

What can speech production errors tell us about cross-linguistic processing in bilingual aphasia? Evidence from 4 English/Afrikaans speaking individuals with aphasia.

Introduction: In an effort to inform clinical practice and our understanding of bilingual aphasia, we examined differential performance in lexical retrieval abilities between first (L1) and second acquired language (L2), types of errors produced, and if performance was influenced by degree of cognate overlap in 4 bilingual aphasic individuals. **Methods:** A case series analysis of four Afrikaans/English bilingual aphasic individuals whose confrontation naming data were subjected to broad phonetic transcription was employed. Research questions were directed toward between language differences in lexical retrieval abilities, the influence of performance by degree of cognate overlap and types of errors produced. **Results:** Three participants showed significantly higher whole word confrontation naming accuracy in L1 relative to L2. One participant showed no difference. Performance for everyone was the poorest for low cognate overlap words. The largest proportion of error type for 3 participants in both L1 and L2 was omission. **Discussion:** These findings show that while all participants had aphasia, their relative naming impairments were consistent with their relative proficiency and use patterns prior to their stroke. The participant without between language differences was equally proficient in both languages and the remaining 3 participants showed an advantage consistent with the language used most frequently.

Speech-language pathologists are charged with providing evidence based assessment and treatment, and with increasing prevalence of bilingualism in the world, special consideration to bilingual aphasia is imperative. Most models of lexical retrieval for bilinguals account for a conceptual/semantic layer (shared between languages for most concepts), a lexical layer (with distinct lexical representations for each of the languages)(Kroll and Stewart, 1994) and a phoneme layer (with a certain degree of overlap between the phonological systems of the languages depending upon how closely they are the languages are sublexically related) (Costa, 2005). Thus, when presented with a picture during confrontation naming, activation of a shared semantic system spreads to both lexicons regardless of the language in which the task is being performed (Costa, 2005); however, likely due to inhibitory processes, production is typically restricted to the target language (Kroll et al., 2008).

According to the hierarchical model of bilingual lexical retrieval, the strength of connections between the semantic system and each lexicon is related to the degree of use and proficiency, generally resulting in more efficient and accurate retrieval of words in the more used and proficient language, which also has a larger lexicon (Kroll & Stewart, 1994). In addition, cognate status (words with the same meaning that have some degree of overlapping phonology (e.g., elephant/*elefante* (Spanish)) has also been shown to improve lexical retrieval in both languages (Costa & Caramazza, 2000).

In this study, we evaluated lexical retrieval in 4 persons from South Africa with aphasia who were bilingual speakers of English and Afrikaans, a population under-reported in the literature. Based on participant report, we compared accuracy across the first acquired (L1) and the second acquired language (L2). Additionally, we examined the

potential effect of high and low overlap across the words and also conducted an error analysis. We asked:

- 1. Is there a significant difference in confrontation naming accuracy between L1 and L2?*
- 2. Is there a trend for higher accuracy in high overlap cognates, and does L2 benefit more from high overlap words as compared to low overlap words?*
- 3. Is there a difference between L1 and L2 in the types of errors produced as measured by raw number and proportion of errors?*

Participants

Four participants (P) ($M=73$ (11.7) years) were enrolled. Inclusion criteria included a left hemisphere stroke, aphasia determined by a speech pathologist, bilingual English/Afrikaans and adequate hearing thresholds to complete the study. Exclusion criteria included psychiatric illness, degenerative neurological disease, chronic medical illness, severe impairment in vision or hearing, or knowledge/use of a third language. P1 reported having relatively equal proficiency across languages, and the other 3 reported more use and proficiency in one language (P2=English, P3 and P4=Afrikaans)(Table 1).

Stimuli

Picture naming of 40 one-, two-, and three-syllable noun items were selected in English and Afrikaans (Table 2). To determine name agreement, each black and white picture was presented on a 14cm by 22cm card to five healthy Afrikaans/English bilingual adults who named the pictures with 100% accuracy and agreement.

