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Training phonological awareness skills in children with Down syndrome

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Abstract

Increasingly, children with Down syndrome receive literacy instruction based on a phonological awareness philosophy with the expectation of acquiring functional reading skills. Previous research demonstrates that a phonological awareness based reading programme delivers excellent results in terms of literacy acquisition and improvements in speech production for children with speech and language delays. Unfortunately, little research exists to support the effectiveness of this approach for children with Down syndrome. The current research study examined using a phonological awareness based intervention programme with three children with Down syndrome (aged 7;2, 8;4, and 8;10). A multiple baseline across behaviours design was selected. The intervention programme focused on the key skills of alliteration detection, phoneme isolation, spelling of orthographically regular words and rhyme detection. Two tasks (comprehension of passive structures and spatial structures) were selected as control behaviours. Phoneme segmentation and speech intelligibility were selected to investigate generalisation of intervention targets to other related skill areas. The results indicated that the participants improved the phonological awareness skills targeted in the intervention programme. Unfortunately, no generalisation to other areas of phonological awareness was noted. In summary, the results indicate that children with Down syndrome can benefit from a phonological awareness based approach to literacy.

Keywords: Down syndrome; Phonological awareness; Literacy; Reading; Speech

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1. Introduction

Despite, the speech–language, hearing, vision and cognitive deficits associated with Down syndrome, learning to read is an important and achievable goal for children with Down syndrome (Buckley, Bird, & Byrne, 1996; Cupples & Iacono, 2000; Fletcher & Buckley, 2002; Fowler, Doherty, & Boynton, 1995; Oelwein, 1995). Mounting evidence suggests that children with Down syndrome display unique developmental characteristics in the areas of speech, language, memory, and auditory processing relative to other children with cognitive impairment (Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998; Marcell & Cohen, 1992; Miller, Leddy, & Leavitt, 1999). Therefore, it is necessary to determine the most effective interventions for literacy.

Children with speech and/or language impairment are at risk for literacy difficulties due to the effects of a disordered phonological processing system. Both assessment and intervention studies investigating phonological awareness in children with speech–language impairment have found they are at risk for literacy failure due, in part, to reduced phonological awareness skills (morpho-syntactic awareness and semantic knowledge also impact on the ability to decode and comprehend text) (Bird, Bishop, & Freeman, 1995; Leitao, Hogben, & Fletcher, 1997; Major & Bernhardt, 1998; van Kleek, Gillam, & McFadden, 1998; Warrick, Rubin, & Rowe-Walsh, 1993; Webster & Plante, 1992, 1995). These speech and language disorders place children with Down syndrome at risk for literacy acquisition difficulties (Bird et al., 1995; Gilbertson & Bramlett, 1998; Gillon, 2000; Harbers, Paden, & Halle, 1999; Leitao et al., 1997; Warrick et al., 1993; Webster & Plante, 1992).

Unfortunately, no published studies have evaluated phonological awareness intervention in children with Down syndrome. Other authors have examined children with specific language impairment. Gillon (2000) demonstrated significant gains in phonological awareness, literacy and intelligibility measures, for children with speech impairment following intensive phonological awareness training (PAT). Specifically, the children made significantly greater gains in phonemic awareness and literacy measures than the children in the minimal intervention and traditional intervention control groups. Not only were the gains observed in measures of literacy but improvements in speech production were also observed. This finding suggests that intervention targeting underlying phonological processing was more effective than traditional speech language therapy in remediating phonological impairment. Gillon (2000) demonstrated that it is possible to achieve improvement in the speech production, phonological awareness, and literacy skills of children with speech impairment through the use of phonological awareness intervention. Similar positive results were also obtained by Major and Bernhardt (1998). Their study of 19 pre-school children with expressive phonological disorders demonstrated that therapy for severe phonological speech impairment was most significant when combined with phonological awareness training.

