

Critical Review:
Cross-linguistic generalization in bilingual aphasia following unilingual intervention

Jacqueline Si-Jing Yeung
M.Cl.Sc SLP Candidate

University of Western Ontario: School of Communication Sciences and Disorders

In this critical review, we examine the evidence on the presence of cross-linguistic generalization (CLG) in bilingual aphasia following unilingual intervention. CLG is an outcome of interest, as it allows for the possibility of rehabilitating all languages spoken by the bilingual person with aphasia (PWA) even in monolingual settings. The articles included in this review are single-subject studies and informational reviews of the literature. Critical appraisal of these articles found suggestive evidence to demonstrate CLG effects following unilingual intervention. Further research is required on the ideal conditions to facilitate these effects. At the current time, clinicians cannot predict with any certainty whether unilingual intervention will produce CLG on a case-to-case basis.

Introduction

Aphasia is an acquired neurological disorder that affects an individual's access to language in multiple modalities (Orange & Roberts, 2020). Although there is extensive literature on best practices for the assessment and treatment of aphasia, most of this research has been done on monolinguals. However, trends in census data indicate that Canada is becoming a more multicultural society. It is estimated that 7.6 million Canadians know a language other than English or French. The 2016 census found that the most common immigrant mother tongues spoken by Canadians included Mandarin, Cantonese, Punjabi, Tagalog, Spanish, and Arabic. In recent years we have also seen an increase in linguistic diversity. The percentage of bilingual/multilingual Canadians rose from 17.5% in 2011 to 19.4% in 2016 (Statistics Canada, 2019). Based on these statistics, SLPs can expect to see more cases of bilingual aphasia during their career, especially if they are practicing in metropolitan areas. Therefore, it is imperative that SLPs are confident in their ability to serve bilingual persons with aphasia (PWA).

The presence of bilingualism raises new questions for SLPs. In which language should the client receive intervention? If bilingual intervention is an option, should the delivery of treatment in each language be sequential or in parallel? Moreover, this matter is complicated by the fact that language is organized and processed differently in the brains of bilinguals compared to monolinguals (Kiran & Goral, 2012; Lorenzen & Murray, 2008). One characteristic of language organization in the bilingual brain is neural overlap. The functional networks that represent knowledge of L1 and L2 have a significant shared component (Kiran & Goral, 2012). Consequently, researchers have studied the efficacy of using a unilingual treatment approach in bilingual PWA to affect widespread change.

Unilingual intervention in bilingual populations is an area of special interest for several reasons. First, most SLPs, even those who speak multiple languages, will likely only be proficient in one of the patient's languages. Because access to bilingual intervention is oftentimes limited, it is helpful to understand the effects of unilingual intervention in bilingual populations. Second, unilingual intervention has been known to bring about gains to the untrained language known as cross-linguistic generalization (CLG). CLG is an outcome of interest as it allows for the possibility of rehabilitating both languages even in largely monolingual environments. This is important, because regaining function in both languages is an important factor in determining life participation for many bilinguals (Faroqi-Shah et al., 2010).

Objectives

The primary objective of this paper is to critically evaluate the existing literature regarding CLG in bilingual PWA following unilingual language intervention.

Methods

Search Strategy

Online databases, including PubMed, Google Scholar, PsycINFO, and ASHA publications were searched using the following search strategy: (bilingual) AND (aphasia) AND ((interven*) OR (treatment)) AND (cross linguistic ((transfer) OR (generalization)))

Selection Criteria

Studies selected for critical review used unilingual language intervention, included participants who were bilingual or multilingual, had aphasia, and studied CLG as the outcome measure.

Data Collection

The search yielded informational reviews of the literature (2) and single-subject studies (5).

Results

Informational Reviews of the Literature

Informational reviews are useful in providing an overview of the literature regarding CLG in bilingual aphasia. They allow for the opportunity to see where evidence converges and diverges. A limitation of reviews is that the reader is reliant on the author's expertise in interpreting the studies that are covered. The reader is thereby subjected to the author's personal biases and potential misinterpretation of the data.

