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Critical Review: In children with hearing loss, is phonological awareness related to literacy development?

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This critical review examines whether or not phonological awareness is related to reading development in children with hearing loss. Children with hearing loss often have reading abilities that are below age expectations so determining the relation between phonological awareness and reading ability could guide decisions that clinicians make when developing intervention goals for these children. A literature search using computerized databases was completed resulting in six articles meeting the inclusion criteria. Study designs included: correlational design, case-control design, cohort study and a meta-analysis. The articles were evaluated using a critical appraisal template evaluating the level of evidence, validity and importance of the information included in the article. Overall, the research indicates that phonological awareness is a low-moderate predictor of reading development. This is different than what we might expect for typically developing children. This is further discussed in the review.

Introduction

Research has shown that many children with hearing loss have reading abilities that are below age expectations (Mayberry & Rachel, 2011). In order to help remediate this lag in literacy development, it would be beneficial for clinicians to know what skills have the greatest effect on literacy development in children with hearing loss.

Kyle and Harris (2010) wrote that phonological awareness is one of the most consistently reported correlates and predictors of reading and spelling achievements for typically developing children. It is for this reason, along with other evidence, that in recent years, phonological awareness has consistently been targeted in early language intervention as a precursor for literacy development. While there is a wealth of literature that supports the relationship between phonological awareness skills and literacy development in normal hearing children (for reviews see, Adams, 1990; Castles & Coltheart, 2004; Wagner & Torgesen, 1987), the evidence to support the relationship in hearing impaired children is not as abundant or clear cut. We might expect the development of phonological awareness in children with hearing loss to differ from normal hearing children because they have reduced auditory access to the sounds of spoken language. (Kyle and Harris, 2010).

Determining whether or not phonological awareness is related to literacy development in children with hearing loss is important because it could guide decisions made regarding intervention approaches and goals for children with hearing loss. If phonological awareness is found to be weakly related to literacy development in hearing-impaired children, clinicians should consider targeting other skills in therapy to provide further support to the literacy development of these children.

Objectives

The objective of this paper is to critically review the literature in order to discover whether a positive relationship exists between phonological awareness and literacy development in children with hearing loss.

Methods

Search Strategy

Articles related to the topic of interest were found using the following computerized database: Scopus. Articles were also located by reading the reference lists of articles related to the topic of interest.

Keywords used for the database search were as follows:

[(hearing loss) and (phonological awareness) and (literacy)]

Selection Criteria

Studies selected for inclusion in this critical review were required to investigate both literacy development and phonological awareness skills in children with hearing loss.

Data Collection

Results of the literature search yielded six articles consistent with the aforementioned selection criteria. Two of the studies employed a correlational design, two of the studies employed a case control design, one of the studies used a longitudinal design and the last was a meta-analysis.

Results

Correlational Studies

Correlational studies are appropriate to be used for finding the relationship between phonological awareness and literacy development in children with hearing loss because we are looking at the existence of a relationship between both variables and the strength of the relationship. A limitation of this design is that causality cannot be assumed so we cannot assume that phonological awareness causes the emergence of early literacy skills or vice versa. Another limitation is that there is no control group to compare results to, which would be a stronger design.

Goldberg and Lederberg (2014) analyzed the relationship between spoken phonology and letter-sound learning in 89 deaf and hard of hearing (DHH) participants recruited over four consecutive school years. The researchers were particularly interested in whether the DHH group showed a typical developmental pattern of learning letters with a consonant-vowel name (e.g., B - /bi/) before vowel-consonant names (e.g., F - /ef/). Good recruitment criteria were used for the study, controlling for gender, ethnicity and level of functional hearing (at least some word identification). The authors included children with both cochlear implants (CIs) and hearing aids in the present study, and did include audiological device in one analysis however no significant differences on study measures were found. Children were administered a battery of tests by the researchers that measured letter-sound knowledge distinguished by whether letter names started with a vowel or consonant, letter-name knowledge and phonological awareness. Using appropriate statistical analyses, results showed that participants knew twice as many letter-names as letter-sounds, and identified more letter names starting with a vowel than a consonant (i.e., opposite to the pattern observed in typical development). An inherent issue with this study was that the authors designed their own letter-sound and letter-name assessments and used only one gold standard assessment procedure. In an appropriate hierarchical regression, both letter-name knowledge and phonological awareness predicted letter-sound knowledge, although the latter explained the largest portion of unique variance. Authors failed to include a statement about reliability which could negatively impact the validity of the study.

