The Understanding Words Reading Intervention: Evidence From a Case Series Design

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Using a case-series design with double baseline and 10-week maintenance phase, 5 struggling readers from middle- to high-income families (age range 6.4–7.9 years) completed a 5-times-weekly intervention (96 sessions) administered by a parent. All participants completed the intervention with phonological decoding, text-reading accuracy and reading comprehension scores above the 30th percentile. Regular-word reading improved significantly, and 3 out of 5 participants achieved average levels at postintervention testing. Growth of 0.58 standard deviations (*SD*) was seen in one participant on a test of irregular-word reading. The other 4 participants made growth of $>$ 0.8 *SD*. However, only 1 participant achieved average levels at postintervention testing on the irregular-word reading measure. Results provide preliminary support for the effectiveness of the intervention in improving word-level decoding and comprehension in struggling readers. Most important, the data provide preliminary evidence that some parents can function as paraprofessionals and provide effective reading intervention for struggling readers. Special education professionals may be able to work around limited funding for struggling readers by recruiting, training, and supervising parents.

Keywords: reading intervention, Understanding Words, effectiveness, clinical significance

Three decades of research has generated substantial knowledge about reading development and the factors that place children at risk of reading difficulties (Bowey, 2002, 2005; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1989; Chall, 1967; Coltheart & Prior, 2007; Ehri, 1987; Frith, 1986; Goswami, 1986, 1993; Gough & Hillinger, 1980; Muter, Hulme, Snowling, & Taylor, 1998; Share, 1995; Vellutino et al., 1996; for reviews, see Castles & Coltheart, 2004; Snowling, 2000; Vellutino, Fletcher, Snowling, & Scanlon, 2004). Reading failure can occur for different reasons (Morrison, Bachman, & Connor, 2005); however, the most common problem for young at-risk students is in word-level reading skills (Bowey, 2006). For this subgroup of students, inaccuracy and/or dysfluency in decoding of unfamiliar words is the principal problem (Bowey, 2006; Torgesen, Wagner, Rashotte, Herron, & Lindamood, 2010).

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It has generally been held that children with word-level reading difficulties represent 5–15% of the population (Shaywitz, 1998); however, recent evidence has indicated that using effective and intensive early interventions can substantially reduce the incidence of reading problems (Mathes et al., 2005; Torgesen, 2004; Vellutino et al., 1996; Wright & Conlon, 2009). For example, Mathes et al. (2005) reported that the incidence of reading difficulties was reduced to less than 1% when an intensive intervention that combined small-group instruction with enhanced classroom instruction was used in Grade 1. Another study conducted in an Australian school examined the response of 13 at-risk students to an intensive reading intervention in Grade 1 (Wright & Conlon, 2009). The intervention was delivered four times weekly for 40 minutes. At the conclusion of the intervention, all students achieved average levels (standard score ≥ 92) on a measure of word recognition, and 12 out of 13 students achieved average levels on measures of nonword decoding and word-reading fluency.

Reading intervention methods described in the literature differ but it is generally thought that students with reading difficulties will require instruction that targets one or more of the following: phonemic awareness, systematic phonics, fluency, spelling, teaching of high-frequency irregular words, and vocabulary and comprehension strategies (e.g., Berninger et al., 2003; Bowey, 2006; Castles & Coltheart, 2004; Department of Education, Science and Training, 2005; National Institute of Child Health and Human Development [NICHHD], 2000; Reynolds, Wheldall, & Madelaine, 2010; Torgerson, Brooks, & Hall, 2006; Torgesen et al., 2010). Instruction should also be 'explicit', referring to the teacher's clear and direct presentation of the instructional content, and 'systematic' (Reynolds et al., 2010). The term systematic refers to a method in which instructional materials (e.g., high-frequency grapheme–phoneme conversion rules) are taught in a clearly defined sequence (Ehri, 2003; Reynolds et al., 2010). Instruction should preferably be cumulative in that new material should be introduced only after students have mastered current and previously taught skills and knowledge (Carnine, 1976). In addition, the issues of timing and intensity of the intervention for at-risk students are important. Timing is critical because research has shown that the effect size of reading intervention halves after Grade 2 (Ehri, Nunes, Stahl, & Willows, 2001). These findings have led to recommendations that early interventions for students at risk of reading difficulties occur as early as possible before reading problems become entrenched (Rose, 2006). The level of intensity of an intervention seems to be as important as quality, so almost all studies provide instruction in one-to-one settings or in small groups at a level of intensity equivalent to daily or almost daily instruction.

Despite this knowledge and despite the existence of best-practice guidelines for the teaching of reading (e.g., NICHHD, 2000), there is some dispute over whether school-based services are as effective as they could be (Coltheart & Prior, 2007; Pressley, 2002; Torgesen et al., 2010). Experimental support for these claims has been provided in a recent study that evaluated the effectiveness of learning support services for students with reading difficulties in eight Australian primary schools (Wright & Conlon, 2012). Student growth in reading skills was measured at each of four school terms in a group of poor readers (word-reading scores $<$ 15th percentile) and a group of good readers (word-level skills $>$ 40th percentile). The results showed that the poor readers did not make significant reading growth during a 9-month period, and on one measure, a pseudohomophone discrimination task, their performance declined relative to the good reader group. Given the adverse behavioural, mental health and economic outcomes to which poor reading predisposes children (Bost & Riccomini, 2006; Brynner, 2008; Ensminger & Slusarcick, 1992; Willcutt & Pennington, 2000), these data emphasise the importance of ongoing research

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into how effective services can be provided to struggling readers in schools and in the community.

Many schools may find it difficult to manage the cost of interventions delivered by specialist teachers (Fielding, Kerr, & Rosier, 2007; Wright & Conlon, 2012). One way of reducing the costs of reading intervention may be to use paraprofessionals to provide teaching within scripted, direct instruction programs (Torgesen et al., 2010; Wright & Conlon, 2009, 2012). A number of studies and reviews have been conducted on the outcomes of reading instruction delivered by paraprofessionals with positive results (Ritter, Barnett, Denny, & Albin, 2009; Savage & Carless, 2005; Wasik, 1997). A recent meta-analytic review (Slavin, Lake, Davis, & Madden, 2009) reported that the effect sizes produced by paraprofessionals were, on average, lower than those delivered by specialist teachers. However, the difference was small and the cost-effectiveness of paraprofessionals makes that type of intervention a viable option for schools (Rose, 2006; Slavin et al., 2009). It is important to note that if paraprofessionals are to be effective they must use a systematic reading program and be skilled in the delivery of that program (Reynolds et al., 2010), as untrained tutors who receive little guidance and no specific instructional materials can produce negative outcomes for students (Slavin et al., 2009).

