Critical Review:
For an individual with chronic conduction aphasia, will a multimodal, combined phonological and semantic, neurolinguistic treatment approach improve auditory comprehension and increase propositional language?

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Conduction aphasia is primarily characterized by phonemic paraphasic language output and severely impaired repetition, with relatively spared auditory comprehension. There is little published clinical evidence supporting successful treatment approaches for persons with conduction aphasia based on a combined, phonological and semantic, neurolinguistic model. This paper critically reviews eight treatment studies in the literature examining existing interventions targeting the unique language deficits seen in conduction aphasia. Results provide suggestive-to-compelling evidence that existing interventions centered on unimodal, phonological approaches result in gains on trained items or tasks with little maintenance and generalization to other language domains.

Introduction

Conduction aphasia is characterized by significant changes to language output particularly phonetically complex paraphasias and severely impaired repetition (Goodglass, 1992; Joanette, Keller, & Lecours, 1980; Kohn, 1984). These deficits are often compounded by the affected individual's high degree of self-awareness leading to multiple attempts to correct spoken errors, also termed *conduit d'approach*e (Goodglass, 1992). This can lead to problems relaying a purposeful and meaningful message to others.

Comparatively, persons with conduction aphasia have relatively spared auditory comprehension. They tend to understand the 'gist' of a spoken message but are unsuccessful in their ability to extract the precise content of the message through the use of auditory rehearsal or phonological short-term memory (Baldo, Klostermann, & Dronkers, 2008). This deficit potentially contributes to communicative difficulties should key information be lost or misinterpreted.

Nickels, Howard, and Best (1997) proposed that individuals with conduction aphasia have difficulty processing auditory-verbal information secondary to disruption in phonological short-term memory (STM). These deficits in conduction aphasia are not exclusive to language output channels, but rather affect language input as well (Baldo et al., 2008; Caramazza, Basili, & Koller, 1981; Shallice & Warrington, 1977; Warrington & Shallice, 1969) Baldo et al. (2008) tested this proposal at the sentence level. Their results contrast with Nickels et al. (1997) to suggest that persons with conduction aphasia rely more on semantic processes than phonological processes when interpreting messages.

To date there is little published clinical evidence supporting successful treatment approaches for persons with conduction aphasia based on a neurolinguistic model or using a combined semantic and phonological treatment approach.

In a neurolinguistic model, it is proposed that language is organized within neural networks (Nadeau, Gonzalez Rothi, & Rosenbek, 2008 2008). These networks, such as the phonological network and semantic network, function simultaneously to support our representation of language and allow us to cross language modalities (e.g., spoken to written language) (Nadeau et al., 2008). By providing comprehensive language assessments guided by a neurolinguistic model to persons with aphasia, the underlying deficits in language impairments can be systematically identified (Ellis & Young, 1988), and therefore, provide a foundation for the development of appropriate intervention.

Based on this information it is hypothesized that by utilizing a combined, phonological and semantic neurolinguistic treatment approach improvements in language functioning will be achieved. Specifically, by activating linguistic strengths (i.e., semantic network) to prime the impaired phonological/articulatory representations, improvement in auditory comprehension and an increase in propositional language may be achieved.

Objectives

The primary objective of this paper is to critically appraise the current literature pertaining to phonological and/or semantically based language treatment approaches in conduction aphasia.

Methods

Search Strategy
Computerized databases including PubMed, PsychInfo and Scopus, were searched using the following search terms:
(conduction aphasia) AND
(treatment OR intervention) AND
(phonological OR semantic OR neurolinguistic)

Selection Criteria
Studies included in this critical appraisal were limited to treatment or intervention studies with adults with conduction aphasia. Treatment or intervention was limited to those using a phonological and/or a semantic and/or a neurolinguistic approach. Non-English language articles were excluded from the review. One article focusing on the treatment of dysgraphia, and one imaging study were also excluded, as their focus was inconsistent with the question presented here.

Data Collection
Results from the literature search yielded five articles that met the above selection criteria. Additional articles matching the aforementioned selection criteria were found through The Aphasiology Archives and through broader search strategies utilized in preparation for an independent *n-of-1* intervention study being conducted by this author. A total of eight articles are included in this critical appraisal.

