

# Reviewing evidence-based practice for pupils with dyslexia and literacy difficulties

Yvonne Griffiths and Morag Stuart

Institute of Education, University of London, UK

There is now a strong evidence base from theory and research providing a ‘template’ to inform practice at Wave 2, guiding the design and implementation of time-limited effective early intervention programmes for pupils identified as ‘at risk’ of reading difficulties following initial literacy instruction (Rose, 2009). In contrast, there is currently an absence of evidence to guide the more fine-grained selection and design of specific interventions (Wave 3) for those nonresponders to otherwise effective reading intervention. In this paper, we first outline our current understanding of the characteristics of effective early intervention programmes, and of the pupils who do not respond. Three theoretically motivated single-case studies from developmental theory and processing models of skilled performance are then considered as a source of evidence providing useful insights into the type of assessment needed to inform the planning of highly individualised intervention programmes for pupils with severe and persisting literacy difficulties.

Recent government-funded reports from different parts of the English-speaking world have emphasised the importance of basing literacy teaching practices in reliable research evidence that can provide a guide as to what might constitute best practice (e.g. Australia: Bond et al., 2010; Rowe, 2005; UK: Rose, 2006, 2009; USA: Report of the National Reading Panel [NRP], 2000). These reports cover both best practice in initial teaching for all pupils at different levels of development (known in the United Kingdom as Wave 1 Quality First Teaching and in the United States as Tier 1) and best practice in intervention for those falling behind despite high-quality Wave 1/Tier 1 teaching. In both the United Kingdom and the United States, there are two levels of intervention, Wave 2/Tier 2 and Wave 3/Tier 3.

In the United States, following the publication of the report of the National Reading Panel (NRP), and in the United Kingdom, following the publication of the Rose report, there were nationwide initiatives to encourage evidence-based practice in the early teaching of reading. In both countries, these included a welcome increase in provision of tightly focused continuing professional development for teachers, and recommendations for or provision of teaching materials based on the findings from these respective reports. These initiatives (‘Reading First’ in the United States; Communication, Language and Literacy Development [CLLD] in the United Kingdom) have influenced what is now considered to be high-quality Wave 1/Tier 1 teaching. National evaluation of the effects

of Reading First in 2008 indicated the programme had not been successful in improving reading comprehension, although there was evidence of significant improvement of decoding skills in Grade 1 (the only grade in which these were measured). However, it has been argued that flaws in the design of the national evaluation study render its findings unreliable, and statewide evaluations in several states have shown steady improvement in reading following implementation of Reading First (e.g. Foorman, Petscher, Lefsky & Toste, 2010; Haager, Dhar, Moulton & McMillan, 2009). Results from the CLLD programme in the United Kingdom show a steady increase in the percentage of children working securely within the literacy scales of the Early Years Foundation Stage Profile, from 49% in 2007 at the start of CLLD to 59% in 2010. Both initiatives emphasised the need for ongoing focused assessment of children's progress, which allows earlier identification of children failing to keep up, and this in turn allows for earlier implementation of Wave 2/Tier 2 intervention.

In the United Kingdom, Wave 2 intervention is defined in Rose (2006, p. 45) as 'additional interventions to enable children to work at age-related expectations or above'. Wave 2 interventions are time-limited, have clear entry and exit criteria and are delivered either one-to-one or in small groups. Wave 3 is defined as 'additional, highly personalised interventions'. Wave 3 interventions are for children whose learning needs are often severe and who require a programme tailored to their individual needs, delivered on a one-to-one basis and providing ongoing support for learning.

In the United States, Tier 2 intervention consists of small group (three to five pupils) supplemental instruction to support and enhance Tier 1 teaching. It is usually delivered for 15–20 weeks with at least three sessions per week. Tier 3 intervention is intended for pupils who fail to respond to Tier 2, and involves more frequent and intensive support through an individualised teaching programme, following multidisciplinary evaluation of a pupil's learning needs (Fuchs & Fuchs, 2005). As the underlying concepts of Waves 1, 2 and 3 in the United Kingdom are so similar to those underlying Tiers 1, 2 and 3 in the United States, in the interests of brevity we will use a single term, Waves, to include reference to both waves and tiers of intervention.

Following recommendations in the Rose report (Rose, 2009) on identifying and teaching children and young people with dyslexia and literacy difficulties, the UK government made provision for the training of 4,000 additional specialist dyslexia teachers. These specialists are traditionally involved in the design and supervision of Wave 2 interventions, and in designing and implementing Wave 3 individual teaching programmes for pupils with severe and persistent reading and spelling difficulties.

Shaywitz, Morris and Shaywitz (2008) argue that research findings to date have provided us with 'an overall template for providing reading interventions to dyslexic students' (p. 466), but that there is not yet evidence that can guide more fine-grained selection of specific interventions for individual struggling readers. This is to neglect a further source of research evidence that is available from theoretically motivated single-case intervention studies. In the present paper, we suggest that different kinds of research evidence are needed to underpin best practice in teaching reading and spelling skills to pupils at Wave 2 from those that are needed at Wave 3. We agree with Shaywitz and colleagues that findings from group intervention studies provide an overall template to guide intervention, and show how this guidance is able to inform practice at Wave 2. We then turn to theoretically motivated single-case intervention studies to examine whether these can provide additional useful insights and fine-grained guidance for practice at Wave 3.

## Wave 2: characteristics of effective interventions

### *A note on methodology*

There have been a number of large-scale systematic reviews of published research-based studies evaluating the efficacy of well-controlled reading intervention studies for word-level reading difficulties (Ehri, Nunes, Stahl & Willows, 2001; Ehri, Nunes, Willows et al., 2001; Scammacca, Vaughn, Roberts, Wanzek & Torgesen, 2007; Swanson, 1999). The current review draws on evidence from both systematic and unsystematic reviews of controlled research evaluating phonological-based reading interventions for dyslexia (Reynolds, Wheldall & Madelaine, 2010; Torgesen, 2002a, 2002b, 2005; Vaughn & Roberts, 2007). The most rigorous method for evaluating the efficacy of interventions is the use of a randomised control trial, where children are randomly assigned to either an intervention or a control group. Evidence from the small number of randomised-controlled studies evaluating early reading intervention are reviewed (Hatcher, Hulme & Ellis, 1994; Hatcher et al., 2006; Mathes et al., 2005; see Torgerson, Brooks & Hall, 2006 for a review of evidence from RCT studies), but the majority of studies included in the review are large-scale, well-constructed, quasi-experimental studies which include a comparison group (for a discussion of methodology, see Carter & Wheldall, 2008; Troia, 1999). Evidence is evaluated from intervention studies targeting early reading instruction for younger children identified as ‘at risk’ of dyslexia during the first few years of formal literacy instruction at school, or reading instruction for older pupils identified as dyslexic (aged between 7 and 12 years) on the basis of moderate to severe, persisting word reading difficulties (e.g. Torgesen, 2005). All of the studies reviewed define dyslexia (or reading disability) as a word-level reading difficulty, which requires explicit instruction in phoneme awareness (PA) and phonemic decoding skills.

