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Authors: Sarah Masso, Elise Baker, Sharynne McLeod and Jane McCormack

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RUNNING HEAD: Phonological awareness and speech sound disorders

Identifying phonological awareness difficulties in preschool children with speech sound disorders

Sarah Masso

Charles Sturt University, Bathurst, Australia

Elise Baker

The University of Sydney, Australia

Sharynne McLeod

Jane McCormack

Charles Sturt University, Bathurst, Australia

Correspondence to:

Sarah Masso

Charles Sturt University

Locked Bag 450, Silverwater NSW 2128, Australia

Tel: +61-2-9752 9031

Fax: +61-2-6338 4417

Email: smasso@csu.edu.au

Abstract

Phonological awareness is one type of phonological processing ability and is considered to be particularly important for early literacy development. Specific phonological awareness skills include: syllable-level awareness, onset-rime awareness, and phonemic awareness. Children with speech sound disorders are at a high risk of difficulties with phonological awareness and literacy. There is a body of literature reporting both composite scores and task-specific phonological awareness scores from the assessment of children with typically-developing speech and school-age children with speech sound disorders. In this study we completed a systematic overview of the available literature regarding the assessment of phonological awareness in **preschool-age** children with speech sound disorders. A systematic search of literature databases yielded 777 articles which were screened. The full text of 30 articles was read and 12 articles met all specified criteria. Ten of the 12 articles reported composite scores for the phonological awareness of participants. The studies rarely reported the profile of specific phonological awareness skills. Of the final 12 articles, eight were case-control studies (Level III) and four were case-series or cross-sectional studies without a control reference (Level IV) (Merlin, Weston & Tooher 2009). There is a need for more research reporting task-specific phonological awareness abilities in preschool-age children with speech sound disorders in order to understand the relationship between specific skills and literacy development in this population.

Keywords: phonological awareness, speech sound disorders, phonemic awareness, assessment

Introduction

Preschool-age children who have speech sound disorders are at significant risk of literacy difficulties (Lewis et al., 2002). Accurate identification of those children who will go on to have literacy difficulties is fundamental to providing targeted early intervention. An important skill associated with literacy acquisition is phonological awareness (Wagner & Torgesen, 1987). Tools have been developed to assess preschool children's phonological awareness abilities and a range of skills involving different levels (e.g., rhyming, syllabification, onset identification, segmenting, and blending of phonemes) and tasks (e.g., identification, segmenting, blending) in different modes (e.g., receptive/pointing, verbal expression) can be examined. In this paper we provide an overview of phonological awareness and how it can be assessed. We also provide a systematic overview of research on the phonological awareness abilities of preschool children who have speech sound disorders in an effort to distil the specific skills that may be important to consider with these children.

What is phonological awareness?

Phonological awareness is one type of phonological processing ability (see figure 1 based on Wagner & Torgeson, 1987). Other components include phonological access to lexical store and phonological working memory (Anthony, 2003). Phonological access to lexical store is best assessed using rapid automatic naming tasks (Anthony et al., 2010); whereas phonological working memory is best assessed through nonword repetition (e.g., Gathercole & Baddeley, 1993; Sutherland & Gillon, 2005) as well as word and digit span tasks (e.g., Gathercole & Pickering, 2000; St Clair-Thompson, 2010). Phonological awareness is the focus of this current paper.

Phonological awareness refers to children's knowledge of the sound structure of a language as well as the ability to manipulate this sound structure (Burt et al., 1999). Phonological awareness is typically described as comprising three levels: syllable-level awareness, onset-rime awareness, and phonemic awareness (Rvachew & Grawburg, 2006) (see figure 1). When engaging in phonological awareness tasks, it is possible to identify, delete, blend or segment, syllables, units of rhyme or phonemes in words.

The development of phonological awareness skills occurs in the years prior to, and during, formal literacy instruction (Carroll et al., 2003). In a series of developmentally predictable, and yet overlapping, stages children initially begin to identify and manipulate large units (e.g., whole syllables) and then progress to the identification and manipulation of smaller units (e.g., individual phonemes) (Anthony et al., 2003). The skill of identifying phonological information (e.g., individual phonemes) develops earlier than the ability to delete, blend, or segment phonological information (Anthony et al., 2003). Specifically, children demonstrate awareness of rhyming words around three years of age (MacLean et al., 1987). Around four years of age, children demonstrate similar competence on syllable awareness and onset-rime awareness tasks (Carroll et al., 2003). Phoneme identification is the next skill to develop and children typically demonstrate this skill during their first year of formal literacy instruction (Paulson et al., 2003). However, as Ukrainetz et al. (2011) have shown, preschoolers are capable of developing phonemic awareness with explicit instruction, without prior instruction on syllable awareness. Once children have developed an awareness of phonemes, they learn to blend onsets with rimes (e.g., /b/ +/it/), blend phonemes (e.g., /b/ + /i/ + /t/), segment words into phonemes (e.g., /bit/ > /b/ - /i/ - /t/), and master the deletion of phonemes (e.g., /bit/ without /b/ is /it/) (Anthony et al., 2003). The described developmental pattern is debated, particularly in the

context of phonological awareness and the development of orthographic awareness (Seymour & Duncan, 1997). The acquisition of age-appropriate phonological awareness skills appears to be related to a number of additional factors including socioeconomic status (Burt et al., 1999), competence with other phonological processing tasks (Lonigan et al., 2009) and expressive speech sound development (Raitano et al., 2004).