Faroqi-Shah et al. (2010) conducted a review of 13 articles (12 case studies, 1 single-subject study) to consolidate the evidence regarding CLG in bilingual PWA (n=43). Studies were written in English and published between 1980 to 2009, presented data directly addressing the research question of CLG, and looked at outcomes in bilingual adults with aphasia following a language intervention. A critical appraisal was completed for each paper. This revealed that although most studies included an adequate description of their procedures, they lacked practices such as random sampling, blinding of the assessors, and evaluation of treatment fidelity. The authors also computed their own data analysis using appropriate statistical approaches to standardize interpretation of the results, thereby increasing validity. Results found evidence for CLG when intervention was administered in L1 or L2. L1 was defined as the first acquired language, and L2 was defined as the later acquired language. It is important to note that in some studies, individuals were more proficient in L2 than L1. All studies found CLG following training in L1 in both receptive and expressive domains. The evidence for CLG following training in L2 varied across studies. The majority of the studies found receptive language gains in the untrained language, but only about half of the studies found expressive language gains. The authors reasonably concluded that because there is evidence to demonstrate that CLG can occur following treatment in L2, SLPs may consider administering treatment in L2 as an option. However, SLPs are unable to predict if CLG will occur with any certainty based on the evidence presented. The strengths of this review are the completion of a critical appraisal and the standardization of statistical analyses. Overall, the evidence provided by this review is suggestive.

Ansaldo & Saidi (2014) reviewed 15 articles (2 systematic reviews, 13 case studies or single-subject studies) to discuss the literature on intervention for bilingual PWA with a focus on the variables that may affect CLG. The studies included used therapies that targeted word-retrieval, described their procedure in adequate detail, had pre- and post- therapy data, and

disclosed the intensity of the treatment. The authors reported extensively on different variables that were observed to affect CLG across the literature. Cognates are words in different languages that have almost identical lexical and semantic representations (e.g. "tiger" and "tigre"). There is some evidence to suggest that choosing cognates as trained stimuli facilitates CLG. In addition, the lexical and structural similarity of languages may be a factor affecting CLG. The more similar two languages are, the more CLG may be expected to occur. Further research must be done to determine the importance of this variable. The literature has also examined the impact of pre- and post- morbid language proficiency and which of these is a better predictor of CLG. Currently, the evidence is mixed, and this area requires further research. Finally, the integrity of the cognitive control circuit has been proposed to be a factor affecting CLG. The cognitive control circuit is responsible for voluntarily switching between languages. There is some evidence to suggest that damage to this area of the brain prevents CLG from occurring. Because the evidence for many of these areas of research is mixed and sample sizes are small, a limitation of this review is that conclusive statements about what can facilitate CLG cannot be made. Overall, this review provides somewhat suggestive evidence.

Single-Subject Studies

The use of single-subject design to address the research question is appropriate due to small sample sizes. This experimental design provides Level 1 evidence. Therefore, we can be reasonably certain that any CLG observed is a result of the unilingual language intervention. A limitation of this type of study is that the small sample size makes it difficult to generalize the results. This challenge is complicated by the fact that bilingual aphasia is a highly variable, heterogeneous group (Centeno & Ansaldo, 2016).

Edmonds & Kiran (2006) conducted a single-subject multiple baseline experiment on bilingual PWA to determine CLG effects following Semantic Feature Analysis (SFA). Participants included three bilinguals (English-Spanish) who were at least 9 months post-onset of left hemisphere strokes, right-handed, and had relatively equal performance in both languages following the stroke. Training consisted of naming ten items after viewing picture stimuli and identifying their corresponding semantic features. These items were chosen to be equivalent in average frequency of occurrence in English and Spanish. The language of training was counterbalanced across participants (P1 and P3 in Spanish, P2 in English). Participants received intervention twice a week in 2-hour sessions. Treatment was discontinued when the participant achieved 80% naming accuracy for two consecutive sessions or had

completed 20 sessions. There was high inter-rater reliability (>95%) for treatment, baseline, and probe sessions. Appropriate statistical analyses were applied to the data. The authors found varying CLG effects across participants. P1 and P3 made gains in naming items in the untrained language (English). P2, who was initially trained in English, did not demonstrate CLG to Spanish. However, when the language of training was changed to Spanish, they demonstrated some CLG to English. Results from standardized language measures were consistent with the CLG effects observed from the naming task. P1 and P3's performances improved on some subtests in English. P2 did not improve on any standardized language measures in Spanish. However, improvements were observed on some subtests in English. A strength of this study is that the authors controlled for important variables, including post-morbid language proficiency and a word's frequency of occurrence in both languages. Overall, this study provides suggestive evidence regarding CLG following unilingual intervention.