Paraprofessionals can provide effective instruction provided the above conditions are met. They can also do so at substantial cost savings relative to using specialist teachers. However, there is no guarantee that a school will have the funding available or that they will allocate available funds to the task. How then might a special education specialist provide services to students with reading difficulties? One possibility may be to train and supervise parents to provide instruction. We are unaware of any studies that have investigated the effectiveness of parents in delivering a systematic reading intervention for students who have reading difficulties.

The current study will investigate this research question using a case series design, with elements reported previously (Wright, Conlon, Wright, & Dyck, 2011a). Parents will be trained to deliver a systematic, direct instruction reading intervention program called Understanding Words (Wright, 2011) to five students who are in Grades 1 and 2 and who have reading difficulties. There is evidence that Understanding Words produces clinically meaningful gains in reading skills in complex populations (Wright & Conlon, 2009; Wright, Conlon, & Wright, 2011; Wright, Conlon, Wright, & Dyck, 2011a, 2011b).

This study used a 10-week baseline, 10-week treatment period, and 10-week follow-up design. It was predicted that growth would be negligible during baseline and that introduction of treatment would co-vary with positive growth in reading ability. Finally, it was predicted that reading growth would be less marked when formal treatment was removed during the maintenance period.

The hypotheses were that (a) few gains would be seen in irregular-word reading because improvements in this skill require word-specific training and/or substantial increases in reading volume, (b) significant improvement would be seen in phonological decoding skills, and (c) improvements in word-level reading skills would co-vary with improvements in reading comprehension.

Method

Participants

Five male participants were included in a case series design (6.4, 7.4, 7.3, 7.9, and 6.11 years of age, respectively). One student was in Grade 1 and four in Grade 2 in Queensland, Australia. None were involved in school-based interventions. The students were referred

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by teachers and/or medical practitioners to a private developmental/learning difficulties clinic due to concerns about reading. Inclusion criteria were (a) being in Grade 1 or 2, (b) having an age-standardised phonological decoding score < 10th percentile, (c) having an age-standardised Full Scale IQ > 85, (d) no diagnosed developmental disorder, (e) having a WISC-IV Vocabulary scaled score ≥ 7, and (f) one parent able to deliver reading intervention five times weekly. All students and families meeting these criteria in the first month of 2010 were recruited for the study. The requirement that a parent be able to deliver reading intervention five times weekly meant that many children who were seen in the clinic were not eligible for the study. These students were catered for with lower intensity interventions or with school-based services.

Measures

Wechsler Nonverbal Test of Intelligence (WNV). The WNV is a nonverbal measure of intelligence (Wechsler & Naglieri, 2006). For the age range in this study, the test has four subtests: Matrices, Coding, Object Assembly and Recognition. These four subtests yield a Full Scale IQ ($M = 100$; $SD = 15$; $\alpha = .91$ for internal consistency; $r = .84$ for test–retest reliability). The correlation of the WNV Full Scale IQ and that from the WISC-IV (Wechsler, 2003) is .76.

Vocabulary. The Vocabulary subtest from Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) was used to provide a measure of expressive vocabulary. Participants were required to define orally presented words that increase in difficulty. The Vocabulary scaled score distribution has a mean of 10 and an *SD* of 3 ($\alpha = .89$ for internal consistency; $r = .92$ for test–retest reliability). This measure was used to screen for oral language weaknesses.

Castles and Coltheart Test 2. The Castles and Coltheart test (CC2; Castles et al., 2009) includes lists of 40 irregular words, regular words, and nonwords. The participant is asked to read each word aloud until five consecutive errors are made on any single item type. A score out of 40 is obtained which can be converted to *z*-scores and percentiles within age bands of 5–6 months. The average raw score in the Grade 1 normative population is 13.1 ($SD = 10$) for regular words, 6.3 ($SD = 5.2$) for irregular words, and 7.8 ($SD = 8.2$) for nonwords (Castles et al., 2009).

GPC Test. The grapheme–phoneme conversion (GPC) test required participants to read 88 nonwords constructed from each of the GPCs taught in Level A of the intervention program. The items were presented on individual cards printed in 48-point Comic Sans font. All participants read the nonwords in the same order (see Appendix A).

Passage Reading Accuracy and Reading Comprehension. The Neale Analysis of Reading Ability (3rd Edition; NARA-III; Neale, 1999) was used to measure text-reading accuracy and reading comprehension. It includes two standardised parallel forms and two supplementary test forms. To measure accuracy, Form B was used at the initial assessment, Form 1 at Week 10 and Form 2 at Week 30 ($r_{xx} = .95$ for internal consistency for Forms 1 and 2; parallel form reliability $r = .98$; maximum raw score = 100). The same forms were used to measure comprehension ($r_{xx} = .71$ for internal consistency for Form 1 and $r_{xx} = .81$ for Form 2; parallel form reliability $r = .86$; maximum raw score = 44). The test requires reading of up to six graded passages. An accuracy score is obtained by subtracting the number of errors from a total possible passage score of 16. The stop rule is enforced after 12 or more errors are made on a single passage. Comprehension questions were presented immediately on completion of each passage for which less than 12 errors were made. The

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test consists of four questions for the first story and eight for all subsequent stories. Each question is worth one mark. The questions assess literal and inferential comprehension (Bowyer-Crane & Snowling, 2005).

Procedure

The study was conducted under the auspices of a private clinic and use of the data was authorised via Griffith University Human Research Ethics Committee arrangements.

After informed written consent was obtained from parents, children were tested over two sessions in a quiet clinical setting. All participants were administered the tests in the following order: WNV, WISC-IV Vocabulary, CC2 word lists, curriculum-based GPC test, and NARA-III.

Participants were initially assessed in January 2010 (Week 0). A second testing session took place 10 weeks after the first and just before teaching began (Week 10). Further testing occurred after 10 weeks of teaching (Week 20), at the conclusion of treatment (Week 30), and at 10-week follow-up (Week 40).