Given the evidence supporting the use of phonological awareness intervention for children with speech impairment, it is possible that these benefits may be obtained in children with Down syndrome. Unfortunately, no study has evaluated the effectiveness of phonological awareness intervention in children with Down syndrome. The present study addresses this question through an intervention programme using a subset of the Gillon (2000) Phonological Awareness Training (PAT) programme. It was expected that the effects of the phonological awareness intervention would lead to improved grapheme–phoneme connections in the participants, and improved speech production.

2. Method

2.1. Participants

Three children with Down syndrome participated in this intervention study (Table 1). These children were selected from a previous study (Kennedy & Flynn, submitted for publication) based having the appropriate speech and language skills for the intervention programme. The metalinguistic and phonological awareness concepts targeted for intervention in the programme can be difficult for some children to grasp and the participants in the intervention programme required a higher level of receptive language and cognitive ability to receive maximum benefit from the short intensive programme. Table 1 lists the assessment profiles of the three children who participated.

Table 1
Profile of participants selected for the intervention phase

Participant	1	2	3
Number of months at school	37	30	17
Age (months)	106	100	83
Pure-tone average—best ear (500, 1000, 2000 Hz)	16.25 dBHL	17.5 dBHL	16.5 dBHL
Burt Word Reading Test	27	29	14
CELF-P standard score	3	3	4
PCC	80	43	72
MLU	2.29	2.74	3.61
Rhyme (%)	70[a]	50	30
Letter-name (%)	100[a]	100[a]	100[a]
Letter-sound (%)	92[a]	100[a]	92[a]
Alliteration (%)	66[a]	83[a]	66[a]
Phoneme blending (%)	42	75[a]	92[a]
Phoneme isolation (%)	0	8	58
Non-word reading (%)	0	20	0
Real word reading recognition (%)	100[a]	85[a]	90[a]

PCC: percent of consonants correct; MLU: mean length of utterance measured in morphemes; Burt Word Reading Test: number of words read correctly (Gilmore, Croft, & Reid, 1981); CELF-P (Wiig, Secord, & Semel, 1992): standard score from three receptive language subtests.

[a] Score above chance levels for choice of three and choice of six tasks (Chaney, 1994).

2.2. Procedure

A multiple baseline across behaviours research design was used. This design allowed the selection of similar yet independent behaviours to be targeted in each individual, so that the intervention was likely to produce effects on the target behaviours. The multiple baseline design permitted generalisation of learning across the targeted behaviours, as was expected with the phonological awareness skills. While targeted behaviours improve, skill levels in control behaviours should remain stable, allowing the conclusion that the intervention produced the effects on the targeted variables.

The intervention programme was preceded by 1-week (three sessions) of baseline assessments and followed with 1-week (three sessions) post-testing. The participants attended twice weekly therapy sessions with the investigators, of 40–60 min duration. To ensure maximum audibility, all sessions were conducted in a clinic room fitted with the Phonic Ear Easy Listener sound field amplification system.

The children participated in eight 1-hr sessions over a 4-week period. The goals of the intervention were to improve (1) alliteration detection, (2) initial-phoneme isolation (synthesis), (3) spelling so that orthographically regular CVC and CVCC words could be represented correctly with letters, and (4) recognition of rhyme across single words. Comprehension of passive structures and spatial terms were used as a control. Additionally, a phoneme segmentation task was used to assess the degree of generalisation of phonological awareness skills.

Baseline assessments: The baseline assessments used were:

1. *Alliteration detection*: Participants were asked to select, from a choice of three, the picture which began with the same phoneme as a pictured character.
2. *Phoneme isolation*: The participants were required to say the initial phoneme of a pictured word named by the investigator.
3. *Spelling of orthographically regular words*: This task consisted solely of control words not used in the intervention activities, but which contained the rime sets targeted in the intervention. Participants were presented with a tray of 18 letter tiles (a, e, i, o, u, c, d, f, g, k, l, m, m, n, p, s, t, w) and were asked to spell the words: *wed, kit, pan, got, pug, lap, mend, dusk, fig, sump*. The two practice items were the words: ''mum'' and ''cat,'' during which corrective feedback was provided.
4. *Rhyme detection*: Rhyme knowledge was assessed using an ''odd-one-out'' task. The participants were asked to match the two pictures that made a rhyming pair and give them to their parent, then give the odd picture to the investigator.
5. *Comprehension of passive structures* (Miller & Paul, 1995, pp. 146–149): Ten passive sentences were selected from those listed in Miller and Paul (1995), six of which were non-sensical (or ''silly'') and four of which were semantically correct (''OK''). The participant was required to judge whether sentences containing passive constructions were either ''silly'' or ''OK,'' by

