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Child Language Teaching and Therapy 2012 28: 211

DOI: 10.1177/0265659012436851

Article

CHILD LANGUAGE TEACHING & THERAPY

Child Language Teaching and Therapy
28(2) 211–223

DOI: 10.1177/0265659012436851
clt.sagepub.com
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Phonological representations in children with SLI

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Abstract

It has been hypothesized that children with specific language impairment (SLI) have difficulty processing sound-based information, including storing and accessing phonological representations in the lexicon. Tasks are emerging in the literature that provide a measure of the quality of stored phonological representations, without requiring a verbal response. This article describes the performance of children with specific language impairment (SLI) (*n* = 21), typically developing children matched for age (*n* = 21), and typically developing children matched for language (*n* = 21) on two measures of phonological representations – the Quality of Phonological Representations (QPR) and the Silent Deletion of Phonemes (SDOP) – and a measure of phonological awareness, the Sutherland Phonological Awareness Test: Revised (SPAT-R). As predicted the age-matched (AM) group demonstrated significantly better performance on all tasks than the SLI group. The AM group performed significantly better than the language-matched (LM) group on the SDOP and SPAT tasks, but not significantly differently on the QPR task. The SLI group performed significantly better than the LM group on both the SDOP and SPAT, but their performance on the QPR was significantly weaker than the LM group. The findings of this study provide support for the notion of lower quality phonological representations in children with SLI thus placing them at increased risk of ongoing language and literacy difficulties.

Keywords

assessment, phonological awareness, phonological representations, specific language impairment (SLI), speech processing

I Introduction

The challenge for speech and language therapists to become evidence based in their practice demands that we understand more about the nature of the underlying deficits with which our clients present. It is difficult, indeed potentially impossible, for us to provide cost-effective intervention until we understand more about the cause and specific nature of developmental speech and language impairments. This can be achieved if clinicians and researchers work together to study both

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the developmental trajectories of language skills and the underlying processing skills required to achieve language competence.

In the adult field clinicians have been using psycholinguistic models to profile clients' strengths and weaknesses and to derive theoretically driven goals for a number of years. Models such as the Psycholinguistic Assessment of Language Processing in Aphasia (PALPA) – which allows an analysis of the input and output processing of both spoken and written language – are useful in exploring the processing demands of language tasks at both the word and sentence level (Kay et al., 1996). One of the reasons that psycholinguistic approaches to assessment can be used successfully with the adult population is that the language system is assumed to have been intact and fully functioning prior to an incident.

There is evidence of emerging application of psycholinguistic frameworks to paediatric assessment/intervention with the work of Chiat (2000), and Stackhouse and Wells (1997). One difficulty in the paediatric population is that assumptions about the system cannot be made in the same way, because the language system is still developing and in most cases a weakness in language skills is developmental rather than the result of a neurological incident (Roy and Chiat, 2008). Thus in planning assessment and interpreting performance on assessment tasks, we need to consider both the processing demands of the individual task as well as the developmental level and experience of the child. In order to interpret assessment findings accurately it is important that we understand the development and processing demands of specific tasks. At this point such information is scarce and consequently clinicians and researchers must work together to 'construct task specific trajectories with hypothesized pathways' (Roy and Chiat, 2008: 5).

The first step in this process is to develop our understanding of such trajectories with typically developing children, in order to increase our understanding of typical language development. This in turn needs to be followed with studies of children with atypical language development such as specific language impairment (SLI), speech impairment and disorders on the autism spectrum.

1 Stackhouse and Wells' psycholinguistic framework

Stackhouse and Wells (1997) devised a theoretically driven and clinically applied psycholinguistic model of speech processing. In this model, the lexicon is described as consisting of phonological, semantic and syntactic representations, as well as a motor program (Stackhouse and Wells, 1997). As literacy is acquired an orthographic representation is also laid down. This model is unique in that it consists of three components: the speech processing profile (as seen in Figure 1), the model of speech processing and the developmental phase model (Stackhouse and Wells, 1997). The combination of these components facilitates theory driven assessment of the whole system, allowing both exploration of processing demands of specific tasks and developmental considerations.