Insert Figure 1

Syllable, onset-rime, and phonemic awareness: What is most important for literacy acquisition?

Research with school-age children examining the relationship between phonological awareness and literacy acquisition suggests that some levels (i.e., syllable, onset-rime and phoneme awareness) and tasks (i.e., identification, blending, segmentation, deletion/elision and manipulation), are more important for literacy than others. For example, phoneme identification and deletion have been correlated with reading outcomes after one or two years of reading instruction (Mann & Foy, 2003). In research studying children with dyslexia, phonemic awareness abilities during the first year of school have also been identified as a useful measure for later risk of reading difficulties (e.g., Elbro et al., 1998). In contrast, onset-rime and syllable level skills have been less predictive of reading outcomes (Mann & Foy, 2003; Muter & Snowling, 1998).

Phonemic awareness (not to be confused with the broader term phonological awareness) focuses on children's abilities to reflect on and manipulate speech sounds in words (National Institute of Child Health and Human Development, 2000). Children rely on phonemic awareness skills to read a word they have not seen before. It takes a level of metalinguistic knowledge for a child to successfully apply this skill and apply it to a written word (Gombert, 1993). For

example, for a child to read a nonword such as ‘dop’, they must have been taught the alphabetic principle, engage in grapheme-phoneme conversion, say the sounds of the letters then blend the sounds together to say the word. The U.S. National Reading Panel Report (2000) discussed the importance of phonemic awareness instruction in tandem with four other critical skills for literacy development: phonics, oral reading fluency, vocabulary and text comprehension. Phonemic awareness is considered important because, unlike syllable and onset-rime level awareness, phonemic awareness has a special reciprocal relationship with literacy acquisition—it can be triggered via formal orthographic literacy instruction (Morais, 1987; Morais & Kolinsky, 1994) which in turn can facilitate literacy acquisition.

Tools for assessing phonological awareness

There are four types of assessments that can be used to assess phonological awareness skills: norm-referenced tools, criterion referenced tools, curriculum-based measurements, and dynamic assessments (Gillam & Ford, 2012; Thatcher Kantor et al., 2011; Sodoro et al., 2002; Spector, 1992).

Norm-referenced assessment tools are considered to be the most useful to determine a child’s ability compared to other children their age (Sodoro et al., 2002). Norm-referenced tools to assess phonological awareness include the Comprehensive Test of Phonological Processing – second edition (CTOPP-2; Wagner et al., 2013) and the Preschool and Primary Inventory of Phonological Awareness (PIPA; Dodd et al., 2000). Designed for children as young as 4;0, the CTOPP-2 includes: elision of syllables and phonemes, blending syllables and phonemes, sound matching, phoneme identification, and blending of realwords and nonwords. The PIPA (Dodd et al., 2000) is designed for children aged 3;6-6;11 and includes subtests for: syllable segmentation,

alliteration identification, rhyme identification, phoneme isolation, phoneme segmentation and letter knowledge.

Criterion-referenced assessment tools are used to measure a child's ability on particular tasks to assist with therapy planning and/or measure the acquisition of specific skills (Sodoro et al., 2002). For example, the Phonological Awareness Test (Bird et al., 1995) was designed for children between 5;0-7;4 years and includes rime matching, onset matching and onset segmentation and matching tasks.

The third category of assessments is curriculum-based measurements. These tools have been reported to be useful to assess a child's progress on specific, curriculum-based tasks (Sodoro et al., 2002). One tool which is frequently used to initially screen and then continue to monitor children is the Dynamic Indicators of Basic Early Literacy Skills (6^{th} ed.) (DIBELS; Good & Kaminski, 2002). DIBELS is designed to monitor children's development from their first year of school and includes phoneme level tasks (identification and production), blending nonwords and segmenting real words. An adjunct to the DIBELS is the Individual Growth and Development Indicator which was designed to screen 3- to 5-year-old children using alliteration and rhyming tasks only (Early Childhood Research Institute on Measuring Growth & Development, 1998–2000).

