

## Critical Review

Does a phonological awareness approach improve literacy skills in children with childhood apraxia of speech

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This critical review examines the persistent nature of literacy deficits in children with childhood apraxia of speech (CAS), as well as the effects of a phonological awareness approach in improving the literacy skills for this population. Overall, research suggests that children with CAS do in fact experience persistent literacy deficits, and that the use of a phonological awareness approach is both appropriate and effective at improving not only the literacy deficits for this population, but is also effective at improving both speech sound production, and phonological awareness skills for children with CAS.

### *Introduction*

Childhood apraxia of speech (CAS) has traditionally been viewed as a disruption in the programming and planning of speech movements (Moriarty & Gillion, 2005). However, it has now become widely recognized that CAS is a complex disorder resulting in both speech and language difficulties (Gillion & Moriarty, 2007). In addition, current research suggests that children with CAS are more likely than children with other speech-language disorders to display written language deficits (McNeil, Gillion, & Dodd, 2009b). It has also been found that children with CAS have difficulties with phonological awareness, which can be described as the conscious awareness of the sound structure of spoken words (McNeil, et al., 2009b). Researchers postulate that it is this deficit in phonological awareness that underlies the written language deficits observed in children with CAS (McNeil, et al., 2009b). Consequently, their difficulties with phonological awareness during the early school years place children with CAS at an increased risk for both written language and reading difficulties with school age (Gillion & Moriarty, 2007).

Currently, it is common-practice for speech-language pathologist to employ interventions only aimed at improving speech production in children with CAS (Gillion & Moriarty, 2007), yet there is limited evidence to suggest that such interventions can simultaneously address the underlying phonological skills necessary for both reading and spelling development (Gillion & Moriarty, 2007). As such, the need for intervention for children with CAS addressing both the speech, language, and co-occurring written language deficits is becoming increasingly evident. Recently, a group of researchers based out of New Zealand have begun investigating an intervention approach that may be able to simultaneously target speech production, phonological awareness, and letter knowledge in children with CAS. If found to be effective, the integrated phonological awareness approach may result in many positive implications for children with CAS including improved written language skills, as well as improved academic outcomes.

### *Objectives*

The primary objective of this paper is to critically evaluate existing literature pertaining to the effectiveness of an integrated phonological awareness approach, at improving phonological awareness and literacy skills for children with childhood apraxia of speech (CAS). The secondary objective is to propose evidence based recommendations pertaining to the use of an integrated phonological awareness approach with children with CAS in clinical practice.

### *Methods*

Search Strategy: Computerized databases, including CINAHL, PubMed, and SCOPUS were searched using the following search strategy: “childhood apraxia of speech” OR “Apraxia of Speech (Developmental) OR developmental verbal dyspraxia” AND “phonological awareness. The search was limited to articles written in English between 1995 and 2010.

Selection Criteria: Studies selected for inclusion were required to examine either the speech, language and literacy deficits of children with childhood apraxia of speech (CAS), or the effectiveness of an integrated phonological awareness approach in treating children with CAS. Participants had to be diagnosed with developmental childhood apraxia of speech or developmental verbal dyspraxia, which is another name for CAS. No limits were set on outcome measures.

Data Collection: Results of the literature search yielded the following article types: multiple single-subject design (2), non-randomized between group clinical trial (2), non-randomized mixed clinical trial (1), multiple single-subject multiple baseline analysis (1), review of topic (1).

