



Annual review

Evidence-based interventions for reading and language difficulties: Creating a virtuous circle

Margaret J. Snowling* and Charles Hulme

Department of Psychology, University of York, UK

Background. Children may experience two very different forms of reading problem: decoding difficulties (dyslexia) and reading comprehension difficulties. Decoding difficulties appear to be caused by problems with phonological (speech sound) processing. Reading comprehension difficulties in contrast appear to be caused by problems with 'higher level' language difficulties including problems with semantics (including deficient knowledge of word meanings) and grammar (knowledge of morphology and syntax).

Aims. We review evidence concerning the nature, causes of, and treatments for children's reading difficulties. We argue that any well-founded educational intervention must be based on a sound theory of the causes of a particular form of learning difficulty, which in turn must be based on an understanding of how a given skill is learned by typically developing children. Such theoretically motivated interventions should in turn be evaluated in randomized controlled trials (RCTs) to establish whether they are effective, and for whom.

Results. There is now considerable evidence showing that phonologically based interventions are effective in ameliorating children's word level decoding difficulties, and a smaller evidence base showing that reading and oral language (OL) comprehension difficulties can be ameliorated by suitable interventions to boost vocabulary and broader OL skills.

Conclusions. The process of developing theories about the origins of children's educational difficulties and evaluating theoretically motivated treatments in RCTs, produces a 'virtuous circle' whereby theory informs practice, and the evaluation of effective interventions in turn feeds back to inform and refine theories about the nature and causes of children's reading and language difficulties.

Learning to read is a complex process. In an alphabetic language such as English, letters and letter strings map on to the sounds or the phonemes of the language. In these languages, a first step for the child is to 'crack the code' and understand the alphabetic principle (Byrne, 1998; Gough & Hillinger, 1980). But learning to decode print is not all that reading is about. To be a proficient reader, the child must be able to decode

*Correspondence should be addressed to Margaret J. Snowling, Department of Psychology, University of York, York, YO10 5DD, UK. (e-mail: mjs19@york.ac.uk).

accurately, and read fluently and with understanding. Spelling and writing are also important aspects of literacy development though we will not be discussing these here (see Fletcher, Lyon, Fuchs, & Barnes, 2007; Treiman & Kessler, 2005, for reviews).

Most children come to the task of reading with a well-established system for processing spoken language. The challenge faced by parents and teachers is how best to harness these oral language (OL) skills in the service of reading, and this depends upon having a theory about how reading develops. A large body of evidence now shows that the best predictors of learning to read in the early stages are measures of letter-sound knowledge and phoneme awareness (Bowey, 2005; Muter, Hulme, Snowling, & Stevenson, 2004); both of these skills draw on the phonological system of language. In contrast, the predictors of reading comprehension include vocabulary and grammatical skills, which depend on non-phonological aspects of language, such as semantics and grammar (Muter *et al.*, 2004). Moreover, beyond the early stages, children must develop reading fluency. Perhaps surprisingly, rather little is known about how reading skills become automatized. However, it appears to be the case that children who are more fluent readers have better knowledge of orthographic patterns that transcend the single letter (e.g., -ai; -igh; -tion); they also practice reading more, and hence the literacy environment plays a key role in the development of reading fluency (sometimes known as print exposure; Stanovich & Cunningham, 1993).

Following on from these ideas, a simple conceptualization of reading is of a mapping process between OL and written language; a process whereby the letters on the page are translated into sounds with connections to meaning, and automatization depends on how frequently these mappings are used. According to this view, proficient OL is a precursor of literacy development and children with language difficulties are at high risk of reading problems; furthermore, at all stages of development, the role of the literacy environment is also crucial. Taking this evidence as a starting point, we begin by considering different forms of reading difficulty before moving to review implications of such findings for the reading intervention.

The nature and identification of reading difficulties

Dyslexia is the term used to describe the difficulties of children whose reading problems are associated with basic decoding (and recoding, that is spelling) skills. While for many years, the accepted view was that 'dyslexia' is a learning disorder defined according to the discrepancy between an individual's general cognitive ability and their measured reading attainment (Snowling, 2009; Virtual Issue), this definition is no longer in use. Rather, there is now evidence that many children show the characteristics of 'dyslexia' either in its 'pure' form or where there are co-occurring difficulties (usually referred to as co-morbidities). According to this conceptualization, the proximal deficit in dyslexia is a phonological deficit that affects the child's ability to abstract the alphabetic principle (Vellutino, Fletcher, Snowling, & Scanlon, 2004 for review). Dyslexia is known to compromise reading throughout the life span with problems of reading fluency and spelling typically persisting even after reading accuracy has developed to acceptable levels. In addition, some individuals with dyslexia appear to have 'double deficits' affecting phoneme awareness and rapid naming (RAN) (Wolf & Bowers, 1999) and co-morbid conditions, such as language impairment or Attention Deficit Hyperactivity Disorder (ADHD) can be expected to modify the expression of 'dyslexia' and are likely to require separate interventions.

In 2008, the UK government commissioned an independent report on how best to teach children with dyslexia and literacy difficulties in English schools (Rose, 2009). Drawing on a consensus of research evidence, the review proposed a working definition of dyslexia that stressed a number of points. First it emphasized that dyslexia primarily affects word-level reading and spelling skills (rather than comprehension) and second, that dyslexia is typically associated with difficulties in phonological awareness, verbal memory and verbal processing speed. An important assumption was that dyslexia can be observed across the range of intellectual abilities and that ‘an indication of severity can be provided by how well a child responds to well-founded intervention’ [p. 10].

This focus on ‘response to intervention’ (RTI) is in line with contemporary practice in the United States (Fletcher *et al.*, 2007). It avoids the use of a categorical diagnosis of dyslexia since such a definition can only be used once a child has failed to reach a given standard relative to their age. Rather, it focuses on the growth in reading skills (Fuchs & Fuchs, 2006), defining a child as reading impaired if they fail to respond to the teaching or intervention they receive. An advantage of this approach is that children who are developing component-reading skills much more slowly than their peers (such as grapheme–phoneme associations or phoneme segmentation skills) can be identified early and provided with appropriate interventions. In a similar vein, and following a tiered approach, children who do not respond to these interventions can be identified as in need of more intensive, continued, or alternative forms of support.