The fourth category of assessment is dynamic assessment of phonological awareness. These assessments are useful to determine the level of prompting and/or cueing children require to achieve a set goal (Carlson & Wiedl, 1992; Spector, 1992). The nonverbal, dynamic phoneme deletion task presented by Gillam and colleagues (2011; 2012) was designed for school-aged children (6;0-8;5 years) and has been used to assess children with typically-developing speech sound skills (Gillam et al, 2011) and school-aged children with speech sound disorder (Gillam &

Ford, 2012). Thatcher Kantor et al. (2011) describe another two types of dynamic phonological awareness assessment specifically for preschool-aged children: one involves scaffolding and modifying items in response to errors (dynamic-supported assessment), and the other direct instruction on phonological awareness tasks (dynamic-instruction assessment). Based on composite measures (including initial sound matching in addition to word, syllable and phoneme level tasks involving elision and blending), Thatcher Kantor et al. reported that the dynamic assessments yielded similar results to the standardized static assessment with typically developing preschoolers.

Phonological awareness abilities of children with speech sound disorders

Speech sound disorders are defined as "…any combination of difficulties with perception, articulation/motor production, and/or phonological representation of speech segments (consonants and vowels), phonotactics (syllable and word shapes), and prosody (lexical and grammatical tones, rhythm, stress, and intonation) that may impact speech intelligibility and acceptability… of both known… and presently unknown origin" (International Expert Panel on Multilingual Children's Speech 2012, p. 1). Many (but not all) preschool-age children with speech sound disorders have difficulties with phonological awareness and are at risk of future literacy difficulties (Holm et al., 2008; Larrivee & Catts, 1999). Although some factors have been identified as increasing a child's risk of literacy difficulties, such as atypical speech errors (Holm et al., 2008), persistent speech sound disorders (Raitano et al., 2004) and concomitant language impairment (Raitano et al., 2004), children who only have a mild speech sound disorder can still find literacy acquisition challenging (Anthony et al., 2011; Rvachew, 2007). What is equally puzzling is that children with a history of a severe speech sound disorder can have no literacy difficulties. Recent research has suggested that like children with dyslexia, the

phonological awareness abilities of children who have speech sound disorders may be an important key to better identifying children most at risk of future literacy difficulties (Anthony et al., 2011; Rvachew, 2007). The appropriate assessment and identification of children with phonological awareness difficulties is important to ensure that appropriate phonological awareness intervention is provided to children both before they start school (e.g., Gillon, 2005) and after they commence formal literacy instruction at school (e.g., Gillon, 2002). The assessment, identification, and description of phonological awareness abilities of preschool-age children who have speech sound disorders is the focus of this paper.

In this paper, we review literature regarding the assessment of phonological awareness in preschool-age children with speech sound disorders via a systematic overview. A systematic overview includes a systematic search, review and synthesis of available literature to describe the characteristics of available evidence (Grant & Booth, 2009). A systematic overview contrasts with a systematic review which aims to evaluate available evidence for a particular intervention strategy or diagnostic test accuracy (Higgins & Green 2011). The aims of our systematic overview were to: 1) explore the current state of the literature on the assessment of specific phonological awareness skills in preschool children with speech sound disorders and 2) examine the relationship between speech sound disorders and phonological awareness abilities in preschool-age children. Of particular interest were peer reviewed studies that included published or commercially-available assessment tools which could be used by speech-language pathologists and early childhood educators.

Method

Protocol

A systematic search of available evidence regarding the phonological awareness skills of children with speech sound disorders was conducted. Online database searches were completed using the search terms presented in Table 1 with no restrictions placed on the years of publication. The selected databases included literature for education, speech pathology, allied health, and medicine. The terms presented in Table 1 were selected to capture the range of articles available which explored the assessment of phonological awareness in paediatric populations. The focus of this review, however, was specifically on phonological awareness in the year/s prior to starting formal literacy education.

Insert Table 1

Eligibility criteria

Articles for inclusion in this review met a strict set of inclusion and exclusion criteria. For inclusion in this review, it was required that the articles:

1) reported the direct assessment of phonological awareness skills using a published or replicable assessment protocol. An assessment protocol was deemed replicable if it was published by an independent supplier or available as an appendix to a published article,

2) included participants who were of preschool-age children at the beginning of the data collection. The search terms did not include a parameter for age due to the large variability in labels for the year before school around the world (e.g., preschool, preparatory school or early childhood education). In Australia, New Zealand, the United States and the United Kingdom, children are required to commence formal schooling around five years of age. Thus, if the level of schooling was not reported in an article, the mean age of participants was required to be under 5 years of age,

3) included at least one group of children with speech sound disorders of unknown origin,

4) included monolingual children of any language. The searches were not limited to English titles.

Intervention studies, studies that did not specify the source of their phonological awareness tasks and, studies that included children older than a mean age of five were all excluded. Also, studies that included children who had diagnoses of speech sound disorders secondary to another condition (e.g., hearing loss, dysarthria due to cerebral palsy) were also excluded.