There is variation across early Wave 2/Tier 2 reading intervention studies in the sampling criteria to identify ‘at-risk readers’, but typically participants are selected on the basis of weak levels of PA and letter–sound knowledge (using standardised tests or teacher-based referral), following 12 months of initial whole class formal literacy instruction (Wave 1). Hence, at the start of an early intervention, pupils from schools in England would be entering Year 1 (P2 in Scotland; age 5–6) and in the United States, Grade 2 (6–7). There have been a small number of prevention studies targeting preschool children identified with a family risk of dyslexia (Hindson et al., 2005) or children who have just started school, in the reception year in schools in England (Hatcher et al., 2006).

Studies considered in these reviews vary in the intervention groups’ average severity of initial reading difficulty, in the use of IQ level as an exclusionary criterion, and in the method used to implement intervention (e.g. the duration of the intervention programme and individual sessions, group size and skill level of the instructor), but typically include a post-intervention follow-up to assess long-term maintenance of gains.

### *Content*

There is now a large evidence base demonstrating that early intervention programmes for children identified as ‘at risk’ of reading difficulties following initial (Wave 1) reading instruction at school are most effective in accelerating the progress in word reading when phonologically based (NRP research reviews: Ehri, Nunes, Stahl et al., 2001; Ehri, Nunes, Willows et al., 2001; Rose, 2009; Vellutino, Fletcher, Snowling & Scanlon, 2004). Several large-scale review papers of this evidence concur that the largest gains in

reading can be obtained when early intervention programmes include the explicit teaching of grapheme-to-phoneme correspondences (structured, systematic phonics), using segmenting and blending strategies, to master the *alphabetic principle* (Byrne, 1998). The most effective interventions are those delivered before Grade 2 in the United States, which is the second year of formal reading instruction when pupils are aged 7–8 years (NRP, 2000; Scanlon, Vellutino, Small, Fanuele & Sweeney, 2005; Wanzek & Vaughn, 2007). The largest gains in word-level reading can be observed for ‘at-risk’ children when structured phonics instruction is embedded within a broader literacy curriculum (Swanson, 2000), with word-level and text reading and writing exercises, to put their new phonic knowledge and strategies to use when reading or writing new words (Ehri, Nunes, Stahl et al., 2001; Hatcher et al., 1994; Wanzek & Vaughn, 2007).

There is also a strong evidence base indicating ‘at-risk’ poor readers benefit from explicit training in phonological awareness skills (specifically PA) as part of their reading intervention programme. Research evidence indicates strongest gains in PA skills are observed when no more than one to two PA skills are taught at any one time (Ehri, Nunes, Willows et al., 2001), emphasising phoneme segmenting and blending sounds in spoken words as key foundation literacy skills. Furthermore, PA training is most effective in facilitating early PA skill and accelerating early word reading, when combined with letter knowledge training (Byrne & Fielding-Barnsley, 1991; Ehri, Nunes, Stahl et al., 2001; Ehri, Nunes, Willows et al. 2001; Hatcher et al., 1994, 2006), and when instruction includes exercises to teach the application of PA in reading (words and connected text) and writing tasks (Cunningham, 1990; Hatcher et al., 1994, 2006).

In practice, when planning PA instruction, some children will require more instruction than others; nonreaders will need more PA and letter instruction than those already reading. The age of the child should be considered when selecting PA at an appropriate conceptual and cognitive level (e.g. minimising working memory demands by using pictures). Children of all abilities can be taught PA skills (Ehri, Nunes, Stahl et al., 2001), and when age-appropriate PA tasks are used, PA training (combined with letter knowledge) for preschool children with a family risk of dyslexia (Hindson et al., 2005) can lead to positive acceleration in the early development of PA skills.

There is currently less agreement about the role of teaching sight words alongside phonics instruction or in the type of text used as instructional material (e.g. real books or graded reading books: for further discussion on both issues, see Reynolds et al., 2010; Solity & Vousden, 2009). Hence, several reviews of the research evidence recommend a structured programme of phonics (gpc knowledge) should be the main emphasis of an early intervention programme for struggling readers. They also emphasise that more than just structured phonics teaching is needed if children are to become skilled and fluent readers who read with understanding, recommending a balanced approach to reading instruction/intervention which includes the following five ingredients depending on the individual needs of the struggling reader: (i) PA, (ii) phonics, (iii) text reading/fluency, (iv) vocabulary and (v) comprehension strategies (NRP, 2000). Similarly, others have used the Simple View of Reading framework (after Hoover & Gough, 1990) to emphasise the importance of instruction targeting the acquisition of a solid foundation in two essential interdependent dimensions for skilled reading – *word recognition skills* (accuracy and fluency) and *language comprehension* (Rose, 2006, 2009; see Stuart, Stainthorp & Snowling, 2008 for a discussion).

Effective intervention programmes for older pupils (aged 7–12) with moderate to severe, persisting dyslexic reading and spelling difficulties typically involve very

intensive, focused, systematic programmes of direct instruction, with a strong emphasis on structured, explicit phonics (e.g. Torgesen et al., 2001; for reviews, see Roberts, Torgesen, Boardman & Scammacca, 2008; Scammacca et al., 2007; Torgesen, 2005). The quality of the earlier Wave 1 reading instruction received by participants in the later intervention programmes is not known, hence it is not possible to ascertain whether some participants may be 'instructional casualties'. Furthermore, intervention studies included in the large-scale reviews vary in their sampling criteria (e.g. severity of pre-intervention reading disability, IQ cut-offs) and implementation (e.g. 1:1, small group). The size of gains in later interventions is typically smaller than those observed for pupils following early intervention. Nonetheless, such large-scale studies have reported evidence that some children with severe phonological difficulties can acquire phonemic decoding skills if they are taught with intensity and skill (Lovett et al., 2000; Rashotte, MacPhee & Torgesen, 2001; Torgesen et al., 2001). The rates of responsiveness are less positive than those following early intervention, ranging from 15% to 60% of pupils in any sample of dyslexics (depending on reading outcome measures) unable to make significant, long-lasting gains, when assessed up to 2 years following the end of the intervention (Torgesen, 2000, 2005). The gains in word reading fluency from phonologically based interventions are typically weaker for older pupils than for younger pupils receiving early intervention.