Knoph et al. (2015) performed a single-subject ABA experiment on a multilingual PWA (Japanese-English-German-Norwegian) to determine CLG effects following SFA targeting verbs. The participant was 7 months post-onset of a left hemisphere stroke and right-handed. After her stroke, she was most proficient in Japanese, followed by Norwegian, then English and German. Training was administered in Norwegian, a late-acquired language. It consisted of naming a verb after viewing an action picture. The clinician would then guide the participant through each item's semantic features. Treatment was delivered in 22 hours over 2.5 weeks. Inter-rater reliability was between 82% to 97% for scoring personal narratives. The data was analyzed using appropriate statistical measures. Results regarding naming accuracy of verbs revealed CLG in German. However, no changes were found in Japanese, and naming accuracy declined in English. Standardized language measures and narrative samples found CLG to English and German for some subtests. Again, no changes were demonstrated in Japanese. A limitation of this study is that when the authors selected stimuli, frequency of occurrence in each language was not controlled for. This is a psycholinguistic variable that is known to affect the ease of naming for PWA (Orange and Roberts, 2020). The only common factor among stimuli that were chosen is that they are "everyday words" in each language. The lack of control regarding frequency of occurrence is a factor that may have affected the validity of the results. Overall, this study provides somewhat suggestive evidence in support of the research question.

Knoph et al. (2017) completed a single-subject multiple baseline experiment on two multilingual PWA to determine CLG effects following unilingual therapy. P1 (Portuguese-Ronga-Norwegian) and P2 (English-Norwegian) were at least 10 months post-onset of a left-hemisphere stroke and used all languages in everyday life. Training was completed in Norwegian, a late-acquired language for both individuals. Communication-based therapy (CBT) was administered in the first treatment block. The participant and the clinician were each given a picture that only they could see, and their task was to describe the picture to one another. The goal was to practice using verbs in complete sentences. Verbs were not pre-determined; any relevant verb was an acceptable response. The authors stated that CBT is based on principles from well-established treatment protocols, but ultimately the level of detail provided regarding the procedure was inadequate. After completing the CBT treatment block, participants underwent SFA targeting verbs. Participants were told to generate complete sentences using target verbs that were given to them. With the help of the clinician, they were then instructed to generate six semantic features for each target verb. Treatment as a whole was delivered in 40 to 50 hours over 4 to 6 weeks, averaging 10 hours per week. Inter-rater reliability was between 87% to 99%. Appropriate statistical analyses were applied to the data. Findings revealed that following CBT, there were no significant changes in naming accuracy for verbs. Following CBT and SFA for verbs, P1 demonstrated improved naming accuracy in Portuguese. Ronga was not assessed, because appropriate test materials were not available in this language. P2 did not show improvements in English for naming accuracy of verbs. Narrative samples found evidence of CLG for both P1 and P2. Similar to the Knoph et al. (2015) study, a limitation of this study is that the authors did not control for any psycholinguistic variables when selecting stimuli for SFA. Another limitation is that Ronga was not assessed for P1. As a result, it is unknown if there was CLG to this language after unilingual intervention. Overall, the evidence provided by this study is somewhat suggestive.

Li et al. (2020) conducted a single-subject multiple baseline experiment on bilingual PWA to determine CLG effects following Verb Network Strengthening Treatment (VNeST). Participants were two bilinguals (English-Mandarin) who were many years post-onset of left-hemisphere strokes, right-handed, and had no other neurological or learning disorder. Prior to the stroke, both were highly proficient in Mandarin (L1) and English (L2), but English was their dominant language. At the time of the study, language performance in Mandarin and English was equivalent. VNeST was

administered in Mandarin. Participants were given a target verb and asked to think of an agent (*Who* is doing the action?) and patient (*To whom or what* is the action being done to?). The goal in this exercise was to generate complete sentences and activate the semantic network around the verb. Each participant received training for 18 verbs. Treatment was administered over the course of 40 hours, with participants receiving approximately 4 hours of therapy per week. Reliability of treatment procedures was determined to be 97%, and inter-rater reliability was 96.5%. Data analyses used appropriate statistical approaches. Results revealed that VNeST training in Mandarin was not a significant factor in predicting changes in English performance for the task probes. On standardized language measures, P1 demonstrated CLG to English through improved noun and verb retrieval, production of complete sentences, and an increase in the percentage of correct information units (CIU). P2 also demonstrated CLG to English through an increase in total number of words, utterance length, and number of CIUs. However, the percentage of CIUs and CIUs produced per minute declined. Overall, the evidence provided by this study is equivocal.