Study selection

The search of each database was completed and a list of the total number of articles was created (n= 777). At each stage of the process, the articles were reviewed for relevance and articles which met one or more of the exclusion criteria were rejected (figure 2). The reference lists of the final 10 papers were scanned for any missed articles which fit the inclusion criteria and one more paper was identified. A final paper was published after the review was completed. This article (Preston et al., 2013) met all the inclusion criteria and was also included in the review. The final 12 papers were reviewed in detail. *Insert Figure 2*

Reliability

Inter judge reliability was undertaken for the selection of articles to be included in the review. An SLP who was blinded to the purpose of the review and was not an author, reviewed titles and abstracts (where appropriate) of 152 (19.5%) articles against the exclusion criteria. There was a 99.3% match with the first author indicating a high level of reliability. In cases of mismatches, the first author's decision was upheld.

Study characteristics

Twelve papers were identified that met all the inclusion criteria. When reported individually, these 12 papers included 684 children (n = 435 with speech sound disorders).

However, these 12 papers reported the results of six unique studies. This means that the total number of individual children assessed in these studies was 439 children (n = 257 with speech sound disorders). Due to the high variability in methodology and statistical analysis between the articles, quantitative meta-analysis of the presented data was not completed. A synthesis of results is presented in Appendix A.

Data analysis process

Data were extracted from each article based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) protocol (von Elm et al., 2008). This protocol highlights 22 areas to assist with standard reporting of observational research. These areas include the theoretical rationale for the study, the methodology of the study (including study design), risk bias, results and statistical analysis, and interpretation, limitations and generalizability of the results. Features of each article were tabulated following the STROBE protocol and key features relating to the research aims of the current paper were extracted.

Evaluation of levels of evidence

The quality of each study was defined using The National Health and Medical Research Council of Australia's four levels of evidence for studies of diagnostic accuracy (Merlin et al., 2009). These levels assist with the critical evaluation of research to inform clinical practice. Each study that met all the inclusion criteria was evaluated following these levels of evidence and guidelines.

Results

Of the 12 papers, six reported results from the Phonological Awareness Test (Bird et al., 1995), two reported results from the Preschool and Primary Inventory of Phonological Awareness (Dodd et al., 2000), one reported results from the Preschool Comprehensive Test of

Phonological and Print Processing (Lonigan et al., 2002), one reported results from the Comprehensive Test of Phonological Processing (Wagner et al., 1999) and two reported on stimuli developed by MacLean, Bryant and Bradley (1987). Of these, 10 papers only provided the children's composite scores and did not provide details about individual phonological awareness skills (i.e., task types at specific levels and in specific modes).

Building an evidence-base

The National Health and Medical Research Council of Australia (NHMRC) identified three key parameters which can be used to evaluate the quality of an evidence base: the quantity of evidence, the level of evidence available, and the quality of the evidence available (Hillier et al., 2011). See Appendix A for comparative analysis of these results.

Quantity of evidence. Due to the small number of papers which met each of the inclusion criteria, study design was not controlled. As a result, cross-sectional (n = 5), case series (n = 2) and cohort (n = 5) studies were identified and included in analysis.

Level of evidence. Eight papers were classified as providing Level 3 evidence. That is, well-designed case-control studies. The remaining four papers demonstrated Level 4 evidence; namely, a case-series or cross-sectional study without a control reference. Study design also varied in terms of the presence, or absence, of a control group of children with typically-developing speech and language. Two studies reported additional comparative data (Anthony et al., 2011; Rvachew, 2007). Anthony et al. (2011) observed the phonological processing skills (including receptive and expressive measures of phonological awareness and measures of the distinctiveness and accessibility of phonological representations) of children with speech sound disorders and matched these participants with two additional groups: children matched on receptive and expressive language tasks and a control group of children with typically-

developing speech and language. Rvachew (2007) reported data on two sub-groups of children with speech sound disorders: children with low phonological processing and children with high phonological processing, and a group of typically developing children. Rvachew's (2007) phonological processing measure was a composite of a measure of speech perception and two receptive measures of phonological awareness (onset awareness and rime awareness).

Quality of evidence. The 12 papers reviewed explored a variety phonological awareness skills of preschool children with speech sound disorders (see Appendix A). However, none of the studies reported blinding of assessors or researchers involved in the data collection, analysis and interpretation of results. The participants in all of the studies were referred at some point, by a qualified speech-language pathologist or concerned parent, to the research team.

To synthesise the results, two primary features of this evidence base have been identified: 1) limited evidence exists related to specific phonological awareness skills in preschool-age children with speech sound disorders and 2) discussion about the features of children's expressive phonology which may correlate to phonological awareness ability remains ongoing.

