A Pilot Study to Evaluate an Integrated Phonics and Language Programme for the Teaching of Reading to Deaf and Hearing Children

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Summary

Both decoding (phonics) and language skills are essential for the development of reading comprehension. Decoding involves teaching letter-sound correspondences and awareness of phonemes, and language skills include vocabulary, grammatical knowledge, and comprehension. However, current educational practice focusses on phonics with less emphasis on language and although many children progress with a phonics approach, a significant proportion struggle, particularly those with weak language skills. This includes children from disadvantaged backgrounds, children with English as an additional language (EAL), and those with language difficulties, of whom deaf children form a significant group, and one which is typically excluded from reading intervention research. For deaf and hearing children who enter school with limited vocabulary knowledge, the impact is not only on the early stages of learning to read; these children typically fail to catch up unless they receive specific support, thus reading delays become more severe as children progress through school. Research including our own has shown that deaf children have specific difficulties accessing spoken language, upon which reading is based, and exhibit deficits in both the decoding and comprehension components of the reading process. Language teaching is therefore needed as well as phonics to support literacy development amongst all children with weak language skills, but may be particularly valuable for those whose language development is at risk due to deafness and those from socio-economically disadvantaged backgrounds.

This report presents the findings of a study to pilot the implementation and evaluation of a literacy intervention that fully integrates phonics and language skills. The intervention included Floppy's Phonics, a systematic synthetic phonics programme and Word Aware, a vocabulary enrichment programme, delivered each day in school by teachers over the course of children's first year in school. The specific aims of the pilot study were to identify whether sampling strategies would be effective in recruiting schools in order to achieve target numbers of deaf and hearing participants; to find out whether the programme would be acceptable to teachers; to investigate teachers' ability to adhere to the integrated programme and deliver it accurately; to explore teachers' expectations and beliefs in response to the integrated programme, and to compare outcomes from the new programme after one year of delivery in comparison to the usual literacy teaching currently provided in UK schools.

Two mainstream primary schools and four primary hearing impairment resource bases (HIRBs)[1] were recruited, and 115 hearing and 23 deaf children took part in the pilot study. For the purpose of the evaluation, half the schools were randomly allocated to the intervention group and half to the control group. The locations of the two mainstream schools were in the 20% to 40% most deprived neighbourhoods in the UK. The locations of the four HIRBs were in the 10% to 50% most deprived neighbourhoods. There were differences between the mainstream schools in that the school allocated to deliver the intervention had a higher proportion of children with EAL and more children with special educational needs (SEN). There were similar proportions of children with EAL in intervention and control HIRBs; however, HIRBs in the intervention group had a higher proportion of children with SEN in addition to deafness than those in the control group. Despite best attempts to select schools and HIRBs that would be well matched, there were inevitably differences once this small number of schools was allocated to intervention and control groups that may have influenced results. Such differences would be minimised in a larger sample of schools and HIRBs.

1 *HIRBs are specialist resource units attached to mainstream schools.*

Reception class teachers in the intervention schools received training and ongoing support from the research team to deliver the programme in their classes, while the control group continued with the schools' standard literacy teaching, receiving the integrated programme at the end of the study. Fidelity of programme delivery was measured during termly visits to classrooms. All children were assessed before the start of the programme on a range of literacy, vocabulary and phonological awareness measures and at the end of one year to investigate literacy and vocabulary gains.

Indications from the pilot study are that recruitment is feasible, and that a specific focus on hearing children from disadvantaged backgrounds and deaf children is justified, given children's low levels of performance on our measures at the start of the study. A future study should seek to recruit a larger sample and match groups closely using measures of social deprivation, SEN and EAL. Furthermore, the presence of deaf children in mainstream schools has implications for the wider applicability of study findings, therefore a future study should identify any in attendance.

Study findings indicate that teachers and children enjoyed the integrated programme, and that teaching staff implemented it effectively with the training and support provided by the research team. As mainstream teachers were reluctant to use programme activity sheets, a future study should offer teachers different ways to address the underlying skills targeted by activity sheets, particularly at the start of the school year, and introduce activity sheets later in the programme.

Preliminary outcomes suggest that the intervention has the potential to highly impact children's literacy scores. Children who received the integrated programme made significantly more progress on key outcome measures of single word reading ($d=.48$, $p=.01$) and spelling ($d=.65$, $p<.001$) at the end of the study in comparison with the control group. Initial data for expressive vocabulary show a small effect size ($d=.15$, $p=.03$); however, similar to previous research findings, group differences were not found for receptive vocabulary. Analyses of phonological measures presented mixed findings, in part due to some of the measures proving too difficult for many of the children at the start of the study, despite being designed for this age group, and different baseline testing points. A future study should include alternative measures of phonological skills and programme vocabulary to avoid floor and ceiling effects and ensure consistent timing of assessments.

In conclusion, our pilot findings indicate that the deaf and disadvantaged children in our sample with extremely low levels of language and literacy at the start of the study benefited from the integrated intervention, and therefore that a full evaluation with a larger sample of children is merited.

