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Journal of Research in Special Educational Needs · Volume 19 · Number 1 · 2019 3–14
doi: 10.1111/1471-3802.12419

Two-step tier three interventions for children in grade three with low reading fluency

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Key words: RTI, intervention, reading disabilities, dyslexia, gender differences.

The main aim of this study was to investigate the effect of a tier three intervention, response-to-intervention design, on children with low reading ability in grade three. Twenty-eight children (12 females and 16 males) participated in this study. The participants were given out a battery of reading tests including decoding and reading comprehension tests, and in total, the children received 20 reading intervention sessions in two waves, during 4 weeks. The results showed substantial gains with large effect sizes (*d* 0.78–2.95) on all the reading tests after the intervention period. A short, intensive and individualised intervention has a substantially positive effect on children's reading ability. For a majority of the children, the increased ability sustains even 4 years after the end of the interventions. However, as boys seem to have the greatest problem to sustain their increased ability, the authors claim that it is important to continue the intervention even after the research interventions have ended.

Introduction

Reading disabilities (RD) are a common difficulty among school children. Approximately 20% have some kind of reading and writing disability (Hessler, 2001; Lundberg, 1985). A great number of studies have advocated the importance of early detection with subsequent interventions for children who show problems in acquiring reading and writing abilities during their first years in school (Catts, Nielsen, Bridges, et al., 2015; SBU, 2014; Snowling, 2013), not least to avoid school failure, low self-esteem and avoidance of school-related issues in the future (Bonifacci, Storti, Tobia, et al., 2016; Burden, 2008). The main purpose of the present study is to investigate the effect of two-step intensive one-to-one reading intervention with a 4-year follow-up for children in grade three with low reading ability. The intervention design is based on the third tier in a response to interventions (RTI) model.

The RTI model is taking into account how children respond to an intervention by modifying pedagogical efforts with regard to the children's responses. The model typically includes three tiers, where the first tier can be regarded as comprising scientifically based effective instructions in the classroom for all children. Children who do not respond to Tier 1 receive small group interventions in Tier 2. Non-responders from Tier 2 receive individual intensive instructions in Tier 3 (Andrade, Andrade and Capellini, 2015; Fuchs, Fuchs and Compton, 2012; Gustafson, Svensson and Fälth, 2014). In Tier 3, the interventions are individualised and more intense, and a continued process of monitoring the children's progress is used in order to modify the instruction when necessary (Fuchs, Fuchs, and Compton, 2012; Wanzek, Vaughn, Scammacca, et al., 2013).

In RTI-based studies, different arguments have been made regarding what is meant by early interventions and in what tier the interventions should start. In some studies, interventions have been used as early as kindergarten, after a screening procedure (McAlenney and Coyne, 2015). Other studies start the first intervention period (Tier 1) in grade one (Gilbert, Compton, Fuchs, et al., 2013). Thus, if students still do not respond in Tier 1, they are eligible for Tiers 2 and 3. Earlier studies have shown (Berkeley, 2009; Fuchs, Fuchs, and Compton, 2012) that the start of Tiers 2 and 3 can vary from grade 1 to grades 3–5. For some children, reading difficulties are not apparent until they reach the third or fourth grade, or even later (Wanzek, Vaughn, Scammacca, et al., 2013). Early difficulties with reading and writing acquisition might be hidden by factors such as high intelligence, compensatory strategies, maturity ('late bloomers'), home conditions, behaviour problems or conduct disorders (Compton, Fuchs, Fuchs, et al., 2008; Svensson, Lundberg and Jacobson, 2003). Because of the various reasons for the development of RD, a thorough investigation is needed. In an RTI model, one aim is to monitor the pupils' reading and writing ability over a relatively long period (Gustafson, Svensson, and Fälth, 2014), which might be essential to receive a clear picture of the origin of the difficulties. However, students in grade three with severe reading difficulties should be placed directly in Tier 3 to get intensive and responsive interventions. Not at least to be as prepared as possible to cope with an

increased amount of text which also has a rising complexity when entering higher grades (Vaughn, Denton and Fletcher, 2010). Wanzek, Vaughn, Scammacca, et al. (2013) argued that instructions in learning to read are fading out after third grade and, if the child has failed to read correctly and with fluency at the end of grade three, it might seriously affect their academic achievement.