Conner et al. (2018) performed a single-subject AB experiment on a multilingual PWA to determine CLG effects following Oral Reading for Language in Aphasia (ORLA) training. The participant grew up speaking Dutch (L1) at home but lived in a multilingual region where he was also exposed to German and French from an early age. He was highly proficient in English and Italian, which were acquired at a later age. Languages spoken at a lower proficiency level were Spanish and Norwegian. At the time of participation, this participant was 1 year post-onset of a left-hemisphere stroke. The language of training was Dutch, which was the participant's first language and most dominant language. ORLA is an oral reading intervention that targets speech rhythm, intonation, and pacing. The participant progressed through a hierarchy of reading single paragraphs, locating words as he read, using specific words in a sentence, reading independently, summarizing text, and answering questions about the text. The total amount of training was 40 hours, and this was completed over the course of 5 weeks. Pre- and post- assessment tasks required the participant to answer *wh-* questions, tell a story based on a sequence of pictures, provide a narrative sample, and generate questions. Appropriate statistical analyses were used. Results revealed an increase in language efficiency (CIU/min) for some assessment tasks in higher proficiency languages (English, French, German, and Italian). Smaller gains were noted for Norwegian, and no changes were observed in Spanish. A limitation of this study is that the authors provided few ways to

measure CLG, as their only outcome measure was language efficiency. Their results could have been more robust had they used other tools to monitor change, such as standardized language measures or self-ratings from the participant. Overall, this study provides suggestive evidence for CLG following unilingual intervention.

Discussion

The current body of literature provides suggestive evidence for the occurrence of CLG in bilingual PWA following unilingual intervention. Out of the seven articles that were critically evaluated, all but one provided some evidence for CLG effects. Although this is encouraging, these articles also raise new questions about the conditions under which CLG can occur. For example, a few articles studied multilingual participants and found that after unilingual training, CLG occurred in some languages but not others (Conner et al., 2018; Knoph et al., 2015, 2017). Additionally, the Edmonds and Kiran (2006) study showed that CLG effects could only be induced after training in one of the participant's languages (Spanish) but not the other (English).

This critical evaluation revealed a few themes across the literature. First, many studies used treatment approaches that aim to activate the semantic network. Out of the five single-subject studies that were reviewed, three used SFA and one used VNeST. In SFA, the participant generates semantic features about a word to facilitate word retrieval. A similar idea is applied to VNeST, where the action word is the anchor around which the semantic network is activated. This preference for semantic-based therapies is likely driven by the organization of language in bilinguals' brains. Modern-day theories propose that the knowledge of the two languages is shared and intricately connected, rather than housed separately. Bilinguals are thought to have a shared semantic store that is linked to separate lexical stores. It is through this shared semantic component that unilingual intervention is predicted to affect widespread change (Edmonds & Kiran, 2006).

Another theme that emerged was the choice to train in the less dominant language (Edmonds & Kiran, 2006; Knoph et al., 2015, 2017). For clarity's sake, in this paper we will assume that L2 is the less dominant language compared to L1. It is important to recognize that in these articles this was not always true, as sometimes L1 was the less dominant language. Many authors chose to train in L2, because this was thought to facilitate the most CLG. Current models of bilingual language organization propose that the strength of the connections between the lexical systems of L1 and L2 depend on the speaker's proficiency level (de Groot,

1992; Kroll & Stewart, 1994). Assuming that L1 is more dominant, there will be stronger lexical connections going from L2 to L1 than L1 to L2. This is because bilinguals who are less proficient in their L2 are thought to first translate their message from L1 rather than access the semantic store directly. These strengthened connections are theorized to facilitate more CLG when the language of training is L2.