How reading is taught

According to the simple view of reading (Gough & Tunmer, 1986), reading involves two separate skills. *Decoding skills* involve translating the letters that make up written words into the sounds of spoken language, e.g. c-a-t, and are important when learning to read and also when reading unfamiliar words. Decoding skills are reliant upon an established speech sound (phonological) system. *Comprehension skills* are needed to understand decoded words. Comprehension is based on a well-developed language system, which includes vocabulary and grammatical knowledge.

In the UK National Curriculum there is a strong emphasis on teaching children decoding skills from school entry using an approach called synthetic phonics. This approach emphasises teaching letter-sound correspondences directly and intensively, coupled with training awareness of phonemes in

speech. Children learn to apply these foundational skills in the context of reading practice with books of appropriate levels of difficulty.

Although there is good evidence for synthetic phonics as an effective approach to teaching early decoding skills (Hatcher, Hulme & Snowling, 2004), research also indicates the importance of broader oral language skills for the development of decoding. For example, Duff et al. (2008) reported that some children with reading difficulties who did not respond well to structured phonics-based teaching did benefit from a programme that integrated vocabulary training with phonics instruction. Such results can be related to ideas that knowledge of word meanings is critical for developing adequate word recognition skills, particularly of words with irregular spelling patterns. Indeed, our previous research with deaf children has argued that very weak language skills have a direct as well as an indirect effect on decoding (Herman, Roy & Kyle, 2017; 2019).

Vocabulary and other language skills including grammatical skills are critical foundations for language and reading comprehension. Variations in a range of language skills are powerful longitudinal predictors of reading comprehension (Muter et al., 2004; Lervåg, Hulme & Melby-Lervåg, 2017), and language interventions that emphasise the development of vocabulary knowledge and speaking and listening skills are effective in improving children's reading comprehension (Clarke et al., 2010; Fricke et al., 2013).

Based on this research, the current study sought to investigate the feasibility and impact of a whole class approach that integrates systematic phonics teaching (including work on letter-sound knowledge and phoneme awareness) with work on vocabulary knowledge and language comprehension. It was anticipated that such an approach would work well for all children but would be of particular value for children at risk of reading problems due to underlying language weaknesses, including children whose language development is compromised due to deafness.

Children who fail to progress with reading

Although national reading standards have improved as a result of the current focus on phonics teaching (DfE, 2015), the National Literacy Trust (2014) estimated that a fifth of all children in England, and close to a third of disadvantaged children, were unable to read well when they left primary school. Poorly equipped to face the challenges of secondary school, these children face educational failure and emotional and behavioural problems during the school years (Rose, 2009; Snowling, Muter & Carroll, 2007; Snowling, 2008), and with reduced earning potential are at increased risk of unemployment and social exclusion in adulthood (DfES 2004; Rose, 2009).

Children who fail to benefit from a phonics-based approach to reading include those with weak language skills, of which vocabulary is a key indicator. Research has repeatedly shown vocabulary to be especially important at the early stages of learning to read, and children who enter school with limited vocabulary knowledge typically fail to catch up unless they receive specific support. This includes children from disadvantaged backgrounds (Roy & Chiat, 2013; Zhang et al., 2013), children with English as an additional language (EAL) (Oxley & de Cat, 2019), and children with language difficulties (Snowling et al., 2016).

Deaf children represent an extreme example of children with poor reading. While recent developments in amplification technology, including digital hearing aids and cochlear implants, and the introduction of newborn hearing screening in the UK have had beneficial effects on early

language and speech development in deaf children, these benefits have not yet translated into equivalent improvements in reading levels for many. Deaf children experience difficulties in learning to read, with reading delays that become more severe as they progress through school (Lederberg, Schick, & Spencer, 2013). These reading delays can be explained within the framework of the simple view of reading as deaf children typically have difficulties with both of the necessary components for reading. Because of their hearing impairment, deaf children struggle to access the speech sounds that make up spoken language (i.e. phonology), upon which written language is based. Even with amplification via cochlear implants or digital hearing aids, normal hearing is not restored. Furthermore, impoverished exposure to early language through incidental learning adversely affects vocabulary development as well as speech perception and speech production, with consequences for the development of phonological representations and word learning efficiency (Herman et al., 2017; 2019). These links between vocabulary size, phonological sensitivity and decoding skills are also evident in hearing children (Morgan et al., 2015; Nation & Snowling, 2004; Silvén et al., 2007).

The skill that appears to be most predictive of deaf children's reading is vocabulary knowledge (Kyle & Harris, 2010; Kyle, Campbell, & MacSweeney, 2016; Herman, Roy & Kyle, 2014; 2017; Easterbrooks et al., 2008). The association between poor vocabulary and reading comprehension is well established in hearing children (Beck & McKeown, 2007; Muter et al., 2004; Ricketts, Nation & Bishop, 2007; Storch & Whitehurst, 2002). It is clear from the existing research and proposed reading models that deaf children exhibit deficits in both the decoding and comprehension components of the reading process, therefore for any form of reading remediation programme to be successful, it must target both. However, deaf children are routinely excluded from mainstream reading intervention studies, either by design or default, and there are therefore no evidence-based interventions that teachers can use with deaf children (Schirmer & McGough, 2005). This is exacerbated by findings that UK teachers feel ill equipped and lack confidence in supporting literacy in children with special educational needs (SEN), including deaf children (Clark & Teravainen, 2015).