In contrast to the problem of word-level decoding seen in dyslexia, some children learn to decode proficiently but have poor understanding of what they read. Such ‘poor comprehenders’ have difficulties in a wide range of OL processes (e.g., with grammar and figurative language) and in text-level skills such as comprehension monitoring and inferencing skills (see Cain, 2010; Nation, 2005 for reviews). Although prevalence estimates for specific difficulties in reading comprehension are in the same range as for decoding difficulties (3–10%), and there is evidence from longitudinal studies that such difficulties originate in semantic, grammatical, and lexical processes outside of the phonological domain (Catts, Adlof, & Ellis Weismer, 2006; Nation, Cooksey, Taylor, & Bishop, 2010), there has not yet been a study examining how these children might be identified in terms of RTI.

The distinctive cognitive profiles of dyslexia and poor reading comprehension make clear that these different forms of reading difficulty require different forms of intervention. We begin by discussing the concept of a ‘well-founded intervention’ and then, building on understanding of the causes of individual differences in reading skills, we proceed to consider the implementation of effective reading interventions, with a focus on studies from the United Kingdom.

What is well-founded intervention?

To be considered ‘well-founded’, an intervention must be based on a sound theory (a ‘causal model’, see below) of how a skill develops and how to promote that skill in children who are struggling to master it. In other words, it is crucial to have a clear idea about the nature and origins of a given child’s difficulties in order to plan a suitable educational intervention. For example, if as argued above, children’s letter-sound knowledge and phonemic awareness skills are two critical foundations for learning to decode print, then for children who are struggling to master decoding skills an intervention should be chosen that will promote these two critical skills. Although

such an approach may be theoretically justifiable, we need evidence from rigorous and educationally realistic trials before we can recommend a particular approach is rolled out in schools. That is, no matter how reasonable an approach to intervention may seem theoretically, we will never know with certainty how well it will work until it has been evaluated in the classroom. Here we believe the best evidence comes from using a randomized controlled trial (RCT) and we will focus upon these in the present paper. Once an intervention is established as effective by one or more well controlled RCTs, ideally there should be follow-up studies to evaluate how effective the approach is when scaled up and rolled out in possibly less well-controlled but more realistic circumstances.

Unfortunately, there is still a dearth of evidence-based interventions in education and we still have a paucity of knowledge of 'what works' and for whom. In the absence of such evidence, there is understandable concern that many school-based interventions are being delivered (often to the most vulnerable pupils) in the absence of evidence of effectiveness (see e.g., Bishop, 2008; Strong, Torgerson, Torgerson, & Hulme, in press). In this paper, we argue that there is a need to develop a 'virtuous circle' linking theory with practice; that is, theory leads to the formulation of recommendations for teaching, and evaluating the effectiveness of such forms of teaching can, in turn, help to inform and refine theory.

How do we establish the causes of reading difficulties?

In order to develop a causal model of Reading Difficulties (RD) that can inform intervention, it is necessary to develop a theory at the cognitive level of explanation (Hulme & Snowling, 2009; Morton & Frith, 1995). Although some causes of RD have a genetic origin, and environmental factors play an important role, cognition mediates brain-behaviour relationships and at the present time, the cognitive level offers a necessary and sufficient level of explanation for the development of principled interventions. In short, we need to understand the cognitive difficulties that underpin reading problems, regardless of whether their origin is constitutional or environmental.

We think it is essential to state clearly the causal theory that forms the basis of any given educational intervention. Any intervention we deliver to children to improve their educational skills should 'make sense' in terms how children typically learn a skill, and the nature of the obstacles that may impede learning in some children. It is very useful to make such theories as explicit as possible, and path diagrams, which arose in biology as a way of representing theories about genetic influences on development (Wright, 1921; see Hulme and Snowling, 2009), are incredibly useful in this respect. Many of the theories we have will be incomplete, and possibly even incorrect in some respects, but having clearly expressed ideas that are incomplete is better than having no well-formulated ideas at all!

We can use a very simple path diagram to illustrate a causal theory about the origins of children's decoding difficulties (see Figure 1).

According to this theory, genetic and environmental differences among children lead to individual differences at the cognitive level in the ability to manipulate phonemes in speech and in knowledge of letter sounds. It is these two skills, according to the theory, that are direct causes of variations in how well children learn to read (learn to decode print). It follows directly (is predicted from the theory) that interventions that train letter-sound knowledge and phoneme manipulation skills should help children who are struggling to master decoding skills.

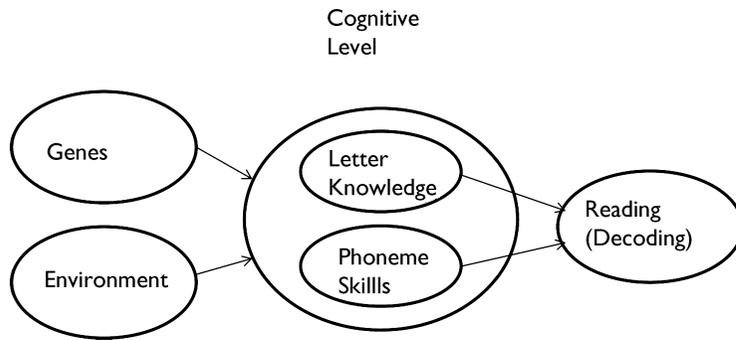


Figure 1. A causal theory of the origins of decoding, shown as a path model.

Randomized controlled trials (RCTs) in education

The approach we are advocating requires us to evaluate the effectiveness of different interventions. We will argue that to provide a rigorous evaluation of an intervention (and hence the theory underpinning it) children must be assigned ‘at random’ to either receive an intervention or to be in a control group (who may receive no treatment, or receive the treatment later, or receive an alternative treatment). If we use random assignment on a sufficiently large sample of people, any pre-existing differences between people in the treatment and no-treatment groups should even out – giving us a fair (unbiased) estimate of the likely effect of the treatment (see Torgerson & Torgerson, 2008).

Although the use of RCTs in education continues to be debated, using random assignment of people to the intervention or non-intervention group gives us the most certain basis for establishing how effective a treatment is. For this reason, RCTs have come to be seen as the ‘gold standard’ for evidence in medicine, because they give the most certain basis for establishing that an intervention causes a change in an outcome. While a range of methodologies including case studies and quasi-experimental designs can be useful when piloting an intervention, we believe it is very important to encourage the more widespread understanding and use of RCTs in education, and perhaps especially among educational policy makers.

Effective interventions to promote decoding skills in poor readers

The issue of how to provide remediation for children with identified reading disorders has a long history dating back to the clinic of Samuel Orton, one of the pioneers of dyslexia (Orton, 1937). This approach was subsequently revised and implemented as the ‘Orton—Gillingham—Stillman approach’ which, together with the work of Fernald (1943), advocated the use of a multi-sensory approach as the foundation of ‘good practice’ in the field of dyslexia worldwide. However, although some small-scale studies provide evidence suggesting that multi-sensory teaching improves learning (Hulme, 1981) we do not have large-scale trials showing how effective such teaching methods are in practice.