Results

Cubelli, Foresti, and Consolini (1988) described a clinical case study using an ABA treatment design. Three persons with conduction aphasia (1-3 months post stroke) participated to determine if controlling phonemic productions would lead to the prevention of phonemic pharaphasic errors in their oral language production. Treatment was conducted in 45-minute sessions, 4 times per week. The total number of treatment sessions was not reported. The treatment protocols consisted of five exercises administered in succession. Pre- and post-treatment measures included standardized language assessments evaluating expressive (oral and written) and receptive language. Descriptive results showed improved linguistic performance in oral and written naming, repetition and oral reading, across participants. The author's acknowledged the shortcoming of this study in its lack of control and consideration of all variables.
Outcomes measures were one of the limitations of this study. Although gains on standardized impairment-based language measures were reported, measures pertaining to phonemic paraphasic errors such as simple counts or discourse measures such as picture description or topic-directed interviews were not collected. As well, within treatment progress was not reported, and no formal pre- vs. post-treatment statistical analyses were completed to support gains made on impairment-based measures.

Overall, Cubelli et al. (1988) presented equivocal level IV evidence for a phonological treatment approach. Results, although positive, should be interpreted with caution, as clear conclusions regarding the efficacy of the treatment approach cannot be drawn.

Beard and Prescott (1989) conducted a multiple baseline, ABA withdrawal study replicating an intervention approach first published by Sullivan, Fisher and Marshall (1986). The replication of this earlier study allowed Beard and Prescott to directly compare their findings to previously published data. Participants (n=2) experienced left hemisphere CVAs that resulted in comparable linguistic deficits as determined by standardized language assessments (i.e., Porch Index of Communicative Ability and the Boston Diagnostic Aphasia Examination). Linguistic deficits were most consistent with conduction aphasia. Both participants were 2-months post-stroke at the start of treatment.

Treatment protocols were phonologically based and designed to improve repetition at the sentence level. It involved repeated oral reading of a printed sentence, followed by repetition either immediately, after 5-seconds or after 10-seconds. Repetition measures were collected at baseline, treatment and withdrawal phases. Results presented through celebration line plots showed statistically significant task specific gains sustained at 8-months post-treatment. Appropriate *C*-statistic analyses of untreated items showed that intervention did not generalize to untreated items. Stability on impairment-based measures was noted following treatment and 8-months post.

Beard and Prescott (1989) successfully replicated the treatment protocol originally presented by Sullivan et al., (1986) suggesting that the protocol is reliable. The intervention protocol focused specifically on improving overt repetition at the sentence level. Overall, this study was well designed and well reported. It provided level I evidence that treatment of sentence repetition can improve sentence repetition in conduction aphasia; however, the clinical significance of the finding is weakened by the lack of generalization to untrained items.

Kohn, Smith, and Arsenault (1990) conducted a single-subject ABA treatment study investigating the efficacy of using repetition as a treatment approach for an individual with conduction aphasia, 7-months post-stroke. The treatment approach was devised from practice based evidence suggesting that the participant was more linguistically fluent at the sentence level than at the discourse level. Treatment protocols consisted of overt sentence repetition tasks. These protocols were combined with ongoing speech and language rehabilitation services. Results were analyzed using appropriate statistical tests (i.e., McNemar's test; Fisher's *p*; *t*-test). Results showed a statistically significant increase in the accuracy and content of words produced, correct word production, and syllable/concept ratio in picture description. The latter two findings are suggestive of treatment generalization.

One limitation of this study was that the experimental treatment was delivered alongside existing treatment protocols, and as such, treatment gains cannot be attributed to the repetition tasks. As well, treatment intensity was reported unclearly. As a result, despite a strong Level 1 study design, the results of this study must be interpreted with caution and provide suggestive evidence demonstrating the effectiveness of utilizing repetition as a treatment approach.

Franklin, Buerk, and Howard (2002) implemented an *n-of-1* experimental treatment design. The focus of intervention was to improve spoken output in an 83-year old female with conduction aphasia through a phonologically based treatment approach. Intervention protocols involved collection of baseline data, treatment administration, post-treatment assessment and 4-month post-treatment follow-up. Intervention was comprised of two phases: 1) phoneme discrimination and 2) self-monitoring of speech production, and re-assessment.

Statistical analyses were conducted using appropriate McNemar's, *z*- and Wilcoxon two-sample tests. Results showed improvements in naming (word and sentence levels), oral reading, and repetition at the word level. Generalization of treatment was noted through improvements in both treated and untreated items, and significant improvement in accuracy and efficiency in a story recall task. As expected, no significant improvements on the control task (i.e., written sentence comprehension) were observed.

Franklin et al. (2002) provided detailed reporting of descriptive data, and utilized appropriate treatment and control outcome measures and statistical analyses. This resulted in compelling Level I evidence supporting improved lexical access across language domains (naming, repetition, reading, and story retell) as a result of their phonological treatment approach.