Intervention Procedures

Teaching Program. Understanding Words was used to deliver reading intervention. The teaching curriculum of Understanding Words contains six strands: phonological awareness, phonics, spelling, irregular words, fluency, and oral language strategies. A brief summary of the types of activities used in each strand is provided below.

Phonological awareness. Phonological awareness activities began at Lesson 1 through onset-rime blending activities. Once blending of onset-rime had been mastered, phonemic awareness activities focused on blending of words of up to five phonemes. The phoneme blending tasks were conducted as stand-alone oral activities (What word do these sounds make? /c/ /a/ /t/) until Lesson 7. Thereafter, phoneme-blending activities were implicit in word-decoding tasks. No specific mastery criteria were used for the transition from the stand-alone oral activities, as there is a reciprocal relationship between reading/spelling ability and phonological awareness (Castles & Coltheart, 2004). Phonemic segmentation activities were implicit in spelling tasks that began in Lesson 6 and continued throughout.

Phonics and spelling. A maximum of one new GPC rule was introduced per lesson. Participants were explicitly taught the new GPC and the act of phonological decoding was reinforced via reading of word lists and spelling. The words in each list consisted of the new GPC and previously mastered GPCs. The grapheme sequence in the first 130 lessons of the program is: t, a, s, p, i, n, d, o, ck, e, m, r, h, u, f, l, b, g, ai, j, oa, w, ay, ch, tch, sh, th, qu, final 'e', ng, oo, ee, x, or, igh, y, z, v, ar, ur, ow (as in *cow*), ou (as in *out*), oi, ear, air, er, le, y (as in *lucky*), the soft 'c' rule (as in *city* and *place*), oy, ue, ge, and dge. Instruction is cumulative in that the word lists and spelling activities continue to use mastered GPCs while introducing new material. No specific accuracy or fluency criteria were used because of the intraindividual variability seen in reading disability and other developmental disorders (Klein, Wendling, Huettner, Ruder, & Peper, 2006; Marinus & de Jong, 2010). The parents administering the instruction were asked to make a subjective judgment as to whether their child had mastered the new GPC and could read and spell novel words containing that GPC, while allowing for the occasional error or lapse of concentration. The phonics/spelling components of the lesson subsequent to a new GPC being introduced either focused entirely on reviewing the GPC or spent considerable time on review. Therefore, lack of mastery did not necessarily precipitate repeating a lesson. However, parents were directed to repeat the phonics/spelling activities for a GPC if they

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judged that their child lacked mastery prior to the introduction of the next GPC in the teaching sequence.

Irregular words and spelling. Beginning at Lesson 11, 66 high-frequency irregular words were taught. Irregular words are those that cannot or can only partially be identified using phonological decoding strategies (e.g., *put*). The words were selected from the Children's Printed Word Database (Masterson, Stuart, Dixon, Lovejoy, & Lovejoy, 2003) and were taught using a combination of flashcards and spelling, methods that have been shown to be effective in improving lexical processing in single cases (e.g., Kohnen, Nickels, Brunsdon, & Coltheart, 2008). Parents were directed to review words for which the child made regular reading errors.

Fluency. Repeated oral reading of sentences and stories was used to address fluency. The sentences and stories were all part of the program and were written to be as decodable as possible and to contain as many of the irregular words as possible. For example, if the participants had learned all of the GPCs for the single letters, learned that the digraph 'ai' represents /ae/, and learned the irregular word *put*, they might read the sentence: *Ted put his bag on the train.*

Oral language activities. Oral language activities began in Lesson 23 and consisted of four types of activities: vocabulary, literal sentence comprehension, drawing inferences, and figurative language. All lessons from 23 onward introduced a new vocabulary word or reviewed previously taught material. Words were primarily taught using the multiple-context approach (Beck, McKeown, & Kucan, 2002; Clarke, Snowling, Truelove, & Hulme, 2010). This approach teaches children how to use contextual clues to identify the meaning of novel words and, through dialogue between tutor and child, encourages children to use new words in new and familiar contexts (Clarke et al., 2010). Seventy-two words are taught in the first 180 lessons.

In the second component, children learned how to deconstruct orally presented sentences. For example, in the sentence *The little boy jumped over the log* children were taught that *boy* represented the sentence subject, *jumped* represented what the boy did, *little* represented something about the boy, and so on. They then used this knowledge to answer questions about orally presented sentences. At least one of these activities was included in each lesson from Lesson 23. In the third component, beginning at Lesson 33, children were introduced to inferences by first teaching them to identify information that is missing from sentences and by providing them with facts (e.g., *All cats are black* and *Snowy is a cat*) and then presenting a question that required an inference based on the facts (e.g., *What else do you know about Snowy? He is* . . . black). In the fourth component, beginning at Lesson 131, children explored figurative language, including jokes and idioms.

Parent training. All parents were initially naive to the intervention methods. They received approximately one hour of lecture material from the first author that explained a skilled reading model (the dual-route cascaded model of reading, DRC; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001) and how different word-level problems can occur based on the DRC model. The importance of oral language skills for comprehension was also explained. The need for systematic rather than ad hoc teaching was explained, and they were introduced to the sequence of teaching in Understanding Words and to the teacher scripts.

In a second hour, the first author modelled the teaching while providing verbal instruction to the parent. Four critical teaching behaviours were emphasised: (a) following the script, (b) following standardised error corrections, (c) continuing teaching until the child achieved mastery, and (d) explicitly reviewing, prompting, attending to, and praising

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effective reading behaviours (e.g., decoding vs. using a salient letter cue to guess a novel word). In the following week, the parent administered five teaching sessions at home by following the teaching scripts. They were required to video the fifth session. Next, the first author reviewed the teaching video and provided verbal feedback to the parent using the four critical teaching behaviours referred to previously as a guide. This took approximately one hour. The first author then modelled another teaching session for the parent. The parent administered another five teaching lessons in the subsequent week and again videotaped the fifth. Review and feedback were provided and another lesson modelled by the first author. Thereafter, the parent was required to administer five weekly lessons to their child. Parents were asked to administer a single lesson from Understanding Words. Table 1 shows the scope and sequence of the first 180 lessons of the program.