The results strongly suggest that there is a relation between phonological awareness and the acquisition of letter-sound knowledge in DHH children with auditory access to speech. As well, there is suggestive evidence that children who are DHH may show a different developmental pattern in responses to cues for letter sound knowledge

Webb et al. (2015) examined the associations among phonological awareness, alphabetic knowledge, word reading and vocabulary skills in deaf and hard of hearing (DHH) children who have auditory access to speech and how they were similar to normal hearing children (based on test norms). 167 DHH children who attended school programs for children with hearing loss were recruited over seven consecutive school years from a variety of school settings. Well-specified inclusion criteria included functional hearing demonstrated in one gold standard speech perception test such that participants were able to identify at least some words. The researchers used six gold standard tests to assess phonological awareness, vocabulary, and letter-word identification, and two researcher developed tests to assess letter-name and letter-sound knowledge. Although these measures were well described they are potentially weaker than the other standardized measures.

Appropriate statistical analysis revealed that DHH children were delayed in both language and phonological awareness skills scoring 1 SD below the mean for the tests' norming samples of hearing children. Outlier screening and careful evaluation of the data did not detect any errors. Using confirmatory factor analyses (CFA), authors found that early literacy formed three constructs which include phonological awareness, alphabetic knowledge and vocabulary and that strong homogenous associations exist between all three. While using CFA has advantages such as overcoming limitations of regression analysis such as measure error, the authors acknowledged the disadvantages such as the small sample size given the heterogeneous population used in this study. The authors concluded that their results support the hypothesis that the structure of reading skills in DHH children with functional hearing is similar to their normal-hearing peers.

The study is well designed but with some weaknesses in procedures. As a result, the study provides suggestive evidence that phonological awareness, alphabetic knowledge and vocabulary are associated

with the emergence of early literacy skills in DHH children and that they are delayed in both phonological awareness and language skills compared to normal hearing children.

Case-Control Studies

Case control studies are appropriate for questions regarding the development of children with hearing loss compared to typical development. However, this design is prone to biases, particularly selection bias so results must be interpreted with caution.

Nittrouer et al. (2012) compared children with cochlear implants (CIs), children with hearing aids (HA) and children with normal hearing (NH) to examine emergent literacy in children with CIs. Fifty-two children who had just completed kindergarten participated in the study as part of a camp at Ohio State University. Of these, 27 wore CIs, 17 had NH, and 8 wore bilateral HAs. All three groups were balanced for gender, socioeconomic status and nonverbal cognitive abilities. All of the participants were tested using several tasks that assessed emergent literacy, phonological awareness, executive functioning and oral language. Only one test was considered a gold standard test (oral language) but the remaining tasks were described in sufficient detail to be replicated in future research. Data entered directly on the computer were scored automatically by the software at the time of testing. Otherwise, videotapes were viewed and scored by experimenters at a later time but reliability of scoring was not evaluated.

Results of all dependent measures were screened to ensure they were normally distributed and there was homogeneity of variances among groups. Of interest to the present question, appropriate statistical analyses (regression analyses and stepwise linear regression) revealed that the score on one phonological awareness task was the most significant predictor in word reading and vocabulary in predicting reading comprehension for children with normal hearing. For children with CIs the most significant predictors for both word reading and reading comprehension were syllable counting and narrative scores, respectively. A corresponding regression for the HA group was not reported.