Research study

The current study aimed to pilot the implementation and evaluation of a theoretically-driven literacy programme that fully integrated phonics and language skills with a sample of children, including some from disadvantaged backgrounds and some who were deaf, in comparison to the standard literacy teaching in schools. The specific aims of the study were:

1. To identify sampling strategies that are effective in recruiting schools and target numbers of children.
2. To determine the acceptability of the integrated programme to teaching staff in schools.
3. To investigate the feasibility of training staff to deliver the integrated programme effectively and fully incorporate it within the curriculum, monitoring teachers' adherence by regular fidelity checks.
4. To investigate teachers' expectations and beliefs about children's literacy potential and to identify whether teaching staff change expectations, beliefs and practice as a result of the integrated programme.

5. To compare preliminary outcomes from the integrated programme with a control group of children receiving their standard school literacy teaching after one year of programme delivery.

Recruitment of the research sample

Ethical approval for the study was obtained from City, University of London's School of Health Science's Research Ethics Committee. Ethical approval was based on headteachers giving consent for hearing pupils to take part in the study, with parents able to opt children out of the assessments if they wished. Parents of deaf children opted in by providing written consent for their children's involvement, as additional information on deaf children was collected (e.g. communication mode, the timing and duration of cochlear implant or hearing aid use, medical history, parental hearing status, etc.), and deaf children's assessments were video recorded to check for reliability.

We sought to recruit children in hearing-impaired resource bases (HIRBs) attached to mainstream schools in the Greater London area. The decision to deliver the integrated programme in mainstream schools with HIRBs would allow for access to larger numbers of deaf participants, since HIRBs contain groups of deaf children, whereas schools without HIRBs typically contain individual deaf children. However, although staff in HIRBs were keen to take part, staff in attached mainstream schools were reluctant to do so if their current literacy strategy was effective.

We recruited two HIRBs and their mainstream schools, but because of large differences in Ofsted ratings and proportions of disadvantaged children, they were not well matched. Subsequently, one of the mainstream schools dropped out because of staffing issues although the HIRB requested to remain in the study. We were therefore forced to change strategy to recruit mainstream schools separately from HIRBs and focussed on mainstream schools with poor Ofsted literacy ratings. Using this strategy, we identified two mainstream schools that were a good match for each other and three further HIRBs. However, because one mainstream school was recruited late, this meant that baseline data collection took place later in the intervention mainstream school than in the control school. To compensate for this, timing of the end of study assessments was delayed in the intervention mainstream school (see Table 1).

Table 1. Allocation of schools and timing of pre- and post-programme assessments

School/HIRB (Intervention/Control)	Baseline (pre-programme) assessments	End of study (post-programme) assessments
HIRB 1 (C)	September	June
HIRB 2 (C)	September	June
HIRB 3 (I)	September	June
HIRB 4 (I)	September	June
Mainstream school 1 (C)	September	June
Mainstream school 2 (I)	October	July

A total of 138 children (77 boys and 61 girls) took part in the study, of whom 23 were deaf. The mean age of the sample was 4 years 9 months. Data were collected from schools on numbers of children in receipt of pupil premium, those with SEN (including deafness) and numbers with EAL to facilitate comparisons between the intervention and control groups. Table 2 below shows sample characteristics for the control and intervention groups. As one mainstream school and one HIRB failed to provide information on pupil premium, this information is not provided in Table 2.

Table 2. Participants in intervention and control groups

Participant characteristics	Intervention	Control	Total
Numbers in each group (boys)	72 (39)	66 (38)	138 (77)
Numbers of deaf/hearing children	15/57	8/58	23/115
Mean age in months (standard deviation)	57.88 (5.61)	56.44 (5.11)	57.19 (5.41)
% Special Educational Needs[2] (n)	22% (16)	17% (11)	20% (27)
% English as an Additional Language[3] (n)	90% (65)	68% (45)	80% (110)

An ideal research design is where one class in each mainstream school delivers the intervention whilst the other acts as a control, since this is most effective in balancing background variables between groups. However, in practice there remains a considerable risk of seepage, whereby intervention teachers share their learning with control class teachers. Moreover, this approach was not acceptable to schools, as teachers felt that it would be difficult to implement different literacy teaching approaches in different classes. Allocation to intervention and waiting control groups was therefore carried out at the level of the school rather than the class. In this way, half of the schools and HIRBs were randomly selected to deliver the integrated programme for a year while the remainder continued with schools' standard literacy teaching. One of the two mainstream schools had a double form entry and the other a four-form entry. The larger mainstream school implemented the integrated programme in all four Reception classes, although due to resource limitations only children in two classes had their outcomes assessed as part of the evaluation. Nonetheless, the wider implementation provided the opportunity to trial the intervention with more teachers and children.