pointing to a picture of either the "silly lady" or the "OK lady." There were six demonstration items, four practice items, during which corrective feedback was provided, and 10 test items.

6. *Comprehension of spatial terms* (Miller & Paul, 1995, pp. 152–155): This task required the participant to draw a dot or line with a felt tipped pen in relation to two stickers on a piece of A4 paper, as directed by the investigator. The 10 prepositions used in this assessment were: *above, to the right of, beneath, beside, around, below, to the left of, between, over, and under.*
7. *Phoneme segmentation* (Burt, Holm, & Dodd, 1999): The task assessed the ability to segment a given word into its constituent phonemes. Three training items and 12 test items were represented with coloured picture cards and the participants were required to sound out and "count" the phonemes on their fingers. One repetition of the pictured word was permitted and all spoken responses were transcribed.

2.3. Phonological awareness intervention

2.3.1. Alliteration detection

These activities focussed on initial-phoneme segmentation, at the onset/rime level, and required spoken or picture selection responses. The phoneme identity materials were based on the Gillon PAT (2000) and supplemented by the investigator. The participants were required to select, from a choice of six, a coloured picture that began with the sound provided by the investigator, and place a counter on it.

2.3.2. Phoneme isolation

The phoneme identity materials were based on the Gillon PAT (2000) and supplemented by the investigator. The intervention focused on, the initial phoneme of pictured (not written) words, spoken by the investigators.

2.3.3. Orthographically regular spelling

Participants were given a sheet with three words typed in boxes, two of which rhymed (e.g., *tap, map, rug*). They were required to select the word which did not rhyme and cross it out. The investigator then said a third rhyming word (e.g., *lap*) which the participants wrote in the box provided on the worksheet. The rhyming words contained the 10 target rimes used in this intervention programme (-ot, -ap, -an, -ig, -end, -ump, -usk, -ed, -it, -ug). In a second activity, four rimes (-ug, -ap, -ot, -ig) were written on cards. A line was drawn at the beginning of the rime to indicate a space to place a letter tile as an onset. The investigator said a real word or pseudo-word that contained the target rime, and the participant was required to find the letter that represented the onset. The onset letters were placed on top of each other as the activity progressed, and the investigators emphasised the rhyming nature of the words. After five or six words were spelled in this way then the pile of onset letters were removed one at a time, and the participant was asked to read each word or pseudo-word as it was exposed.

2.3.4. Rhyme detection

Rhyme skills were initially targeted visually by drawing the participant's attention to the similarities in the written forms of rhyming pairs, through games of snap, and memory. The participant's attention was drawn to the identical letters at the end of the written word as well as the phonological similarity. Pictures of rhyming words from reproducible resources (Gorrie & Parkinson, 1995; Oelwein, 1995) were photocopied onto coloured card, to supplement the rhyme resources in the Gillon PAT (Gillon, 2000). After four intervention sessions rhyme playing cards without written words were introduced, as were a different set of cards and games to play with the written words beneath the pictures. Rhyme judgement was further reinforced through a choice-of-two task (Gorrie & Parkinson, 1995). Two coloured pictures were printed onto an A4 sheet, and the participant selected the picture that rhymed with the word produced by the investigator. The pictures used on the boards represented wide phonological contrasts (sheep/bed, clown/bee, jug/man, and star/cake).