If, after a screening procedure, children belong to an 'at risk' group of reading failure, the question is raised as to whether they should start with interventions in Tier 1, which entails a lower intensity of the interventions carried out in the classroom, or whether they should start directly with the more intensive individual interventions that are typical of Tier 2 or 3. In a research review by Vaughn, Denton, and Fletcher (2010), the authors argued that less intensive interventions might not be effective enough for pupils with severe reading difficulties and that it is more cost-effective to immediately provide pupils having obvious reading difficulties with more intensive (Tier 3) interventions. Otherwise, the pupils have to pass through lower intervention layers (Tiers 1 and 2) with low or no response at all, which is disadvantageous, not least from an ethical point of view. The authors concluded that 'effective reading interventions, particularly for students at the greatest risk for reading failure, are implemented at a high level of intensity' (Vaughn, Denton, and Fletcher, 2010, p. 441). In a study by Al Otaiba, Connor, Folsom, et al. (2014), the researchers came to the same conclusion. They had two RTI tracks for the children with the weakest skills entering the first grade, one 'typical RTI' track where the students were to move through all the three tiers, and one fast track, called 'dynamic RTI', where the students started immediately in Tier 2, or in Tier 3 after the screening procedure. Students who immediately received more intensive interventions gained more from the reading interventions than those following the typical RTI procedure of going through all the three tiers. Furthermore, if students still have low reading scores in grade three or later, Vaughn, Denton, and Fletcher (2010) argued that they should receive intensive interventions and start directly at Tier 3.

Some studies (Fuchs, Fuchs, and Compton, 2012; Gilbert, Compton, Fuchs, et al., 2013; Tran, Sanchez, Arellano, et al., 2011; Wanzek and Vaughn, 2008) have investigated the impact of the intensity of the interventions that is their number and length of sessions, the length of the intervention period as well as the type of intervention (one-to-one or in small groups). At this stage, there is no consensus among researchers regarding these issues. Some authors have advocated that students will benefit more from the intervention if they are involved in sessions continuously over several years (Gilbert, Compton, Fuchs, et al., 2013; Vaughn, Wexler, Roberts, et al., 2011), while others argue for a shorter but more intensive intervention (Torgesen, Alexander, Wagner, et al., 2001; Wanzek, et al., 2006). In a study by Tran, Sanchez, Arellano, et al. (2011), no differences were observed between low responders (aged 7–10 years), with regard to length and number of sessions as well as type and number of weeks of interventions. It appears that more research is needed about intervention layout.

Two important factors that affect learning are the child's motivation to participate in intensive training and the teacher's ability to provide emotional support to the child. In a reading intervention study by Fälth, Gustafson, Svensson, et al. (2014), the authors interviewed both the children receiving a reading intervention and the teachers who carried out the intervention regarding how they had perceived the interventions. The programme included 25 thirty-minute sessions over a period of approximately 10 weeks. Both the children and the teachers claimed that it was intensive and hard work to carry out the training throughout the intervention period. The children also stated that they were looking forward to the end of the programme. Potentially, an intervention that is intensive over a long time might jeopardise the children's (and the teachers') motivation, which in turn may negatively influence its results (Fälth, Gustafson, Tjus, et al., 2013).

In different studies, researchers argue that individualised interventions are important in order to reach optimal results (Fuchs, Fuchs and Vaughn, 2014; Wanzek and Vaughn, 2008). However, there are studies that have shown no differences in improvement between more and less standardised interventions, although research in this area is sparse (Vaughn, Wexler, Roberts, et al., 2011; Wanzek, Vaughn, Scammacca, et al., 2013). Vaughn, Wexler, Roberts, et al. (2011) carried out a study among seventh- and eighth-grade students, which compared standardised interventions, individual interventions and a comparison group (including 'no researcher-provided intervention' Vaughn, Wexler, Roberts, et al., 2011, p. 2). Both the standardised and the individual interventions outperformed the comparison group on different reading abilities, while there were no differences between the two intervention groups.

One of the most common criticisms against RTI is that the interventions are not clearly specified for each tier, for example what are the differences between Tiers 2 and 3? The interventions are quite often described as 'more of the same' from one tier to another (Gilbert, 2013; Reynolds and Shaywitz, 2009; Wanzek and Vaughn, 2008). As Gilbert, Compton, Fuchs, et al. (2013) concluded that an increase of interventions in Tier 2 or 3 might not be enough, the instruction must also be more individualised. This is understandable, since it is difficult to find one universal intervention for developing reading- and writing-related skills that suits all children with early difficulties. Thus, for some children, the main difficulties are decoding and fluency, while for others it is reading comprehension or spelling that causes most problems. In a study by Morris, Lovett, Wolf, et al. (2012), the conclusion is