Both mainstream schools had an above average proportion of children with EAL, especially the school allocated to the intervention group where 97% of children had EAL compared to 78% in the control school. The intervention school also had a slightly higher proportion of children with SEN

[2] UK national average for primary schools 15% (DfE, 2019)

[3] UK national average for primary schools 21% (DfE, 2019)

(11%) compared with the control school (4%). Based on postcode data entered into the Indices of Deprivation Explorer (http://dclgapps.communities.gov.uk/imd/idmap.html), the locations of the two mainstream schools were in the 20% to 40% most deprived neighbourhoods in the UK and both schools' most recent Ofsted reports indicated that they required improvement, including in the area of literacy teaching.

The HIRBs in the intervention and control groups had similar proportions of children with EAL (66%), with figures above the national average. The locations of the four HIRBs were in the 10% to 50% most deprived neighbourhoods and in both intervention and control groups, one HIRB was in a very deprived neighbourhood and the other in a less deprived neighbourhood. All HIRBs had received good or outstanding Ofsted ratings. Although we endeavoured to match schools and HIRBs, these differences between the intervention and control groups may have influenced results. Such differences would be minimised in a larger sample of schools and HIRBs.

Test battery

Tests were selected to measure skills related to vocabulary and reading in hearing children. Additional tests targeted skills known to be important to reading in deaf children only. Children's nonverbal skills were tested to compare differences between children in the control and intervention groups. All deaf children additionally had a pure tone hearing test carried out at the start of the study.

The test battery covered the following skills (see Appendix 1 for tests used):

- Nonverbal skills
- Single word reading
- Spelling
- Letter-sound knowledge
- Phonological skills
- Vocabulary*
- Speech intelligibility
- Speechreading

**Measures were used to test expressive and receptive vocabulary, and an additional measure was developed using words taught as part of the integrated programme*

Children were assessed before starting the intervention and shortly after the intervention had finished, i.e. at the start and end of the school year. Some tests were administered to small groups of children and others were administered individually (see Appendix 1 for details). Children were tested by independent testers who were blind to condition. Trained specialist testers with experience of testing deaf children administered tests to deaf participants. Trained student and qualified speech and language therapists carried out testing on hearing child participants.

The integrated intervention

The integrated intervention combined two practitioner-developed programmes that target the components of the simple model of reading in a complementary way: Floppy's Phonics Sounds and Letters (Hepplewhite, 2011) and Word Aware (Parsons & Branagan, 2016). For deaf children, the integrated intervention augmented Floppy's Phonics with a system of visual hand cues, Visual Phonics by Hand (http://visualphonicsbyhand.com). Visual phonics cues have been found to be effective in highlighting the letter-sound links that deaf children find difficult to hear (Trezek et al., 2007).

Figure 1. Components of the integrated programme

Floppy's Phonics is an evidence-based systematic synthetic phonics programme with a rich language base that links directly to the widely used Oxford Reading scheme and can also be used with other reading schemes. The programme is systematic and cumulative across the first two years of primary school. Children develop their decoding skills by learning and consolidating the letter-sound correspondences using mnemonic pictures (e.g. sun for 's'), letter tracing, saying the sound and key word, blending to read words (s-u-n), writing the grapheme, orally segmenting words, and spelling. The programme provides practice in reading cumulative texts and carefully selected stories.

Teaching is delivered in two types of session, delivered on the same or different days: whole group teaching using interactive whiteboard-based activities (see sample interactive whiteboard display, Appendix 2), and small group and individual work using books and activity sheets to revise learning and to send home in order to keep parents informed of their child's developing literacy skills. The programme encompasses lesson plans and assessment sheets so that teachers can fully monitor children's progress.

Floppy's Phonics includes an emphasis on vocabulary as part of the programme's design and delivery. In addition, we taught children vocabulary selected from Floppy's Phonics using Word Aware, a structured, multilevel whole class approach to the teaching of vocabulary. Originally designed for hearing children with language impairments (Parsons et al., 2005), Word Aware was successfully piloted in a small unpublished study with deaf children (Withnall, 2015). Word Aware incorporates four key principles to support vocabulary learning: teachers are trained to create a word rich classroom environment; select and directly teach vocabulary; support children to develop independent word learning skills, and use word games to promote word learning skills and motivate children. Word Aware strategies target the meaning and grammatical role of each word, showing children how to define words and use them in sentences. In addition, strategies such as highlighting

the phonic structure of new words through sounding out, counting syllables, spelling, and using written words to support vocabulary learning (see Appendix 3) directly complement the phonics programme and the development of decoding skills. This range of strategies for developing vocabulary has been shown to be effective with both hearing (Bowyer-Crane et al., 2007; Tse & Nicholson, 2014) and deaf children (van Staden, 2013; Easterbrooks & Maiorana-Basas, 2014). Furthermore, the emphasis on word learning strategies enables children to become independent word learners so that they continue to develop their vocabularies in and outside the classroom and beyond the intervention period.