### *Results*

In their study, Lewis, Freebairn, Hansen, Iyengar, and Taylor, (2004) sought to identify the differences in speech/language and written language skills between children with suspected CAS and children with other speech sound disorders at school age. This evidence based level II study utilized a non-randomized mixed clinical trial design, and contains 3 experimental groups: (1) an isolated speech-sound disorder group (S), with 15

participants, (2) a combined speech-sound and language disorders group (SL) with 14 participants, and (3) a childhood apraxia of speech group (CAS), with 10 participants. All participants were recruited during preschool (ages 4-6), and were followed-up on from ages 8-10. The following statistical analysis were used to interpret the findings: Chi square tests and ANOVAs were used to examine group differences in age, gender, and socioeconomic status; ANOVA tests were used to compare groups across the domains of speech sound development, language, and oral motor skills during the preschool years, and the domains of speech sound development, language, oral motor skills, reading, and spelling at school age; the Tukey HSD test was used for post-hoc testing of significant main effects for group; Bonferroni corrections were made within each domain for multiple comparisons; finally, the Partial Eta squared statistic was used to calculate effect sizes to determine the strength of association between group and dependent variables with a very large effect size being  $> .80$ ; and a large effect size being  $= .50-.80$ . Results of the statistical analysis revealed the following: the CAS group performed more poorly than the S group on all preschool measures, but the CAS group was not statistically different from the SL group on preschool measures; the CAS group continued to perform more poorly than the S group at school-age follow-up, and they also performed lower than SL group on most measures; the CAS group made more speech-sound errors than the S and SL groups during conversational speech. When examining the CAS group more closely, the following observation were made: overall, all participants with CAS exhibited deficits in speech and in receptive and expressive language at both assessments; their reading comprehension was deficient relative to normal standards; and they performed more poorly on spelling measures than reading measures. The results of this study must be interpreted with some degree of caution however, as the researchers failed to control for the effects of speech therapy on school-age outcomes, and apart from one test, the same test instruments were not used at both preschool and school-age assessments.

This study provides compelling results, which serve to highlight the comorbidity of CAS with deficits in both expressive and receptive language, as well as the persistent nature of CAS, extending from the preschool years, into the school-age years. The results further suggest that children with CAS are at risk for school-age language, reading and spelling difficulties, which lends support the concept that providing training to these children using a phonological awareness approach may be appropriate.

In their study, McNeil and Dodd, (2009c) attempted to determine how phonological awareness and reading development skills compare among children with CAS, and children with inconsistent speech disorders (ISD).

This evidence based level II study utilized a controlled non-randomized comparative, between groups design. There were 36 participants, 12 participants diagnosed with CAS, 12 participants diagnosed with ISD, and a control group with 12 participants with normal speech and language development (TD). Each group consisted of 9 males and 3 females, and all ranged from 4-8 years of age. All participants were given phonological awareness, letter-sound knowledge, and reading tasks. Multiple ANOVAs were performed to compare each group's performance on the phonological awareness, reading, and phonological representation measures. The effect size was also calculated for all statistically significant comparisons. The following results were obtained: for phonological awareness, the TD group scored significantly higher than ISD and CAS group, in addition, ISD group scored significantly higher than CAS group; for letter knowledge, the TD group scored significantly higher than ISD and CAS group, with no significant difference between the CAS and ISD groups; for letter knowledge, the TD group scored significantly higher than both the CAS and ISD groups, with no significant difference between the CAS and ISD groups; for non-word reading tasks, the CAS group appeared to have more difficulty, compared to the TD and ISD groups. However the results of the non-word reading task had to be qualitatively analyzed due to small number of 6+ year old participants, and thus, these results should be interpreted with caution. Finally, overall it was found that the CAS group had fewer participants performing within or above normal limits than the ISD/TD groups in phonological awareness, letter knowledge, and word reading. Some caution must be used when interpreting the results of this study. In particular, it failed to control for the effects of speech therapy on school-age outcome, and raw scores were used to compare the reading measures instead of scaled scores.

In conclusion, this study provides compelling results, suggesting that children with CAS have poorer phonological awareness skills than children with ISD. In addition, this study further supports the notion that intervention for children with CAS should not be limited to speech difficulties, but that the use of a therapy model targeting speech, phonological awareness, and reading is critical.