A small number of studies have started to evaluate the efficacy of programmes targeting 'word study instruction' (also known as 'advanced word study', Curtis, 2004) for those older pupils who have responded well to additional, sustained Wave 2 phonic (gpc) level instruction (see Roberts et al., 2008 for a review), but who continue to have difficulties decoding multi-syllabic words in text. This does not include those dyslexic pupils with persisting, severe word level reading difficulties requiring continued focus on phonics. 'Word study' intervention aims to move pupils on from the teaching of gpc phonic strategies to read monosyllabic words, to instruction targeting effective strategies to read multi-syllabic words. Programmes focus on meaning/morphology, structure (i.e. orthography – letter patterns and structural features associated with predictable speech patterns) and irregular words (Scammacca et al., 2007). Effect sizes from evaluations of the small number of studies in this area with older pupils are significant and moderate in their impact on word reading, but further research is needed to evaluate its impact on reading comprehension. In their review, Roberts et al. (2008) suggest the five areas recognised by the NRP as key ingredients for early reading intervention should be adapted for older readers to include: (i) word study, (ii) fluency, (iii) vocabulary, (iv) comprehension and (v) motivation. Low levels of motivation are a common barrier to learning (Guthrie & Davis, 2003) and a predictor of response to intervention (RTI: Duff, 2008), particularly in older pupils. Reduced reading experience following a long-lasting reading difficulty may also impact on a pupil's spoken and written vocabulary, reading fluency and effective comprehension strategies. Hence, careful assessment and diagnosis of older pupils is essential to ensure the appropriate programme of intervention is provided.

A relatively small number of large-scale group studies have reported the efficacy of phonological-based interventions to improve dyslexic spelling difficulties, but most are from studies designed to target word-level reading difficulties, where gains in both reading and spelling have been evaluated (Bryant & Bradley, 1983; Hatcher et al., 1994; Torgesen et al., 2001). While these studies report significant gains in spelling at the immediate post-test, where studies have reported results from delayed follow-up testing,

disappointing results are typically found for spelling with ‘wash out’ of the intervention effects. Similar results have been reported from a morphological-based intervention study specifically designed to target spelling difficulties in a group of 7–8-year-old children (Nunes, Bryant & Olsson, 2003).

A final caveat concerns pupils who may have good phonic decoding skills, but struggle with reading comprehension due to a specific comprehension difficulty (see Nation, 2005 for a review) and associated problems with non-phonological oral language skills. The evidence base for effective interventions for poor comprehenders is much smaller than that for dyslexia (see Hulme & Snowling, 2009 for a review), but some promising results are emerging from structured, intensive interventions targeting oral language skills (Clarke, Snowling, Truelove & Hulme, 2010). Co-occurring difficulties with dyslexia are known to include weak oral language skills (Bishop & Snowling, 2004; Catts, Adlof, Hogan & Weismer, 2005; McArthur, Hogben, Edwards, Heath & Mengler, 2000; Rose, 2009), hence some pupils with dyslexic word reading difficulties may also require intervention targeting oral language (e.g. Duff et al., 2008). Co-occurring difficulties with attention are also recognised to be an area of concern for some pupils with dyslexia, with evidence suggesting inattention is a predictor of pupils’ response to reading intervention (Duff, 2008; Rose, 2009; Torgesen, 2005). There is currently limited available evidence from research to inform the planning of intervention for pupils with complex difficulties (Rabiner & Malone, 2004), and causal theories of co-occurring developmental disorders are still in their early stages (for reviews, see Hulme & Snowling, 2009; Pennington & Bishop, 2009). Support from multiagency teams is expected when planning a programme of reading intervention and educational management.

### *Delivery/implementation*

Intervention studies described in the literature vary in the number of sessions, their frequency, number of weeks, total number of hours and group size, and few studies have systematically manipulated these variables to rigorously examine their effects (Simmons et al., 2007). Further research is needed to examine the interactions between these variables and their impact on effectiveness, but the main findings from recent reviews considering the impact of these implementation variables on reading intervention efficacy will be outlined next. It is also important to take account of the severity and persistence of the reading difficulties of programme entrants. There is need for research to investigate how ‘implementation’ impacts on individual differences in responsiveness to intervention.

*Group size.* Evidence from reviews of the literature has shown small group delivery (typically three to four pupils per adult) can be as effective as individual tutoring (1:1) when effect sizes are compared across studies employing one of these two methods of delivery (Elbaum, Vaughn, Hughes & Moody, 2000; Vaughn, Linan-Thompson, Kouzekanani et al., 2003; see also Hatcher et al., 2006). To our knowledge, only one study has manipulated group size using the same intervention programme (Helf, Cooke & Flowers, 2009), reporting equivalent levels of programme efficacy for small group instruction (1:3) relative to individual tutoring (1:1). Even with older pupils with severe and persisting dyslexic reading difficulties, there is evidence from well-controlled studies that small group intervention, when intensive (e.g. 100 hours), can be as effective as individually delivered intervention, bringing below average pre-intervention reading levels into the average range (Lovett et al., 2000; Rashotte et al., 2001; Torgesen,

Rashotte, Alexander, Alexander & MacPhee, 2003). Such findings have clear implications for costs, when making decisions about effective Wave 2 reading intervention programmes.

Of course there is likely to be an interaction between the severity and persistence of the reading impairment and intensity of the instruction required (Torgesen et al., 2003). When making comparisons across different group studies, there is variability in the pre-intervention levels of reading, ranging from moderate to severe reading difficulties (see table 27.2 in Torgesen, 2005, p. 530). In Torgesen's review of studies evaluating the efficacy of reading interventions with older dyslexic pupils, similar size gains are reported for the small group intervention studies and the individual tutoring programmes. However, inspection of the pre-intervention reading levels across studies suggests the small group studies included pupils with less severe reading difficulties (higher scores on standardised reading tests) than those included in the samples using 1:1 methods of delivery. It would be feasible to expect those pupils with the most severe reading difficulties before the intervention to be the hardest to teach. Furthermore, the suitability of small group instruction for dyslexic pupils with co-occurring difficulties (e.g. behaviour problems, inattention) should be considered, when 1:1 instruction may be more effective (Wanzek & Vaughn, 2008).