The assessment of specific phonological awareness skills in preschool children with speech sound disorders

The first key finding during the analysis of this evidence was the limited reporting of specific phonological awareness skills for preschool children with speech sound disorders (see Appendix A). Specifically, there was limited discussion about relationships between specific phonological awareness skills, speech sound errors, and literacy outcomes. Nine of the 12 papers reviewed reported phonological awareness skills as a combined composite score (Anthony et al., 2011; Mortimer & Rvachew, 2008; Preston & Edwards, 2010; Preston et al., 2013; Rvachew, 2007; Rvachew et al., 2007; Rvachew et al., 2003; Sutherland & Gillon, 2005, Sutherland &

Gillon, 2007) and one study reported a smaller composite score for phonemic awareness and segmentation skills (Rvachew & Grawburg, 2006). Only one research group reported data related to specific phonological awareness skills (Webster & Plante, 1995; Webster et al., 1997).

Speech sound disorders and phonological awareness skills

In preschool children with a speech sound disorders, phonological awareness skills appear to be correlated with morphosyntactic ability (Mortimer & Rvachew, 2008) and other phonological processing skills (Anthony et al., 2011; Rvachew, 2007; Sutherland & Gillon, 2005, Sutherland & Gillon, 2007). Debate continues over whether speech sound error types predict competence on phonological awareness tasks. Rvachew et al. (2007) reported that types of speech sound errors were not significantly correlated to phonological awareness skills in preschool. In contrast, other researchers have indicated that atypical sound errors in preschool may correlate with phonological awareness ability in preschool (Preston & Edwards, 2010) and after literacy instruction (Foy & Mann, 2012; Preston et al., 2013). Further, there is evidence to suggest that there is no formal link between phonological awareness skills and severity of disorder (Rvachew et al., 2007). What does seem to be clear is that the phonological awareness abilities of children who have a speech sound disorder can vary; some have good awareness while others have poor (Rvachew, 2007). Rvachew (2007) found that preschoolers with poor phonological processing (including speech perception and phonological awareness) had difficulty with nonword decoding in the early school years. The children's performance on specific phonological awareness skills (different levels and task types) was not reported.

Discussion

Preschool-age children with speech sound disorders are at risk of literacy difficulties. Through a systematic overview of the evidence exploring the assessment of phonological

awareness abilities in preschool-age children with speech sound disorders, a number of findings emerged. Firstly, the evidence suggests that phonological awareness skills can be assessed in preschool-age children with speech sound disorders. Secondly, available evidence has demonstrated links between speech sound disorders and phonological awareness ability in preschool-age children. What remains to be identified are the specific phonological awareness difficulties that place preschool-age children at risk of future literacy difficulties. In the final section of this paper, we discuss the issue of the assessment of phonological awareness in preschool-age children, outline the limitations of our study and offer future directions for research.

The development of phonological awareness has been more widely studied in the early years of education with typically-developing populations. Based on research with early school-age children, it is clear that phonological awareness skills and more specifically, phonemic awareness skills are important for literacy development (Gersten et al., 2007). Age-appropriate phonological awareness skills for preschool children however include the identification, blending and elision of larger units of words (Anthony et al., 2003; Thatcher Kantor et al., 2011). These skills, however, are less directly correlated to later literacy development than phonemic-level skills (Muter & Snowling, 1998). Thus, we considered whether there were specific, age-appropriate phonological awareness skills which may be predictive of sensitivity to phonemic-level instruction and/or whether phonemic-level awareness could be reliably assessed with this age group.

The studies identified in this review reported primarily on composite scores of phonological awareness ability among participants. Due to the composite nature of reporting phonological awareness in preschool children with speech sound disorders, it is difficult to

determine which phonological awareness skills are most sensitive for identifying and differentiating those children at particular risk of literacy difficulties from those who will not have literacy difficulties. Three suggestions are offered for future research. First, research is needed to identify developmentally appropriate static assessments which are sufficiently sensitive to capture subtle variability in the developing phonological awareness skills of children with speech sound disorder. Second, given that phonemic awareness does not naturally develop, but can be taught to preschoolers (Ukrainetz al., 2011), dynamic assessment of phonemic awareness may prove valuable. A measure of phonemic awareness may help address the current quandary of trying to assess a skill triggered by formal orthographic instruction with preschool children not routinely exposed to such instruction. Thirdly, it would also be important to consider the role of phonological awareness in the context of other phonological processing abilities such as the perception and creation of phonological representations, phonological working memory and phonological access to lexical store .

Limitations

The focus of this overview was on reporting outcomes which could be replicated by speech-language pathologists and early childhood educators. For this reason, a number of studies were not included as they did not meet this criterion. The two inclusion criteria that excluded the most studies were participant age, and reporting of phonological awareness tasks. A lack of high quality, cohort studies which included a control group also limited the scope of this review.