Cognate analysis

English and Afrikaans are both West Germanic languages that are widely used official languages in South Africa. Due to common origins, contact between the languages and borrowed words, many words share some degree of phonological overlap. In order to determine the degree of phonological overlap across the words in this study, Kohnert et al's (2004), 10-point scale, which indexes four features, initial sound, number of syllables, percentage of overlapping consonants and percentage of overlapping vowels, was used (Table 2). Total amount of cognate overlap was determined into 3 categories (high, medium and low). Due to relatively few number of medium overlap words (compared to high and low), only high and low results were examined for trends (Table 3).

Data collection procedures

The participants were instructed by a bilingual clinician in both languages to name the pictures first in L1, then again in L2. Responses were recorded and later scored for word and phoneme accuracy and error type by three experienced clinicians (first, fifth and sixth authors).

Error coding procedures

Correct responses included the correct lexical item (all of which corresponded to the healthy adult responses). Incorrect responses were coded for error type (phonologic, semantic, mixed, omission, neologism, translation).

Data analysis

Student's paired-samples *t* tests (with unequal variance) comparing accuracy between L1 and L2 were performed. For the error analysis, paired-samples *t* tests compared L1 and L2 for raw number of each error type and error type proportions. For the cognate analysis, percent accuracy was documented for high, medium and low overlap cognate words.

Results

Consensus reliability on 25% of the corpus resulted in 98% point-to-point reliability on accuracy scores and 83% reliability on error type coding.

Accuracy results for P1 showed no difference across language (L1=75%, L2=83%, $p=.209$). Significant differences were observed for P2 (L1=57.5%, L2=27.5%, $p=.038$), P3 (L1=37.5%, L2=20%, $p=.047$, and P4 (L1=22.5%, L2=0%, $p=.047$) (Figure 1).

Error type and cognate results are displayed on Figures 2-6.

Discussion

With respect to accuracy, all participants exhibited naming accuracy consistent with their reports of relative premorbid proficiency and use patterns. P1, who reported relatively balanced use and proficiency across languages, did not show significant crosslinguistic differences in accuracy. The other participants, though they acquired both languages relatively young, reported less balanced premorbid use and proficiency. Consistent with this report, all three achieved higher accuracy in the more used language, which corresponded to their first acquired language (L1). Thus, these findings show that while all participants had a diagnosis of aphasia, evident by their naming scores, their relative naming impairments were consistent with their relative premorbid proficiency and use patterns. Thus, their recovery patterns are consistent with those that are most commonly observed in persons with bilingual aphasia (Paradis, 1987).

The high and low overlap words show patterns of higher performance in L1, with higher performance overall for the higher overlap words. P3 and P4, who had the lowest accuracies overall did not correctly name any low overlap words, indicating that the phonological overlap on the high overlap words may have contributed to higher L2

performance on those words. Thus, there was evidence of a cognate effect, consistent with previous findings (Costa & Caramazza, 2000). Additionally, degree phonological overlap may be an informative way to characterize words for bilinguals in testing and treatment in addition to more conventional, psycholinguistic terms, which lack normative data for bilinguals (Edmonds & Donovan, 2012).

Finally, the error pattern analysis showing that P1 had more semantic substitutions relative to other error types is consistent with his milder form of anomia indicating the presence of lexical/semantic activation. Also, P1's semantic substitutions are seen in both L1 and L2 which is expected. The omissions seen in P2, P3 and P4 (in both L1 and L2) be is likely due to the combined effect of lower proficiency/usage, which 1) affects the strength of the connections for retrieval, so that if the word was known pre-morbidly, it might be too difficult to get post-stroke due to the effect of the lesion, or 2) the word was not known pre-stroke.

In conclusion, these results highlight the importance for clinicians who are working with individuals with bilingual aphasia to closely consider proficiency of language use as well as severity of aphasia.

Table 1: Participant (Pt) demographics.