The assessment framework allows clinicians to develop hypotheses about a client's speech processing skills in terms of speech input, lexical storage and speech output, and then design and/or draw on existing assessment tasks to test these hypotheses and plan theory-driven intervention. Assessment tasks are developed with consideration of the gradual development of the speech processing system and children's performance interpreted in terms of developmental phases of the unfolding system (Stackhouse and Wells, 1997).

2 Phonological representations

Phonological representations are the sound-based codes stored in the lexicon for each word (Anthony et al., 2010; Gillon, 2002). It is generally accepted that phonological representations are

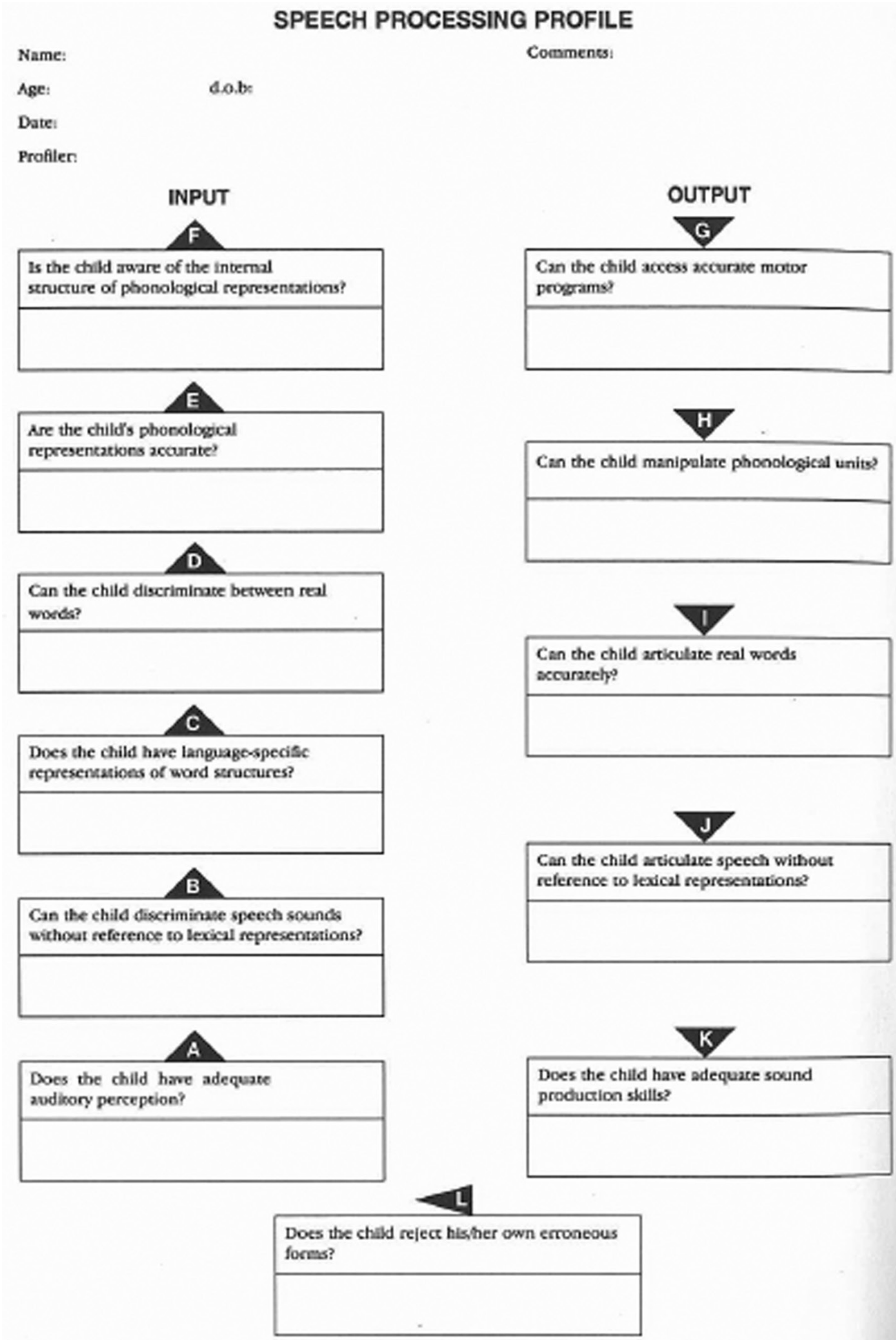

Figure 1 The speech processing profile: Children's speech and literacy difficulties: A psycholinguistic framework
Source: Stackhouse and Wells, 1997 (reproduced with permission from John Wiley and Sons)