Corsten, Mende, Cholewa, and Huber (2007) investigated the efficacy of a computer-based program in treating both phonological encoding and decoding in an individual with conduction aphasia. A multiple baseline, single subject, ABA treatment design was utilized. Treatment was neurolinguistically based and phonological in nature. Treatment protocols consisted of three tasks: 1) discrimination, 2) identification, and 3) reproduction. Treatment stimuli included real words and pseudo words presented in both oral and written forms.

Results were analyzed using appropriate statistical tests (e.g., ANOVA, Page rank test, Wilcoxon exact signed-ranks test, Fisher's exact test) and ad hoc adjustments (e.g., Bonferroni). Results showed treatment specific gains in identification of pseudo words and reproduction of real words. Task maintenance on repetition of real and pseudo words was 3-months post-treatment. Improved lexical access on a standardized naming test was also reported post-treatment. The latter finding is suggestive of treatment generalization.

This study was limited by its lack of generalization. Although lexical access improved in confrontation naming tasks, other measures of generalization were not reported. Despite this limitation, Corsten et al. (2007) provides compelling, theoretically based evidence for improving phonological encoding and decoding in an individual with conduction aphasia.

Koenig-Bruhin and Studer-Eichenberger (2007) implemented a single-subject multiple baseline ABA experimental treatment study. The goal of treatment was to improve verbal STM in an individual with conduction aphasia. Their phonologically based treatment approach included both a treatment (i.e., repetition) and control task (i.e., recall) measured across treatment sessions. Treatment stimuli included nouns and sentences that were presented with varying time intervals.

Analyses were conducted using appropriate statistical Trend Tests. Descriptive results were also provided. Results showed improved repetition at the sentence level. Outcome measures showed a significant increase in sentence length on a picture description task.

Despite the positive treatment results, this study did not report treatment follow-up or maintenance measures and provided incomplete reporting of treatment outcomes. Thus, the long-term affects of this treatment, or the treatment's carry-over to more functional language domains are unknown. Overall, Koenig-Bruhin and Studer-Eichenberger (2007) provide suggestive level I evidence for improving verbal STM through a phonological approach in an individual with conduction aphasia.

Harnish, Neils-Strunjas, Lamy, and Eliassen (2008) conducted a functional magnetic resonance imaging (fMRI) *n-of-1* experimental study to determine discrepancies between therapy intensities (massed versus distributed). Although the purpose of this study does not directly correspond to the confines of this critical appraisal, it was included based on the multimodal treatment approach and tasks utilized to elicit the fMRI results.

Overall, therapy was multimodal, targeting a wide range of linguistic deficits including word retrieval and phonological processing. When conducting fMRI scans pre- and post-treatment the patient (8 years post-stroke, conduction aphasia) completed a non-verbal semantic decision task (control) and a letter decision task (experimental) compared using appropriate regression analyses.

fMRI results demonstrated increased perilesional activation on experimental tasks (i.e., letter decision) following treatment. Descriptive results of standardized language measures demonstrated improvement across language domains. Particularly, modest gains were seen in naming and auditory comprehension. On story retell tasks appropriate Type Token Ratios (TTRs) were calculated showing improved lexical retrieval pre- to post-treatment. Qualitative analyses further supported improved lexical retrieval.

For the purposes of this critical appraisal, this study lacked a complete description of the treatment protocols and reporting of generalization and maintenance post-treatment; however, it did provide suggestive Level I evidence of the efficacy of multimodal language therapy even 8 years post-stroke.

Kalinyak-Fliszar, Kohen, and Martin (2011) investigated whether treating the fundamental cognitive abilities supporting linguistic functioning (i.e., short term memory, executive functioning) through a multimodal, phonological and semantic approach, would lead to improved language abilities in aphasia. The author's utilized a single-subject ABA treatment design with multiple baseline and multiple probe measures. The participant was a 55-year old female, 29-months post-stroke whose language deficits were most consistent with conduction aphasia. The primary goal of treatment was to increase the activation and maintenance of phonological representations in verbal STM to improve language output at the word level. Treatment consisted of two modules, only the first of which was completed for this study. Treatment stimuli consisted of 2-3 syllable concrete real words and 2-3 syllable non-words that were presented in a hierarchy of 10 phonological and lexical-semantic input tasks across 3 varying time intervals.

Analyses were conducted using appropriate Shewart-chart lines and effect sizes. Results indicated improved accuracy of repetition (dependent variable) across the 3 time variations (independent variable), with agreement between Shewart-chart lines and calculated effect sizes on trained items.