The results of this study strongly suggests that literacy emerges differently in children with hearing loss, specifically those who wear CIs. In particular, significant predictors of phonological awareness for the typical group were word level measures (word reading, vocabulary) and syllable and language measures for the CI group (syllable counting, narrative).

Ambrose, Fey and Eisenberg (2012) conducted a case control study to determine whether preschool-age children with cochlear implants have age-appropriate phonological awareness and print knowledge and to examine the relationships of these skills with related speech and language abilities. Well specified selection criteria including age (36-60 months), bilateral severe-profound prelingual sensorineural hearing loss, use of a CI for a minimum of 18 months, no additional disabilities, and primary home language of English resulted in the recruitment of 24 children in the cochlear implant group. A matching control group of 26 children with normal hearing (passed a hearing screening) were recruited, although 3 were later excluded for well-specified reasons and not included in the analyses. A limitation to this study is that the sample size is small. Appropriate statistics revealed no group differences for both age and maternal education. A standardized test was used to assess phonological awareness and print knowledge. Additional gold standard tests were administered to assess the children's speech and oral language abilities. Appropriate statistical measures (independent-samples *t* tests, Mann-Whitney *U* test) were used to confirm that the NH group significantly outperformed the CI group on all measures but no information was given about who administered the test, or about the inter or intra-rater reliability which could impact the validity of the study.

Appropriate statistical measures (independent-samples *t* tests) show the CI group's mean score on the phonological awareness measure was slightly more than 1 SD below the mean score of the NH group which was statistically significant. In contrast, there were no significant between-group differences for print knowledge scores. In additional statistical analyses (zero-order correlations), phonological awareness was found to be significantly correlated with all five speech and language variables while print knowledge was found to be significantly correlated with all except language comprehension. Regression analyses were used to examine the contributions of related skills (speech and oral language skills) to the variability in phonological awareness and print knowledge of the CI group. The authors found that both related skills significantly predicted variance in phonological awareness and print knowledge.

The study is well designed but with some weaknesses in procedures. As a result, the study provides suggestive evidence children with hearing loss have

below average phonological awareness skills and that both speech and oral language skills appear to relate to variance in phonological awareness.

Cohort Study

Kyle and Harris (2010) examined predictors of reading development in deaf children over three-years. This was an appropriate design because literacy develops over time and variables may contribute differently depending on the stage of reading development. A potential weakness of this design is selection bias as a result of loss to follow-up but that was not an issue with this particular study.

Participants (N=29, 14 boys) were selected based on good recruitment criteria which included age, severity of hearing loss (greater than 70 dB), type of hearing loss (prelingual, sensorineural) and nonverbal intelligence quotients in the normal range. For this study design the small sample size was acceptable. The children were tested four times (at the beginning of the study and once every 12 months (T1-T4)) over the course of the three years using a battery of tests that included three reading tests and four additional tasks measuring skills hypothesized to be important for literacy development, including phonological awareness and speech reading ability. While the reading tests were gold standard tests, the additional tasks had weaker validity due to their lack of normed samples.

Appropriate statistical measures (correlations, fixed-order multiple regressions) were employed and showed that as a group, children exhibited significant delays on all reading tests at each testing phase and the average reading delay increased with time, relative to test norms. Results showed there were no significant associations between phonological awareness at T2 and later reading scores but performance on all three reading tasks particularly word reading and sentence comprehension at T2, showed significant positive relations with later phonological awareness scores at T4. A weakness in this study is that phonological awareness was not tested at T3 due to time constraints which prevents the researchers from knowing whether or not phonological awareness had significant effects on reading scores before T4. An interesting finding was that speech reading at T1 was a stronger longitudinal correlate of later word reading and sentence comprehension ability at T2 than phonological awareness but speech reading and phonological awareness were strongly correlated from the beginning to the end of the study. The strong longitudinal correlations across different time periods make it unclear which variable is a unique predictor of reading ability. Lack of statistical power in this study precludes the use of statistical methods able to compare predictors.