*Duration of intervention.* Typically, early intervention studies reported in the literature with children 'at risk' of reading difficulties use programmes ranging from 10 to 20 weeks (Elbaum et al., 2000; see also Vaughn, Linan-Thompson & Hickman, 2003; Vaughn, Linan-Thompson, Kouzekanani et al., 2003), and the NRP (2000) review of research evidence reported diminishing gains in PA skills following training of 12 weeks or more. Hatcher et al. (2006) were able to evaluate the effect of overall programme duration in their small group intervention study for children struggling with reading after the first year of whole class literacy instruction. Using an RCT design, the experimental group received an intervention programme over a 20-week period (62 hours in total, over two school terms), with alternating daily small group and individual sessions (*small group*: 25 × 20-minute sessions with 3 pupils per tutor, targeting letter-sound learning [phonics], phoneme identification/linkage and writing activities; *1 to 1*: 25 × 20-minute sessions for the reading of graded texts).

The waiting control group received the same content and implementation, but over a shorter duration of 10 weeks (31 hours in total, over one school term). Nonetheless, similar size gains were observed for both groups (maintained over the 11 months after the intervention had ended) in letter knowledge, single word reading and PA. The gains observed for the intervention group began to taper off after the initial 10 weeks, with the waiting control group only needing 10 weeks to catch up to the post-intervention literacy levels of the intervention group (after 20 weeks). These results suggest efficacy is not improved by providing early interventions of longer duration for pupils not making progress after the initial 12 months of literacy instruction at school. However, despite the overall significant gains in literacy for the group as a whole, approximately a quarter of the participants did not show any acceleration in reading progress, suggesting the need for more intensive and sustained intervention to improve their reading.

Similar findings were reported by an early intervention study of atypical length by Torgesen et al. (1999), who taught 135 5–6-year-old children with low levels of letter-sound knowledge and PA skills on a 1:1 basis over 2 years (20 minutes a day for 4 days per week). Despite the intensity of this programme, up to 34% of the children were

reported as making limited or no progress (reading levels falling below the 30th centile), consistent with the response rates reported by other studies of shorter duration, where nonresponse rates range from 11% to 35% (Hatcher et al., 2006; Torgesen, 2002a, 2002b).

In one of the few 'prevention studies' reported in the literature, Hindson et al. (2005) investigated the efficacy of a phonological-based programme for preschool children (4–5-year-olds in Australian schools) with a family risk of dyslexia. The programme involved training phoneme identity skills, combined with letter knowledge and structured book reading. Participants received 30-minute sessions, typically two to three times per week, continued until they reached criterion (with a maximum of 17 sessions). The 'at-risk' children required 'more teaching sessions' to reach criterion in their PA skills than non-risk preschool children, and were unable to catch up to their peers by the end of the programme (i.e. the gap had not closed). Hence, these results provide additional evidence supporting the view that some children will require more sustained intervention for the consolidation of learning to provide a secure solid foundation in word-level literacy skills (see also Scanlon et al., 2005).

In another early intervention study with older poor readers (Vaughn, Linan-Thompson, Kouzekanani et al., 2003), those individuals failing to make adequate progress in response to instruction after the first block of 10 hours continued to receive additional 10-hour blocks until they reached the exit criteria or 30 hours of intervention. The additional time over and above 20 hours did not make a difference to the observed gains in reading; however, the results need to be interpreted cautiously due to the absence of a comparison group.

*Length of intervention sessions.* Few studies have directly manipulated the time/intensity of the intervention, for example, whether 2 hours per day over 10 weeks or 1 hour per day over 10 weeks (Wanzek & Vaughn, 2008). Reviews of the research evidence report the typical length of a single teaching session is of 20–50 minutes duration per day, and the US NRP review (2000) proposed that individual sessions should not exceed 30 minutes. Some studies have involved more intensive delivery, but these are typically interventions targeting older pupils with persisting, severe dyslexic reading and spelling difficulties (Torgesen et al., 2001; see Torgesen, 2005 for a review).

The very intensive Torgesen et al. (2001) large-scale intervention study targeting older pupils involved two 50-minute 1:1 sessions daily over an 8–9-week period (67.5 hours in total). At the end of the intervention, word-level reading was observed to fall within the average range, and importantly, these gains were maintained in a 2-year follow-up after the end of the intervention. But as mentioned earlier, even with the most intensive, well-implemented Wave 2 programme, a significant number of pupils will fail to make progress in reading (Rose, 2009; Torgesen, 2005).

#### *Personnel and programme fidelity*

Some research studies evaluating controlled, well-implemented early intervention programmes have reported educationally significant gains in reading (maintained 2 years later), when delivered by well trained and supported teaching assistants (Elbaum et al., 2000; Hatcher et al., 2006; Savage & Carless, 2004; Savage, Carless & Stuart, 2003; Vadasy, Jenkins, Antil, Wayne & O-Connor, 1997; Vadasy, Jenkins & Pool, 2000; but see Ehri, Dreyer, Flugman & Gross, 2007). In a recent review of the efficacy of early

intervention studies, similar effect sizes were found for programmes implemented by trained personnel who were not teachers to those delivered by teachers (Scammacca et al., 2007). Essential features leading to this success include: appropriate training and clear guidance before the intervention, structured programmes following predetermined lesson plans, and ongoing monitoring, support and guidance for the TAs throughout the intervention (Byrne & Fielding-Barnsley, 1995; Hatcher et al., 2006; Scammacca et al., 2007). To illustrate what is meant by ‘well trained and supported’, the teaching assistants who delivered the intervention programme in the Hatcher et al. (2006) study received 4 days of training, a teaching manual and ongoing support throughout the intervention period from fortnightly tutorials by one of the research team. While intervention programmes typical of Wave 2 are highly structured and prescriptive, teachers/teaching assistants may make adjustments to the content appropriate for the starting level of the student following initial assessment (see the Reading Intervention framework in Hatcher et al., 2006).

The NRP (2000) review emphasised the importance of checks on the fidelity of the programme implementation when considering the efficacy of reading intervention programmes, particularly when delivered by teaching assistants or other support staff (Byrne & Fielding-Barnsley, 1995; Vadasy et al., 1997). Fidelity checks involve audio recordings of sessions, on-site supervisors or random visits to schools for observations of teaching. Check lists are typically used by the observer to record the quality of teaching the core components of the programme. Check lists of programme fidelity can then be evaluated across schools and staff (Compton, Fuchs, Fuchs & Bryant, 2006).

