Introduction

Current research on bilingual aphasia has only begun to inform us about the optimal rehabilitation for bilingual aphasic patients and the literature is still sparse in terms of interpreting impairment and recovery in these individuals. Two recent reviews (Faroqi-Shah, Frymark, Mullen, & Wang, 2010; Lorenzen & Murray, 2008) highlight the beneficial effects of rehabilitation in bilingual aphasic patients, however, both reviews underscore the need for theoretically motivated and well controlled rehabilitation studies. There are still several unanswered questions about outcomes in bilingual aphasia rehabilitation, including (a) is it sufficient to rehabilitate only one language, (b) what are the nature of gains in the trained language, and (c) does rehabilitation in one language have beneficial effects in the untreated language? The present experiment attempts to address these questions with a relatively large set of Spanish-English bilinguals with aphasia, all of whom receive therapy in one language at a time. The extent of improvements in the trained language items, semantically related untrained items in the trained language, and between-language transfer to untrained items is examined. In addition to picture naming, changes in the evolution of naming errors and category fluency are also examined in this study.

Methods

Participants. Seventeen patients with bilingual aphasia participated in the therapy experiment. Five of these patients have been reported previously (Edmonds & Kiran, 2006; Kiran & Roberts, 2010). All were at least five months post-onset from a left perisylvian area CVA (one had a gun-shot wound), were pre-morbidly right-handed and bilingual speakers of English and Spanish. Post-CVA they had language impairment in both languages. For each participant, a detailed language use questionnaire that obtained information regarding Age of Acquisition (AoA), pre-stroke lifetime exposure, post-stroke current language use, education history for each language (See Table 1).

Stimuli. For each participant, three sets of stimuli were developed for each language, English set 1 (e.g., *table*), semantically related items in English (set 2; e.g., *chair*); unrelated controls items in English (set 3; *celery*); translations of English set 1 in Spanish (set 1; e.g., *mesa*), semantically related items in Spanish (set 2; e.g., *silla*), unrelated control set in Spanish (set 3; e.g., *apio*). All word pairs were category coordinates and, to the extent possible, the lists were balanced for average frequency in their respective languages. For each item, six true semantic features referring to the superordinate category, function, general characteristic, physical characteristic, location and association were developed. Six false, distractor features for each item were created.

Design. A single subject experimental multiple baseline design across participants was implemented following a treatment protocol previously described (Edmonds & Kiran, 2006; Kiran & Roberts, 2010). Following baseline testing, treatment was conducted in one language for either ten weeks or until the patient achieved 80% accuracy across two consecutive sessions on the trained items. Three patients received therapy in the second language after completion of the first treatment. Generalization to the translation of the trained set, semantically related items in both languages and control items was examined.

Results

Table 1 reports effect sizes (Busk & Serlin, 1992) for all participants for the trained and untrained languages. Treatment for naming on set 1 items resulted in significant improvement (ES > 4.0) on the trained items in 75% of cases. Within-language generalization to semantically related items was observed in 35% of cases. Between-language generalization to the translations of trained items was observed for 30% of cases, whereas between-language generalization to the translations of the untrained semantically related items was observed for 20% of the cases. To identify the relationship between the trained set and the untrained sets in both languages, we calculated cross-correlation coefficients using SPSS between the trained set 1 and the untrained sets within and between languages. In this paper, we only examined a correlation at 0 lag that indicated that changes are concurrent in the two time series.

Results revealed that improvements in the trained language set were accompanied (based on correlation coefficients of .50 or higher) by (a) improvements in the within-language semantically related set in 58% of cases; (b) improvements in between-language translations of trained set in 35% of cases, and (c) improvements in between-language translations of the untrained semantically related set in 35% of cases (see Figure 1). Additionally, changes were also noted in the evolution of errors and category fluency as a function of treatment. The relationship between variables including pre-stroke proficiency, post-stroke naming impairment and the language trained was also examined.

Discussion

Results of this showed beneficial effects of a semantic based treatment on naming in one language. Improvements in the semantically related untrained items within the trained language was also observed indicating that therapy targeted at emphasizing semantic features improves access to trained items as well as semantically related items irrespective of which language is trained (Kiran & Bassetto, 2008). While it was predicted that generalization to translations of the trained item in the untrained language would occur since phonological representations of targets in both languages access a common semantic representation, this was not always observed and appeared to be dependent upon pre-stroke proficiency, level of language impairment and the language trained. For instance, patients who showed significant between-language generalization effects were either proficient bilinguals or trained in their weaker language. Surprisingly, several participants showed improvements on semantically related targets in the untrained language. One explanation for this result may be that strengthening semantic representations of a target in one language improved access to the phonological representation of semantically related words in the untrained language by way of spreading activation. An alternate more controversial explanation may be that repeated exposure to targets in one language may have resulted in the inhibition (Costa, Santesteban, & Ivanova, 2006) of the translations in the untrained language (hence the limited generalization effects) whereas semantically related targets in the untrained language are not subject to this inhibition and hence demonstrate improvements as a function of treatment. Analysis of the relationship between pre-stroke language proficiency and treatment outcomes suggests some possible explanations for therapy outcomes.