Clinical Implications

The evidence suggests that SLPs may observe CLG effects following unilingual intervention. Assuming that the bilingual client was proficient in both languages pre-morbidly, they may receive more benefit from being trained in their less dominant language. Furthermore, semantic-based therapies may be especially beneficial for this population. SLPs should also take into consideration modulating factors such as linguistic similarity of the languages and pre- and post-morbid proficiency level. Because the evidence is inconclusive about the conditions under which CLG can occur, clinicians cannot predict with any certainty on a case-to-case basis whether unilingual intervention will result in CLG for bilingual PWA. If it is the client's wishes to regain function in both languages, bilingual intervention may be necessary to achieve this goal.

References

- Ansaldo, A. I., & Saidi, L. G. (2014). Aphasia therapy in the age of globalization: Cross-linguistic therapy effects in bilingual aphasia. *Behavioural Neurology, 2014*.
<https://doi.org/10.1155/2014/603085>
- Centeno, J. G., & Ansaldo, A. I. (2016). Customizing treatment for bilingual speakers with aphasia. *The ASHA Leader, 21*(10).
- Conner, P. S., Goral, M., Anema, I., Borodkin, K., Haendler, Y., Knoph, M., Mustelier, C., Paluska, E., Melnikova, Y., & Moeyaert, M. (2018). The role of language proficiency and linguistic distance in cross-linguistic treatment effects in aphasia. *Clinical Linguistics and Phonetics, 32*(8), 739–757.
<https://doi.org/10.1080/02699206.2018.1435723>
- de Groot, A. M. B. (1992). Determinants of word translation. *Journal of Experimental Psychology: Learning, Memory and Cognition, 18*, 1001–1018.
- Edmonds, L. A., & Kiran, S. (2006). Effect of semantic naming treatment on crosslinguistic generalization in bilingual aphasia. *Journal of Speech, Language, and Hearing Research, 49*, 729–748.
<https://doi.org/10.1016/j.bandl.2004.06.041>
- Faroqi-Shah, Y., Frymark, T., Mullen, R., & Wang, B. (2010). Effect of treatment for bilingual individuals with aphasia: A systematic review of the evidence. *Journal of Neurolinguistics, 23*(4), 319–341.
<https://doi.org/10.1016/j.jneuroling.2010.01.002>
- Kiran, S., & Goral, M. (2012). One disorder, multiple languages. *The ASHA Leader, 17*(7), 1–6.
<https://doi.org/10.1044/leader.ftr4.17072012.22>
- Knoph, M. I. N., Lind, M., & Simonsen, H. G. (2015). Semantic feature analysis targeting verbs in a quadrilingual speaker with aphasia. *Aphasiology, 29*(12), 1473–1496.
<https://doi.org/10.1080/02687038.2015.1049583>
- Knoph, M. I. N., Simonsen, H. G., & Lind, M. (2017). Cross-linguistic transfer effects of verb-production therapy in two cases of multilingual aphasia. *Aphasiology, 31*(12), 1482–1509.
<https://doi.org/10.1080/02687038.2017.1358447>
- 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.
- Li, R., Li, W., & Kiran, S. (2020). Effect of Mandarin Verb Network Strengthening Treatment (VNeST) in Mandarin-English bilinguals with aphasia: A single-case experimental design. *Neuropsychological Rehabilitation, 0*(0), 1–30.
<https://doi.org/10.1080/09602011.2020.1773278>
- Lorenzen, B., & Murray, L. L. (2008). Bilingual aphasia: A theoretical and clinical review. *American Journal of Speech-Language Pathology, 17*(3), 299–317.
[https://doi.org/10.1044/1058-0360\(2008/026\)](https://doi.org/10.1044/1058-0360(2008/026))
- Orange, J.B & Roberts, A. (2020). *Introductions, definitions, and Hx*. Personal Collection of J.B. Orange, University of Western Ontario, London ON.
- Orange, J.B. & Roberts, A. (2020). *Assessments and interventions for word retrieval (naming)*. Personal Collection of J.B. Orange, University of Western Ontario, London ON.
- Statistics Canada. (2019). *Census in brief: Linguistic diversity and multiculturalism in Canadian homes*.