### *Evaluation*

When evaluating the efficacy of an intervention programme, it is essential that any immediate gains reported at the end of the intervention programme are reassessed at a later date (delayed follow-up) to establish whether learning has been maintained after the child has returned to regular literacy instruction in the classroom. There is a large body of research evidence from early intervention and later interventions for older dyslexic pupils, reporting maintenance of gains in word reading (particularly phonological decoding), when participants are followed up 12–24 months later (Rose, 2009). Overall group effect sizes are typically medium or large for both younger (Torgesen, 2002a, 2002b) and older poor readers (Torgesen, 2005). Very few studies have evaluated maintenance of gains longer than 24 months later, but impressive results have been reported from at least one early intervention study reporting maintenance of gains in reading when participants were followed up 6 years later (Byrne, Fielding-Barnsley & Ashley, 2000).

At present, there are very few studies that have followed the longer-term impact of Wave 2 early intervention programmes on a pupil’s progress, which within an RTI framework would ideally require evidence of adequate Wave 1 classroom literacy instruction (Compton et al., 2006). Evidence from longitudinal research is now required to evaluate not only the progress of poor responders to Wave 2 intervention and their progress following more intensive, individualised Wave 3 instruction, but also the progress of the ‘good responders’ to Wave 2 intervention, to ascertain whether initial gains in reading are truly maintained over longer periods than the 12–18-month delayed follow-ups characteristic of large-scale intervention studies. Response rates for many studies typically appear much healthier when immediate gains are reported, but the gains

for a good proportion of participants ‘wash out’ when tested at delayed follow-up (see Whiteley, Smith & Connors, 2007). This suggests some pupils will require ongoing instruction over a sustained period for new knowledge from learning to be consolidated (Hindson et al., 2005; Rose, 2009).

### Wave 3

As stated above, intervention at this third level is advocated for pupils with severe and persistent difficulties (which includes those who have failed to benefit adequately from Wave 2 interventions), and requires the design and delivery of programmes individually tailored to the pupil’s identified learning needs. Third-level intervention is usually delivered intensively on a 1:1 basis or to groups of no more than three children. It is therefore costly, which makes it all the more important that it should be effective. In this section, we first outline what is known of the characteristics of ‘nonresponders’. We then consider what research evidence can tell us about their likely need for ‘more of the same’ versus ‘something completely different’. Finally, we turn to single-case intervention studies to see how they can inform the design of Wave 3 individually tailored interventions.

#### *Characteristics of pupils who fail to respond to Wave 2 intervention*

Recent research has begun to investigate the characteristics of these ‘nonresponders’ to otherwise effective early reading intervention (at Wave 2), with a small number of longitudinal studies evaluating progress of pupils from Wave 1 through Wave 3 within the RTI framework. A number of the large-scale intervention studies reviewed in previous sections concur that predictors of poor response rates in their studies include weak pre-intervention levels of phonological/reading skills, problem levels of teacher-rated behaviour and inattention and low SES (Hatcher et al., 2006; Torgesen et al., 1999; for reviews, see Al Otaiba & Fuchs, 2002, 2006; Duff, 2008; Nelson, Benner & Gonzalez, 2003). A small number of studies have identified co-occurring weak oral language skills as an additional predictor of response to phonological-based interventions (e.g. Vadasy, Sanders & Abbott, 2008; Whiteley et al., 2007; but see Hatcher & Hulme, 1999; Vellutino et al., 1996). A recent meta-review of five intervention studies reported in the United States identified seven cognitive–linguistic variables related to variation in RTI, listed from strongest to weakest predictor (see Duff, 2008 for further details): slow rapid naming (RAN), problem behaviour, poor PA, limited understanding of the alphabetic principle, weak verbal memory, IQ and demographics.

Environmental factors influencing RTI potentially include quality of Wave 1 teaching, point of intervention (early or late, where ‘late’ is defined as after KS 1 in England or G2 in the United States) and programme fidelity. The careful training, implementation, supervision and monitoring which characterises research studies may not always be observed in other circumstances with detrimental effects on the outcome of the intervention (Byrne & Fielding-Barnsley, 1995; Byrne et al., 2010; see Carter & Wheldall, 2008 for further discussion of this issue). Programme content may also influence outcome when the evidence base for inclusion of that content is weak or the content and/or implementation is inappropriate for the individual’s profile of needs, due to insufficient assessment and monitoring.

*What 'else' do nonresponders need?*

The evidence base reviewed above, of the characteristics of effective Wave 2 intervention programmes for early and more persisting word reading difficulties, suggests more research is needed to better understand the role of: (a) instructional intensity (length of intervention, hours of instruction, optimal ratios of teachers to students, reading time, etc.); (b) programme integrity/fidelity; (c) teacher ability/experience; (d) programme focus/explicitness/multidimensionality; and (e) individual student prior instructional experiences/exposure and reading abilities. The ways in which these factors, individually and together, affect treatment outcomes are just beginning to be addressed, particularly for treatment resisters (Shaywitz et al., 2008).

Only a few studies have examined the impact of intensity of instruction on children who had previously shown poor levels of response to early phonologically based intervention (Wave 2) (Vadasy, Sanders, Peyton & Jenkins, 2002; Vaughn, Linan-Thompson & Hickman, 2003). Vaughn, Linan-Thompson and Hickman (2003) randomly allocated children to one of three groups receiving: (i) 30-minute daily sessions, (ii) two 30-minute daily sessions (60 minutes per day) or (iii) no intervention (control group). Varying the session duration did not differentially impact on the response to the intervention (Wave 3), with both intervention groups showing stronger reading gains than the control group. However, records from the fidelity checks during the intervention indicated challenging pupil behaviour was a problem in the small groups receiving the two-sessions-per-day delivery. This may indicate some pupils would respond better in an individual situation, or need a longer gap in-between the two daily sessions, to maintain their levels of attention and motivation.

In a recent UK early intervention study targeting 'at-risk' poor readers from low SES background (Whiteley et al., 2007), almost half their sample of at risk children showed good response after the initial 15-week small group intervention programme. However, some children only made progress after an extended period where instruction was delivered on a 1:1 basis. Interestingly, some of the children who made good progress after the small group intervention had not maintained their initial gains in reading/spelling when followed up at the end of the study. This result highlights the importance of monitoring the subsequent progress of children who may show good initial responses to early intervention (see Byrne et al., 2000; Hindson et al., 2005 for similar evidence). In line with other studies, RTI was predicted by poor levels of expressive vocabulary and letter knowledge.