drawn that an intervention programme that incorporates multiple components targeting a variety of language skills (phonology, orthography and morphology) leads to gains in a range of reading abilities. Fälth, Gustafson, Tjus, et al. (2013) carried out a study among children with RD in grade two. The interventions included two computerised programs. One program aimed to improve word decoding skills and phonological abilities (COMPHOT), while the other aimed to increase word and sentence levels (Omega-interactive (Omega-IS) sentences). The children were randomly assigned to four different groups: (1) the COMPHOT program, (2) the Omega-IS program, and (3) a combination of these two training programs, (4) the fourth group received treatment as usual. The intervention was given in a 'one-to-one teaching design'. A follow-up 1 year later showed that students in all the groups had improved their reading. However, the combined intervention group showed the strongest improvement and also contained the fewest children that still needed special education 6 months after the interventions had been terminated.

Response to interventions has also been used as an instrument to identify reading and writing difficulties as well as learning disabilities (Andrade, Andrade, and Capellini, 2015; Catts, Nielsen, Bridges, et al., 2015). The main point is that children who have the lowest RTI after tiers of reading interventions are the ones with constitutional RD, for example dyslexia, in contrast to RD that have arisen from environmental factors such as a lack of reading experience or poor teaching.

In the present study, the participant group of children is made up of an almost equal number of girls and boys. The aim of this design is to investigate gender differences in RTI. Thus, children that are low or non-responders might be those with the most severe difficulties and therefore shed light on the issue of gender differences among those having severe problems with the written language such as dyslexia.

For decades, discussions have been going on regarding gender differences related to reading and writing difficulties. Some researchers claim that there is an overrepresentation of boys while others assert that there are no differences (Jiménez, de la Cadena, Siegel, et al., 2011; Rutter, Caspi, Fergusson, et al., 2004; Siegel and Smythe, 2005; Wheldall and Limbrick, 2010). The disparate results among studies in this respect might be due to several circumstances, one being that teachers are more likely to refer to boys as having special difficulties as they show more behavioural problems than girls (Shaywitz, 2003). Another reason could be that environmental influences or gender differences are most apparent in orthographic skills which chiefly affect writing (Berninger, Nielsen, Abbott, et al., 2008). Furthermore, differences between the genders seem to be more notable when looking at the lower end of the distribution. In a study by Vaughn, Linan-Thompson and Hickman (2003),, an RTI model was used to identify 45 second-grade students at risk for reading problems. The participants were given 10 weeks of intervention. For those who did not meet the criteria after this period, another 10 weeks of intervention were added, and those who still did not meet the criteria received a further 10 weeks. It was found that slightly more girls were identified as being at risk (20 males and 25 girls) and that more girls than boys (7 girls and 4 boys) never met the criteria. The authors agreed with earlier studies suggesting that boys are not more vulnerable to serious reading problems than girls (for an overview of gender differences, see: Quinn and Wagner, 2015; Vaughn, Linan-Thompson, and Hickman, 2003; Wheldall and Limbrick, 2010).

In the present study, one research question focuses on the long-term effects of an intervention where the children's reading ability is assessed 4 years after receiving the intervention. Earlier studies have shown remaining positive gains after an RTI intervention compared to the effect for a comparison group after a 2-year follow-up (Denton, Nimon, Mathes, et al., 2010; Fuchs, Compton, Fuchs, et al., 2008). However, for those pupils with severe difficulties who do not respond sufficiently or are non-responders, reading interventions are required throughout middle school (Pyle and Vaughn, 2012). Vaughn, Linan-Thompson, and Hickman (2003) stated that 'we expect that some students will benefit both initially and in the long term from supplemental instructions but that for some students benefits will fade unless subsequent supplemental instruction is provided' (p. 407).

Aims

The first aim of this study was to investigate the effect, among children in grade three with low and severe reading ability, of two-step Tier 3 reading interventions including both phonological and orthographic aspects. A second aim was to investigate whether the results on the reading test showed any gender differences before and after the interventions. A third aim was to analyse the children's reading ability 4 years after the end of the interventions.

Method

Participants

Thirty-one children in grade three (9 years old), 17 boys and 14 girls, participated in this intervention study. The children, with Swedish as their first language, came from six schools in a municipality in Sweden. The first criterion for participation was that the children should comprise the three girls and the three boys who had the lowest reading ability in each class, as judged by their classroom teacher. Earlier studies have shown that teachers are quite good at determining which children are in need of reading remediation (Compton, Fuchs, Fuchs,

et al., 2010). In two out of the six schools, it was not possible for the teachers to obtain children with such a low reading ability that they could be eligible for a reading intervention. Thus, there were three more boys than girls in the total sample.