All participants began the study on Lesson 1 of Level A. Six lessons, including the two modelled by the first author, were provided in each of the first two weeks of the intervention. Thereafter, five lessons per week were administered by the parent for a period of 18 weeks. Weekly email and telephone contact were provided to parents by the first author.

Fidelity of Treatment Method. Three controls were used to achieve and monitor the fidelity of the treatment method. First, Understanding Words contains detailed scripts that guided the parents. Second, the training described above was sufficient for all five parents to competently, if not fluently, follow the directions set out in the teacher scripts. All parents were aware of the four critical teaching behaviours and had demonstrated competence. Third, the first author observed a teaching lesson each fortnight and provided feedback in reference to the four critical teaching behaviours.

Results

Outcome Measures

Participants' scores on each of the measures used to assess baseline reading skills and the effectiveness of the treatment program are shown in Table 2. The data include the raw and standard scores, where available, for each participant on each outcome measure. Weeks 0–10 act as a baseline measure, as no treatment was provided during this time. Weeks 10–20 and 20–30 represent the intervals over which treatment occurred and Week 40 represents a 10-week follow-up during which no treatment was received.

Baseline

Repeated measures *t* tests were used to determine if there were differences in scores on the two baseline measures (Weeks 0 and 10). No significant differences were found across time for raw scores for CC2 regular words, $t(4) = -1.37$, $p = .24$, CC2 irregular words, $t(4) = -1.6$, $p = 0.17$, or CBM nonwords, $t(4) = -2.7$, $p = .052$. There was a significant improvement across baseline for the raw scores for CC2 nonwords, $t(4) = -4.8$, $p = .009$. Repeated measures *t* could not be computed for the difference between the two baseline measures of text-reading accuracy and reading comprehension because the raw scores obtained at Week 0 and Week 10 were the same.

An average of the two baseline measures was obtained for all reading tasks, with the exception of CC2 nonwords, to provide a single baseline of reading skills. Week 10 baseline data for CC2 nonword reading was used to provide a more conservative estimate of beginning phonological decoding ability due to the significant improvement on this measure from Week 0 to Week 10.

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TABLE 1

Scope and Sequence of the First 180 Lessons From the Understanding Words Reading Intervention Program

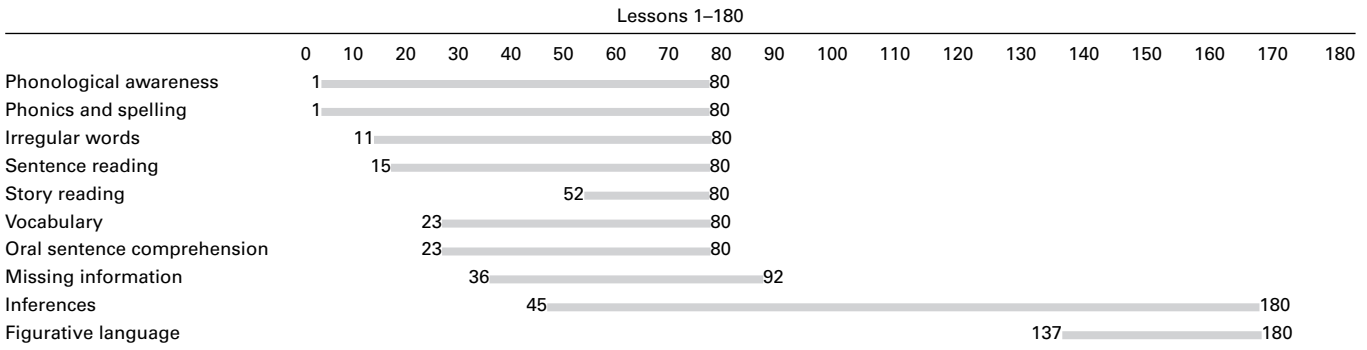

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TABLE 2
Individual Reading Scores

	Sig Chg[a]	Week 0	Week 10	Week 20	Week 30	Chg (*SD*)[b] Week 10–30	Week 40
Task	**S1 age = 6.4 yrs, FSIQ[c] = 91, Vocabulary[d] = 7**						
CC2 Normative sample: age band 6.0–6.5 yrs (Base); 6.6–6.11 yrs (Treatment)							
Regular	Y	−1.58 (0) 5th	−1.12 (1) 13th	−0.92 (4) 18th	0.03 (16) 51st	1.15	−0.04 (15) 48th
Irregular	Y	−1.58 (0) 6th	−1.58 (0) 6th	−0.99 (2) 16th	−0.26 (2) 40th	1.32	−0.26 (2) 40th
Nonwords	Y	−1.21 (0) 11th	−0.63 (1) 20th	0.02 (6) 51st	0.86 (16) 81st	1.49	0.69 (14) 75th
Neale Base Yr 1, Level 1; Treatment Yr 2, Level 2							
Accuracy	Y	(0)	(0) 10th		(19) 69th		
Comprehension	Y	(2)	(2) 21st		(9) 80th		
GPC test. Developed from Understanding Words (raw scores only available)							
Score/88		0	4	18	45		52
	S2 age = 7.4 yrs, FSIQ = 88, Vocabulary = 8						
CC2 Normative sample: age band 7.0–7.5 yrs (Base 0); 7.6–7.11 yrs (Base 1, Treatment)							
Regular	N	−1.37 (10) 9th	−1.39 (9) 8th	−0.90 (19) 18th	−0.90 (19) 18th	0.49	−0.77 (21) 22nd
Irregular	I	−1.79 (4) 4th	−1.85 (4) 3rd	−1.15 (6) 13th	−0.96 (8) 17th	0.89	−0.96 (8) 17th
Nonwords	Y	−1.37 (2) 9th	−1.25 (3) 11th	−0.70 (10) 24th	−0.01 (19) 50th	1.24	0.01 (21) 51st
Neale Base Yr 2, Level 1; Treatment, Yr 2, Level 2							
Accuracy	Y	(4)	(4) 4th		(23) 39th		
Comprehension	Y	(2)	(2) 5th		(9) 40th		
GPC test. Developed from Understanding Words (raw scores only available)							
GPC		15	17	36	45		51
	S3 age = 7.3 yrs, FSIQ = 108, Vocabulary = 12						
CC2 Normative sample: age band 7.0–7.5 yrs (Base 0); 7.6–7.11 yrs (Base 1, Treatment)							
Regular	I	−1.96 (0) 3rd	−1.81 (2) 4th	−1.31 (9) 10th	−0.77 (21) 22nd	1.04	−0.60 (23) 23rd
Irregular	I	−1.97 (0) 2nd	−2.29 (1) 1st	−1.85 (4) 3rd	−1.05 (7) 15th	1.24	−1.07 (7) 15th
Nonwords	Y	−1.65 (0) 5th	−1.25 (2) 11th	−0.92 (7) 18th	−0.45 (13) 33rd	0.80	−0.22 (17) 41st
Neale Base, Yr 2, Level 1; Treatment Yr 2, Level 2							
Accuracy	Y	(0)	(0) 2th		(20) 34th		
Comprehension	Y	(0)	(0) 2nd		(11) 52nd		
GPC test. Developed from Understanding Words (raw scores only available)							
GPC		0	6	30	63		71
	S4 age = 7.9 yrs, FSIQ = 95, Vocabulary = 9						
CC2 Normative sample: age band 7.6–7.11 yrs (Base); 8.0–8.5 yrs (Treatment)							
Regular	Y	−1.81 (2) 4th	−1.73 (4) 4th	−1.48 (16) 7th	−0.68 (25) 25th	1.05	−0.78 (28) 32th
Irregular	N	−1.93 (3) 3rd	−1.93 (3) 3rd	−1.87 (6) 3th	−1.35 (9) 9th	0.58	−1.3 (10) 10th
Nonwords	Y	−1.73 (1) 4th	−1.25 (3) 11th	−0.93 (9) 18th	−0.41 (18) 34th	0.84	−0.3 (19) 38th