initially a holistic articulatory gesture associated with the meaning of a word (Maillart et al., 2004; Snowling and Hulme, 1994). The lexical restructuring (Metsala and Walley, 1998) and segmentation (Fowler, 1991) hypotheses suggest that with the rapid increase in vocabulary during the preschool years, more finely grained phonological representations are developed and stored. As vocabulary continues to develop, so phonological representations become more specific, with lexical items segmented into increasingly smaller units. Precise, well-defined phonological representations are important for distinguishing between similar sounding lexical items, retrieving words and performing phonological awareness tasks (Fowler, 1991). It has been suggested that it may be more difficult to segment and manipulate low quality phonological representations (Elbro et al., 1998).

Phonological representations are of interest to both clinicians and researchers alike, as there is evidence to suggest that the establishment of precise and well-defined phonological representations is vital for achieving language competence and later for literacy acquisition (Bishop and Snowling, 2004).

3 Phonological representations in specific language impairment

It has been suggested that weaknesses in the establishment and maintenance of phonological representations is an underlying deficit in conditions such as specific language impairment, and dyslexia, as well as sub-groups of children with speech sound disorder (Pennington and Bishop, 2009). In fact the firmly established and long standing observation that children with SLI exhibit weakness carrying out nonword repetition tasks (Bishop and Snowling, 2004; Conti-Ramsden et al., 2001) and word learning tasks (Kan and Windsor, 2010) has led to speculation that difficulty forming and retrieving phonological representations may be an underlying deficit in SLI. The repetition of nonwords requires the formation, storage and retrieval of a new phonological representation, while learning new words requires the development of both phonological and semantic representations and the development of links between the two (Alt and Plante, 2006).

The relationship between, and co-existence of, SLI and dyslexia has been explored by a number of researchers with some proposing that children with dyslexia have more severe phonological difficulties than those with SLI (Catts et al., 2005). Other researchers have proposed that disorders such as these are a result of a range of risk and protective factors that may be shared (Pennington, 2006). However, in order to understand the role of phonological representations in SLI and related conditions it is vital that we develop a battery of discriminatory assessment tasks.

4 Assessment of phonological representations

A range of tasks such as nonword repetition, auditory lexical decision and gating tasks have been used to assess quality of phonological representations. For example, in Elbro et al. (1998) a child was required to correct a puppet's inaccurate productions of common words such as 'crocodile'. In 2007, Stackhouse et al. released a compendium of tasks to be used in conjunction with the speech processing model in order to facilitate interpretation of performance. This book provides examples of tasks mapped to the Speech Processing Profile for a range of developmental stages, and normative data where available. However to date there are only a limited number of tasks that measure the quality of a child's phonological representations (Level E on the framework 'Are the child's phonological representations accurate?'; Stackhouse and Wells, 1997). Tasks to assess Level F on the framework, 'Is the child aware of the internal structure of phonological representations?' (Stackhouse and Wells, 1997) are even more scarce. Assessment of these levels on the profile is vital as they provide insight into a child's own stored phonological representation rather than the child's ability to judge, store or manipulate a word that they have heard.