References

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Pii 915031956

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Table 1

Demographic information for seventeen bilingual patients with aphasia including AoA, pre-stroke lifetime exposure, post-stroke current language exposure, pre-stroke education history, self-rating of language abilities in each language. Also reported in the table is the language of therapy and effect sizes for the trained and untrained language. For each language, ES are reported for set 1, semantically related set 1, and unrelated control set 3. * denotes participants that have been previously reported.

P#		AoA		Lifetime exposure		Current exposure		Education history		Self-rating		Trained Language	Trained language Effect Size			Untrained language Effect Size		
	Age	Eng	Spa	Eng	Spa	Eng	Spa	Eng	Spa	Eng	Spa		Set 1	Set 2	Set 3	Set 1	Set 2	Set 3
U01*	53	0	0	75%	25%	94%	6%	100%	0%	100%	40%	English	12.7	7.5	0.6	0.6	-0.6	-0.6
U01*												Spanish	12.7	0.5	0	13.8	9.8	0
U02 *	54	21	0	31%	69%	50%	50%	33%	67%	90%	100%	Spanish	11.1	6.4	2.1	4.9	6.8	2.1
U07 *	56	0	0	ND	ND	ND	ND	100%	0%	94%	31%	Spanish	12.4	0.9	1.5	3.1	2.8	4.9
U09 *	56	5	0	58%	42%	61%	39%	100%	0%	100%	82%	Spanish	11.0	2.6	0.0	2.1	1.9	5.1
U11 *	87	11	0	ND	ND	ND	ND	ND	ND	98%	100%	English	14.9	5.2	1.1	1.1	-0.6	-0.6
U11 *												English	13.0	1.1	1.1	6.3	5.15	2.8
U16	53	0	0	61%	39%	54%	46%	67%	33%	67%	53%	Spanish	6.8	6.8	6.6	0.8	0.2	2.8
U17	52	6	0	66%	34%	55%	45%	58%	42%	100%	100%	English	5.3	0.4	-5.4	1.2	-0.6	-0.6
U17												Spanish	1.4	1.9	-0.7	0	2.6	-3.0
U18	74	17	0	40%	60%	0%	100%	29%	71%	100%	100%	Spanish	15.2	-0.3	3.5	1.7	0.9	3.5
U19	75	27	0	16%	84%	15%	85%	0%	100%	20%	100%	English	1.4	4.8	0.0	4.9	1.1	0
U20	85	69	0	5%	95%	8%	92%	ND	ND	20%	57%	Spanish	0.0	0.0	0.0	0.0	0.0	0.0
U21	88	5	0	72%	28%	99%	1%	100%	0%	ND	ND	English	0.0	-0.7	0.0	0.0	0.0	0.0
U22	41	18	0	10%	90%	29%	71%	0%	100%	34%	94%	Spanish	12.7	0.2	2.8	1.9	1.2	-1.4
U23	41	9	0	32%	68%	26%	74%	22%	78%	66%	94%	Spanish	13.8	13.5	1.4	10.7	6.4	0.6
B01	44	15	0	28%	72%	22%	78%	0%	100%	89%	89%	English	4.9	3.6	1.6	1.4	2.3	1.3
B04	37	6	0	76%	24%	66%	34%	100%	0%	100%	49%	Spanish	16.5	4.3	0.8	2.5	2.4	0.6
B07	65	45	0	13%	87%	4%	96%	0%	100%	29%	100%	English	2.9	2.0	0.3	4.1	1.8	2.3
B12	33	14	0	33%	67%	46%	54%	28%	72%	80%	100%	English	8.2	0.0	0.0	0.0	0.0	0.0

Figure 1

Cross correlation coefficients (values > .5 are significantly above 2 standard deviation) are reported for all participants for (a) trained set and untrained set within the trained language (within-language generalization), (b) trained set 1 and untrained language set 1 (between-language generalization) and (c) trained set 1 and untrained language set 2 (between-language generalization). Three participants (U20, U21, B12) did not show improvements on trained items, hence coefficients for these patients are negligible.