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TABLE 2
Continued

	Sig Chg[a]	Week 0	Week 10	Week 20	Week 30	Chg (*SD*)[b] Week 10–30	Week 40
Neale Base, Yr 2, Level 1; Treatment Yr 2, Level 2							
Accuracy	Y	(0)	(0) 2nd		(24) 41st		
Comprehension	Y	(3)	(3) 11th		(10) 46th		
GPC test. Developed from Understanding Words (raw scores only available)							
GPC		10	12	30	63		67
			S5 age = 6.11 yrs, FSIQ = 111, Vocabulary = 11				
CC2 Normative sample: age band 6.6–6.11 yrs (Base 1); 7.0–7.5 yrs (Base 2; Treatment)							
Regular		−1.06 (2) 14th	−1.06 (2) 14th	−0.58 (8) 28th	−0.46 (21) 32nd	0.60	−0.33 (24) 37th
Irregular	I	−1.56 (0) 6th	−1.79 (1) 4th	−1.54 (3) 6th	−0.94 (7) 17th	0.85	−1.73 (5) 10th
Nonwords	Y	−0.96 (0) 17th	−1.16 (3) 12th	−0.65 (7) 26th	0.05 (17) 52nd	1.21	−0.08 (15) 47th
Neale Base Yr 1, Level 1; Treatment Yr 1, Level 2							
Accuracy	Y	(0)	(0) 10th		(20) 70th		
Comprehension	Y	(2)	(2) 21st		(10) 86th		
GPC test. Developed from Understanding Words (raw scores only available)							
GPC		7	7	28	54		59

Note. Standard scores are presented where available with raw scores in brackets.
[a]Sig Chg = clinically significant change; Y = significant growth and clinically improved; I = significant growth, but not clinically improved; N = neither significant growth nor clinical improvement. [b]Chg (*SD*) = change score in standard deviation units. [c]FSIQ = Full Scale IQ. [d]WISC-IV Vocabulary scaled score.

Change in Reading Skills From Baseline to Postintervention

The difference between baseline raw scores and the Week 30 postintervention raw score was assessed at a group level using repeated measures *t* tests. Further *t* tests examined the difference between Week 30 and Week 40 maintenance scores, to determine the stability of growth for those measures that had maintenance data (CC2 and CBM nonwords).

There was a statistically significant change from baseline to Week 30 postintervention for CC2 regular words, $t(4) = -7.8$, $p = .001$, CC2 irregular words, $t(4) = -11.5$, $p < .001$, CC2 nonwords, $t(4) = 18.9$, $p < .001$, and CBM nonwords, $t(4) = 10.1$, $p = .001$, text-reading accuracy, $t(4) = -21.9$, $p < .001$, and reading comprehension, $t(4) = -19.0$, $p < .001$. The difference between Week 30 posttest and Week 40 maintenance was not significant for CC2 regular words, $t(4) = -2.4$, $p = .07$, CC2 irregular words, $t(4) = -0.4$, $p = .70$, or CC2 nonwords, $t(4) = 0.5$, $p = .60$. These data indicated that intervention gains were maintained. The Week 40 maintenance score for the CBM nonwords was significantly higher than the Week 30 postintervention score, $t(4) = 4.06$, $p = .01$. These data indicated that further improvements in this curriculum-based measure were seen despite intervention no longer being provided.

Individual Response

The response of each participant on the reading outcome measures across baseline, treatment and maintenance stages is shown in Figures 1–6. Two measurements were required before we were able to analyse participants' responses quantitatively. First, the growth in reading skills from baseline to the Week 30 postintervention measurement was obtained

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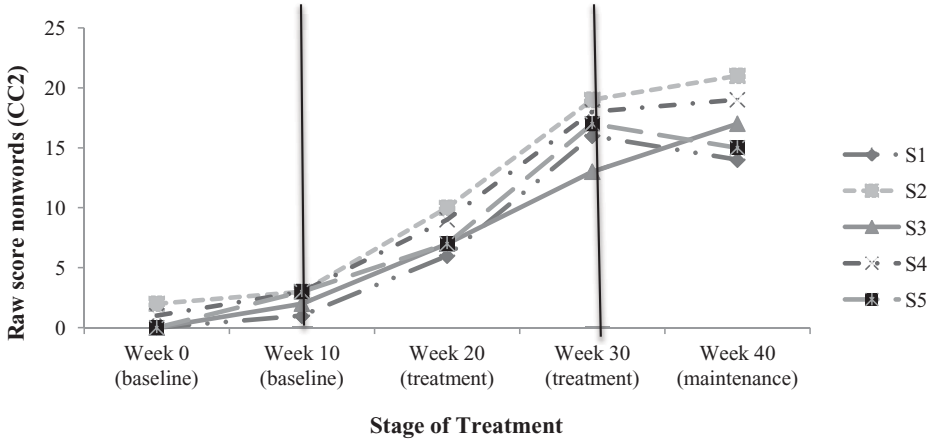