2.3.5. Manipulation of phonemes in isolation

This activity was based on the phoneme discrimination task from the Gillon (2000). Participants were presented with one of the playing boards from the phoneme segmentation task. The investigator produced two or three isolated phonemes, which the participant was required to represent with coloured blocks. If the two phonemes presented were the same (e.g., /p/, /p/) then two blocks of the same colour were placed on the board, if the sounds were different (e.g., /m/, /g/) then different coloured blocks were used.

2.4. Reliability

In order to validate the scoring procedure of the baseline tasks inter-rater reliability was calculated for 33% of the pre- and post-intervention probe results. An independent rater was trained in scoring procedures by the investigator and calculated number and percent correct for each task. Inter-rater agreement was 95 and 100%. Intra-rater reliability was calculated for PCC by the investigator re-transcribing the pre- and post-intervention speech samples for each of the participants in the intervention programme. This constitutes 50% (6 out of 12) of the speech samples gathered in the study, including those recorded as part of the assessment phase. The PCC scores derived from the reliability rating were correlated with the original PCC scores to yield a reliability coefficient of $r = .997$, indicating a high level of intra-rater reliability.

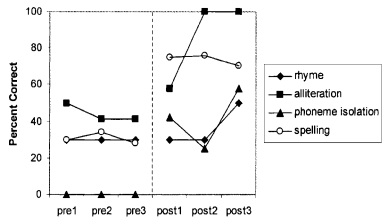
3. Results

The single-subject data collected from the pre- and post-intervention probes were examined for differences in each participant's performance as a result of the intervention. Data were grouped into phoneme awareness skills (alliteration

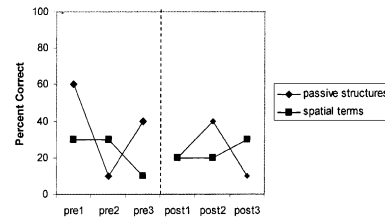
detection, phoneme isolation and the spelling task), rhyme detection and the control tasks.

3.1. Participant 1

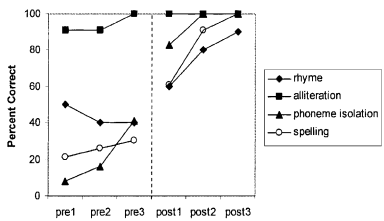
Participant 1 presented with stable baseline performance pre-intervention on all the tasks measuring phonological awareness skills. Fig. 1A presents the results in the pre- and post-intervention probes for the phoneme level awareness tasks (alliteration detection, initial-phoneme isolation and the spelling task) and rhyme detection task. As observed in Fig. 1A she demonstrated significant improvement in these skills, which remained stable or continued to increase across the post-test measures. For the rhyme detection task, however, there was no improvement in this



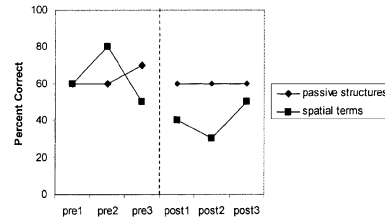
Panel A: Participants 1's phoneme and rhyme skills pre- and post- intervention.



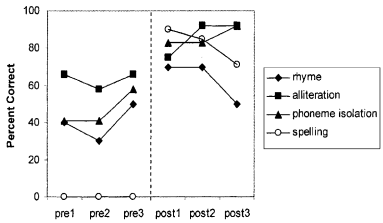
Panel B: Participants 1's performance on control activities pre- and post- intervention.



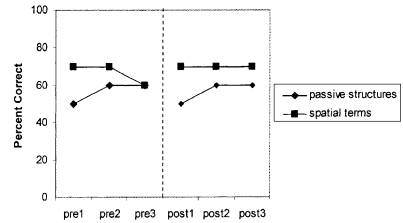
Panel C: Participants 2's phoneme and rhyme skills pre- and post- intervention.



Panel D: Participants 2's performance on control activities pre- and post- intervention.



Panel E: Participants 3's phoneme and rhyme skills pre- and post- intervention.



