD* = 1101.10)	13%	1895.453 (*SD* = 1259.65)	42%	1810 (*SD* = 638)	21%	2203 (*SD* = 871)	31%

	Naming to definition	
	Normal bilingual adults	*Patient MT*
English		
Concrete	9% (*SD* = 21%)	47%
Abstract	78% (*SD* = 21%)	100%
Spanish		
Concrete	30% (*SD* = 31%)	37%
Abstract	91% (*SD* = 11%)	97%

Mean reaction times (standard deviations in parenthesis) and error percentages for target and filler items across concrete and abstract words observed for English and Spanish languages for normal bilingual adults and patient MT on the semantic priming task. Also reported here are the percent errors for concrete and abstract words across English and Spanish languages on the naming to definition task.

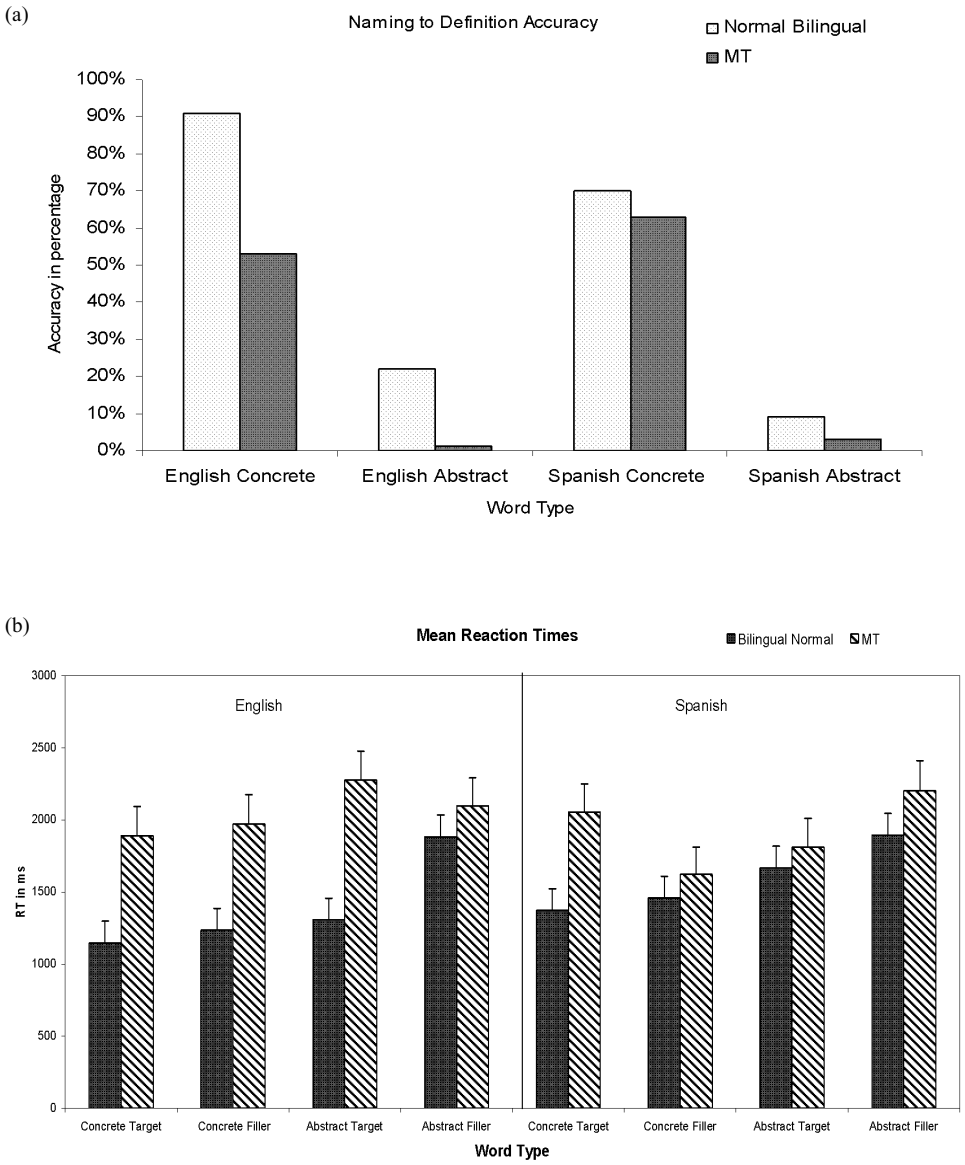

Figure 1. (a) Percentage accuracy by word type on the naming to definition task for normal bilingual adults and patient MT. (b) Mean reaction times (and standard errors) by word pair type on the semantic priming task for normal bilingual adults and patient MT.

abstract target pairs ($p < .05$), concrete target ($p < .05$), and concrete filler pairs ($p < .05$). No other significant interaction effects were found.