Despite the small sample size, the evidence in this study strongly suggests that earlier reading ability was predominantly associated with later phonological awareness and that early speech reading is associated with later word reading in children who are deaf.

Meta-analysis

Mayberry, del Giudice and Lieberman (2010) used a meta-analysis to analyze whether there is a relationship between reading ability and phonological awareness (PCA) skills in individuals who are severely-profoundly deaf. This is a strong, appropriate design for this specialized population as it allows the researcher to use a large amount of data which provides stronger evidence.

A total of 2, 078 participants over 57 studies were included in the analysis. Studies were selected based on specified inclusion criteria including that each study investigated PCA skills, that participants had a severe-profound hearing loss, and the study reported original data collected by authors using the experimental method. A thorough search involving relevant databases and additional communications was undertaken. The authors specified exclusion criteria such as not considering unpublished work. Inter-rater reliability was established as each study coder independently recoded 2-3 studies originally coded by another researcher.

The authors calculated appropriate effect sizes and found that phonological awareness was a low-moderate predictor of reading achievement, although considerable inconsistencies across studies was observed. A test of heterogeneity was not reported, although modulator analyses examining task difficulty, spelling and reading level did not explain the variance farther. An analysis involving a subset of the articles revealed language as a significant moderator.

The results show a lack of consistent findings of whether or not phonological awareness/coding skills are related to reading ability in the deaf and hard of hearing population.

Discussion

Overall, the studies indicate that phonological awareness is a low to moderate predictor of reading development in children with hearing loss. This is not as strong as a predictor that we may expect in

typically developing children. While there were strengths in the research such as good subject selection; inherent weaknesses of the methodology and the small sample sizes of the included studies reduce the strength of evidence. Additionally, some studies did not provide strict criteria concerning the severity of the hearing loss of participants. This could have a large impact on results because you may expect children with a mild hearing loss to have better auditory access to speech and thus develop better phonological awareness skills than a child with a severe-profound hearing loss and so phonological awareness skills may play a larger role in reading development for those children with a mild hearing loss.

Clinical Implications

Although there is limited strength in the level of evidence provided by the reviewed articles, they did provide important findings that can be implemented in a clinical setting.

We have learned that therapy does not have a "one size fits all" model but based on the literature about phonological awareness being a strong predictor of reading development for typically hearing children, clinicians often focus on that in therapy for all children, when it may not always be the best use of their time or show the greatest results.

Since phonological awareness was found to be a low-moderate predictor of reading development in children with hearing loss, clinicians should continue to work on this skill with these children but they should also target other skills that are precursors to reading. Mayberry, del Giudice and Lieberman (2010) found that language skills were more predictive of reading development in children with hearing loss than phonological awareness skills. Clinicians should continue to focus on core language skills such as vocabulary, receptive language and expressive language in order to support the acquisition of early literacy skills in addition to phonological awareness skills. Speech reading was found to be associated with phonological awareness and early word reading (Kyle and Harris, 2010) so clinicians should try to use speech reading to support the development of phonological awareness skills and later reading development.

In addition, phonological awareness skills appear to develop differently in children with hearing loss compared to children with normal hearing. Across studies, children with normal hearing consistently had higher phonological awareness scores than children with hearing loss. There is also evidence that phonological awareness develops differently in each of these groups. Nitrouer et al. (2012) found that significant predictors of phonological awareness for the typical hearing group were word level measures (word reading, vocabulary) and syllable and language measures for the CI group (syllable counting, narrative). This suggests that clinicians should target different early language skills depending on whether or not a child has hearing loss.

Other clinical considerations for working with children with hearing loss include language outcome factors such as age of identification, consistency of amplification use and severity of the hearing loss (Tomblin et al., 2015). These factors along with others can impact the development of early communication skills including phonological awareness, language skills and reading development.

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