Panel F: Participants 2's performance on control activities pre- and post- intervention.

Fig. 1. Performance of the three participants pre- and post-intervention on the four intervention tasks and two control tasks.

skill following the intervention. The improvements in phoneme level awareness can be attributed to the effects of the intervention, as the control probes remained stable, or equally variable, at pre- and post-intervention measures (Fig. 1B).

3.2. Participant 2

At the pre-intervention probes, Participant 2 did not demonstrate stable performance in phoneme isolation, and had mastered the ability to detect alliteration (Fig. 1C). Grapheme–phoneme connection knowledge, as measured in the spelling with the letter tiles task and rhyme detection were stable pre-intervention, with less than 15% variation across probes (Tawney & Gast, 1984). Participant 2's performance in phoneme isolation improved with exposure to the assessment procedures (Fig. 1C), despite an absence of feedback from the investigator. The improvement in this skill at post-intervention testing cannot therefore be attributed solely to the intervention. The improvement in spelling scores, however, was significant and attributable to the intervention. On the pre-intervention probes the initial letters for the words *wed, kit, pan*, and *got* were the only letter tiles correctly placed by Participant 2, however, on the post-intervention probes he was also consistently selecting the correct letter for the final sounds on all the test words. This indicates an increased awareness of the word-final phonemes, a more advanced level of Grapheme–phoneme connections (Gillon, 2000).

The results of the control tasks at pre- and post-intervention probes indicated that these abilities were stable, and below chance for the passive structures (Fig. 1D). His knowledge of the spatial terms used in the second control probe, was less stable, but did not improve during the intervention programme. Therefore, the improvements demonstrated in the phonological awareness skills are attributable to the intervention programme.

3.3. Participant 3

Participant 3's scores in the pre-intervention probes were stable for both the alliteration detection and spelling skills, however, a slightly increasing baseline was produced in the phoneme isolation task, indicating that exposure to or practice with the assessment may have caused her to learn the task, even in the absence of feedback from the investigator (Fig. 1E). Rhyme detection skills were consistently below chance level at pre-intervention assessment. There was a significant improvement in Participant 3's spelling scores following the intervention. At pre-intervention probes, letters were chosen randomly from the board; while post-intervention the initial letters were consistently correct, and errors in the final letter selection were usually due to Participant 3 choosing the voiced or unvoiced cognate (e.g., ''got,'' was spelt ''god''). This represents a marked strengthening of Grapheme–phoneme connections. Alliteration detection skills were also significantly above chance levels of 70% correct (Maclean, Bryant, & Bradley, 1987) following the intervention. The accuracy of phoneme isolation

skills also improved at post-intervention probes, however, given the increasing baseline this cannot be attributed solely to the programme. Rhyme detection skills improved to above chance levels at post-intervention probes, although performance was variable. This variation in performance could have been due to fatigue effects in attention and motivation, as higher scores were obtained for a task when the assessment was administered earlier in the session.

The control probes yielded stable scores at both pre- and post-intervention as shown in Fig. 1F. There was less than 10% variation in the passive structures task, which was consistently below chance level, and the knowledge of spatial terms did not vary during the intervention. Therefore, the improvements in Participant 3's phonological awareness skills can be attributed to the intervention programme.

3.4. Generalisation of phonological awareness skills

Despite all participants improving in the phonemic level tasks that were the focus of the intervention, none of the participants demonstrated generalisation of this improvement to the phoneme segmentation task, which was not a target. Scores were consistently zero for Participants 2 and 3 in all pre- and post-intervention probes, however, in the first post-intervention probe Participant 1 produced one instance of correct phonemic segmentation for the word "eat." This was not repeated on the following post-intervention probes. The types of errors made in the phoneme segmentation task further emphasised the lack of generalisation. The participants provided neither the correct initial phoneme, nor the correct number of phonemes, as they had been able to do for the phoneme isolation assessment, and in the training of phonemic manipulation during the intervention sessions. The more difficult nature of this task is also reflected in the consistently zero correct performance on this assessment at pre-intervention, unlike the other initial-phoneme skills which increased for Participants 2 and 3 during the pre-intervention testing. The lack of generalisation can be attributed to the shortened length of the intervention programme. This short amount of time, with little opportunity for consolidation of learning outside the intervention sessions, did not lend itself well to generalisation across phonological awareness skills. The phonemic segmentation task, therefore, served as a control behaviour in this study, further demonstrating the efficacy of the intervention programme in improving the specific phoneme awareness skills targeted.