Many assessment tasks involve both the processing of speech input and the production of a motor output response as well as accessing stored phonological representations. Interpretation of a child's performance can be confounded because it is difficult to isolate the locus of the breakdown. In an attempt to address this, researchers have begun to develop tasks that require a child to make judgements about the accuracy of multisyllabic word productions, and to provide responses that do not require output/verbal responses: the Quality of Phonological Representations task (QPR), (Claessen et al., 2009) and the Phonological Representation Accuracy Judgment task (Sutherland and Gillon, 2005). Tasks such as this assess the quality or precision of stored phonological representations at the whole-word level. In order to investigate the internal structure of underlying stored phonological representations, Claessen et al. (2010) developed the Silent Deletion of Phonemes Task (SDOP). This task requires a child to reflect on and analyse the internal structure of their stored phonological representation.

5 The current study

One of the major limitations in both research and clinical practice with children with SLI has been the lack of valid and reliable receptive measures of phonological representations. Tasks have been emerging in the literature, with indications of validity and reliability and normative data for typically developing children, however there has been little research into the performance of children with SLI.

Thus the aim of this article is to explore the quality of phonological representations in children with SLI, as compared to age-matched and language matched peers, and add to the evidence base to support informed clinical decision-making. The article will compare performance on two previously reported silent measures of phonological representations, to performances on a traditional phonological awareness test. One measure of phonological representations, the QPR, investigates the quality of stored phonological representations at the whole word level. The second task, the SDOP, aims to measure a child's ability to reflect on, and manipulate the internal structure of stored phonological representations. Both of these tasks are receptive measures of phonological representations, and do not require a verbal response. The specific hypothesis for this study is that children with SLI will perform significantly worse on measures of phonological representations and phonological awareness than age-matched and language-matched peers.

II Method

1 Participants

Approval for all aspects of this research was granted from the Curtin University Human Research Ethics Committee and the Western Australia Department of Education and Training Research and Planning Unit. Procedures complied with confidentiality guidelines and both caregivers and participants provided informed consent to participate.

Sixty-three children were recruited for this study (36 males, 27 females). All participants passed a hearing screen at 25 dB across the range 500–8,000 Hz; demonstrated intelligible speech as judged by an experienced Speech and Language Therapist; and appropriate pragmatic skills as judged by their classroom teacher. English was the first language for all participants in this study.

Twenty-one children with SLI were recruited from a language development school in Perth, Western Australia. To be included in this group participants were required to have nonverbal cognitive skills within the average range as measured by the Block Design and Picture Concepts subtests of the Weschler Intelligence Scale for Children: Third revision (WISC-3) (Wechsler, 1991). Participants were also required to have a Core Language Standard Score of 85 or less on the Clinical Evaluation of Language Functioning: IV (CELF-IV) (Semel et al., 2003). The CELF-IV was selected as the reference measure for language skills as it has sensitivity and specificity of .83 and .90 respectively for the Core Language Score with the adopted cut-off of 1 standard deviation below the mean (Semel et al., 2006). Scoring of all formal measures (the CELF-IV, WISC-3; WPPSI-III,) followed the guidelines in the manual accompanying each test.

Twenty-one age-matched (AM) participants and 21 language-matched (LM) participants were recruited from a metropolitan primary school in Perth, with a similar socioeconomic profile to the Language Development Centre. All participants for these groups were required to have nonverbal cognitive skills within the average range as measured by the Block Design and Picture Concepts subtests of the WISC-3 (Wechsler, 1991) for the AM group, and the Block Design and Matrix Reasoning Subtests of the Wechsler Preschool and Primary Scale of Intelligence: Third edition (WPPSI-III) (Wechsler, 2004) for the younger LM group. Participants were also required to have a Core Language Standard Score of more than 85 on the CELF-IV (Semel et al., 2003).

Each SLI participant was matched to an AM participant by age in months and gender. The average difference in age between the SLI and AM participants was 13 months. Each SLI participant was matched to a LM participant by gender and receptive language skills as measured by raw score on the Concepts and Following Directions Subtest on the CELF-IV. The average difference in raw scores between the SLI and LM participants was .65. Participants were matched by gender to ensure the groups were as similar as possible. Participants' performance on selection measures are summarized in Table 1.

2 *Measures*

Each participant was assessed on two measures of phonological representations: the Quality of Phonological Representations Task (QPR) (Claessen et al., 2009) and the Silent Deletion of Phonemes Task (SDOP) (Claessen et al., 2010). These tasks were scored following the published guidelines. In addition each participant was assessed on a measure of phonological awareness, the Sutherland Phonological Awareness Test: Revised (SPAT-R) (Neilson, 2003a), which was scored according to the manual guidelines.