Recent attention has turned to the broader oral language weaknesses known to occur with dyslexia for some individuals (Bishop & Snowling, 2004). Duff et al. (2008) report an intervention to improve the demonstrated relatively weak oral language skills of pupils who did not benefit from an early phonological-based intervention of proven effectiveness (that reported in Hatcher et al., 2006). Positive gains in word reading were achieved when these nonresponders received an additional intervention programme targeting vocabulary knowledge. This is interesting in the light of reported links between low SES, early decoding skills and foundation literacy skills (Duncan & Seymour, 2000), together with an association between low SES and vocabulary delays (Dickinson, McCabe, Anastopoulos, Peisner-Feinberg & Poe, 2003; Hart & Risley, 1995). Hence, these initial results are promising, but more research is needed to investigate whether an additional focus on oral language might be one of the missing ingredients for nonresponders with persisting word-level reading difficulties.

*How might single-case studies inform the content and implementation of Wave 3 interventions?*

Wave 3 intervention was redefined by Rose (2009) as needing to provide intensive support for those children who require the personalised approach of a programme that is tailored to their specific, often severe, difficulties. It is usually taught as a one-to-one programme by a teacher or a member of the support staff who has undertaken some additional training for teaching children with reading difficulties.

In the research literature, there is a small set of theoretically motivated single-case intervention studies of individual pupils with reading and/or spelling difficulties. There are two immediately notable features of these studies: first, the degree of careful and detailed assessment of each child's existing skills carried out to inform design of the intervention programme, and second, the use of theory to guide this assessment. These two features combine to provide precise specification of the proximal source(s) of the child's difficulty – with the important caveat that this can only be achieved if the theory that guides assessment is sufficiently detailed, and is based in evidence that validates its premises.

Both developmental theories (e.g. Apel & Masterson, 2001; Broom & Doctor, 1995a, 1995b; Norbury & Chiat, 2000) and processing models of skilled performance (e.g. Brunson, Colheart & Nickels, 2005; Brunson, Hannan, Colheart & Nickels, 2002; Kohnen, Nickels, Brunson & Colheart, 2008; Kohnen, Nickels, Colheart & Brunson, 2008) have been used to inform assessment in single-case intervention studies of children with reading and spelling difficulties.

We present below three single-case intervention studies to illustrate the adoption of a personalised approach tailored to an individual's specific difficulties, with teaching programmes devised and in many cases also implemented by highly knowledgeable researchers. These three studies all deal with spelling difficulties, as these tend to persist even when reading difficulties have been overcome. However, Broom and Doctor (1995a, 1995b) and Brunson et al. (2002) provide single-case studies presenting successful intervention for reading difficulties, similar in rationale and methods to the spelling studies presented here.

Apel and Masterson (2001) present a case study of a 13-year-old pupil (Minnie) to exemplify how theories of typical spelling development can guide assessment of a pupil's spelling and lead to the design of effective intervention programmes. They give advice on how to obtain a sufficient corpus of spelling errors suitable for the error analysis that is the basis of their assessment, and on ways of examining these errors to reveal the child's knowledge of and ability to use the phonological, orthographic and morphological information that is necessary for accurate spelling.

Examination of Minnie's error corpus revealed several areas of difficulty. Spellings of *canyon* as 'canon' and *description* as 'disciption' were taken to indicate problems with PA. Spellings of *consume* as 'consum', *swim* as 'swimm' and *extension* as 'icstention' were taken to indicate problems with knowledge of orthography and orthographic constraints. Spellings of *recognize* as 'recikniz' but *recognition* as 'reckiktion' were taken to indicate problems in knowledge for the morphosemantic relationship between some base words and their derived forms. Finally, spellings of *signal* as 'signel' and *royal* as 'roaly' were taken to indicate lack of well-formed mental representations of stored spellings. It should already be clear to the attentive reader that interpretation of errors is subjective and that the same kind of error (e.g. misspelling of the schwa vowel in

*extension* and *signal*) can be interpreted as indicating different kinds of difficulty. Notwithstanding this, the summary of Minnie's performance concludes that half of her errors were likely due to insufficient orthographic knowledge, 20% to a deficit in phonemic awareness, a further 20% to difficulties using morphological knowledge, with only 5% due to reliance on insufficiently detailed mental representations of whole word spellings.

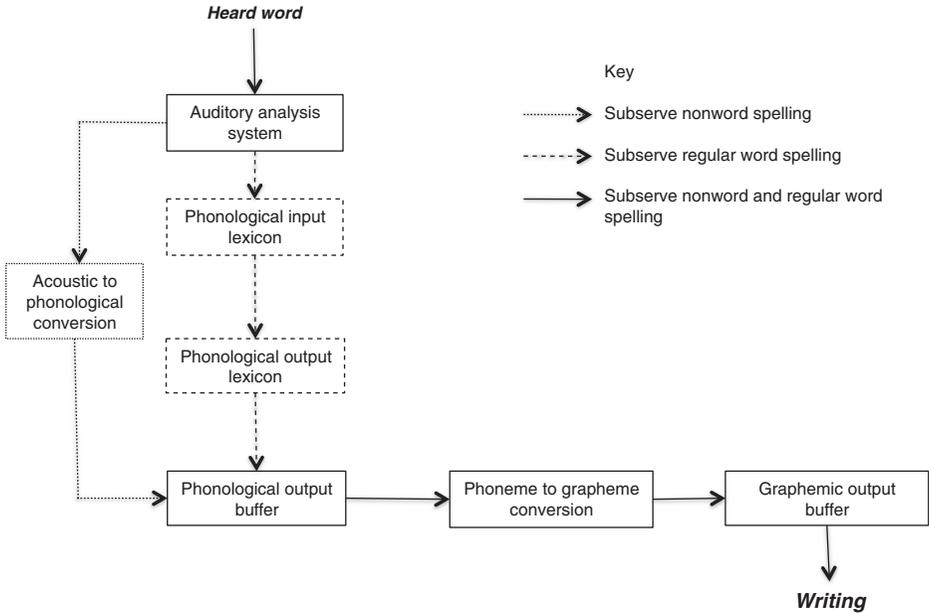
Each of these likely causes of difficulty was then further investigated. Minnie performed poorly on phoneme segmentation tasks (PA and nonword reading), confirming her problems with phonological skills. Investigation of her performance on a task requiring her to spell pairs of morphologically related words (e.g. *glory*, *glorious*) confirmed that she did not routinely use morphological knowledge to spell related forms. Mental representations of whole word spellings were investigated by a word reading task and results interpreted as providing confirmation that, with a word reading performance level more than 1sd below that of her age peers, it was likely that her mental representations of words lacked sufficient detail to support accurate spelling.