3.5. Effects of the intervention on intelligibility

The participant's overall Percentage Consonants Correct (PCC) as recorded in the speech samples did not significantly improve following the intervention ($F(1,4) = 7.70$, $p = .85$). There was, however, a discernable improvement in the percent of stops, fricative and affricates correctly produced by Participant 2, and a 16% decrease in the use of the cluster reduction process. There was also an increase in the percent of fricatives produced correctly by Participant 3, from 46%

correct to 64% correct. These improvements in PCC are minimal and the effects of natural maturation cannot be ruled out. There were no discernable patterns of change in the speech production of Participant 1, who presented with the highest pre-intervention PCC, when pre- and post-intervention samples were compared.

4. Discussion

The results indicate that improved phonological awareness skills of children with Down syndrome, within a relatively short period of intervention can be obtained. Each participant demonstrated strengthening of Grapheme–phoneme connections, as evidenced by the growth in spelling skills. Pre-intervention probes indicated that Participant 2 was able to correctly represent some initial phonemes. Following the intervention, however, Participant 2 demonstrated significant improvement in correctly spelling initial and final phonemes in words, including cluster elements. A similar pattern was also evident in the other two participants. This is consistent with the spelling development of children with speech impairment, as shown in the work of Gillon (2000). The ability to correctly spell final phonemes and vowels emerged after phonological awareness training for the children with speech impairment, whereas initial-phoneme representation had been consistently low (0 and 30%, respectively) pre-intervention.

The improvement in spelling skills in the current study is consistent with the literature implicating the need for phonological awareness skills in learning to spell (Lennox & Siegel, 1993; Treiman, 1998). The increased strength of Grapheme–phoneme connections in the participants is further evidence that phonological awareness intervention is more effective in improving reading and spelling abilities when the links to letter–sound relationships are made explicit (Bus & van Ijzendoorn, 1999; Cunningham, 1990; Torgesen, 1999), and are targeted through the use of manipulative materials (Gillon & Dodd, 1997).

Although rhyme detection was a focus of the intervention programme, only Participants 2 and 3 demonstrated an understanding of the concept of rhyme at post-intervention testing, with Participant 1 also exhibiting the least improvement in phoneme isolation. It was observed throughout the intervention sessions that this participant was not improving in accuracy of responses in the rhyme tasks, as were the other two children; she was unable to reliably match rhyming words even when comparing the written words. The reasons for this difficulty with rhyme are unclear; however, causes should be explored in order to best determine the children for whom phonological awareness is most beneficial (Blachman, 1997; Torgesen & Davis, 1996).

During the assessment phase, Participant 1 achieved 100% accuracy in the real word choice of three reading recognition tests, and scored above chance in the alliteration detection task; yet was unable to score above zero in phoneme isolation, each time responding with letter names instead of phonemes. In the non-word reading task, which also required spontaneous responses, she produced six real words, only three of which began with the same initial phoneme as the

printed non-word. These results suggest a heavy reliance on visual ''sight word'' recognition strategies pre-intervention. This pattern of responses is in contrast to the other two participants, who demonstrated improvement in phoneme isolation scores during the pre-intervention probes in the absence of feedback from the investigator. This increasing baseline may indicate an increased ability for learning phonological awareness concepts and skills. This speculation is consistent with the findings of previous research investigating individual responses to phonological awareness training. Torgesen and Davis (1996) analysed the pre-intervention profiles of the 21 of participants with a history of reading disability, who did not demonstrate improvement in phonological awareness following 12 weeks of training. They found that these participants performed poorly in non-word spelling at pre-intervention, implying reduced Grapheme–phoneme connections and analytic phonological awareness. Given that the only analytic phonological awareness task used in the current study was phoneme isolation, there appears to be evidence to suggest children with Down syndrome display similar patterns of responses to phonological awareness intervention, as do other children with low reading skills. This does not explain why rhyme was not learned, while other phonemic awareness skills improved; the factors influencing responses to phonological awareness intervention in children with Down syndrome require further investigation.