FIGURE 1

Raw Scores for all Participants on the CC2 Nonword Reading List.

in *SD* units for each of the outcome measures. For the CC2 and NARA-III these were obtained using the normative distributions based on age from each of the test manuals (Castles et al., 2009; Neale, 1999). Meta-analyses of the average effect size from early intervention programs have shown the average growth in reading skills to range between .53 and .86 (Ehri et al., 2001). We therefore used a change of $\geq$ 0.8 *SD* from baseline to postintervention to indicate reliable improvement in reading skills. This represents a large effect size (Cohen, 1992) and was adopted to take into account normal growth without the intervention. The second issue concerns the clinical meaningfulness of change. Some studies have used posttreatment status, for example, a posttest standard score of $\geq$ 90, which corresponds to the 25th percentile, as a benchmark for sufficient response to intervention (Torgesen, 2000; Torgesen et al., 2001; Wright & Conlon, 2009). An age-adjusted score corresponding to the 30th percentile rank has been reported to represent the low end of the normal range on the CC2 (Castles et al., 2009). Clinically meaningful change can only be established if meaningful reading growth occurs and children move from having a severe reading disability to a part of the distribution consistent with average reading performance (Campbell, 2005). On this basis, clinically meaningful change for each measure was determined by growth in reading skills of 0.8 *SD* and a postintervention percentile rank of at least 30.

Nonword Reading

Figure 1 shows growth over the course of the study on the CC2 nonword reading measure. Minimal gains were made in the Week 0–10 baseline period, while substantial growth occurred in the Week 10–20 and Week 20–30 treatment periods. All participants met the criterion set for clinical significance of $\geq$ 0.8 *SD* unit change from pre-post. In addition, all children had reached at least the 30th percentile for their age on nonword reading at the conclusion of the intervention (see Table 1).

Similar patterns of growth can be seen in Figure 2, which displays raw score data from the CBM nonword reading test. Minimal gains were made during the 10-week baseline, whereas substantial gains were made during the treatment phases. Gains were maintained

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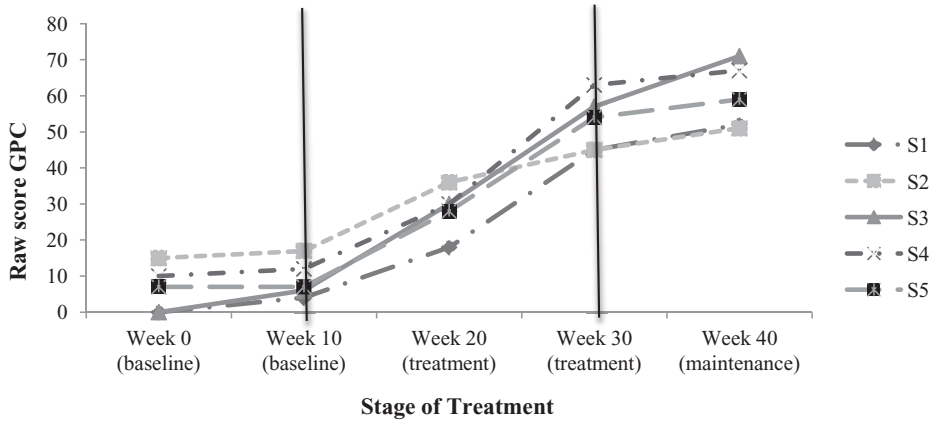

FIGURE 2

Raw Scores for all Participants on the Curriculum-Based GPC (Nonword Reading) Test.

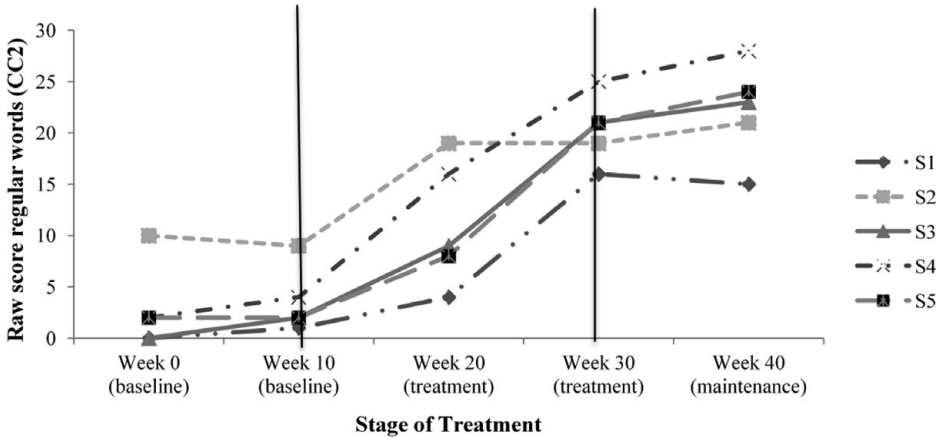

FIGURE 3

Raw Scores for all Participants on the CC2 Regular Word Reading List.

at follow-up. Note that clinical significance criteria could not be applied due to lack of normative data for this task.

Regular-Word Reading

Figure 3 shows baseline, treatment and maintenance effects for the CC2 regular word list. Minimal growth was made across baseline. Figure 3 shows that all participants with the exception of S2 and S5 made strong growth in regular-word reading over the 20-week treatment periods, and that these gains were maintained at 10-week follow-up. With the exception of S2 and S5, all participants achieved the pre–post change of ≥ 0.8 *SD* unit change set as a criterion for clinical significance. With the exception of S2 and S3, all children reached the 30th percentile at postintervention on this measure.