Although the original search was not restricted by language type, all the eligible papers were based on English-speaking children. Thus, additional issues based on the development of orthographies without direct grapheme-phoneme correspondence have not been explicitly discussed, although the variation is acknowledged.

Source bias (Schlosser et al., 2007) was reduced through the systematic search of seven electronic databases (see Table 1). These databases covered literature for education, speech pathology, allied health, and medicine but not specifically for linguistics. Possible publication bias is also acknowledged as the systematic search for evidence only occurred through online databases. However, the reference lists for all eligible studies were also reviewed.

Clear limitations also exist regarding the studies reported in this overview. The data from six different studies was reported across the 12 papers. Sample size between the papers was also varied between the largest (n = 68; Anthony et al., 2011) and the smallest (n = 9; Sutherland & Gillon, 2005, Sutherland & Gillon, 2007) data sets.

Across the studies, there was a large variability in the phonological awareness skills reported in children with speech sound disorders (Appendix A). It may be argued some studies did not select tasks that were sensitive enough for a preschool population (e.g., Webster & Plante, 1995; Webster et al., 1997). The noted ceiling effect highlights the need for valid assessment tools for this population. The large variability in performance (e.g., Sutherland & Gillon, 2007) and limited analysis of variability (Rvachew, 2007) were also limitations within the presented evidence. The definition of speech sound disorders was also variable. The most common criteria for speech sound disorders was low percentage consonants correct (PCC). In addition, although most of the studies reported children with speech sound disorders as a homogeneous group, the variable phonological processing abilities of participants reported in some studies (e.g., Rvachew, 2007; Anthony et al., 2011) suggests an element of heterogeneity.

Conclusions

Phonological awareness is a difficult skill to assess in preschool-aged children with speech sound disorders. The importance of accurate assessment and subsequent intervention is

acknowledged throughout the presented literature. However, our systematic overview of the literature highlighted two issues which require further investigation. First, phonological awareness assessments are needed to allow clinicians and researchers to assess and report specific age-appropriate phonological awareness abilities in preschool-age children with speech sound disorders. Such assessments could be both static—assessing developmentally appropriate skills involving larger phonological units, and dynamic—assessing phonemic level abilities via instruction or support (Thatcher Kantor et al., 2011). . Secondly, assessment and analysis of the features of children's expressive phonology, including the presence of atypical speech errors and/or concomitant delayed morphosyntactic skills, may also be valuable.. Through the development of more sensitive diagnostic tools, clinicians and educators will be in a better position to accurately identify preschool children with speech sound disorders most at risk of future literacy difficulties.

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Appendix A. Reported results of the identified studies

Reference	Study design	Level of Evidence[a]	Participant ages	Number of participants	Test	Phonological awareness skills assessed and reported			
						Composite	Syllable level	Onset-rime level[b]	Phonemic level
Anthony et al. (2011)	Cross-sectional with control group	Level III-2	Mean age at baseline was 4;8 (range: 3;5-5;6)	204	Preschool Comprehensive Test of Phonological and Print Processing (Lonigan et al. 2002)	✓ only reported composite			✓ elision and blending
Mortimer and Rvachew (2008)	Case-series study	Level IV	Mean age at baseline was 4;8 (range: 53-66 months)	38	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ only reported composite		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching
Preston and Edwards (2010)	Cross-sectional	Level IV	All participants were between 4;0-5;9 at baseline	43	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ only reported composite		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching
Preston, Hull and Edwards (2013)	Cohort study	Level III-2	All participants were between 4;0-5;9 at baseline	25	Comprehensive Test of Phonological Processing (Wagner, R. K., Torgesen & Rashotte 1999)	✓ only reported composite			✓ elision and blending
Rvachew, Chiang and Evans (2007)	Case-series	Level IV	Mean age at baseline was 4;8	58	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ only reported composite		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching

Rvachew et al. (2003)	Cross-sectional study with control group	Level III-2	Mean age in both groups was 4;7 (range: 4;0-4;11)	26	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ reported composite phonemic scores		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching
Rvachew (2007)	Cohort study with control group	Level III-2	Between 53 to 67 months at time of initial assessment	68	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ only reported composite		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching
Rvachew and Grawburg (2006)	Cross-sectional study	Level IV	Mean age at baseline was 4;8 (range: 48-67 months)	95	Phonological Awareness Test (PAT; Bird et al., 1995).	✓ only reported composite		✓ rime matching ✓ onset matching	✓ onset segmentation ✓ onset matching
Sutherland and Gillon (2005)	Cross-sectional study with control group	Level III-2	Mean age at baseline was 4;5 (speech sound disorder group) and 4;7 (control)	26	Preschool and Primary Inventory of Phonological Awareness (Dodd et al. 2000)	✓ only reported composite	✓ syllable segmentation	✓rhyme awareness	✓alliteration awareness ✓phoneme isolation ✓phoneme segmentation
Sutherland and Gillon (2007)	Cohort study with control group	Level III-2	Mean age at baseline was 4;5 (speech sound disorder group) and 4;7 (control)	26	Preschool and Primary Inventory of Phonological Awareness (Dodd et al. 2000)	✓ only reported composite	✓ syllable segmentation	✓rhyme awareness	✓alliteration awareness ✓phoneme isolation ✓phoneme segmentation
Webster and Plante (1995)	Cohort study	Level III-2	Mean age at baseline was 3;6	45	modified from MacLean, Bryant and Bradley (1987)			✓ rhyme idntification	✓ alliteration identification
Webster, Plante and Couvillion (1997)	Cohort study	Level III-2	Mean age at baseline was 3;6	30	modified from MacLean, Bryant and Bradley (1987)			✓ rhyme idntification	✓ alliteration identification ✓ segmentation of nonwords

[a]Merlin, Weston and Tooher (2009), [b]the use of onset-rime/rhyme terminology is consistent with Holm, Farrier and Dodd (2008)

Table 1.

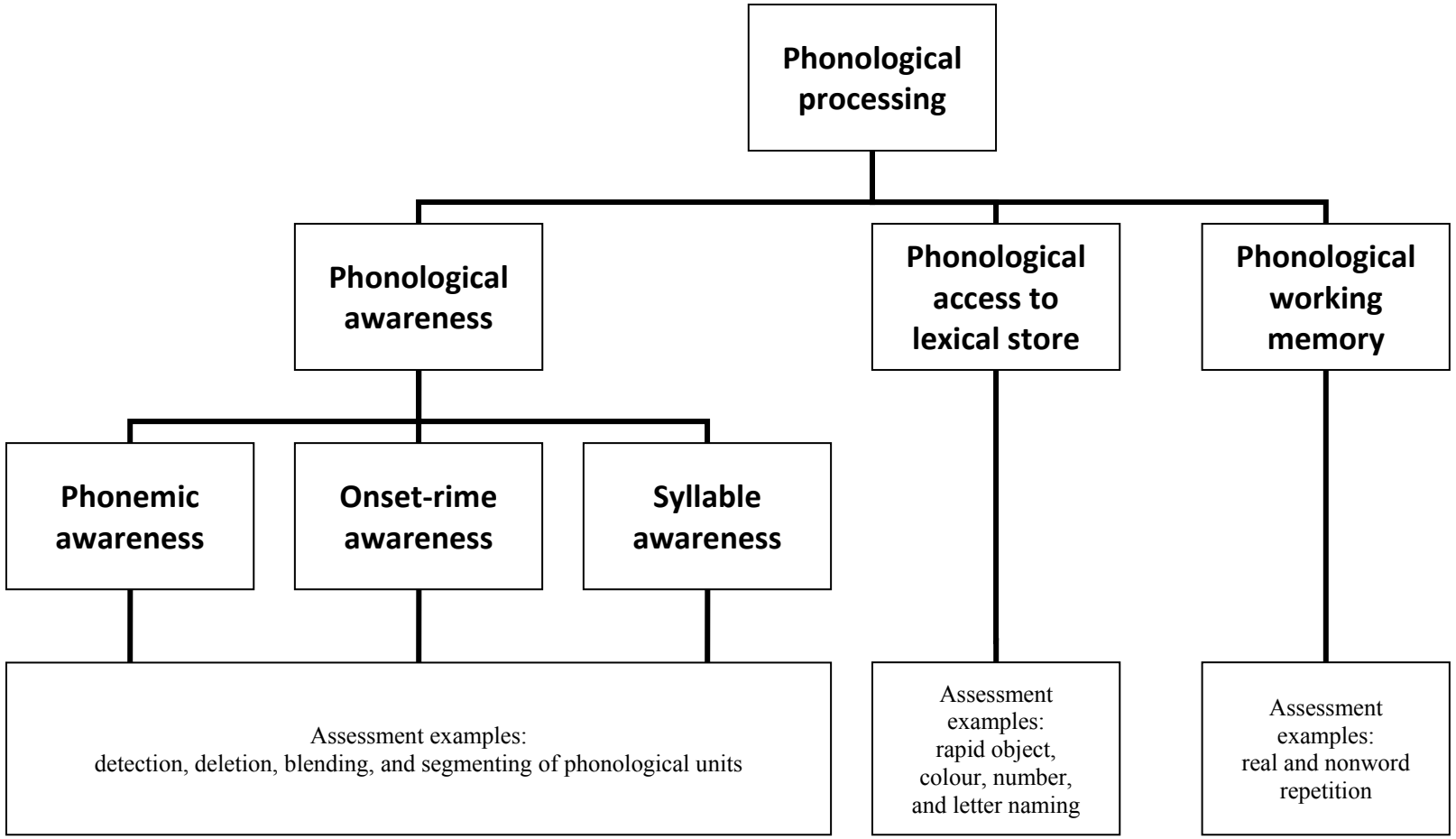
Databases searched, inclusionary terms and exclusionary terms for this review.