In contrast, starting from the premise that poor decoders have phonological difficulties, there is now considerable evidence pointing to the importance of explicit training in the alphabetic principle (understanding how letters in printed words map onto the phonemes in spoken words they represent) as a key component of a successful

intervention for children who have decoding difficulties or dyslexia. According to a meta-review of evidence by the National Reading Panel (2000), interventions that incorporate training in phoneme awareness are most effective when the training also includes work on letters and when the intervention is for no more than 20 h in duration.

A great deal of evidence regarding interventions for poor readers emanates from the work of Lovett and colleagues who were among the first to evaluate different methods of teaching for clinically 'diagnosed' children with dyslexia who had severe reading impairments (below the 5th centile). Lovett *et al.* (1994) evaluated two different interventions that focused on promoting procedures for identifying unknown words and dealt with print at sub-word as well as word levels, one emphasized phonological analysis and blending of printed words, and direct instruction in letter-sound correspondences, the other training in word identification strategies focusing on large orthographic units and matching words children were trying to decode to their spoken vocabulary. Children in a treatment-control group received instruction in a variety of study skills. While children in both treated groups made gains relative to the control group, the two interventions had specific effects: the first group that had received the phonological intervention did better than those trained in strategies for word identification in non-word reading; conversely the word identification group did better when tested for their ability to read exception words. More recently, Lovett, Steinbach, and Frijters (2000) went on to implement a combined programme, comparing it in a RCT with either intervention alone or an active treatment control. Importantly, the combined treatment was more effective than either of the treatments alone.

Another important set of studies that speak to the efficacy of remedial approaches for children with dyslexia has emanated from the Colorado reading study (Olson & Wise, 1992 for a review). The initial studies involved a teaching technique in which children read from computer-presented books at an appropriate level of difficulty. Whenever the child encountered an unfamiliar word they could highlight it and the computer provided feedback using synthesized speech. Children taught using this method made significantly more progress than children in regular remediation but those with poor phoneme awareness fared least well. Following on from this, Wise, Ring, and Olson (2000) developed a small-group intervention that included training in phonological and articulatory awareness, decoding of words and non-words, and accurate reading on the computer including assistance with decoding (phonological intervention). Although this intervention included some direct teaching and also some comprehension work, its focus was on phonological skills. Wise *et al.* (2000), contrasted this intervention with one described as 'Accurate Reading in Context' that included independent reading of texts on the computer and small-group work to promote comprehension within the reciprocal teaching (RT) framework (Palinscar & Brown, 1984).

Together the evidence from these studies points to the importance of designing interventions to target specific component reading skills, and also to the benefits of combining different approaches to intervention for the most disabled readers (Morris *et al.*, 2010). In terms of theory, the evidence pointing to treatment-specific effects confirms the componential structure of the reading process, as implemented in models of single word reading. However, in contrast to this, other studies indicate that the intensity of a programme might be just as important as its nature. Torgesen *et al.* (2001) evaluated the impact of an intensive 8-week programme comprising 67 h of instruction in grades 3-5. The study incorporated a comparison of two different forms of phonics instruction combined with phonological awareness training and included time to practice emergent skills in context. There was no significant difference in the efficacy of the two methods

of intervention; both brought about gains in reading accuracy and comprehension, and these gains were maintained for 2 years with about 70% of children then reading within the average range. While impressive, these gains did not extend to reading fluency and many poor readers read grade level reading materials more slowly than their peers.

Turning to the United Kingdom, the evidence base for interventions for poor decoding is less extensive, arguably because of funding constraints. In an early study, Hatcher, Hulme and Ellis (1994) used a controlled design to evaluate three forms of intervention for 7-year-old children with significant reading difficulties (the bottom 10% of the cohort in a local education authority). Building on the work of Marie Clay (1985) and Reading Recovery, the first intervention 'Reading Alone' (R) directly targeted reading skills in the context of real books. The second 'Phonology alone' (P) involved training in phonological awareness building on the pioneering approach of Bradley and Bryant (1983). The third intervention was a combined approach involving an integrated sequence of the elements from the reading and the phonology (R + P) approaches. The interventions were delivered by trained specialist teachers who taught in each arm of the study. Children identified as having reading difficulties within schools were allocated to matched groups to receive one of the interventions and their progress was compared with that of children who received 'treatment as usual'.

After 20 weeks of intervention, the children in the R + P condition who had received training linking phonological awareness with letter sounds in the context of reading books made most progress in reading, reading comprehension, and spelling. Indeed children receiving the R + P intervention made approximately twice the average rate of progress in the 6-month period. We can express this gain in terms of an 'effect size' - a standardized measure that reflects the difference between the means of the treated and untreated group, divided by the pooled standard deviation. Expressing gains in this way makes it possible to compare the size of the gains between different interventions (e.g., Torgesen, 2005). In this case, the effect sizes were moderate to large when comparing the R + P group to Controls in word reading $d = .45$, and on a measure of non-word reading $d = .60$ and gains for reading (but not spelling) were maintained at follow-up 9 months later. Phoneme awareness was overall a strong predictor of RTI in all groups except the phonology alone group but other measures including intelligence (IQ), verbal memory, and rhyming skills played no additional role as predictors (Hatcher & Hulme, 1999).

The effective R + P programme of Hatcher *et al.* (1994) has formed the basis of several intervention programmes for failing readers subsequently developed and evaluated at the University of York. First, together with colleagues in North Yorkshire local authority, Hatcher, Goetz *et al.* (2006) conducted a feasibility study to investigate whether a version of the R + P programme could be designed to be delivered by trained teaching assistants to small groups of Year 1 children requiring a 'catch-up' programme. Accordingly, its effects were compared with those of the Early Literacy Support (ELS) programme (DfES, 2001) delivered to small groups of children over a period of 12 weeks. To ensure that children could receive individualized reading practice as well as training in phoneme awareness, the R + P programme alternated on a daily basis between small group and one-to-one work whereas the ELS programme was only delivered in the group.

The findings of the study were encouraging. Children in both arms of the intervention made significant reading gains and hence both programmes were deemed suitable for children who were having difficulties in the early stages of reading development. However, an important question was whether teaching assistants could deliver this

programme successfully to more significantly delayed poor readers. Since local authority policy issues depended on the answer to this question, it was necessary to run a RCT of the R + P programme (Hatcher, Hulme *et al.*, 2006).