Kalinyak-Fliszar et al. (2011) provided a detailed report of a well-designed study. Despite the large effect sizes shown in treatment, results failed to demonstrate generalization to untrained items or modalities, or changes in functional language and discourse outcome measures. As such, this level I evidence provides compelling support that a theoretical and systematically based intervention approach addressing the phonological deficits in conduction aphasia can result in gains specific to the skills targeted in treatment.

Discussion and Clinical Implications

The results presented in six of the eight treatment studies provides suggestive-to-compelling evidence that unimodal phonological approaches to treatment can be effective in remediating some of the unique language output deficits seen in conduction aphasia. These studies employed a single-subject *n-of-1* design, highly appropriate for studying individuals with rare disorders, such as conduction aphasia, requiring individualized treatment. Despite this high level of evidence, the research lacks evidence supporting generalization and maintenance of the deficits.

Regardless of aphasia type, generalization and maintenance are hallmarks of treatment success (Brookshire, 2007); however consistently, studies report greater improvement on trained items compared to untrained items. Generalization is influenced by various factors, including the outcome measured used to evaluate generalization, the treatment protocols themselves, and the patient (Mitchum & Berndt, 2007). Comparatively, maintenance is also dependent upon the patient in that maintenance of any newly acquired or reacquired skill requires practice. Thus, by altering treatment items or protocols to make them more salient to the patient's life, maintenance and generalization may be more likely to occur.

Furthermore, three of these six studies (Beard & Prescott, 1989; Koenig-Bruhin & Studer-Eichenberger, 2007; Kohn et al., 1990) utilized a phonological approach to treat the repetition deficit. Although repetition is a primary deficit and characteristic of conduction aphasia, treatment of the repetition deficit in and of itself may not be a valid goal to improve oral expression in persons with conduction aphasia (Kohn et al., 1990). Placed within a neurolinguistic model, such as that proposed by Ellis and Young (1988), repetition as a separate linguistic domain completely bypasses the semantic network and as such, is merely repeated through an auditory to phoneme mechanism, void of context or meaning. This may help to explain why in cases such as that presented by Beard and Prescott (1989), patients improved their performance on overt repetition tasks; however, gains did not generalize to untrained items, or other language domains. Comparatively, in Kohn et al.'s (1990) study, treating repetition did lead to generalization of increased syllable-to-concept ratio on a picture description task. It is unclear whether this generalization effect could be directly attributed to the repetition treatment or to the combination of the repetition treatment with existing treatment protocols. Koenig−Bruhin and Studer−Eichenberger's (2007) study also reported treatment generalization, however the generalization was measured as increased sentence length in a story retell task, and cannot soley attribute conclusions of treatment generalization.

Additionally, there is a lack of research systematically investigating semantic based treatment approaches in conduction aphasia. This lack of research may be due to the fact that persons with conduction aphasia generally have intact semantic systems, as shown by their relatively spared auditory comprehension (Baldo et al., 2008). Only two studies (Harnish et al., 2008; Kalinyak-Fliszar et al., 2011) provided evidence supporting a multimodal or a combined phonological and semantic treatment approach. Harnish et al.'s (2008) study, although more rooted in treatment intensity than protocols did provided qualitative evidence of generalization to other language domains; however, Kalinyak-Fliszar et al.'s (2011) treatment, like the other studies, failed to report generalization of gains in phonological STM to untrained items or other language domains.

Future clinical research addressing the unique deficits seen in conduction aphasia is warranted. Given that persons with conduction aphasia have language deficits primarily centered in the phonological domain (i.e., phonological STM) it is suggested that a multimodal, combined language domain approach be utilized. Whether that approach be a combined, phonological and semantic or phonological and grammatical would have to be considered on a patient-by-patient basis. More careful consideration and evaluation of maintenance and generalization effects is also warranted.

In summary, conduction aphasia is characterized by significant changes to language output, despite relatively good comprehension of the 'gist' of a message. A number of proposals have been presented to account for these deficits, including disruption of phonological processes (Nickels et al., 1997) and over reliance on semantic processes (Baldo et al., 2008). A critical appraisal of the current clinical literature pertaining to the deficits seen in conduction aphasia was conducted. As demonstrated in six of the eight studies, existing interventions tend to focus on unimodal phonological approaches to the language output deficits with little maintenance and carryover. There is little available evidence to evaluate the treatment potential of a multimodal, combined semantic and phonological approach to remediate both language input and output deficits seen in conduction aphasia. Further clinical research addressing such treatment approaches is warranted.