Table 1 Performance on participant selection tasks

Variable	SLI			AM			LM		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age (months)	91.05	3.60	82–96	90.90	4.19	82–98	65.86	3.47	59–71
Cognitive skills[a]	9.81	1.65	8–13	10.43	1.62	8–13	9.86	1.63	8–13
Language skills[b]	69.90	11.34	45–85	101.19	6.95	90–115	101.43	9.32	85–117
Language matching score[c]	26.62	9.135	11–42	40.38	6.289	23–50	26.86	7.735	15–42

Notes: [a]Cognitive skill is the mean of the subtest standard scores from the WISC-3, and WPPSI-III. [b]The Language skills score is the Core Language Score obtained from the CELF-IV. [c]The raw score on the Concepts and Following Directions subtest on the CELF-IV *a Quality of phonological representations task (QPR)*: The QPR task is an auditory lexical discrimination task where children are required to judge the accuracy of a production of multi-syllabic word. In this task children are presented with four correct and six incorrect productions of each of the 10 stimulus items (for a list of stimulus items, see Appendix 1). Incorrect productions were generated by varying either one consonant or one vowel in the stimulus item (for details, see Claessen et al., 2009). For the QPR the measure of Correct Rejections was adopted, based on the number of inaccurate productions that were judged to be inaccurate. This measure had been found to be more closely linked to measures of phonological awareness and literacy than to the total number of items completed correctly (Claessen et al., 2009). There is moderate internal consistency of .84 for the task with children of a similar age to the SLI sample in this research; however, as the QPR task is unique, concurrent validity has not yet been established (Claessen et al., 2009).

b Silent Deletion of Phonemes (SDOP) task: The SDOP requires children to look at a picture and perform a deletion task without either hearing the word said aloud or saying it aloud themselves. The child is provided with a verbal instruction and then asked to select the correct item from an array of four pictures presented on a computer screen (Claessen et al., 2010). For this task, each participant achieved a raw score, based on the number of items that were completed correctly. The SDOP was selected as there is a relative paucity of tasks available that assess ability to reflect on stored representations. There is moderate internal consistency of .845 for the 35 test items (Claessen et al., 2010) and a correlation of .63 with the SPAT-R (Neilson, 2003a). This correlation was deemed to be sufficient to demonstrate concurrent validity, particularly given the different methods of data presentation and nature of the response required (Claessen et al., 2010).

c Sutherland Phonological Awareness Test: Revised (SPAT-R): The SPAT-R (Neilson, 2003a) was selected as the measure of phonological awareness as it has reliable psychometric properties, and as it was developed in Australia test items and normative data were suitable for the participants in this study. The subtests of the SPAT-R require judgement, production, segmentation, blending and deletion of syllables, onsets, rimes and phonemes. There is strong internal consistency of .95 for the items in the SPAT-R (Neilson, 2003a) and a strong correlation of .86, with an alternate measure of phonological awareness, The Astronaut Invented Spelling Test (Neilson, 2003b).

3 Procedure

Each participant was assessed in a quiet, familiar environment within their school setting. All tasks were administered by the first author, a speech and language therapist experienced in working with school-age children. Tasks were administered over two sessions at least one week apart. In the first session the participant selection tasks were administered, and all items from the SDOP were named to ensure children were familiar with each item. In the second session, the SDOP task was completed and the QPR and SPAT-R administered. A Hewlett Packard laptop computer was used to administer the SDOP and QPR tasks. Headphones were used for these tasks to minimize the impact of background noise, and results were digitally recorded on the computer.

III Results

The means, standard deviations and percentile ranks for the QPR, SDOP and SPAT-R are shown in Table 2. Percentile ranks for the SDOP were obtained from the data provided in Claessen et al. (2010); for the QPR from the data provided in Claessen et al. (2009); and for the SPAT-R from the examiner's manual (Neilson, 2003a).