In their study, Bradford-Heit, and Dodd, (1998) sought to determine if children with different underlying deficits perform differently on new word learning tasks depending on the provision of a verbal model to imitate with or without an additional cue. In this evidence based level II study, the researchers used a non-randomized, between groups clinical trial design, with 27 participants with disordered speech: 10 participants had consistent deviant speech errors, 12 participants had inconsistent deviant speech errors, and 5 had developmental verbal dyspraxia, or CAS. Of these 27

participants, there were 19 males, and 8 females, ranging from 3;1 to 7;1 years of age. In addition, there was a control group which consisted of 12 participants with normal speech, and language, 8 of whom were males, and 4 of whom were females, ranging from 3;3 to 7;0 years of age. The experimental task for this study consisted of learning to say new words using imitation and cues. There were 5 template non-word names to be learned, and 5 different feedback cues were given following inaccurate imitation of targets: (1) imitation only, (2) imitation with stress on the syllable in error, (3) imitation and feedback on the phonological plan, (4) imitation and phonetic/articulatory cues for a single error phoneme, and (5) imitation and oro-motor sequencing information. Scores were determined by calculating the number of attempts with a cue. Statistical analysis revealed the following: a Kruskal-Wallis analysis of variance determined that the groups did not differ significantly in age; an additional Kruskal-Wallis ANOVA, as well as a Post hoc Mann-Whitney U-test with Bonferoni corrections indicated that the consistent group, the inconsistent group, and the CAS group had fewer correct responses on their initial imitation attempts than the control group, however the consistent, inconsistent, and CAS groups did not significantly differ from each other in this measure. In addition, a Kruskal-Wallis ANOVA, as well as a Post hoc Mann-Whitney U-test with Bonferoni corrections indicated that compared to the controls, the CAS group made significantly fewer responses that were not produced accurately within 10 trials. Upon closer examination of the CAS group, it was found that none of these participants were able to produce any of their targets on their initial imitation attempts, and it was also found that cues which provided information about the phonological plan of the target elicited more accurate information than the other cues did. However, this result must be interpreted with caution as the authors made this suggestion based on the percent of children who correctly produced the target after the cue, rather than performing statistical analysis to determine any significant differences between the effectiveness of the different cues.

The results of this study provide suggestive evidence that intervention techniques that provide phonological information, rather than imitation strategies, may indeed be more effective at improving the speech production of children with CAS

In their evidence based level V journal article, Gillion, and Moriarty, (2007) provide a discussion pertaining to four important factors that contribute to a persistent risk of reading and spelling disorders in children with CAS. First, they discuss the nature of CAS, namely that it is comprised of a cluster of speech, motor, and/or language characteristics, and that reading and spelling disorders occur in at least a portion of children with CAS. They next discuss the frequent occurrence of phonological

awareness difficulties in this population. In particular, children with CAS have been found to display phonological awareness deficits at the syllable, rhyme, and phoneme level on both receptive and expressive tasks. Next, the authors discuss the genetic risks associated with CAS. They suggest that CAS does not have a unique genetic cause but rather, that families of children with CAS hold more affected genes for speech or language disorders. Furthermore, they suggest that genetic risk factors for the phonological processing deficits associated with CAS place these children at increased risk for reading and spelling difficulties. Finally, the authors discuss the cumulative negative effects of early reading difficulties, suggesting that unresolved speech and language impairments, combined with poor phonological awareness abilities may lead to difficulty with reading acquisition upon school entry, and that such difficulties place these children at significant risk for persistent reading and spelling difficulties in later school years.

Although they do not provide any new research data in their article, the authors do draw from past research in order to support their discussion, which permits this article to be more suggestive than expert opinion alone.