Databases searched	**Terms included**	**Terms excluded**
EbscoHOST	**Each of the following**	therap*
Education Resources	articulation OR	intervention*
Information Centre	phonolo* OR	treatment*
(ERIC)	speech*	narrative*
ProQuest	assess* OR	stutter*
Medline	test* OR	fluency*
ScienceDirect	evalu* OR	voice*
Cumulative Index to	measu* OR	
Nursing and Allied	screen*	
Health Literature	child* OR	
(CINAHL)	pediat* OR	
Web of Science	paediat*	
	phonological awareness	

Figure captions

Figure 1. Phonological processing abilities (based on Anthony, 2003; Bird & Bishop, 1995; Sutherland & Gillon, 2005; Wagner & Torgesen, 1987; Wagner et al., 2013).

Figure 2. Systematic database search and selection of articles which met all inclusion criteria.



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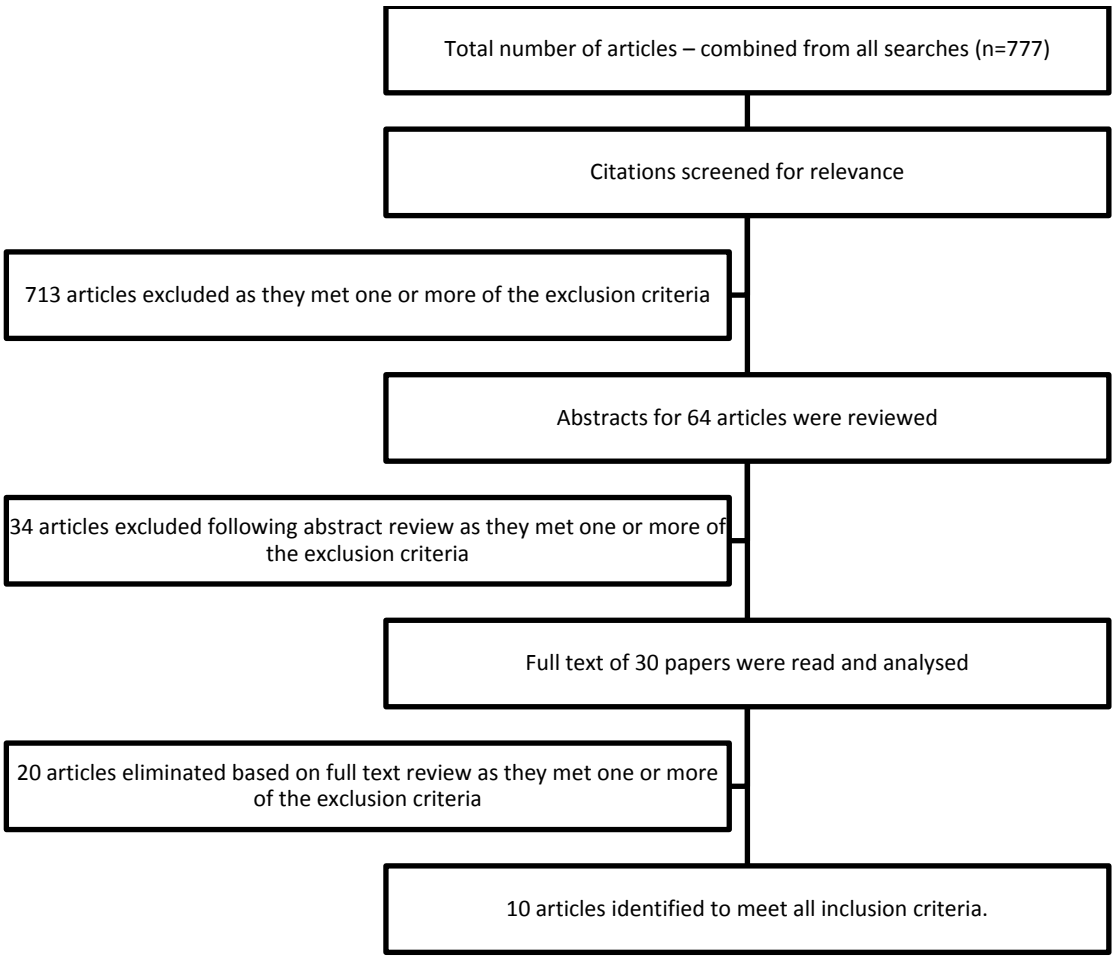

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