The trial began by screening 635 Year 1 children in 16 schools on a group test of spelling. Children, aged 5–6 years, who were identified on the basis of poor performance as being ‘at risk’ were followed up (t1) with individually administered tests of letter–sound knowledge, early reading vocabulary, receptive vocabulary, and phoneme awareness. Finally, in each school, the six children with the poorest literacy skills were identified. This ‘screening + testing’ procedure led to the identification of roughly the bottom 8% of the population for early reading development in these schools. The six children identified within each school were next allocated at random to receive the R + P intervention for either a 20-week period (20-week intervention group) or for a 10-week period (10-week intervention group; these children acted as a ‘waiting-list’ control group for the first 10 weeks and then received the teaching during weeks 10–20).

After 10 weeks of daily intervention (t2), the children in the ‘20-week’ intervention group had made gains of approximately four standard score points on a test of single word reading ability, significantly more than controls in the ‘waiting list’ (‘10-week’) group who made negligible gains. After the subsequent 10 weeks when both groups had received the intervention (t3), the ‘10-week’ intervention group had caught up with the ‘20-week’ group (see Figure 2).

The intervention as a whole (pooling across the 10- and the 20-week groups) had raised the average standard score for reading for these children from 81 to 87, as the result of approximately 25 h of intervention delivered by a teaching assistant. The 20-week group made an average gain of 7.8 SS points in 33.3 h (this gain is equivalent to .23 SS pts/h, which compares favourably with international comparisons; Torgesen, 2005). Moreover, at t4, 11 months after the intervention finished, the gains they had made as a result of the intervention were maintained (69 children were available for re-assessment).

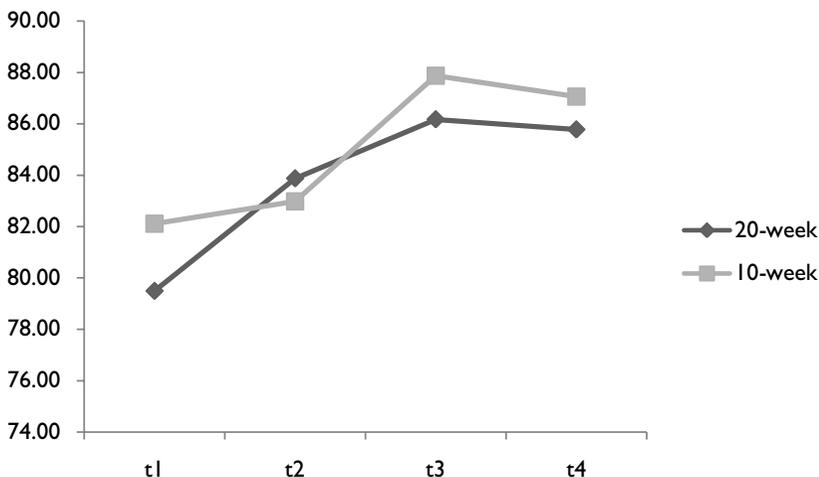


Figure 2. Performance on the BASII Reading Scale for the 20-week and 10-week (waiting control) groups between pre-intervention (t1) and post-intervention (t3) and at 11-month follow-up (t4) (standard scores).

Table 1. Percentage of children in each reading skill band at three time points

	N	<80 severe impairment (%)	81–90 moderate impairment (%)	>90 normal range (%)
Pre-intervention (t1)	77	36	56	8
Post-intervention (+20 weeks; t3)	68	25	34	41
Follow up (+11 months; t4)	68	29	32	38

Given the nature of the screening procedure adopted in this study, a range of reading levels were represented in the children who were identified. Table 1 shows the number of children within each of three ability bands across the sample as a whole at t1, t3, and t4. There was a clear shift in the distribution of test scores over time. At the beginning of the intervention, 8% of the sample were average readers compared with 36% after the intervention. These are significant gains given the nature and severity of these children's early reading problems and the relatively brief intervention they received.

Thus, we have good evidence, based on several cycles of the virtuous circle that a theoretically motivated intervention, building on two sorts of evidence (the importance of phonological awareness to reading development and the need to incorporate training directly targeting mappings between orthography and phonology) provides an effective strategy for improving children's decoding skills. However, it is also important to consider the longer term outcome of this kind of intervention. To make an informal assessment of this issue, 54 of the children who received R + P intervention in Year 1 were traced and re-assessed mid-way through Year 6 in primary school (21 of the original sample had moved away). Each child was administered the *BAS-II Word Reading* scale to provide a direct comparison with tests given in the first phase of the research. Also, to provide an assessment of prose reading accuracy, fluency and comprehension, they were given the *York Assessment of Reading for Comprehension (YARC) Passage Reading* test (Snowling *et al.*, 2009). This test requires children to read a passage and to answer questions based on it. It also provides an estimate of reading fluency.

The findings of the follow-up assessments in Year 6 are given in Table 2, together with the mean reading attainment of the sample at the end of the intervention for comparison purposes.

As Table 2 shows, the children had maintained the gains they had made during the intervention and on average, both prose reading accuracy and text comprehension (TC) skills were within the typical average range. Moreover, although the attrition rate was relatively high (27%), the children who remained in the cohort did not differ from those lost to sample in BAS reading skill at any of the previous test points; in fact, there was

Table 2. Performance of the children who received R + P intervention when re-assessed in Year 6 (standard scores)

	BAS reading post-intervention (t3)	BAS reading follow-up (t5)	YARC accuracy	YARC reading rate	YARC comprehension
Mean	86.4	88.8	98.3	88.4	96.8
SD	12.6	13.9	10.7	10.0	9.9

a trend for them to do better. Notwithstanding this, it can be seen that the outcomes of the children were less good in terms of reading rate. This finding is a common one in intervention studies with poor readers and a recurrent theme is how to improve the reading fluency of poor readers. The issue is of particular importance for readers of transparent languages, such as Italian or Finnish, in which even poor readers can reach a good level of accuracy in reading but the process remains slow and effortful with a detrimental effect on comprehension.

At the time of writing, there is limited understanding both of the causes and the treatments for poor reading fluency. Views differ as to whether slow reading is a consequence of generally slow speed of processing or whether it is more specific to the decoding of printed words. As Torgesen (2000) has argued, difficulties with fluency may represent the cumulative effect of years of poor reading and hence a small sight vocabulary. Although a number of programmes that incorporate 'repeated reading' are bringing about positive effects (Levy, 2001; Morris *et al.*, 2010), it might be argued that the lack of good evidence concerning the causes of poor reading fluency has limited progress in interventions. Here the virtuous circle is still seeking a theory!

Interventions to promote reading comprehension

For many children, poor decoding skills pose a bottleneck to understanding. For such children, an intervention to promote the development of word-level decoding skills is entirely appropriate. However, for children who have more specific problems with reading comprehension (poor comprehenders), a different form of intervention is needed.