Patient MT. For the bilingual aphasic patient, A 2 × 2 × 2 ANCOVA with cognate status as a covariate performed on the error data revealed significant effects for target/filler, $F(1, 106) = 4.35$, $MS_e = .8064$, $p < .05$, and interaction between language and target/filler status, $F(1, 106) = 8.44$, $MS_e = 1.5$, $p < .01$, showing that targets in English were less accurate than fillers in English.

Semantic priming (SP): Response time analysis

Normal bilinguals. Mean response times (RTs) for the normal bilingual adults and the one aphasic patient are included in Table 2 and are summarised in Figure 1b. A 2 × 2 × 2 ANCOVA with cognate status as a covariate was performed on the mean reaction times as an item analysis, and a separate 2 × 2 × 2 ANOVA was performed on mean reaction times as a participant analysis. Results revealed mean RTs in English were significantly faster than in Spanish, $F_1(1, 111) = 7.41$, $MS_e = 8619$, $p < .05$, on the item analysis (F_1), but not on the subject (F_2). RTs for concrete words were significantly faster than abstract words, $F_1(1, 111) = 28.7$, $MS_e = 3337$, $p < .0001$; $F_2(1, 112) = 13.094$, $MS_e = 4.43883e6$, $p < .001$, and target pairs were significantly faster than filler pairs, $F_1(1, 111) = 11.41$, $MS_e = 1326$, $p < .0001$; $F_2(1, 112) = 5.326$, $MS_e = 1.80547e6$, $p < .05$. No significant effects of cognate status were observed, $F_1(1, 111) = .14$. Significant interaction effects were observed for language and target/filler status, $F_1(1, 111) = 3.92$, $MS_e = 4562$, $p < .05$, indicating that targets in English were faster than targets in Spanish ($p < .05$) and fillers in English ($p < .05$) and Spanish ($p < .05$). Additionally, significant interaction effects were observed for imageability and target/filler status, $F_1(1, 111) = 9.62$, $MS_e = 1118$, $p < .01$, indicating that abstract fillers took longer to respond than abstract targets ($p < .0001$), concrete targets ($p < .0001$), and concrete fillers ($p < .0001$). Interaction effects were only significant on the item analysis (F_1) and not participant analysis (F_2).

Patient MT. For the aphasic patient, a 2 (Spanish × English) × 2 (abstract × concrete) × 2 (target × filler) ANCOVA with cognate status as a covariate performed on the mean reaction times revealed no significant effects for language, imageability, or target/filler status.

Accuracy rates across tasks

Accuracy rates across the NTD and SP tasks were compared using a 2 (NTD × SP) × 2 (English × Spanish) × 2 (concrete × abstract) ANCOVA with cognate status as a covariate on the mean error rates. Results indicated higher accuracy on the SP task than NTD, $F(1, 231) = 234.3$, $MS_e = 9.4$, $p < .0001$, in English than in Spanish, $F(1, 231) = 13.17$, $MS_e = .53$, $p < .001$, and on concrete words than abstract words, $F(1, 231) = 125$, $MS_e = 5.04$, $p < .0001$. Also significant was the critical task by imageability interaction, $F(1, 231) = 79.2$, $MS_e = 3.19$, $p < .0001$, indicating that accuracy rates for abstract words on the NTD task were significantly lower than accuracy rates for concrete words on that task ($p < .0001$), and compared to abstract ($p < .0001$) and concrete words ($p < .0001$) on the SP task.

DISCUSSION

The present experiment investigated the effect of imageability in normal English–Spanish bilingual individuals and in one patient with bilingual aphasia, using two tasks, naming to definition and semantic priming. In general, normal bilingual participants performed better in English than in Spanish, reflected through higher accuracy rates on the NTD task and faster reaction times on the SP task. This advantage for English corresponded directly to the observation that the majority of the normal participants stated English language dominance, even though all had learned both languages before the age of 10. Notably, in the bilingual aphasic individual, who was equally proficient in both languages, no

difference was found between performance on English and Spanish stimuli. These results support a growing body of evidence suggesting that level of current proficiency, based on frequency of usage not age of acquisition, may be a more reliable determinant of bilingual lexical access (Abutalebi, Cappa, & Perani, 2001; Edmonds & Kiran, 2004; Kohnert, 2002).