In the pilot study, vocabulary items from Floppy's Phonics were selected by the research team for direct teaching across all schools using Word Aware, in comparison with an equivalent untaught vocabulary list. Selected words included a range of word types (e.g. nouns, verbs, adjectives), and one word was targeted for each day of the intervention period with opportunities for revision. In addition, teachers delivering the integrated programme were encouraged to teach other vocabulary using Word Aware strategies.

Training staff to deliver the integrated programme

The research team received training from the authors of Floppy's Phonics and Word Aware and used this to develop a training programme for teachers to present these combined approaches as an integrated phonics and language programme.

Staff (teaching and non-teaching support staff) in the intervention schools were trained and supported by the research team to implement the integrated programme in place of the schools' literacy curriculum for a year with the children in their classes. Each school received two days of training, delivered across two terms, and copies of all teaching materials, programme manuals and full programme resources free of charge. Training was delivered to the smaller numbers of staff in the two HIRBs selected to deliver the intervention together, which allowed for discussion and sharing of ideas across schools.

Some schools requested whole day teaching; in other schools, teaching was preferred in a series of twilight sessions. Following teacher feedback and from observations made on fidelity visits, training was refined to be more interactive and include opportunities for staff to practise delivery of key aspects of the intervention in small groups. The amended training was delivered to schools in the control group at the end of the study, along with the same training materials and resources.

Acceptability of the programme and programme fidelity

The ability of teachers to deliver the integrated programme consistently was measured through termly fidelity checks entailing visits to schools to conduct teacher observations, inspection of weekly teacher logs and pupil records (child attendance and parental involvement), discussions with teachers about their experience of delivering the integrated programme, feedback and trouble-shooting. The control schools delivered their usual literacy teaching and were also subject to termly fidelity checks, including teacher observations. A systematic fidelity checklist was developed and refined during the course of the study for use on visits, comprising key features of the integrated programme. The fidelity checklist was used to identify whether teachers in the intervention schools

were implementing the integrated programme accurately, and to determine the extent to which teaching in the control schools compared to the integrated programme. Following classroom observations, teachers delivering the integrated programme discussed their experiences of using the programme and were given feedback to enhance adherence to the programme.

Although only two classes of children had their outcomes assessed in the intervention mainstream school, fidelity visits were conducted to all four classes because children were divided into ability groups across all classes. This provided an opportunity to see more teachers implement the intervention and obtain feedback from larger numbers of teaching staff including nursery nurses, whose job it was to provide additional sessions to the least able pupils.

Overall, teachers and children enjoyed the programme and found it acceptable, evidenced through adherence to the key aspects of the integrated programme. In addition, there were examples of excellent practice observed and adherence to the integrated programme improved with subsequent fidelity visits as teachers became more familiar with the programme.

All teachers enjoyed using the whole class whiteboard-based activities. Mainstream teachers were reluctant to use activity sheets and preferred to target activities within activity sheets in other ways, e.g. using individual whiteboards. A key factor influencing mainstream teachers was the support children needed to complete activity sheets independently at the start of Reception, which was challenging with large class sizes. In contrast, teachers of deaf children worked with smaller numbers of pupils where use of activity sheets was more manageable. Teachers of deaf children used Visual Phonics consistently and reported that children were very interested in and motivated to use Visual Phonics, particularly signing deaf children who had not previously been exposed to phonics teaching.

The fidelity checks established that although literacy teaching in the control schools included an emphasis on phonics, it was different in many ways from the integrated intervention. The mainstream control school used Letters and Sounds to teach phonics and adopted different strategies to teach vocabulary, including displaying vocabulary grouped around a common theme such as colours or a children's story. One of the control HIRBs used a different order of presentation of sounds based on how visible the sounds appeared when lipreading. Overall, the control HIRBs adopted a more individualised approach to teaching literacy based on individual children's abilities.

In addition, differences were observed between mainstream teachers and teachers of the deaf in the intervention group as a result of fidelity checks as follows:

Group sizes: Mainstream teachers taught large groups of up to 30 children at a time, whereas teachers of the deaf worked with much smaller groups, ranging from two to six children.

Frequency of delivery: Mainstream teachers delivered daily literacy sessions, whereas some teachers of deaf children delivered sessions less frequently. A key focus following the first fidelity visit was therefore to streamline frequency of delivery across schools so that all staff delivered sessions on a daily basis.

Consolidation of learning: Mainstream teachers needed encouragement to spend more time consolidating phonics learning and revisiting taught vocabulary. In contrast, teachers of the deaf regularly allocated time for consolidation of skills.

Teaching vocabulary: Mainstream teachers taught all targeted vocabulary. Some teachers of the deaf reported that certain items of vocabulary selected for teaching were at too high a level for some deaf children. During training, other teachers of the deaf gave examples of how they had taught

these more challenging words and the benefits they had observed in children's use of a wider vocabulary. This motivated teachers to attempt more of the targeted vocabulary.