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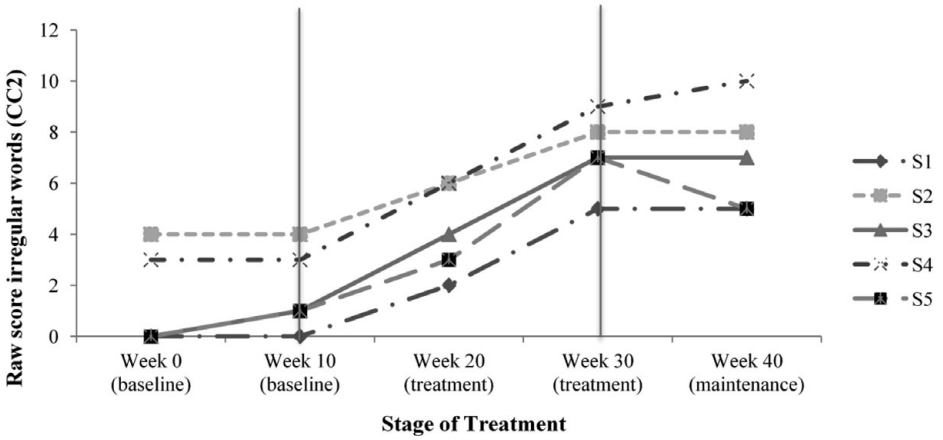

FIGURE 4

Raw Scores for all Participants on the CC2 Irregular Word Reading List.

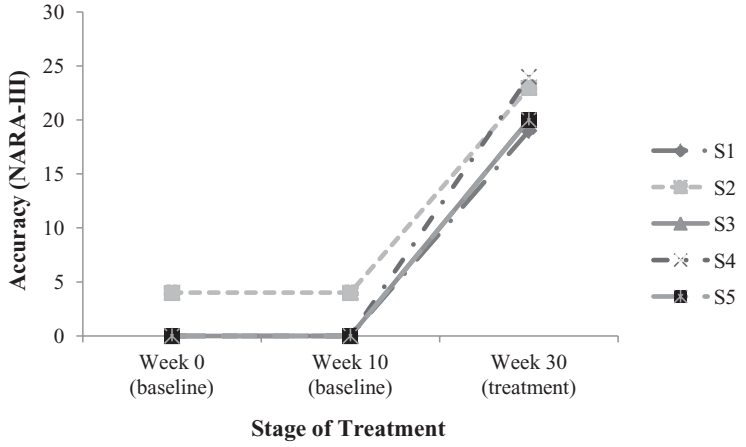

FIGURE 5

Raw Scores for all Participants on the NARA-III Passage Reading Accuracy Measure.

Irregular-Word Reading

Figure 4 shows minimal growth in baseline irregular-word reading. With the exception of S4, whose growth in irregular-word reading was 0.58 *SD*, all other children improved over the treatment period by at least 0.8 *SD*, gains that were maintained at Week 40. Only S1 satisfied the criteria for clinically significant improvement on the measure, reaching the 40th percentile at postintervention. Scores for the remaining three children were below the 30th percentile rank for this task.

Reading Accuracy and Comprehension

Figures 5 and 6 show the data for the reading accuracy and reading comprehension tasks, respectively. Negligible change occurred across baseline for both tasks. All five participants

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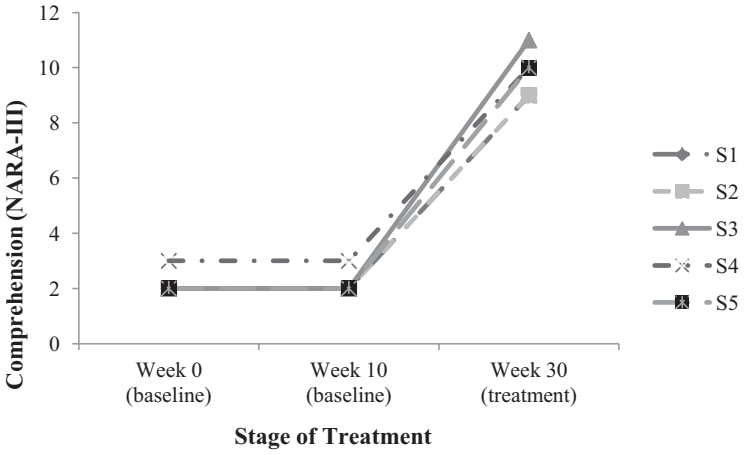

FIGURE 6

Raw Scores for all Participants on the NARA-III Reading Comprehension Measure.

made substantial growth over the 20-week treatment period on both reading accuracy and reading comprehension so that at the end of treatment they showed evidence of growth. All children reached at least the 30th percentile for both accuracy and comprehension at the end of the treatment phase.

Discussion

In this study, we aimed to determine if parents, acting as paraprofessionals, could effectively deliver a systematic reading intervention to children with word-level reading difficulties. The main outcomes are listed below and are then discussed in turn:

1. Reading intervention delivered by a parent on a one-to-one basis led to substantial gains in phonological decoding. These gains were greater than seen over a double baseline period and were maintained at 10-week follow-up. All five participants met the criteria for clinically significant change at the conclusion of treatment ($\geq$30th percentile rank), indicating that all had returned to what could be considered to be the average range (Torgesen, 2000).
2. Reading intervention also led to substantial improvements in text-reading accuracy (reading in context). The growth in text-reading accuracy was such that all participants returned to the average range (Torgesen, 2000) at the conclusion of treatment.
3. Perhaps most important, reading comprehension improved substantially from double baseline to conclusion of treatment in all participants. All five participants concluded the treatment period with reading comprehension back within the average range (post-treatment score $\geq$ 30th percentile rank).
4. Greater gains were seen in regular-word reading during the treatment phase compared to baseline. Three of the five participants made clinically significant change (posttreatment score $\geq$ 30th percentile rank).

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5. Gains were seen in irregular-word reading that co-varied with onset of treatment. However, only one participant made clinically significant change (posttreatment score $\geq$ 30th percentile rank).

Treatment Efficacy When Delivered by Paraprofessionals

The inclusion of a double baseline and maintenance phase strengthens the conclusions that can be drawn from this study. A randomised trial will be required to firmly settle the question of whether the improvements were due to treatment effects or to some other factor. However, that reading growth was almost nil over the baseline period and that growth was strong over the two treatment phases provides further preliminary evidence for the efficacy of the intervention approach.

That improvements in phonological decoding were accompanied by improvements in text-reading accuracy is important because it shows that improvements in single-word decoding may lead to improvements in the more functional skill of text reading. Furthermore, the data showed that not only did all the students improve but also that they improved to a point considered clinically significant (i.e., they returned to the average range; Torgesen, 2000). These data are important because in large group studies a statistically significant effect can often hide the fact that participants' skills remain at less than functional levels following treatment (Campbell, 2005; Kazdin, 1999).