A meta-analysis of reading comprehension interventions designed for typically developing children reported that the eight most effective methods for improving text comprehension were comprehension monitoring, co-operative learning, graphic/semantic organizers for learning new vocabulary, story structure training, question answering, question generation, summarization, and multiple strategy teaching (National Reading Panel, 2000). However, growth in understanding of the specific problems of poor comprehenders has not yet been matched by an evidence base regarding the efficacy of theoretically motivated intervention programmes.

Oakhill and colleagues in the United Kingdom carried out some of the earliest studies of interventions for poor comprehenders using controlled studies. Yuill and Oakhill (1988) developed an intervention that focused on inferencing skills for skilled and less skilled comprehenders aged 7 years. Less skilled comprehenders benefited significantly more from inference and comprehension training than decoding training, and gains in individual scores were particularly impressive for training in inferencing skills with reported improvements in comprehension age of 17 months. Oakhill and Patel (1991) evaluated the potential of mental imagery training for improving reading comprehension skill. Poor comprehenders benefited more from imagery training than good comprehenders, suggesting that mental imagery may either increase the engagement of the children with the stories or help to circumvent verbal working memory limitations. In a similar vein, Johnson-Glenberg (2000) examined whether poor comprehenders would benefit more from a visual or a verbal training programme. The verbally based RT programme (Palinscar & Brown, 1984) was compared to a visually based visualizing/verbalizing programme (Bell, 1986). Fifty-nine poor comprehenders assigned to either one of the training programmes or a control group participated in small-group teaching over 16 weeks. Both training programmes were equally effective in

improving poor comprehenders' reading, language, and memory skills associated with reading comprehension ability.

With these findings as a backdrop, Clarke, Snowling, Truelove and Hulme (2010) went on to run an RCT to evaluate the efficacy of three comprehensive reading comprehension training programme for poor comprehenders. The theoretical rationale behind the design of these interventions came from reports of the putative causes of poor comprehension. There are two alternative hypotheses regarding the origins of poor reading comprehension. According to Nation (2005), the difficulties of poor comprehenders can be traced to Oral Language weaknesses and recent longitudinal evidence confirms these are evident before learning to read and not just a consequence of poorly developed reading skills. In contrast, Oakhill and colleagues (Cain, 2010) have highlighted problems with text-based meta-cognitive strategies and inferencing skills. Accordingly, one intervention targeted OL skills, another text-based strategies and a third comprised an integrated programme of OL training and text-level work. Children within each school were randomly allocated to receive one of these three forms of intervention, or assigned to a waiting list control group.

Each of the active interventions was a comprehensive programme designed for delivery by trained teaching assistants. The Text Comprehension programme comprised four components: meta-cognitive strategies, reading comprehension, inferencing from text, and written narrative. A typical session would include children reading aloud a short passage and completing comprehension questions about that passage. They would then be taught about a particular strategy that they could use to help them to answer the comprehension questions. The children would next practice the strategy before moving on to complete an activity based on the four key skills (clarification, summarization, prediction, question generation) included in the RT approach to supporting reading comprehension.

The structure of the OL programme was similar to that of the TC programme, with the four components being: vocabulary, listening comprehension, figurative language, and spoken narrative. Each session would typically begin with a 'word of the day' taught primarily using the multiple context learning (MCL) approach (Beck, McKeown, & Kucan, 2002). The MCL approach was supplemented with additional vocabulary activities including graphic organizers, verbal reasoning, visual and physical mnemonics, and illustrations. After this, children would listen to a passage and practice the four key skills included in the RT approach to supporting reading comprehension (clarification, summarization, prediction, question generation).

The Combined programme included all eight components from the TC and OL programmes and, within each session, children were given the opportunity to both read and listen to sections of the same passage; while the combination of components varied the sessions always included two components from one programme and three components from the other. Because the narrative component required a degree of continuity across sessions, the children in the COM programme spent the first 10 weeks of the programme creating a spoken narrative and the second 10 weeks producing a written narrative.

This trial, known as *README* (short for *reading for meaning*) began by screening all Year 4 children (aged 8–9 years) in 20 participating schools to identify children whose general cognitive ability was within the normal range and who demonstrated age-appropriate decoding skills alongside relatively weak comprehension skills. Three group-administered tests were selected for this purpose; a test of spelling, listening comprehension (as a proxy for reading comprehension), and non-verbal IQ. In each

school, the children who achieved the lowest scores on the listening comprehension task relative to their peers were identified. Of these, those with age-appropriate spelling and non-verbal ability above 80 were selected to complete individually administered tests of reading fluency (TOWRE; Torgesen, Wagner, & Rashotte, 1997) and reading comprehension (NARA II (Neale, 1989)). Data from each school were ordered according to the magnitude of the discrepancy in standard score points between NARA II reading comprehension and TOWRE word reading efficiency and the eight children with the greatest discrepancies within the sub-sample tested from their year group were chosen as suitable candidates for the intervention. The interventions were delivered by trained teaching assistants who were supported throughout the trial. Each child received one individual session and two sessions with a peer in a dyad each week for 20 weeks.

The primary outcome of the study was reading comprehension ability assessed by two standardized measures: NARA II and the Weschler Individual Achievement Test 2nd Edition (WIAT II; Wechsler, 2005). Secondary outcomes were assessed using a range of measures tapping specific abilities targeted in the intervention programmes including listening comprehension, vocabulary, and figurative language. Assessments of numerical skills were included to provide a control measure on which children in the intervention groups were not expected to differ from those who received the intervention.

The findings of the study were clear. At t3, immediately after the intervention had finished, all three intervention groups made significant gains on the WIAT test of reading comprehension relative to the waiting control group (the effect sizes (d) here ranged between .59 and .99). At t4, 11 months later, the absolute gain of the group who had received the OL programme increased to almost seven standard score points ($d = 1.24$) over that of controls. Gains on the NARA II were less impressive and for this measure, there were no statistically significant gains relative to the control group who also improved (perhaps because of practice effects). The OL intervention group also significantly outperformed the control group on the WASI measure of vocabulary and both the OL and COM groups (but not the TC or control groups) showed improved knowledge of vocabulary and idioms. As expected, none of the intervention groups made significant gains relative to the control group on a measure of arithmetic (WIAT II Numerical Operations), showing that the interventions had specific effects on reading, that did not generalize to other areas of the curriculum.