Involvement of parents: All teachers sent books home for parents to read with children. However, only teachers of deaf children shared information about the integrated programme and the vocabulary taught with parents. Mainstream school staff reported that they did not do so because so few parents spoke English at home.

Teacher expectations, beliefs and feedback on the integrated programme

All teachers completed a questionnaire adapted from Sandvik et al., (2014) at the start and end of the school year to identify methods used to teach reading at their school and to explore teachers' expectations and beliefs about literacy development in hearing and deaf children. The questionnaires used to investigate teacher expectations and beliefs were not discriminating. Teachers gave best responses, with no differences between the start and end of the study that may be attributable to the intervention.

To obtain further feedback from teachers involved in delivering the intervention in all schools, we set up a focus group led by an independent researcher. Teachers were asked what they understood to be the purpose of the integrated intervention, and provided feedback on the training, fidelity visits, and the support provided by the research team. Overall, teachers confirmed what had been said on fidelity visits and were positive about using the integrated intervention and the resources provided. The focus group responses confirmed that teachers particularly liked the interactive whiteboard activities, but that mainstream teachers did not like the activity sheets (see above). Mainstream teachers reported that they had gained a better understanding of the importance of language as a result of their involvement in delivery the intervention. Language had not been a focus for them previously, and they felt that explicit teaching of vocabulary had been helpful for the children in their classes. A negative comment was the lack of games included in the programme. They also reported difficulties with involving parents in children's learning and suggested that a pack for parents which was translated into different languages might help to involve them more.

Comparing outcomes between intervention and control groups

Planned key outcome measures were literacy (reading and spelling), vocabulary, letter-sound knowledge, speechreading and phonological skills. Scores on the YARC Single Word Reading Test could not be analysed because too few children were able to attempt this test at the start of the study. A large proportion of data was missing on the speechreading test in one school, therefore scores for this measure were not analysed.

An unexpected finding was that nonverbal scores of children in the intervention group were substantially lower than those in the control group. This imbalance reflects the fact that there were so few schools and allocation to groups was at school level. Because of this finding, nonverbal scores were used as a covariate in all analyses to control for differences in general ability between the control and intervention groups.

The children's scores were generally poor for their age, with many children at floor on most literacy and phonological measures and some of the vocabulary measures at the start of the study, indicating

extremely low levels of ability in the sample. This was further supported by scores across the sample on the three standardised measures used. Only one of these tests yielded scores within the average range (YARC Early Word Recognition Test), and 74% of the sample achieved zero scores. The other tests produced borderline average scores (YARC Sound Deletion), with 56% achieving zero scores,

or below average scores (Preschool-CELF Expressive Vocabulary Test). These results indicate the unusually low levels of ability and particularly poor vocabulary skills in the sample as a result of social disadvantage, EAL and deafness.

The effects of the intervention on each outcome measure were assessed in a series of regression (ANCOVA) models with pre-test score and NVIQ (Raven's Matrices) as covariates and group as the predictor. Table 3 presents the effect sizes and significance values of the literacy, language and phonological measures.

Table 3. Standardized mean differences between the intervention and control groups on literacy, language and phonological measures

Measure	Effect size (Cohen's d)	Significance level
YARC Early Word Recognition Test	.60	.07
Bespoke Picture Word Reading Test	.48	.01
Bespoke Spelling Test	.65	.001
Preschool-CELF Expressive Vocabulary Test	.15	.03
BPVS Receptive Vocabulary Test	-.33	.002
Bespoke Vocabulary Test	-.41	.03
Letter-Sound Knowledge	-.20	.13
YARC Sound Deletion	-.02	.97

Single word reading and spelling

Overall, the key literacy targets of the intervention, reading and spelling, showed advantages for the intervention group. Our bespoke measure of single word reading showed a medium effect size and the spelling test showed a large effect size (see Table 3). The YARC Early Word Recognition Test showed a medium effect size that did not reach significance due to lack of power and in addition exhibited large floor effects at the first assessment point.

Vocabulary

Results were different for receptive and expressive vocabulary. Whereas expressive vocabulary scores on the Preschool CELF scores showed a statistically significant impact of the intervention with a small effect size, there was no effect on receptive vocabulary, as measured by our group-administered BPVS. This has been observed in our previous research, with expressive vocabulary showing a greater response to intervention than receptive vocabulary. The bespoke vocabulary

checklist developed for the pilot study failed to show an effect for the intervention which may be explained by the test format: requiring children to give the meaning of words was too complex for children with weak language skills, especially at the start of the study when a third of the sample achieved zero scores. An alternative picture naming test format would be preferable in a future study to test knowledge of programme vocabulary.

Letter-sound knowledge and phonological skills

Scores for letter-sound knowledge yielded nonsignificant results, with children in the intervention group making less progress than the control group. This can be explained by two factors. Firstly, because of late recruitment to the study, the hearing children in the intervention group were tested later in the first term than children in the control group, and therefore obtained higher scores at the outset. Secondly, scores at the end of the year were at ceiling in both groups, cancelling out any effect due to delayed post testing to compensate for different start dates. Therefore, the lack of effect for the intervention group is most likely due to different starting levels and limitations in the measure.