In their article, McNeil, Gillion, and Dodd, (2009b) sought to examine the clinical effectiveness of an integrated phonological awareness intervention approach for 12 children (3 females, 9 males) with CAS. Participants ranged from 4-7 years of age. In their evidence based level I study, the researchers utilized a controlled multiple single subject design with repeated measures, including an AB format for each treatment goal, and control probes. Each participant received a diagnosis of CAS, and all participants had no history of sensory, cognitive, or neurological impairments. Each participant received 24 individual 45-minute treatment sessions over 18 weeks (two 6 week blocks of therapy, one 6 week block of withdrawal), within which the goals of therapy were (1) to reduce speech error patterns at the single word level and in connected speech, (2) to improve phoneme awareness, and (3) to improve letter-sound knowledge. Both pre and post-intervention scores were gathered. Statistical analysis of the data obtained revealed the following: the two standard deviation (2SD) band and the test of significance of the split middle line methods were used to identify significant improvements in 9 participants whereby they demonstrated both improvements in trained speech probes for both (2/2) of the targeted speech error patterns, and 9 participants were able to transfer speech targets from the first block of treatment to a spontaneous speaking context. In addition, 5 participants demonstrated significant improvements for both (2/2) phonological awareness trained error pattern probes, and an additional 3 children demonstrated significant improvements in one phonological awareness trained error pattern. An effect size appropriate for single cases

was used to analyze the participants' change in performance from pre- to post-test on untrained speech and phonological awareness probes. Untrained speech results revealed that 3 participants had strong effect sizes ( $d = \text{greater than } 0.80$ ) for both speech error patterns, and a further three participants showed strong gains. Likewise, 6 children demonstrated a strong effect size for phonological awareness error patterns, and an additional 2 showed strong gains. A paired t-test was used to evaluate change over the intervention period in the pre- and post-measures. Results of the paired t-test displayed a significant increase in the suppression of speech error patterns for target one, and target two ( $p < 0.001$ ), but no significant change in the suppression of control speech error patterns ( $p = 0.08$ ). A paired t-test also revealed significant improvements for all areas of literacy tested except one, real word decoding. Finally, it was found that on average, the participants learned 8.5 letter-sound combinations throughout intervention. This study provides compelling evidence that the use of an integrated phonological awareness intervention approach may indeed be appropriate for treating children with CAS. Results of statistical analysis reveal that it is possible to simultaneously target speech production, phonological awareness, letter knowledge, reading and spelling skills in children with CAS. An additional important implication derived from this study is that change in speech production, phonological awareness, and literacy skills can be achieved for some children with CAS over a relatively short treatment period.

In the following study, Moriarty, and Gillion, (2005) sought to determine whether or not an integrated phonological awareness intervention approach would serve to improve the speech production, phonological awareness and printed word decoding skills for children with CAS. This study utilized a multiple single-subject design with repeated measures, and had participants serving as their own controls. There were 3 participants two males, one female, ages 7;3, 6;3, and 6;10. Each participant engaged in an integrated phonological awareness intervention, composed of three 45 minute sessions/week for 3 weeks. Each session contained tasks such as identifying phonemes in isolation, identifying initial and final phonemes in words, phoneme segmentation/blending, and phoneme manipulation with letter blocks. Both pre and post-intervention scores were gathered. Statistical analysis of the data obtained revealed the following: the celeration line and 2SD band methods were used to identify whether variations between baseline and post-treatment phases were significant. It was found that 2/3 participants demonstrated a significant improvement in targeted speech production measures, and one participant demonstrated a significant improvement in control speech production measures. For phonological awareness skills, it was found that 2/3 participants

demonstrated significant improvements in trained phoneme segmentation skills, and were both able to transfer these skills to untrained items. In addition, 2/3 participants significantly improved trained phoneme manipulation skills. Finally for non-word reading & letter sound knowledge skills, it was found that 2 participants increased their letter-sound performance, and their non-word reading scores. It must be noted however, that for the non-word reading and letter knowledge skills, the authors simply examined change in these measures by calculating percent change pre- and post therapy, therefore due to the lack of statistical analysis performed, the results of these measures must be interpreted with caution.