A second criterion for participation was that the children performed below the 30th percentile on at least one of two reading tests. A word recognition test and a reading fluency test which are commonly used as screening instruments for reading difficulties (Andrade, Andrade, and Capellini, 2015; Beach and O'Connor, 2015; Rasinski, Blachowicz and Lems, 2012) were used to measure if the children were below the 30th percentile. Even though this cut-off may be considered fairly liberal for being assigned to an at-risk group (−0.5 SD), the 30th percentile has been used in earlier studies (Al Otaiba, Connor, Folsom, et al., 2014; Barth, Stuebing, Anthony, et al., 2008; Simmons, Coyne, Kwok, et al., 2008). A liberal cut-off is preferable to enable as many students as possible to reach a sufficient level of reading (especially in grade three). Furthermore, the intervention programmes in the present study are beneficial for the reading acquisition process even among pupils that do not have any reading difficulties (Elliott and Grigorenko, 2014). Thus, children performing above the 30th percentile can be regarded as meeting the grade level (Al Otaiba, Connor, Folsom, et al., 2014; Andrade, Andrade, and Capellini, 2015). Consequently, children who were considered as the three who were lowest in reading ability in their class and performed below the 30th percentile on at least one of the two reading tests were eligible for participation in the present study.

Out of 31 children, 28 (90%) who were selected by the teachers as low readers, performed below the 30th percentile on at least one of the two tests. These 28 children (12 girls and 16 boys) were included in the data analysis. Consequently, three children were removed from the data analysis since they performed above the 30th percentile on the two tests at baseline. For one of the tests, 'Wordchains' (measuring word recognition), a comparison group was available existing of pupils from a grade three class (n = 20, 10 girls and 10 boys). These pupils carried out the word recognition test four times at the same time interval as the experimental group but without any research interventions. There were no gender differences between the comparison class and the experimental group. For this test, the researchers used separate norms for boys and girls, because of the obvious differences between the genders on the norm data with the girls outperforming the boys (see Jacobson, 2001).

The present investigation has received ethical approval (Reference number: 2011/303-32) by the Regional Ethical Review Board, Linköping, Sweden.

Procedure

The children were given a battery of reading tests including both computerised and paper and pencil tests on four occasions: The first test session (T1) took place just before the interventions, the second (T2) immediately after the first intervention, the third (T3) just after the second intervention and the fourth test session (T4) at the first follow-up. The total time between the first (T1) and the last sessions (T4) was 14 weeks. Four years later (in the first semester of grade seven), a second follow-up was carried out (T5). Special education teachers carried out all the interventions. One special education teacher who was not involved with the children's interventions performed all tests. The intervention was carried out between September and December 2011 and the follow-up in November 2015.

The teacher was instructed that the child should receive at least 30 minutes' individual instruction in each session. At T1, the children carried out a battery of reading tests (see Table 1). The first intervention period (Intervention 1) comprised 10 sessions, in total, and included both programs (Omega-IS and COMPHOT) with the children receiving five sessions of each over 2 weeks. This was followed by the second test session (T2), after a 2-week pause from the interventions had been imposed. During that time, two of the authors (I.S. and L.H) decided which intervention the children should proceed with on the basis of the results from T2. The children who had the greatest problems with low-level abilities, such as accuracy and fluency in decoding, received an additional 10 sessions for two more weeks with the COMPHOT program (n = 6), while those whose difficulties appeared on a higher level, such as grammatical issues and reading comprehension, received instead 10 more sessions lasting 2 weeks with the Omega-IS program (n = 8). Those who showed low responses to both phonological and orthographic aspects continued to receive training with both programs for the additional 10-week training period (five sessions with each program; n = 14). After this second intervention period (Intervention 2), came a new test procedure (T3). In total, all children received 20 sessions. A follow-up (T4) with the same tests was carried out 5 weeks after the interventions. One more follow-up (T5)

Table 1: Intervention design

T1	Intervention 1	T2	Pause	Intervention 2	T3	T4	T5
Week 1	2 weeks	Week 4	2 weeks	2 weeks	Week 9	Follow-up Week 14	Follow-up 4 years

was concluded in grade 7 (4 years after the intervention) with some of the tests used on the former test occasions (word recognition, sight-word reading, non-word reading and reading comprehension).