Thus, this assessment of her written and spoken language skills was able to outline three broad types of knowledge used in spelling (i.e. phonology, morphology, orthography), which all contributed to Minnie's spelling difficulty, and to provide guidelines for targeted intervention. Given her marked difficulties using a phoneme segmentation strategy in reading and spelling, her intervention programme initially targeted phonemic awareness and segmentation strategies with written words, with less emphasis on orthographic and morphemic strategies until her phoneme segmentation skills improved.

Results from the intervention implemented following this assessment were disappointing. Although Minnie's performance on a standardised test of spelling (the *Test of Written Spelling-4*, Larsen et al., 1999) improved by 6 standard score points, this improvement was within the standard error of measurement on the test. Analysis of her errors in a post-intervention writing sample demonstrated the continuing existence of the same types of error, albeit with a slight decrease in error incidence. It is difficult to ascertain the likely causes of this lack of reliable improvement, as only the broadest outline of the nature of the intervention is given. What is clear is that Minnie was not taught individually, but in a group of four pupils: it is more difficult to deliver teaching focusing precisely on an individual's identified difficulty in these circumstances. It also seems likely that the assessment conducted in Minnie's case was able to deliver only a relatively broad outline of the nature of her difficulties, based in subjective interpretation of her spelling errors unrelated to any modelling of the cognitive processes involved in accurate spelling.

A different approach to assessment was taken in two further single-case spelling intervention studies (Brunsdon et al., 2005; Kohnen, Nickels, Brunsdon et al., 2008). These authors conducted assessments based in the dual-route model of cognitive processes involved in spelling to specify the source of difficulties in MC (Brunsdon et al., 2005) and KM (Kohnen, Nickels, Brunsdon et al., 2008). In this model, the 'phonological' knowledge and strategies described in the developmental literature correspond to use of *sub-lexical* processes, which entail use of grapheme-phoneme correspondences in reading and phoneme-grapheme correspondences in spelling. The 'orthographic' and 'morphological' knowledge and strategies described in the developmental literature are subsumed within the use of *lexical* processes, which entail use of mental representations of the spelling patterns of whole words.

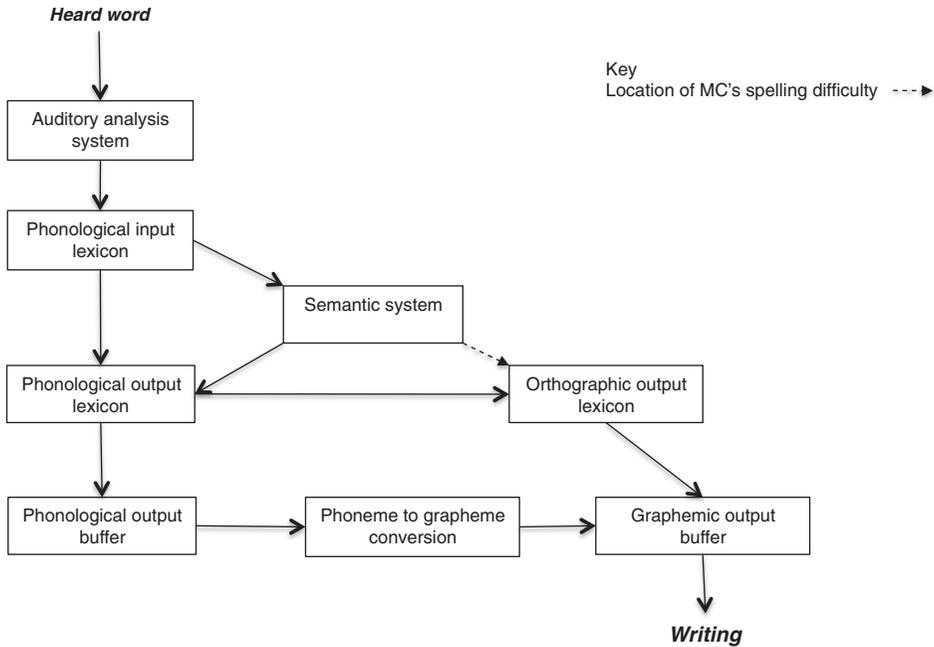
MC, a 12-year-old boy, had received extra tuition for reading and spelling difficulties over the course of 3 years in primary school. In initial pre-intervention assessment, he achieved a



**Figure 1.** Sub-lexical spelling processes.

standard score of 75 for spelling on the Wide Range Achievement Test – Revision 3 (WRAT-3), confirming he did indeed have spelling difficulties. Word reading skills fell within the average range for his age. When tested on spelling regular and exception words and nonwords (Coltheart & Leahy, 1996), his nonword spelling was at ceiling, and he spelled regular words more accurately than exception words. His errors on both spelling tests were largely phonologically plausible misspellings (e.g. *reasonable* spelled ‘resanerball’, *surprise* spelled ‘serprires’). This is the pattern typically found in spellers who rely on sub-lexical processes: better performance on regular words and nonwords (which can be spelled accurately by phonic rules) than exception words (e.g. *choir*) which violate these rules; phonologically plausible misspellings. These findings suggest that MC relied on sub-lexical processes in spelling. Figure 1 shows the sub-lexical spelling processes available to MC.

Spellers who rely on sub-lexical processes also confuse homophones, because there is no semantic involvement in sub-lexical spelling, and semantics (word meanings) are essential to production of the correct spelling pattern of each member of a homophone pair. MC’s performance on a test of homophone spelling (with words presented in disambiguating sentence context) demonstrated this tendency to confuse homophones (e.g. in response to ‘maid, the maid cleaned the house’ he wrote ‘made’). However, some of the wrong homophone partners he spelled were exception words (e.g. in response to ‘bred, they bred the cattle carefully’ he wrote ‘bread’) and, although his spelling of regular words and nonwords was better than his spelling of exception words, he did spell some exception words correctly. Brunson and colleagues therefore suggest that he had partially developed the additional lexical spelling processes and stores shown in Figure 2, because he was able to retrieve the correct spelling of some exception words from the orthographic output lexicon. He also performed at ceiling on three tests of picture naming, spoken word to picture matching and written word to picture matching, demonstrating well-developed semantic representations. However, the fact that despite this he still made homophone confusion errors suggests that



**Figure 2.** Lexical spelling processes.

the location of his difficulty lies in accessing representations of correct spellings in the orthographic output lexicon from semantics (see dashed arrow in Figure 2). This forces him to access representations in the orthographic output lexicon from the phonological output lexicon (see dashed arrow in Figure 2), hence the homophone errors.

Thus, this assessment was able to pinpoint quite precisely where and which of MC's spelling processes were well or poorly developed, giving clear guidelines for targeted intervention.