Pt	Age	Occupation	Gender	Time post stroke onset	Age of exposure for first (L1) and second language (L2) learned	Relative proficiency and/or use information by participant report
1	72	University lecturer (PhD)	Male	4 years	L1 Afrikaans (birth) L2 English (3 years)	Fully bilingual since early age with equal mastery of both languages.
2	84	Housewife	Female	4 years	L1 English (birth) L2 Afrikaans (4 years)	More English use. Exposed to Afrikaans through community and school.
3	57	Engineer (4 year degree)	Male	3 months	L1 Afrikaans (birth) L2 English (10 years)	More Afrikaans use and proficiency. Exposed to English first through TV. Used both languages at work.
4	79	House wife (High school degree)	Female	4 months	L1 Afrikaans (birth) L2 English ("as a young child")	High frequency Afrikaans use, though she reported good English vocabulary.

Table 2: Stimuli in Afrikaans and English and cognate overlapping ratings

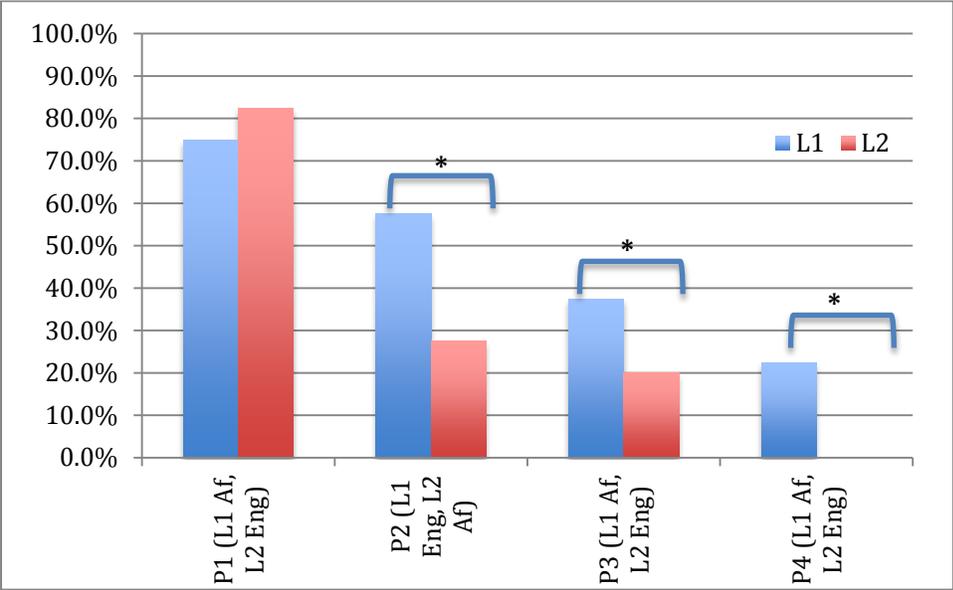
Afrikaans	English	Initial sound overlap 3 = same consonant 2 = same vowel 1 = similar sound 0 = mismatch	# syllables 2 = same # 1 = different by only 1 syllable 0 = different by > 1 syllable	Consonants 3 = >70% overlap 2 = 50-70% overlap 1 = ≤ 50% overlap 0 = no overlap	Vowels 2 = >80% overlap 1 = <u>50-80%</u> overlap 0 = no overlap	TOTAL AMOUNT OF OVERLAP (out of 10) High=8-10, Medium=5-7, Low=1-4, No=0
Man	Man	3	2	3	0	8
Hart	Heart	3	2	3	1	9
Kinders	Children	0	2	1	1	4
Tafel	Table	3	2	1	1	7
Tamatie	Tomato	3	2	2	1	8
Slak	Snail	3	2	1	0	6
Baba	Baby	3	2	3	0	8
Boek	Book	3	2	3	0	8
Telefoon	Telephone	3	2	3	1	9
Wol	Wool	3	2	3	0	8
Skoenlapper	Butterfly	0	2	0	0	2
Blaar	Leaf	1	2	1	0	4
Aarbeie	Strawberries	0	1	1	1	3
Hoed	Hat	3	2	2	0	7
Atleet	Athlete	3	2	1	1	7
Hond	Dog	0	2	1	0	3
Roomys	Ice cream	0	2	0	0	2
Perd	Horse	0	2	0	0	2
Oog	Eye	0	2	0	0	2
Robot	Robot	3	2	3	2	10
Deur	Door	3	1	3	0	7
Kat	Cat	3	2	3	0	8
Venster	Window	0	2	1	0	3
Reenboog	Rainbow	3	2	2	0	7
Rekenaar	Computer	0	2	1	0	3
Sop	Soup	3	2	3	0	8
Skeermes	Razor	0	2	1	0	3
Kam	Comb	3	2	3	0	8
Pynappel	Pineapple	3	2	3	1	9