Results from this study provide compelling evidence that speech production skills, phonological awareness skills, and literacy skills can be improved for some children with CAS, through the use of an integrated phonological awareness intervention model. Furthermore, it can be concluded that changes in speech production, phonological awareness, and literacy skills can be achieved in some children with CAS over a relatively short treatment period. However, it must be noted that despite providing follow-up measures, these measures were taken only one and two weeks post-therapy, therefore they may not reflect the participants' actual maintenance and or improvement of skill post-therapy. As such, post treatment results must be interpreted with caution.

In their evidence-based level IV study, McNeil, Gillion, and Dodd (2009a) employed a multiple baseline analysis in order to determine the long-term effects of an integrated phonological awareness intervention approach for identical twin boys with CAS. The two boys were initially tested at the age of 4;5, and follow-up measures were re-administered at the ages of 4;9, 5;3, and 5;9. The following results were obtained from this study: for speech production, both participants improved their consonant production within single words over each assessment point and vowel production improved over each assessment point, except for a slight decrease in one participant's vowel accuracy from the third to fourth assessment. Generally, it was found that both participants' speech productions became more consistent throughout the study. For their phonological awareness and representation abilities, it was found that both participants performed within or above the expected range on the phonological awareness measure following the intervention. For their reading and spelling development, it was found that both participants had achieved age-appropriate scores on the normative decoding and reading comprehension measures at the second follow-up assessment and they both showed phonetic and semi-phonetic spelling strategies in story writing during their first term of school. Finally, it was found that both participants

displayed persistent expressive morpho-syntactic deficits.

Generally, this study suggests positive speech, phonological awareness, and early literacy gains from participation in an integrated phonological awareness intervention program at preschool age, and provides suggestive evidence of the benefits of a integrated approach for children with concurrent oral-motor, phonological, and linguistic deficits. However, results of this study must be interpreted with considerable caution, as this study lacks statistical analysis, with the researchers opting to examine standard scores and percent of items correct for pre- and post intervention measures. Therefore, it is uncertain whether pre- and post-intervention improvements in speech, phonological awareness, and literacy skills are indeed statistically significant, rendering the results of this study to be suggestive, rather than compelling.

### *Discussion*

Each of the studies examined provide support for either the persistency of literacy deficits in children with CAS, and/or provide support for the effectiveness of a phonological awareness approach in treating children with CAS. The studies ranged from evidence level I to evidence level IV, with most studies being either evidence level I or II. Together, the seven studies reviewed provide compelling evidence for the need to adopt a phonological awareness approach when treating children with CAS, with co-occurring literacy deficits. In addition, the two evidence level I studies by Moriarty & Gillion (2005), and McNeil et al., (2009a) provide compelling evidence for the effectiveness of employing an integrated phonological awareness approach when targeting literacy skills in children with childhood apraxia of speech. Furthermore, these studies provide additional compelling evidence, demonstrating that for some children with CAS, the phonological awareness approach is not only successful at improving literacy skills, but it is also successful at improving both speech sound production, and phonological awareness skills.

### *Recommendations*

#### Future Research:

- Further large scale studies need to be conducted in order to confirm the literacy-related benefits of employing the phonological awareness approach for children with CAS
- Follow-up data should be gathered in respect to the long-term literacy benefits of employing the phonological awareness approach for children with CAS from both the Moriarty & Gillion (2005), and McNeil et al. (2009a) studies

### *Clinical Implications*

This review has examined the current literature pertaining to the persistence of literacy deficits in children with childhood apraxia of speech, as well the

effectiveness of employing a phonological awareness approach with this population. The results have revealed both the appropriateness, and the effectiveness of employing a phonological awareness approach for children with CAS and co-occurring literacy deficits. Not only does this approach lead to improved literacy skills, but it has also been found to lead to improved speech-sound production, and phonological awareness skills, making this multi-goal, integrated approach ideal for speech-language pathologists working with this target population within a clinical setting.

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