Intervention targeted exception word spelling. Given MC's good performance on semantic tasks, it was assumed that his semantic representations of targeted words were intact, and that what was needed was to improve functioning of the access route from semantics to output orthographic representations. If intervention did improve functioning of this access route, then there should also be generalisation of improved spelling to nontargeted exception words. MC was trained on three sets of 74 exception words, all of which were spelled incorrectly on at least one of the two baseline assessments. Each set was trained once. MC saw a correct spelling of each word, and was asked to copy it. The word was then removed from view and MC wrote it after a 10-second delay. If incorrect, he was shown the correct spelling again. He then wrote the word to dictation, with the correct word again shown every time he misspelled a word. In-between training sessions, he practised at home with his parents who were given instructions in the experimental training procedure.

Following this training, MC correctly spelled 67% of the treated words, a significant improvement from baseline. At delayed post-test 2 months later, this had declined significantly to 60%, still representing a significant improvement from baseline. It was also clear that generalisation had occurred: spelling of words not yet treated also showed significant improvement. Thus, intervention which precisely targeted the identified location of processing difficulties was in this case successful in improving spelling.

In a contrasting case, Kohnen, Nickels, Brunsdon et al. (2008) describe KM, an 8-year-old girl who had suffered a head injury at age 4 before starting school. She was receiving daily support at school to improve her word reading and spelling skills; her spoken language skills assessed on the *Clinical Evaluation of Language Fundamentals* (CELF: Semel, Wiig & Secord, 1995) were in the average range. At initial assessment before intervention, her letter-sound knowledge for single letters was at ceiling on all measures taken, but her spelling of all three types of stimuli presented (regular and exception words and nonwords, Robinson & Weekes, 1995) was significantly worse than that of chronological age controls. From this, Kohnen and colleagues conclude that KM has difficulty in developing both lexical and sub-lexical spelling processes. Analysis of her spelling errors revealed many phonologically implausible spellings that were hard to decipher (e.g. *wharf* spelled 'wofe', *bite* spelled 'buit'). Kohnen and colleagues therefore decided to focus on improving KM's ability to use sub-lexical spelling processes, by improving her knowledge of phoneme-grapheme correspondences. KM was explicitly taught two spelling rules ( $u = /ʌ/$ , and the final E rule) which she had not yet acquired, and required to verbalise the rule as she used it. In the case of the final E rule, teaching focused exclusively on o-e and a-e words. Results were analysed using McNemar's test.

At immediate post-test, and at four further post-tests up to 16 weeks post-training, there was significant improvement in  $u = /ʌ/$  spellings for trained words and untrained nonwords (all  $p < .001$ ). At immediate post-test, there was no significant improvement in spelling untrained words, but significant improvements on all subsequent post-tests up to final post-test 16 weeks post-training.

For o-e words, at immediate post-test there was no significant effect of training on trained or untrained words and nonwords. However, by 3 weeks post-training, significant improvement was seen in trained words and untrained nonwords, and these significant improvements were still evident significant at the final post-test. Significant improvement in untrained words evident 3 weeks post-training was not maintained at final post-test.

For a-e words, at immediate post-test there were significant improvements in spelling trained and untrained words and nonwords, and these significant improvements were maintained at the final post-test. Generalisation to untaught instances of the final E rule were also evident, with significant improvement in spelling i-e and u-e words and nonwords found three weeks post-final E rule training.

Each of these case studies emphasises the important contribution of theory-guided assessments of literacy (accuracy and error profiles) and related cognitive skills to establish a child's individual profile of strengths and weaknesses when planning appropriate, evidence-based Wave 3 intervention programmes. The developmental and educational history (e.g. response to previous interventions) of each child would also inform decision-making at this stage (see Rose, 2009 for more detailed recommendations), and for some pupils, input from multidisciplinary teams may be required when there are concerns about co-occurring difficulties (e.g. inattention, co-occurring language impairment or challenging behaviour).

## Conclusions

In conclusion, there is a strong evidence base to inform Wave 2 intervention for early word reading difficulties. Several large-scale reviews of the literature have concluded early intervention can be effective when delivered to small groups and by well-trained

and supported support staff, but with checks on the fidelity of programme implementation. For interventions to be effective for older pupils with persisting reading difficulties, programmes need to be intensive for gains to be observed in reading accuracy. However, further research is required to build an evidence base for effective interventions targeting persisting reading fluency and spelling difficulties. Longer-term follow-ups of pupils who make progress following early Wave 2 intervention are required.

Both pupil- and environmentally based factors are known to be associated with poor response levels to otherwise effective interventions, even when delivered early and intensively, on an individual basis. This emphasises the importance of theoretically guided, individually based assessments of literacy and cognitive skills to inform decision-making and planning for Wave 3 interventions. More research is needed to better understand the extent to which Wave 3 interventions targeting oral language skills are effective for nonresponders to Wave 2 interventions. More research is also needed to explore the impact of other co-occurring difficulties, such as inattention, on responsiveness. Empirical investigation of ways to increase the motivation of older struggling readers could also impact on the effectiveness of teaching these hard-to-teach pupils.

While the group studies reviewed above have clear implications for the kinds of training that are needed to equip teachers with the ability to design and implement Wave 2 interventions, questions remain as to the degree of theoretical knowledge and understanding that might be desirable in specialist teachers trained to design and implement individual intervention programmes at Wave 3. The individual case studies reviewed above might indicate that such specialist teachers will need detailed understanding of the cognitive processes involved in word reading and spelling, so that they are able to assess each component process and interpret the results of their assessment to locate as precisely as possible the source of an individual child's difficulties, and then design, implement and evaluate interventions which target these difficulties. This also requires knowledge and understanding of single-case intervention methodology. As noted above, we found very few examples of single-case intervention studies in the research literature. More such well-designed studies are needed if this kind of theoretically motivated, tightly focused intervention is to become incorporated into Wave 3 interventions.

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**Yvonne Griffiths** is Lecturer in psychology and special education in the Department of Psychology and Human Development at the Institute of Education (University of London). Her research interests are in reading and spelling development and developmental disorders of language and literacy. In particular, she is interested in the cognitive–linguistic basis of individual differences in literacy development and implications for assessment and intervention.

**Morag Stuart** is Emeritus Professor of the psychology of reading in the Department of Psychology and Human Development at the Institute of Education (University of London).

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**Address for correspondence:** Yvonne Griffiths, Department of Psychology and Human Development, Institute of Education, University of London, 25 Woburn Square, London, WC1H 0AA, UK. E-mail: [y.griffiths@ioe.ac.uk](mailto:y.griffiths@ioe.ac.uk)