Zip	Zip	3	2	3	2	10
Helikopter	Helecopter	3	2	3	1	9
Ster	Star	3	2	3	0	8
Mikrogolf	Microwave	3	2	1	1	7
Neus	Nose	3	2	2	0	7
Oorbel	Earring	0	2	0	0	2
Huis	House	3	2	3	0	8
Pizza	Pizza	3	2	3	2	10
Knoop	Knot	3	2	2	0	7
Stoel	Chair	0	1	0	0	1
Legkaart	Puzzle	0	2	0	0	2

Table 3: Percent correct for L1 and L2 performance for high and low overlapping cognates.
(Research Question #3)

	High Overlap (n=17 words)		Low Overlap (n=14 words)	
	L1	L2	L1	L2
P1	0.71	0.88	0.64	0.43
P2	0.65	0.35	0.43	0.21
P3	0.47	0.33	0.29	0.00
P4	0.41	0.29	0.29	0.00

Figure 1: Confrontation naming accuracy for 4 bilingual - Afrikaans (Af) and English (Eng) - persons with aphasia (Research Question #1)



* indicates significance at $p \leq .05$.

Figure 2: Participant 1: Proportion of error types for L1 (Afrikaans) versus L2 (English). Error types include phonologic (P), semantic (S), mixed (M), omission (O), translation (T) and neologism (N). (Research Question #3)

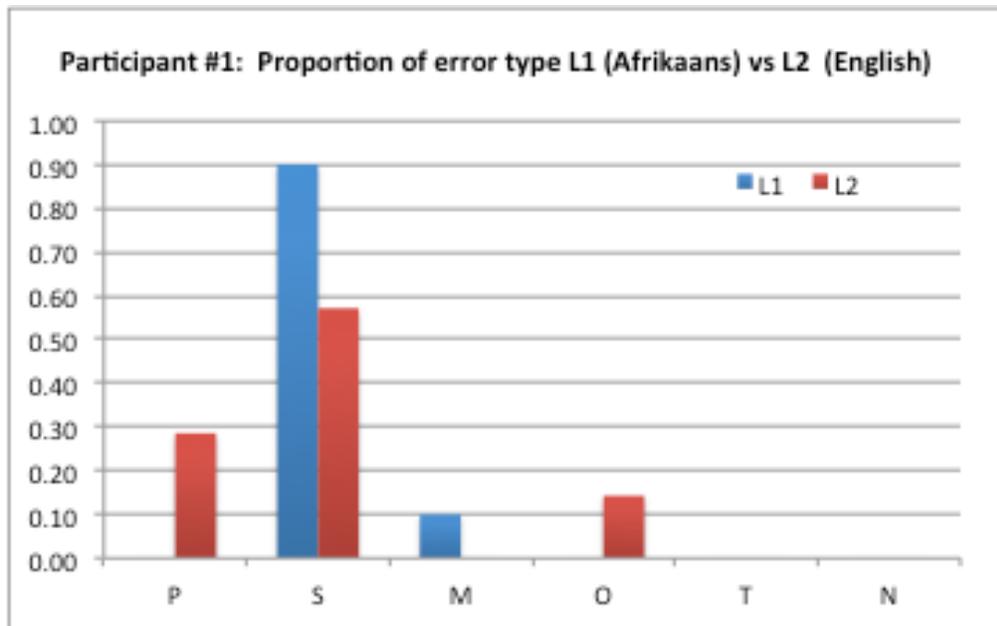


Figure 3: Participant 2: Proportion of error types for L1 (Afrikaans) versus L2 (English). Error types include phonologic (P), semantic (S), mixed (M), omission (O), translation (T) and neologism (N). (Research Question #3)