Scores for the YARC Sound Deletion Test were extremely low at the start of the study, with many children in both groups at floor. Even at the end of the study, a fifth of the sample failed to achieve any score on this test. This suggests that an alternative measure of phonological skills is needed that is more accessible for the large proportion of children in the sample with weak language because of deafness, disadvantage and EAL.

Conclusions

This pilot study sought to determine the feasibility of recruiting and implementing the integrated programme in schools and sought to provide a preliminary evaluation of outcomes on key measures.

Our initial recruitment target of HIRBs attached to mainstream schools was unsuccessful; nonetheless we were able to identify alternative sampling strategies, recruiting schools and HIRBs separately, that can be adopted in a future evaluation with larger numbers of children. The change in strategy has no impact on hearing child participants, since very few attend schools with HIRBs, therefore study findings remain representative of hearing children more broadly. For the deaf children, those in the pilot study were taught literacy almost exclusively in the HIRBs with only a few attending classes within the mainstream school. Therefore, study findings will apply to deaf children in HIRBs. In addition, at least one deaf child was identified within a mainstream school by our testers. A future study should investigate whether there are any deaf children in mainstream schools as their presence has implications for the applicability of study findings to deaf children in mainstream settings.

Many of the hearing children we recruited across both mainstream schools demonstrated very low levels of reading, extremely poor vocabulary, and difficulties accessing our test of phonological skills. These children highlight the need for the type of additional support provided by the integrated programme we developed. A future study should additionally replace the phonological test and vocabulary checklist we used with alternatives that less able children are able to access.

One of our aims was to investigate the acceptability of the integrated programme to teachers and fidelity of delivery. The teachers we trained to deliver the integrated programme made many positive comments about the programme on fidelity visits, on feedback forms and at an end of study focus

group. They particularly liked the interactive whole class sessions and the systematic nature of the programme, and rated the training and support provided by the research team highly. The use of activity sheets was less well received by mainstream teachers, although teachers of deaf children found these valuable. Mainstream teachers reported that activity sheets would be appropriate with older children. A future study should seek to address the underlying skills targeted by activity sheets in Reception classes in different ways, particularly at the start of the school year, with worksheets being introduced later in the programme. Teachers also reported difficulties in engaging parents of children with EAL. A future study should consider translation of a programme pack for parents who do not speak English to improve access and encourage parents to support children's learning.

The fidelity checklist developed during the study was effective in identifying key components of literacy teaching and facilitating comparisons between intervention and control schools. Visits established that different teaching practices were in place in intervention and control schools. Use of the checklist on fidelity visits confirmed where teachers were adhering to the integrated programme and where further support was required and was useful in feedback discussions with teachers. With subsequent visits, adherence to programme fidelity improved.

Our aim of investigating teachers' expectations and beliefs about children's literacy potential was uninformative. In future, we propose to retain the focus exclusively on child outcomes as a measure of the effectiveness of the integrated programme.

Indicative data was collected to assess the potential of the integrated intervention to raise attainment. Significant effects were found on key outcomes, with medium and large effect sizes on tests of single word reading and spelling and a smaller effect size for expressive vocabulary. Outcomes of our analyses are mixed, in part due to participants' very low performance on some of the tests used, and in certain cases, the need for alternative measures. Challenges in matching schools resulted in the intervention group containing larger proportions of children with SEN and EAL and displaying lower nonverbal skills than those in the control group, differences which would be minimised in a larger sample of schools. Given these imbalances between groups, the overall findings in favour of the intervention are encouraging.

The pilot study provided invaluable opportunities to trial different aspects of the study and address specific aims surrounding recruitment, measures, staff training, delivery of the integrated intervention, fidelity and initial outcomes on key measures. Providing preliminary evidence of programme effectiveness through a methodologically rigorous pilot study is important before moving to the next stage in evaluation, a full-scale randomized control trial.

The results suggest that a full evaluation of the integrated programme is merited and, given the profiles of children in the sample, that a future study should retain a specific focus on hearing children from disadvantaged backgrounds and deaf children. The next stage of this research should additionally address the limitations of the pilot study by ensuring better balanced samples, consistent timing of assessment measures, inclusion of measures that avoid floor and ceiling effects where possible and better engagement of parents of children with EAL. Finally, a full evaluation should seek to recruit a much larger sample, targeting areas of extreme social disadvantage throughout the UK, to ensure analyses are appropriately powered and that findings are maximally generalisable. Larger numbers will also allow for an investigation of the effects of the intervention on deaf and hearing children separately.