Finally, that paraprofessionals (parents) were able to deliver a reading intervention in an efficacious manner bodes well for the development of a cost-effective program to be used in schools; a task identified as important by previous research (e.g., Wright & Conlon, 2012). Using paraprofessionals markedly reduces intervention costs to schools. Schools are also more likely to instigate and stick at a systematic reading intervention if paraprofessionals can be trained with relatively little effort and if they can deliver intervention via scripted administration guidelines with only supervisory guidance from a learning support coordinator. Research is now needed to determine if similar effects can be obtained in schools using trained teacher assistants.

Reading Comprehension Gains

That all participants made clinically significant gains in reading comprehension is important because comprehension is the end goal of reading. Some previous studies have shown that 25–50% of students do not make clinically meaningful gains in reading comprehension in response to word-level interventions (e.g., Hatcher et al., 2006; Wright et al., 2011b). There are two explanations for why the entire sample in the current study concluded the intervention with normal reading comprehension. First, the intervention method included teaching of vocabulary, oral sentence comprehension, and inference drawing in addition to the word-level teaching. The time spent on oral language comprehension may have influenced the response on the reading comprehension measure. Second, the students in the current sample may have responded regardless of the inclusion of oral language activities. Future research needs to investigate which components of the intervention described in this study are necessary to bring about reading comprehension gains in children with particular characteristics. For example, word-level exercises may be sufficient to produce normal growth in comprehension in students who begin intervention with good vocabulary and other aspects of oral comprehension. In contrast, students who have both word-level and oral comprehension weaknesses may require a combination of word-level and oral comprehension training. That future research addresses the question of "who needs what to produce what type of change" is crucial because special

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education professionals need to know what type of training they must provide children with particular characteristics to produce meaningful change. Furthermore, resources are scarce in schools so we need to know if any aspects of instruction are redundant for certain students.

Irregular-Word Reading

The hypothesis that fewer gains would be seen in irregular-word reading was not supported by the outcomes. While only one participant made a clinically meaningful gain (postintervention score > 30th percentile), all participants achieved a growth of > 0.58 *SD* units and four of the five participants had a growth of > 0.8 *SD* units. It had previously been thought that irregular-word reading gains would occur only for trained items (Broom & Doctor, 1995). However, there are reports of generalisation occurring (Brunsdon, Hannan, Nickels, & Coltheart, 2002; Kohnen et al., 2008; Wright et al., 2011a). This study adds to these data and suggests that irregular-word learning can occur without specific training.

All the GPC rules taught in the current intervention occur too frequently to be considered irregular. They were therefore unlikely to have assisted participants in 'sounding out' novel irregular words. However, a combination of improved GPC knowledge and increased reading volume (with the subsequent increase in the availability of semantic information in texts) may have allowed the participants to partially resolve decoding ambiguity for irregular words and therefore learn some irregular words without direct training. This suggestion is consistent with the notion of a self-teaching hypothesis (Share, 1995). Finally, some authors have previously speculated that gains occur on irregular-word items for which individuals have partial orthographic representations at pretreatment. The suggestion is that the additional activation of the orthographic lexicon during treatment helps these representations to become better specified (e.g., Brunsdon et al., 2002; Wright et al., 2011a). Future research will need to address this hypothesis by using lexical decision tasks at pretreatment to determine irregular-word items that cannot be named but that have partial representations in the orthographic lexicon. Identifying how and why generalisation occurs is an important avenue for future research because time is such a precious commodity in school-based intervention, and if skills can be acquired without direct teaching, it will save considerable time and money.

Limitations and Future Directions

Case series designs do not permit strong conclusions to be drawn regarding wider populations. These data should therefore be seen as preliminary evidence of the effectiveness of Understanding Words. Future research will need to use randomised trial designs to enable more firm conclusions.

The selection criteria for the current study were quite specific. The advantage of tight selection criteria is that cognitive factors beyond reading can largely be ruled out as drivers of response or nonresponse. However, it does mean that it is unclear how representative the sample was of the typical learning support population in schools. The way children who have complex and/or severe coexisting developmental conditions respond to reading intervention(s) remains an important area of investigation.

Another limitation was that reading comprehension measures were not administered at every stage of the study. This occurred because in planning the study we had concerns about practice effects if the same measure was used multiple times. It was felt that the effects of practice might be insidious in a case series design where the dependent measure was individual change. Practice effects are less problematic in controlled designs as the

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effects of practice should be comparable in both groups. It is therefore possible to use a single instrument for repeated measures. Future group investigations of the intervention program described here and investigations of the effectiveness of parents in delivering reading intervention should ensure that reading comprehension is measured comprehensively because the transfer to comprehension is arguably the most important outcome in intervention research.

Finally, one of the most exciting outcomes from the study was that parents were able to produce clinically meaningful change in word-level skills and reading comprehension. It would therefore be tempting to claim that any parent may deliver the same efficacious instruction. However, the data do not permit this conclusion. The parents essentially self-selected for this study because the selection criteria included the willingness and capability to provide daily reading instruction. They may therefore have been somehow different to other parents and to some teacher aides who might be used to delivering instruction in school settings. These differences may have been due to education status, literacy status and/or cognitive factors such as perceived competence and perceived control. The characteristics of those who can deliver effective reading intervention is as important as the characteristics of the children who respond or do not respond, and will need to be the subject of careful future investigations.

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Appendix A

Curriculum-Based GPC Test

ti	na	ip	sa	op
pon	dost	pock	dep	sint
nesp	mep	rop	remp	tem
pasp	hon	sut	hund	fen
frip	moff	fest	sluck	lib
rell	basp	caft	peb	gop
pog	lusp	teck	waim	jat
faip	jomp	daint	shoap	juss
broan	toak	scay	chid	snay
pench	sutch	spatch	shick	chay

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shup	snash	lotch	frith	quiff
meeth	thoap	quist	fash	quate
pite	trong	dake	peng	sping
droom	meep	loost	hux	sparm
eem	forp	frex	feech	lorp
steek	nord	figh	mizz	zigh
yight	tuve	arp	yart	yest
zup	marb	toom		

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