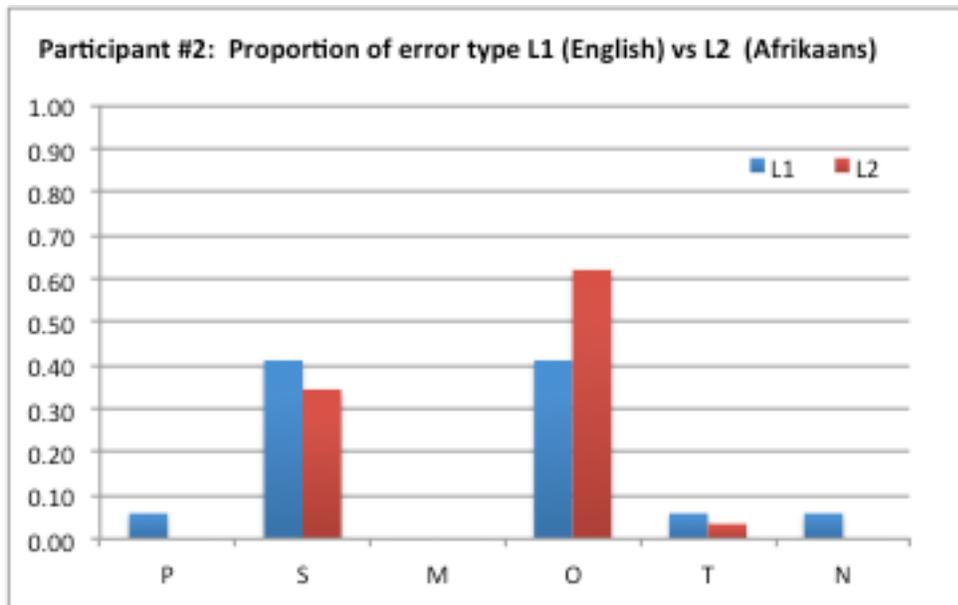


Figure 4: Participant 3: Proportion of error types for L1 (Afrikaans) versus L2 (English). Error types include phonologic (P), semantic (S), mixed (M), omission (O), translation (T) and neologism (N). (Research Question #3)