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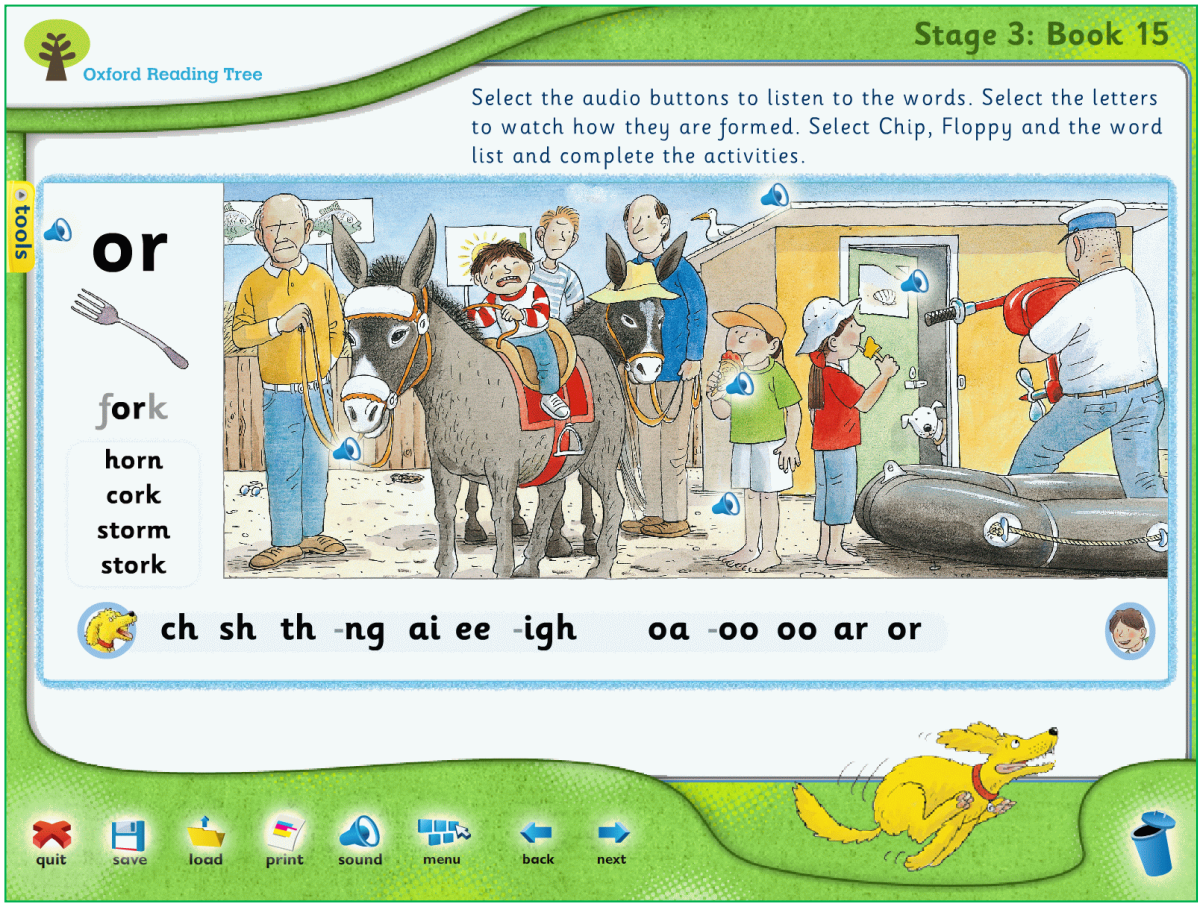
Appendix 1. Test battery

Target	Test
Nonverbal skills	Raven's Matrices (Raven et al., 2008) - group administered
Reading	York Assessment of Reading Comprehension (YARC, Snowling et al., 2009) Early Word Recognition Test
	YARC Single Word Reading Test
	Bespoke Picture Word Matching Test (Caravolas et al., 2012) - group administered
	YARC Letter-Sound Knowledge Test
Spelling	Bespoke Spelling Test – letters and single words (Caravolas et al., 2012) - group administered
Phonological skills	YARC Sound Deletion Test
	Initial Phoneme Matching test (James et al., 2008),
Language skills: vocabulary	Preschool Clinical Evaluation of Language Fundamentals 2 UK (Wiig et al., 2006) Expressive Vocabulary Test
	British Picture Vocabulary Test (Dunn et al., 2009) - group administered
	Bespoke Vocabulary Test
Speech intelligibility	Speech Intelligibility Rating Scale (Allen et al., 2001)
Speechreading	Single Word Speechreading Test (Worster, 2019)

Appendix 2. Sample interactive whiteboard display from Floppy's Phonics



Appendix 3. The Word Wizard form from Word Aware used to teach vocabulary from the phonics programme

Word Wizard

New word .....

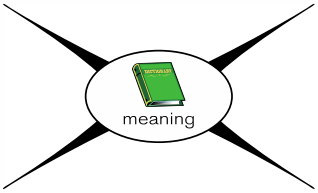
Symbol/picture

b, c, t It starts with ...

It rhymes with ...

It has ... syllables

Say the word to your partner



Use the word in a sentence .....

.....

Action

Song or Rap

Word Wall

Word Pot