References

Baldo, J. V., Klostermann, E. C., & Dronkers, N. F. (2008). It's either a cook or a baker: patients with conduction aphasia get the gist but lose the trace. *Brain and Language, 105*(2), 134-140. doi: 10.1016/j.bandl.2007.12.007

Beard, L. C., & Prescott, T. E. (1989). *Replication of a treatment protocol for repetition deficit in conduction aphasia*. Paper presented at the Clinical Aphasiology Conference, Lake Tahoe, NV. Retrieved from http://aphasiology.pitt.edu/archive/00000115/

Brookshire, R. H. (2007). *Introduction to Neurogenic Communication Disorders* (7th ed.). St. Louis, Missouri: Mosby Elsevier.

Caramazza, A., Basili, A. G., & Koller, J. J. (1981). An investigation of repetition and language processing in a case of conduction aphasia. *Brain and Language, 14*, 235-271.

Corsten, S., Mende, M., Cholewa, J., & Huber, W. (2007). Treatment of input and output phonology in aphasia: A single case study. *Aphasiology, 21*(6-8), 587-603. doi: 10.1080/02687030701192034

Cubelli, R., Foresti, A., & Consolini, T. (1988). Reeducation strategies in conduction aphasia. *Journal of Communication Disorders, 21*, 239-249.

Ellis, & Young. (1988). *Human cognitive neuropsychology*. Hillsdale: Lawrence Erlbaum.

Franklin, S. (1997). Designing single case treatment studies for aphasic patients. *Neuropsychological Rehabilitation, 7*(4), 401-418.

Franklin, S., Buerk, F., & Howard, D. (2002). Generalised improvement in speech production for a subject with reproduction conduction aphasia. *Aphasiology, 16*(10-11), 1087-1114. doi: 10.1080/02687030244000491

Goodglass, H. (1992). Diagnosis of Conduction Aphasia In S. E. Kohn (Ed.), *Conduction Aphasia* (pp. 39-49). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Harnish, S. M., Neils-Strunjas, J., Lamy, M., & Eliassen, J. (2008). Use of fMRI in the study of chronic aphasia recovery after therapy: A case study. *Topics in Stroke Rehabilitation, 15*(5), 468-483. doi: 10.1310/tsr1505-468

Joanette, Y., Keller, E., & Lecours, A. R. (1980). Sequences of phonemic approximations in aphasia. *Brain and Language, 11*, 30-44.

Kalinyak-Fliszar, M., Kohen, F., & Martin, N. (2011). Remediation of language processing in aphasia: Improving activation and maintenance of linguistic representations in (verbal) short-term memory. *Aphasiology, 25*(10), 1095-1131. doi: 10.1080/02687038.2011.577284

Koenig−Bruhin, M., & Studer−Eichenberger, F. (2007). Therapy of short−term memory disorders in fluent aphasia: A single case study. *Aphasiology, 21*(5), 448-458. doi: 10.1080/02687030600670593

Kohn, S. E. (1984). The nature of the phonological disorder in conduction aphasia. *Brain and Language, 23*, 97-115.

Kohn, S. E., Smith, K. L., & Arsenault, J. K. (1990). The remediation of conduction aphasia via sentence repetition: A case study. *British Journal of Disorders of Communication, 25*, 45-60.

Mitchum, C. C., & Berndt, R. S. (2007). Comprehension and production of sentences. In R. Chapey (Ed.), *Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders* (5th ed., pp. 632-653). Philadelphia: Lippincott, Williams & Wilkins.

Nadeau, S. E., Gonzalez Rothi, L. J., & Rosenbek, J. C. (2008). Language rehabilitation from a neural perspective. In R. Chapey (Ed.), *Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders* (5th ed., pp. 689-734). Philadelphia: Lippincott, Williams & Wilkins.

Nickels, L., Howard, D., & Best, W. (1997). Fractionating the articulatory loop: Dissociations and associations in phonological recoding in aphasia. *Brain and Language, 56*, 161-182.

Shallice, T., & Warrington, E. K. (1977). Auditory-verbal short-term memory impairment and conduction aphasia. *Brain and Language, 4*, 479-491.

Sullivan, M. P., Fisher, B., & Marshall, R . C. (1986). Treating the repetition deficit in conduction aphasia. In R. H. Brookshire (Ed.), *Clinical aphasiology,* Vol. 9 (pp. 270 - 277). Minneapolis, MN: BRK Publishers.

Warrington, E. K., & Shallice, T. (1969). The selective impairment of auditory short-term memory. *Brain, 92*, 885-896.