The study design used here does not permit a clear answer to the important question of which components of the different interventions caused the gains in reading comprehension ability. However since two of the interventions also brought about significant gains in vocabulary, it seemed likely that growth in vocabulary might be one cause of improvements in comprehension skill. In line with this hypothesis, a mediation analysis revealed that for children in the OL group, gains in comprehension score at t4 were partially mediated by a composite measure of vocabulary at t3, and for the COM group, this score fully mediated comprehension outcome. The measure of vocabulary here was based on children's ability to provide definitions to words they had been taught in the intervention (as well as untaught words). This is a complex measure that likely reflects children's ability to benefit from a language intervention, as well as their ability to express the knowledge they have acquired as a result of the intervention. Nevertheless, the results of these mediation analyses suggest strongly that one aspect of children's OL skills (their ability to acquire and express vocabulary knowledge) is one cause of the improvements in reading comprehension seen in two of the interventions studied. This, coupled with the strong effect of the OL programme at t4, provides

evidence for the theory that difficulties with reading comprehension frequently arise from OL comprehension difficulties (that include, but are not restricted to, limitations of vocabulary knowledge).

In summary, although the bulk of research focusing on interventions for children with poor reading comprehension has focused on building meta-cognitive strategies that will increase engagement with written texts and enable children to process them more efficiently, this form of training was less effective in the longer term for poor comprehenders than an intervention that focused on OL skills. While arguably counterintuitive, these findings are what might be expected if the proximal cause of reading comprehension impairments is OL difficulties. This is a clear example then of the virtuous circle; the OL intervention was theoretically motivated (and possibly counterintuitive since it did not directly target the behavioural manifestation of the problem). The fact that it was found to be effective, and its positive effects were mediated by gains in vocabulary, provide support for a causal hypothesis. The findings from this study showing the critical role of vocabulary, also lead to a refinement of the causal hypothesis about the role of language difficulties in causing reading comprehension problems.

The issue of poor responders

Definitions of dyslexia acknowledge that for a minority of children, reading problems are severe and persistent and response, even to effective, well-implemented intervention is poor. In the R + P intervention study reported above (Hatcher, Hulme, 2006), 28% of the 20-week and 21% of the 10-week intervention group had standard scores below 80 at the end of the intervention (2% of the Year 1 population that was sampled). Moreover, children varied in their responsiveness to the teaching they received and about a quarter could be defined as treatment 'non-responders'. (This term is used advisedly; the children had made gains in letter-sound knowledge and phoneme awareness but they showed no 'catch up' in terms of a gain in standard score on the reading test.)

These children were typically those with more severe phonological impairments and poor vocabulary skills and they tended to have problems in attention control. Figure 3 shows the progress of the 'non-responders' in the intervention cohort against the progress of those who responded. Although most children showed good progress in response to the intervention, the figure shows that those who were slow to respond had severe and persistent reading impairments.

Similar findings have been reported by a number of investigators in the United States working within the 'RTI' framework. According to a review by Nelson, Benner, and Gonzalez (2003) six broadly defined learner characteristics significantly predict individual differences in RTI: poor RAN ($d = .51$), problem behaviour ($d = .46$), poor phoneme awareness ($d = .42$), poor understanding of the alphabetic principle ($d = .35$), poor memory ($d = .31$), lower IQ ($d = .26$). In contrast, demographic factors such as social class and broader *OL skills* (vocabulary and grammar) are less good predictors of RTI and poor readers with an experiential basis for their reading delay should be expected to show a good response to early reading intervention (Vellutino *et al.*, 1996).

In summary, there is accumulating evidence that children who fail to respond to intervention in well-founded programmes are those who have poorly developed phonological skills, often coupled with behaviour problems. It is clear that these children require longer term and/or more intensive support. However, as yet, there is a dearth of evidence concerning the precise form such programmes should take, and how effective

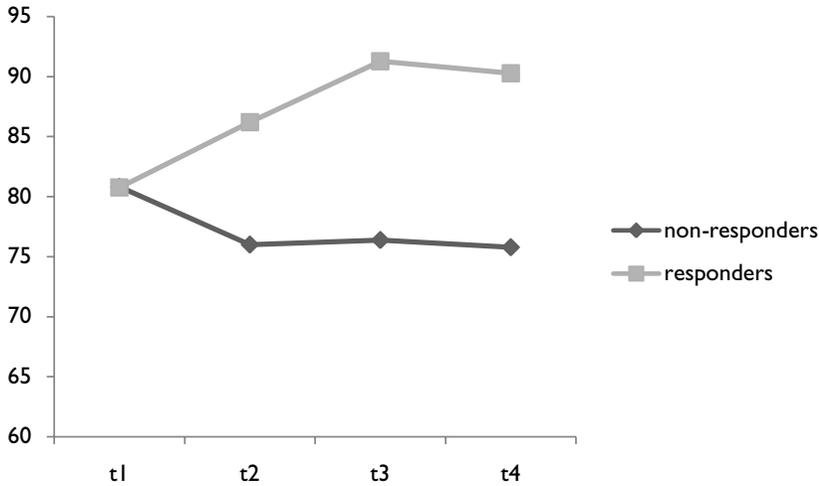


Figure 3. Performance over time of children who show poor response to effective intervention compared with that of responders.

we can expect them to be (see, Duff *et al.*, 2008 for a preliminary study). Remembering the ‘virtuous circle’ the findings of this study have implications for theory too. First, in line with theory, it is the children with the weakest phonological skills who appear to have the most difficulty with reading. But their ‘resistance’ to intervention suggests other factors may be involved. Two alternative hypotheses might be posed: the first refutes a single deficit view of dyslexia. Perhaps in some children, dyslexia can be traced to OL difficulties that in turn impact phonological awareness? This would require modification of the simple causal model we began with (Hulme & Snowling, 2009). Second, it invites further research on how problems of attention control are related to dyslexia (e.g., Gooch, Snowling, & Hulme, 2010).

Is it possible to prevent reading difficulties?

It is important to bear in mind, that the majority of variance in reading outcome, as well as in broader measures of educational attainment, can be accounted for by individual differences in the skills with which children enter school (Snowling, Stothard, & Bishop 2000; Wagner, Torgesen, & Rashotte, 1994). Prima facie, this is an argument for focusing interventions on early stages of development. In addition, in the early years there is less stability in language development and hence, it can be argued this presents an opportunity to foster the skills that children need to be effective learners.