Table 2 Means, standard deviations and percentile ranks for measures of phonological representation

Measure	SLI			AM			LM		
	Mean	SD	Percentile	Mean	SD	Percentile	Mean	SD	Percentile
SDOP	17.77	5.97	16	23.81	6.05	50	12.29	4.28	n/a[a]
QPR	38.24	5.66	7	47.52	4.80	36	44.10	7.01	54
SPAT-R	40.00	9.67	28	46.76	5.81	54	17.86	7.64	20

Note: [a]No normative data is available for this age group on the SDOP task.

A multivariate analysis of variance (MANOVA) was used to examine the differences between groups on the measures of phonological representation and phonological awareness. Prior to carrying out the MANOVA, the data were examined to ensure all assumptions were met. As all assumptions were supported by the data, the MANOVA was conducted. Results indicated there was a significant difference between the groups on the combined dependent variables, $F(6,118) = 23.532$, $p = < .001$, partial $\eta^2 = .543$.

Analysis of individual dependent variables, showed that the QPR variable was significantly different across groups, $F(2, 60) = 13.337$, $p < .001$, partial $\eta^2 = .308$. Post-hoc analysis using Tukey's HSD (alpha = 0.05) revealed that the AM group ($M = 47.52$, $SD = 4.80$) performed significantly better than the SLI group ($M = 38.24$, $SD = 5.66$), and the LM group ($M = 44.10$, $SD = 7.01$) performed significantly better than the SLI group. The difference between the AM and LM groups was not significant. Effect size for these relationships were $d = 1.319$, .832, and .487 respectively, indicating moderate to large effect sizes.

The SDOP was significantly different across groups, $F(2, 60) = 23.088$, $p < .001$, partial $\eta^2 = .435$. Post-hoc analysis using Tukey's HSD (alpha = 0.05) revealed that the SLI group ($M = 17.76$, $SD = 5.97$) scored significantly lower than the AM group ($M = 23.81$, $SD = 6.05$) and significantly higher than the language-matched group ($M = 12.29$, $SD = 4.28$). The difference between the AM and LM groups was also significant. Effect sizes of $d = .920$, .8334, and 1.754 respectively, indicated large effect sizes for these relationships.

The SPAT variable was also significant across groups, $F(2, 60) = 77.50$, $p < .001$, partial $\eta^2 = .721$. Post-hoc analysis using Tukey's HSD (alpha = 0.05) revealed that the SLI group ($M = 40$, $SD = 9.67$) scored significantly lower than the AM group ($M = 46.76$, $SD = 5.81$) and significantly higher than the language-matched group ($M = 17.86$, $SD = 7.64$). The difference between the AM and LM groups was also significant. Effect sizes were $d = .72$, 2.35, and 3.07 respectively, indicating large effect sizes for these relationships.

IV Discussion

This study aimed to explore the quality of phonological representations in children with SLI compared to age matched and language matched peers, and to add to the evidence base to support informed clinical decision-making. It was predicted that the children with SLI would perform significantly more poorly than the comparison groups on each of the measures

1 *Summary of performance*

As predicted, the AM group demonstrated significantly better performance on all tasks than the SLI group. The AM group also performed significantly better than the younger LM group on the

SDOP and SPAT tasks but not significantly differently on the QPR task. In contrast, the SLI group performed significantly better than the LM group on both the SDOP and SPAT tasks but significantly weaker than the LM group on the QPR task. This pattern was not predicted, and therefore differences between participant groups and the nature of the individual tasks must be considered.

2 Differences in groups

The SLI and AM groups consisted of children with an average age of 7;6 (7 years, 6 months) who were in their third year of formal schooling, while the LM group had an average age of 5;6 and were in their first year of formal schooling. This is important as not only were the LM participants two years younger than the other participants, but they had not received the same level of formal literacy instruction as the other groups. Given the strong evidence that phonological awareness (PA) skills and reading skills are highly correlated, early literacy instruction generally includes a significant PA component (Gillon, 2004), which must be considered in the interpretation of results. Thus we would expect the LM group, who are at an earlier developmental stage, to have weaker performance on tasks that draw on underlying PA skills and knowledge, as well as working memory, such as the SPAT-R and also the SDOP.