The second aim of the study was to investigate if concrete words were accessed differently from abstract words across both languages. Across both languages and both tasks, concrete words were judged and named faster and more accurately than abstract words. Further, the bilingual aphasic patient also demonstrated an imageability effect on the NTD task with superior concrete word naming across both languages. The lack of significant effects on reaction time precludes us from making any broad conclusions concerning the semantic priming component of this patient's results. It is noteworthy that in both the normal individuals and the aphasic patient, there was no significant interaction between imageability and languages in either task, indicating that concrete and abstract words were treated similarly across both languages. Two interpretations can be drawn from this result. First, abstract words in the less dominant language (e.g., *conocimiento*) were not processed significantly more poorly than their translations in the dominant language (e.g., *knowledge*). Second, concrete words such as *chair* and *silla* were both accessed faster than abstract words like *knowledge* and *conocimiento*, presumably because *chair* and *silla* share a conceptual representation that is richer in semantic information than *knowledge* and *conocimiento*, which may not share a conceptual representation and may be selected only in a language-specific context.

This hypothesis is in line with theoretical accounts provided by Van Hell and de Groot (1998) who suggest that concrete words share conceptual nodes across both languages that facilitate easier translation between languages whereas abstract words share fewer conceptual elements with semantically related words across language translations. A similar monolingual model by Newton and Barry (1997) suggests that concrete words have a high degree of specificity in the process of lexical access compared to abstract words because of specific and strong representations underlying their meanings. In general, the present results are also compatible with the premise of the bilingual version of the dual coding model (Paivio & Desrochers, 1980) and the context availability theory (Schwanenflugel et al., 1988; Schwanenfluge & Stowe, 1989) as described in the introduction.

Another important goal of this experiment was to determine if differences between concrete and abstract words arose at the semantic/conceptual level (during the semantic priming task) or at the phonological level (during the naming to definition task). Results revealed that whereas accuracy rates for the NTD task were lower than those on the SP task, accuracy of abstract words on NTD was significantly lower than accuracy of concrete and abstract words during the SP task. In other words, retrieving the word *doctrine* in the presence of the context ''*a set of principles presented for belief by a religious organisation*'' was significantly more difficult than judging that *doctrine* and *philosophy* were related. As a comparison, retrieving *sword* in the context of ''*a weapon with a long blade for cutting or thrusting*'' was no more difficult than judging that *knife* and *sword* were related. This effect was similar across both languages. Notably, the patient with aphasia was unable to retrieve any abstract words on NTD task (0–3% accuracy), whereas concrete word naming ranged between 53% and 63% accuracy. Extending the framework of concrete and abstract words discussed above, it can be posited that contextual information provided for the ''semantically dense'' concrete word during the NTD task is adequate to map a specific semantic representation onto a target

word form, increasing its likelihood of lexical retrieval. In contrast, contextual information provided for the already sparse semantic representation comprising the abstract word is insufficient to activate the corresponding phonological form (Newton & Barry, 1997; Van Hell & De Groot, 1998). Results from the bilingual aphasic patient suggest a systematic deterioration in the normal bilingual language system in this patient. Specifically, concrete word retrieval is relatively spared due its conceptual specificity and redundancy across languages, whereas the already vulnerable abstract word representation is unable to support its corresponding word retrieval (Newton & Barry, 1997). Whereas trends on the semantic priming task in this patient supported an imageability effect (at least in English), the lack of significance and the variability in the data preclude any conclusive interpretations.

Results of the present study have clinical implications for bilingual patients with aphasia. First, interpretation of assessments should take into account prior proficiency so that differential performance (or the lack thereof) on various lexico-semantic variables is not necessarily construed 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 be influenced by various factors. To conclude, the present experiment was a preliminary investigation of the effect of imageability on semantic processing and lexical access across two languages in normal bilingual adults and in one patient with bilingual aphasia. These results need to be extended to examining normal bilingual individuals with no preferential language dominance, and bilingual patients with aphasia who demonstrate differential language dominance and language impairments.

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