With studies of effective interventions for poor readers as a backdrop, prevention studies aim to identify children ‘at risk’ of reading failure early and to provide training to boost foundation skills such as phoneme awareness, phonics and decoding. In the United States, ‘classroom-based’ interventions that capitalize on the professional education of teachers to enable them to foster reading in at-risk children have enjoyed some success, particularly when the teaching they delivered included explicit code instruction (Fletcher *et al.*, 2007 for a review). Likewise in the United Kingdom, Hatcher, Hulme, and Snowling (2004) implemented a whole-class intervention involving direct instruction in phonics together with reading from real books during the first five terms of primary

school. Teachers were randomly allocated to one of four groups that delivered either this phonics teaching alone or a similar regime, supplemented by training in phoneme awareness, rhyme awareness or phoneme + rhyme. Children in the upper two-thirds of the class on measures of phonological and language skills learned to read equally well regardless of the teaching programme they received. However, those in the bottom third, deemed to be 'at risk', fared significantly better if the programme was supplemented with training in phoneme awareness.

A more common approach to the teaching of 'at-risk' children involves small group or one-to-one tutorial support on a regular basis outside of the mainstream classroom. In one of the first studies to evaluate such an approach, Vellutino *et al.* (1996) identified children scoring below the 15th centile in reading after the first semester of Grade 1 to receive a daily 30-min intervention programme. The programme included explicit training in phonics, and phoneme awareness as well as activities to reinforce emerging skills in reading and writing and text-based comprehension strategies. By the end of just one semester, 70% of students were reading within the average range for their age, and those who caught up tended to retain their skills through to follow-up in Grade 4. The remaining children who 'failed to respond' were characterized by more severe phonological difficulties in kindergarten and first grade than their peers (although they did not in this study differ in terms of broader OL skills).

A more systematic comparison of different forms of early intervention was conducted by Torgesen *et al.* (1999). The study involved 180 children at risk of reading difficulties who received intervention from kindergarten through Grade 2. Following identification in kindergarten, the children were randomly allocated to receive one of three interventions or assigned to the control group who received regular 'best practice'. The active interventions were: 'embedded phonics' involving training in phonological awareness and synthetic phonics (PASP) embedded in word reading and spelling activities, 'phonics instruction' in the context of reading and spelling and regular support to reach the objectives of the mainstream classroom. While children in all three interventions gained higher scores than the control group on measures of word reading, those who received the PASP programme outperformed the other groups in terms of gains in alphabetic skills (that skills that offer the most generalization). Moreover, at the end of Grade 2, the children in the PASP group who received the most explicit instruction in alphabetic skills had much stronger reading skills on average than the children in the other groups. It is notable nonetheless that about a quarter were still reading below average levels.

In the United Kingdom, there has been recent interest in early intervention in the pre-school years targeting language skills, which arguably feed into literacy development (e.g., Dockrell, Stuart, & King, 2006). Although the impact of such interventions can be positive in the short term, few studies have followed children into school and therefore the longer term consequences for literacy cannot be judged. Beginning with somewhat older children, Bowyer-Crane *et al.* (2008) evaluated the efficacy of two early intervention programmes to promote the language skills that underlie reading development in an RCT. Building on evidence that poor readers make significant gains in progress when they receive training in letter-sound knowledge, phoneme awareness, and reading, one programme involved a 'downward extension' of Hatcher's (2000) programme, adapted to be suitable for children in the very early stages of reading instruction; the 'Phonology with Reading' (P + R) programme. The second intervention aimed to boost OL skills, the rationale being that such skills would contribute to the development of reading fluency and strengthen the foundations of reading comprehension. This 'OL' Programme incorporated four key elements; vocabulary training, narrative work,

independent speaking, and listening skills. Both programmes were highly structured and used multi-sensory teaching techniques and were delivered by trained teaching assistants who were supported during the 20-week intervention phase (see Carroll, Bowyer-Crane, Duff, Hulme, & Snowling, in press for more details). Progress was monitored from pre-test (t1) through mid-test after 10 weeks (t2), to post-test at the end of the 20-week intervention (t3) and 5 months after the intervention had ceased to assess maintenance of gains (t4).

Given the nature of the trial, it was important to assess gains in reading-related and language-related skills in both groups of children. Key measures included tests of phoneme awareness, early literacy measures and tests of vocabulary, grammar, and narrative skills. Data analyses compared the effects of the two alternative treatments (P + R or OL) controlling for the clustering of data in schools and where possible for baseline performance (the auto-regressor). Since there was no untreated control group in this study, the focus was on the differential benefits of the two intervention programmes. In line with expectations, children who received the P + R programme did significantly better on tests of phoneme awareness, letter-sound knowledge, basic reading, and spelling skills than children who received the OL programme, whereas those who received the OL programme did significantly better on tests of vocabulary and grammar and there was a trend for more improvement in narrative skills. Moreover, the relative gains were maintained 6 months later when the P + R group also did better on a test of non-word reading, suggesting that the teaching had promoted independent phonic decoding skills.

Another way of considering these findings is in terms of how well the interventions could 'lift' children from the 'at risk' to the typical range of reading and language skills for their age. Data from some 500 of these children's classroom peers at time 4 of the study were used as a benchmark against which to evaluate the relative standing of the intervention groups. With respect to reading development, a standard score below 85 was used to classify children as being 'at risk' of literacy difficulties. At the end of the intervention, 68.1% of the OL group remained at risk on this criterion compared with only 50% of the P + R group. Moreover, 7.1% of children in the P + R group now had above average reading scores (greater than 115), while none of the OL children had scores in this range.

A limitation of the trial of Bowyer-Crane and colleagues was that it did not include an untreated control group. Therefore, there is no way of knowing what the benefits of the interventions were in absolute terms. In terms of our virtuous circle, these findings confirm that OL difficulties are risk factors for reading impairment - because the group who received the OL training (and did not receive intervention to promote early reading) lagged behind in reading skills. Moreover, they underline the need for interventions to be specifically targeted. The lack of transfer of OL training to reading skills suggests language and phonological skills are modular systems or dimensions that underpin reading development (and its difficulties; see Bishop & Snowling, 2004). In terms of practice, the findings show conclusively that early intervention programmes can be delivered successfully by teaching assistants to 5- and 6-year-olds at risk of literacy difficulties, a finding echoed by Bianco *et al.* (2010) who reported a recent trial along similar lines with French children.

Implementation

The focus of this review has been on the characteristics of poor readers and related to this, the content of interventions. Aside from learner and programme characteristics, instructional factors may also contribute to responsiveness to intervention. Under research conditions, tuition is likely to be carefully implemented, supervised and monitored; however such circumstances are not the norm in everyday school situations and this can have consequences for learning outcomes (Carter & Wheldall, 2008). We discuss here one example of successful implementation that took forward Hatcher *et al.*'s R + P intervention into a field trial led by North Yorkshire Local Authority.