As expected the AM group performed significantly better than the LM group on each task, suggesting that their phonological processing skills are well established in the metaphonological phase of the speech processing model (Stackhouse and Wells, 1997), while the skills of the younger LM participants are still emerging in this phase. The performance of the SLI participants falls between that of the other two groups on the SDOP and SPAT-R; however, their performance on the QPR is worse than predicted and, thus, in addition to a developmental perspective, the processing routes for the individual tasks need to be considered.

3 Differences in demands of the tasks

According to the Stackhouse and Wells (1997) framework, each of the three experimental measures requires the use of different processing routes.

The QPR task aims to explore the quality of stored phonological representations and addresses the Level E question on the Stackhouse and Wells speech-processing profile (1997) ‘Are the child’s phonological representations accurate?’ This task requires input processing and judgement at the whole-word level, with the child required to compare the phonological forms provided to them by the speaker with the phonological representation that is activated from their own underlying semantic representation for the lexical item. On this task the SLI participants evidenced the weakest performance, with the difference between the SLI and both AM and LM groups being significant. These results suggest that the SLI children have more imprecise or ‘fuzzy’ phonological representations than either age-matched or language-matched peers and thus are more likely to accept ‘near misses’ as correct productions than either of the groups with typically developing language skills. This result is consistent with the recent findings of Marshall et al. (2010) who adopted a similar approach and found that children with SLI were more likely to accept words that were produced with phonological errors than either typically developing or dyslexic peers.

The SDOP corresponds to Level F on the Speech Processing Profile – ‘Is the child aware of the internal structure of phonological representations?’ (Stackhouse and Wells, 1997) – again requiring input, but not output processing. It can be considered an input PA task, where the child is required to analyse the internal structure of the word stored in their lexical representation. Items in the SDOP are presented randomly, and then scored. A score higher than 15 indicates the ability to delete a phoneme from a consonant cluster (e.g. delete the /r/ sound from /bred/). On the SDOP, the AM group achieved a mean score of 23.81, demonstrating they are able to perform deletion at this complex level; the SLI group achieved a mean of 17.77 suggesting this ability is emerging; while the LM group achieved a mean of 12.29 suggesting they are able to delete at a single phoneme level, but are not yet able to delete phonemes from consonant clusters. On this input phonological awareness task, the AM group performed significantly better than the SLI children who in turn performed significantly better than the LM children, and thus a developmental pattern was observed.

The SPAT-R is a traditional measure of PA and thus addresses the Level H question: ‘Can the child manipulate phonological units?’ (Stackhouse and Wells, 1997). This task involves both input and output processing as the target items are presented verbally and the child is generally required to perform a metalinguistic analysis on an input phonological representation provided by the tester, create a motor program for output and formulate a verbal response. On this task, the AM children performed at the highest level, followed by the SLI group then the LM group, with the differences between each group significant. The LM group had significantly weaker PA skills than either the AM or SLI group. This finding is not surprising given the difference in both age and formal schooling between the LM group and the other groups. The SLI children did significantly better on the PA task than the LM children, and not as well as the AM children, which suggests both the developmental nature of PA and their emerging skill development in the metaphonological phase.

The difference in patterns of performance between the Level E task and the Level F and Level H tasks was unexpected. This finding suggests that perhaps children with SLI have difficulty laying down accurate phonological representations, but also that the quality of their semantic representations and the links between these representations in the lexicon may not be as well developed and this may influence their ability to judge the accuracy of spoken words. This observation is consistent with the proposal that the difficulty that children with SLI have in learning new words is due to ‘difficulty creating and storing phonological representations of new words and establishing a strong link between those representation’ (Gray and Brinkley, 2011: 870).

A further consideration is the role of working memory (WM) required in the QPR task, which involves holding the heard word in working memory while comparing it to the semantic and phonological representation of the word accessed by recognition of the picture. The WM difficulties of children with SLI have been established (Montgomery et al., 2010), and future studies should explore the potential influence on working memory on performance on the QPR and similar tasks.