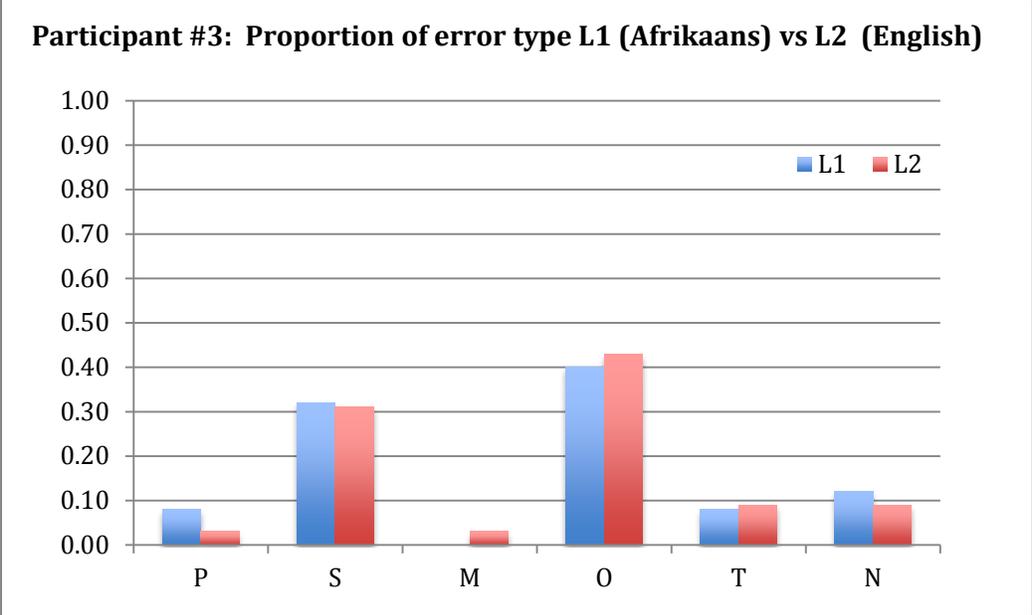
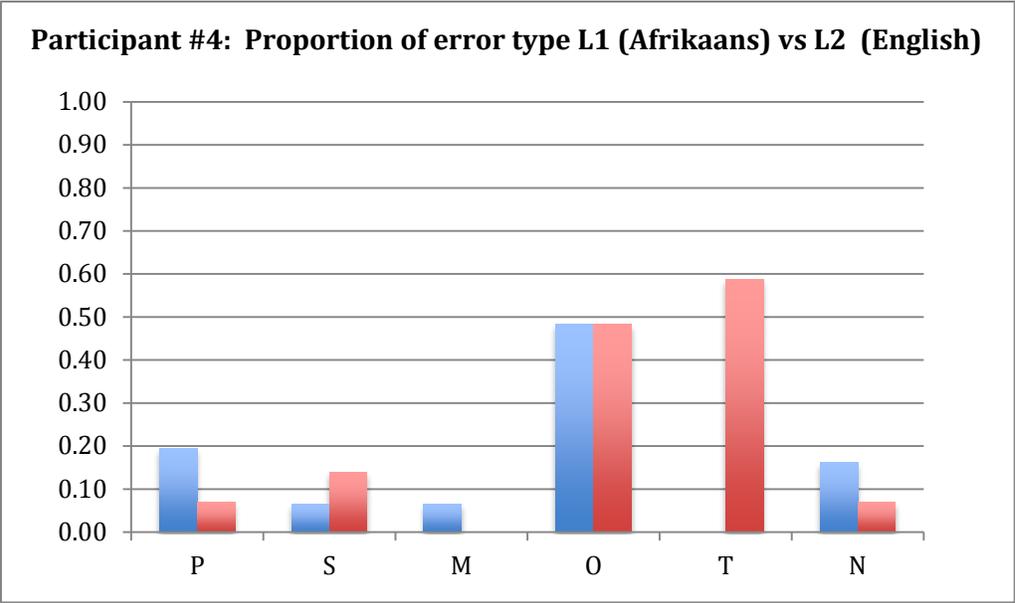


Figure 5: Participant 4: Proportion of error types for L1 (Afrikaans) versus L2 (English). Error types include phonologic (P), semantic (S), mixed (M), omission (O), translation (T) and neologism (N). (Research Question #3)



REFERENCES

- Costa, A. (2005) Lexical access in bilingual production. In J. F. Kroll and A.M.B. de Groot Handbook of Bilingualism: Psycholinguistic Approach. Oxford University Press. pg. 308-325.
- Costa, A., Caramazza, A., & Sebasti_an-Galles, N. (2000). *The cognate facilitation effect: Implications for models of lexical access*. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26, 1283–1296.
- Edmonds, L.A., & Donovan, N. (2012). Item level psychometrics and predictors of performance for Spanish/English bilingual speakers on *An Object and Action Naming Battery*. *Journal of Speech, Language and Hearing Research*, 55, 359-381
- Kroll, J.F., Bobb, S.C., Misra, M., & Guo, T. (2008). Language selection in bilingual speech: Evidence for inhibitory processes. *Acta Psychol*, 128(3), 416-430.
- Kroll, J.F. & Stweart, 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.
- Kohnert, K., Windsor, J. and Miller, R. (2004) Crossing borders: Recognition of spanish words by english-speaking children with and without language impairment. *Applied Psycholinguistics*, 25, 543-564. doi: 10.1017.S0142716404001262
- Paradis, M. (1987). *The assessment of bilingual aphasia*. Hillsdale, NJ:Erlbaum.