In the first year of this implementation (2005–2006), 50 teaching assistants and one teacher from 38 primary schools undertook a 4-day training programme delivered by members of the local authority in six venues across the county (coordinated by Glynnis Smith, then the Consultant in Inclusion). Following training, the 'trainees' delivered the R + P programme to 142 children, the majority being children in Year 1. Children received an average of 38 sessions in a 10-week period and the teaching assistants tested the children before and after they carried out the intervention. On average, children made over 7 months progress in reading age during the 10-week period (Simon Gibbs, unpublished data). Gains were also evident in writing levels that increased, on average, by 1.3 sub-levels over the 10-week period.

In the second year of this implementation (2006–2007), 102 teaching assistants from 92 schools undertook the 4-day training programme. In addition, they received four or five follow-up tutorials while they were delivering the intervention. During this phase, the 'trainees' delivered the R + P programme to 148 children, with the number of sessions they received varying between 10 and 50, with an average of 34 sessions. On average, the children progressed from a reading age of 6 years 5 months to a reading age of 7 years 3 months. This amounts to an increase in progress of 10 months in reading age during the 10-week period and, according to the local authority's data, just over 70% of the children made more than 6 months progress in reading during the course of the 10-week intervention. These gains were associated with gains in phoneme awareness and letter knowledge but, as in research trials, some children showed poor response: in fact, six children (4%) made little or no progress (less than 3 months) and can be considered in need of more prolonged or intensive support.

Many of the research-led interventions described in this paper, as well as the interventions in these field trials, have been implemented by trained teaching assistants. More generally, in the United Kingdom, there has been a substantial increase in the number of teaching assistants employed in schools over recent years and many now support children with Special Educational Needs (Blatchford *et al.*, 2009). An issue that attracts considerable debate is whether it is appropriate for such less qualified staff to be supporting children who are often the lowest attaining and hence most vulnerable learners. The data presented here provide good evidence, in line with Albers, Pearson, Farrell, and Howes (2009), that, under certain conditions, teaching assistants can have a positive effect on pupil progress. In order to do so, we would argue that teaching assistants need to be properly trained, prepared, and adequately supported in their role.

Closing the circle: Implications for theory and future research

This review began by laying out the predictors of individual differences in reading and thereby defining the cognitive and linguistic skills that are the foundations of literacy. If, as findings of longitudinal studies suggest, these predictors are causally related to reading outcomes, and deficits in these skills are the proximal cause of reading failure, then training these skills should promote reading skills.

The evidence from decoding is in line with what might be predicted given the hypothesized causal chain. Training in letter–sound knowledge and in phoneme awareness brings about improvements in decoding, and these can be seen in non-word reading. It seems that this form of intervention is effective whether it be provided very early, shortly after formal reading instruction has started, or at a later date, though the longer intervention is delayed, the likely greater the impact on motivation to read and hence on print exposure. In less than auspicious circumstances, the downward spiral from poor reading will be poor reading fluency at the least and often in addition, poor educational attainment and low self-esteem.

Many children with poorly developed OL skills are at risk of reading failure because they have poor phonological awareness (Bishop & Snowling, 2004). A second theoretical prediction that follows from this is that training in OL skills should generalize to phoneme awareness. The data presented here, however, do not support this hypothesis. While training in OL has beneficial effects on the components that are taught (e.g., vocabulary and grammar), there was no direct benefit for phoneme awareness or for decoding, at least not in the early years.

A third theoretical hypothesis tested here is that the specific causes of reading comprehension difficulties can be traced to OL weaknesses, particularly in semantic and grammatical skills. In line with this view, an effective intervention for poor comprehenders was one that incorporated training in vocabulary, figurative language, and oral narrative skills.

There are however, many questions still left to be answered. One crucial issue is when is it best to intervene? Theories of brain plasticity suggest that interventions should be early in development but against this is the idea that children need a degree of readiness in order to develop the meta-linguistic skills required to learn to read a symbolic code (Gombert, 1992). Furthermore, although direct teaching of TC strategies was not as effective for 9- to 10-year-olds with specific reading comprehension difficulties as an OL intervention, text-based approaches that rely more heavily on meta-cognitive skills might well be more effective for students in secondary schools settings. More generally, there is a dearth of evidence on what works beyond the primary years and the early stages of learning to read, and for children from special groups (cf. Goetz *et al.*, 2008; Lemons & Fuchs, 2010).

Closing the circle: Implications for practice

The findings of this review have clear implications for practice.

- Individual differences in language development affect the course of learning to read.
- Children with poor phonological skills are at risk of decoding difficulties/dyslexia.
- Children with broader OL weaknesses (particularly weaknesses in vocabulary knowledge and grammatical skills) are at risk of reading comprehension difficulties (this

includes children with a poor command of English because it is not their native tongue).

- Early identification of language difficulties is possible using check lists or simple screening tests (e.g., for language, a measure of expressive vocabulary/naming; for phonological difficulties, a test of non-word repetition).
- It is not necessary to wait until a child has a reading problem or a 'diagnosis'; early intervention to promote the foundations of reading (*via* explicit training in phoneme awareness and letter knowledge) is beneficial and can be delivered by trained Teaching Assistants.
- As advocated by Rose (2009), a tiered approach to intervention whereby accommodations are first made to high-quality mainstream teaching, then more specific interventions are delivered, makes sense.
- OL skills, such as vocabulary, grammar, and narrative skills can be fostered as early as pre-school to provide a firm foundation for the development of OL (which is important in its own right) as well as reading comprehension.
- OL approaches incorporating vocabulary development and listening comprehension can be as effective (or possibly more effective) as a treatment for reading comprehension difficulties as text-based approaches.
- The impact of interventions should be monitored to identify RTI.
- When response to a well-founded intervention is poor, it is important to consider the possibility that co-occurring difficulties are affecting progress and may require separate treatments.

Conclusions

During the past 10 years, research on interventions for language and literacy has begun to influence policy, as evidenced by the implementation of the Rose Review of Early Reading (2006) throughout primary schools in England. However, there are still far too many interventions that lack an evidence base being rolled out in schools. There is an urgent need for practitioners to adhere to guidance such as that embodied in *What works for children with literacy difficulties?* (Brooks, 2002) and, through their knowledge of evidence, secure the confidence of parents who otherwise can easily 'buy in' to unproven approaches. The review presented here is not comprehensive but serves to demonstrate a methodology within which the design of interventions builds on theoretical understanding of the causes of reading and language difficulties, and their evaluation involves robust experimental trials. However, it is worth noting that, no matter what the approach, many children with reading difficulties or 'dyslexia' require an individualized approach that is ongoing and many need to continue through the school years. Interest is already turning to examine the neurobiological bases of individual differences in learning. Yet there remains a significant research agenda calling for more behavioural trials if the virtuous circle between theory and practice is to be closed and policy makers informed about effective interventions for language and literacy.

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