4 Evaluation of the hypothesis

The hypothesis that children with SLI will have weaker phonological representations and phonological awareness than age-matched and language-matched peers received limited support. The SLI participants demonstrated significantly lower quality phonological representations than either the AM or LM participants. In contrast their PA skills, on the SPAT, fell between those of the age-matched group and the language-matched group. In addition, on the SDOP task, which draws on both underlying representations and PA, the SLI participants demonstrated skills that, while not as strong as the AM group, were significantly better than the LM group.

This finding supports suggestions that with a focus on PA skills in the early school years, children’s PA skills can improve and underpin development through the metaphonological phase, allowing children to take advantage of phonological awareness and literacy instruction (Stackhouse and Wells, 1997). However, it also suggests that for children with SLI, improvement in PA as occurs in traditional PA programs – based on a metalinguistic, predominantly output-based approach to therapy using task items presented to the child by a therapist – does not in turn necessarily lead to higher quality, more accurate stored phonological representations.

5 Importance of high quality phonological representations

Many researchers (Alt and Plante, 2006; Chiat, 2001; Gray, 2005) suggest that development in the areas of vocabulary and syntax relies heavily on phonological information being perceived and represented accurately in order to establish the strong links between semantic and phonological representations of words required to learn new words. The work of Stackhouse and Wells (1997) has emphasized the role of a strong and well-developed underlying speech processing system in processing phonological information and establishing the foundations for speech, language and ultimately literacy. Poor quality representations may also impact on a child's ability to use phonological information in reading and spelling (Sutherland and Gillon, 2005), and there is evidence to support the notion of less mature phonological representations in children with dyslexia (Boada and Pennington, 2006). Claessen et al. (2010) found significant correlations between performance on the SDOP and performance measures of spelling and reading in typically developing children, again providing support for the importance of high quality phonological representations for literacy.

The findings of this present study also provide support for the notion of lower quality phonological representations in children with SLI, thus placing them at increased risk of ongoing language and literacy difficulties.

6 Clinical implications

In recent times much emphasis has been placed on teaching children the metacognitive skills required to complete PA tasks, with the aim that this would in turn lead to better specified phonological representations and therefore improved literacy skills (Gillon, 2004). There is evidence that PA therapy is effective but results of studies designed to measure the effect of PA instruction on literacy acquisition have been inconsistent (Hesketh, 2010). Results of this study suggest that the focus on PA skills in the early school years does support the development of PA; however, in children with SLI their underlying phonological representations may remain significantly weaker than those of typically developing children.

In clinical practice, we must consider how to improve the quality and accuracy of phonological representations in children with SLI. Rees (2001) recommends that therapy should target and strengthen links in the lexicon. Hesketh (2010) cites one example of a study designed to target phonological representations directly. In this study by Rvachew et al. (2004) one group of children received intervention based on mispronunciation detection tasks in addition to standard speech and language therapy. This led to an improvement in detection of mispronunciations; however, there was no improvement in PA. While this avenue of research looks promising, further research is necessary to develop, and evaluate theory driven therapy that has been designed to develop PA skills while also aiming to improve underlying phonological representations and strengthen the links in the lexicon.

Acknowledgements

The authors acknowledge the contribution of the schools and children who took part in this study; thanks also to Cori Williams, John Hogben and Nick Barrett, who provided valuable support and assistance in the early stages of this project.

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Appendix 1 Items from the quality of phonological representations task

Item	Phonological representation
Training A: Boomerang	/buməræŋ/
Training B: Ambulance	/æmbjuləns/
1. Helicopter	/helikɒptʌ/
2. Telescope	/teləskoʊp/
3. Dominoes	/dɒmɪnoʊz/
4. Crocodile	/krɒkʌdaɪl/
5. Television	/telʌvɪʒən/
6. Hippopotamus	/hɪpʌpɒtəməs/
7. Binoculars	/baɪnɒkjuləz/
8. Microphone	/maɪkrəfoʊn/
9. Rhinoceros	/raɪnɒsərəs/
10. Spaghetti	/spəgeti/