The short length of the intervention programme may have accounted for the reduced generalisation of improvement in the phoneme segmentation skills and in PCC scores of the participants. Gillon (2000) reported significant improvements in speech production, as measured by overall PCC following 20 hr of phonological awareness training in children with speech impairment. This compared with 8 hr of intervention in the current study. While, there were no significant changes evident in two of the participants' overall PCC, one participant did demonstrate improvement in fricative and affricate production, and in consonant cluster elements. Speech production skills were not explicitly targeted during the intervention, therefore improved PCC following the short time of intervention is significant; however, the effects of natural maturation on speech development cannot be ruled out. Future research into the effects of phonological awareness intervention in children with Down syndrome should continue to monitor changes in speech production.

The unstable, and in some cases, increasing performance of the participants in the post-intervention probes is likely to be a combination of the several influences. First, the intervention programme may not have been long enough to allow consolidation of the skills, which were still stabilising during post-testing. This is especially evident in the performance of Participant 3 in the phoneme awareness probes, which increased from 61 to 100% correct on the final assessment probe. Second, the number of assessments to be completed required post-testing sessions of 45–60 min duration. The scores of Participant 3 revealed fatiguing effects as the session progressed, despite frequent breaks. Presentation of the post-tests was randomised within each session, in an effort to overcome the effects of diminishing motivation and attention to task, which may account for the variance in the scores.

Notably, all of the participants demonstrated improvements in phoneme awareness skills which, were associated with improved spelling skills and stronger Grapheme–phoneme connections, even in the absence of rhyme awareness as with Participant 1. The results of the current study suggest that children with Down syndrome do not require rhyme awareness before being able to develop higher levels of phonological awareness, such as phoneme awareness and Grapheme–phoneme connections. Therefore, phonological awareness intervention should focus on teaching skills at the phoneme level. This is consistent with the phonological awareness literature emphasising the need for intervention to target phoneme level awareness skills in order to produce effects on reading and spelling abilities (Byrne & Fielding-Barnsley, 1995; Fowler et al., 1995; Gillon, 2000; O'Connor, Slocum, & Jenkins, 1995; Torgesen, 1999).

The lack of generalisation of phoneme awareness to the phoneme segmentation task also has implications for future phonological awareness intervention with children with Down syndrome. Both Fowler et al. (1995) and Kay-Raining Bird, Cleave, and McConnell (unpublished manuscript) concluded that children with Down syndrome need to be specifically taught the phonological awareness skills needed for fluent decoding of text, and the lack of generalisation to phoneme segmentation skills evidenced in the current investigation is consistent with that conclusion. It seems that the limited amount of time did not allow the participants to apply their phonemic knowledge to novel contexts, but this may underlie a reduced capability for generalisation amongst children with Down syndrome. In either case, specific training targeting phonemic awareness with explicit links to Grapheme–phoneme connections is recommended.

A controlled study is required to investigate the most effective method of phonological awareness training for children with Down syndrome, and its effects on reading and spelling development. The participants selected for the phonological awareness intervention may not represent the wider population of children with Down syndrome, therefore the effects of phonological awareness training need to be investigated with a larger group. In providing longer periods of intervention, the efficacy of training agents for the therapy, such as teacher aides could be investigated, to ensure generalisation of skills learnt to the classroom.

This present study demonstrated significant improvements in phoneme level awareness skills for the three participants, indicating that training is effective in improving phonological awareness skills, with concurrent improvement in Grapheme–phoneme connections.

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