Materials

To assess reading fluency and reading comprehension in connected text, LOGOS subtests were used. LOGOS is a computerised assessment battery (with 16 subscales) used to screen RD, and it is criterion-referenced (Barth, Stuebing, Anthony, et al., 2008) that is those children that do not reach the 30th percentile on the different subskills are regarded as at-risk children. Furthermore, those who fail to reach the 15th percentile are considered as having severe reading difficulties (Høien, 2007).

Reading fluency. Reading fluency was assessed by the oral reading of passages in LOGOS. In total, there were five passages containing 6–10 sentences each which were to be read aloud from a computer screen. The average number of words read correctly per minute was used as the measure of reading fluency (Høien, 2007).

Reading comprehension. Reading comprehension was assessed by asking children to respond to questions related to each one of the passages used to assess fluency. In total, there were five passages linked to three questions (in grade seven 4 questions), one of the questions to each passage requiring inference, while the answers to the two remaining questions could be found directly in the text. The maximum score was 15 for grade three and 20 for grade seven (Høien, 2007).

To assess word recognition, sight-word reading and non-word reading three paper and pencil tests were used.

Word recognition. Word recognition was assessed by the Wordchains test (Jacobson, 2001). The task for the children was to silently read chains of words where the blank space between the individual words had been removed and then to mark each word boundary with a pencil. Each chain consisted of three semantically unrelated words. The Wordchains test had test–retest correlations at an interval of 12 months between the measurements of $r = 0.80$–0.90 in different groups of children in grades 1–6 (Jacobson, 2001).

Sight-word reading (LäSt). The children were asked to read single words aloud as quickly as possible for 45 seconds. The test includes two test versions (A and B), the results of which were aggregated. The reported test–retest reliability for children aged 6–9 years at this test was 0.97. The maximum score was 100 (Elwér, Fridolfsson, Samuelsson, et al., 2011).

Non-word reading (LäSt). The task was to read in 45 seconds as many non-words as possible from a list. The test–retest correlation between T1 and T2 in this study was $r = 0.90$. The test includes two test versions (A and B), the results of which were aggregated. The reported test–retest reliability for children aged 6–9 years at this test was 0.97. The maximum score was 100 (Elwér, Fridolfsson, Samuelsson, et al., 2011).

Intervention programs

Orthographic training – Omega-IS. Omega-interactive sentences is a multimedia program applying a top-down strategy that is by clicking on buttons with words or phrases, sentences are constructed (Heimann, Lundälv, Tjus, et al., 2004). Immediate feedback is obtained for both words and sentences. The program is based on one-to-one teaching with exercises that encourage the child to explore and also construct sentences and coherent text. Omega-IS contains 200 words and nearly 2000 sentences. The sentences combine verbs, nouns, prepositions, conjunctions and adjectives. The program includes exercises ranging from two-word (noun + verb) and three-word sentences (noun + verb + noun) to stories within which the children could construct their own stories and choose different actors and scenarios. The children's own creation is in focus, since it is they who design the sentences and also the small stories. This was done in order to increase their motivation to explore the Swedish language. Each exercise includes speech and animation feedback. The language material of the program is meant to be explored by the child with the help of – and in interaction with – the teacher. The goal is to achieve an errorless co-construction of meaning from text through multimedia and supportive interaction.

Phonological training – COMPHOT (Computerised Phonological Training). The phonological training program, named COMPHOT (Ferreira, Gustafson & Rönnberg, 2007), contained four sections: position analyses (8 exercises), synthesis (5 exercises), rhyme (4 exercises) and segmentation (3 exercises). All exercises were based on phonological training but also included links to orthography (i.e. written letters and words). There was picture assistance for each word, and the task for the child was to decide which pictures (and corresponding words) rhymed or had the same initial phoneme, or to combine or remove segments of words. The units of language that were focused on in COMPHOT were phonemes, word segments and words. No sentences or passages were presented to the participants. Immediate feedback is received after each task with the inclusion of personal high-score lists where the performances on the different exercises could be checked.

Statistical analyses

The first aim of this study was to analyse the effect of a two-step reading programme for children in grade three with low and severe reading ability (below the 30th and the 15th percentiles for their age group). Cronbach's alpha was used to measure the agreement between the test scores at

T1 and T2. Longitudinal changes were analysed by paired sample *t*-tests, using change scores (SC) for each reading test between T1 and T4. Cohen's *d* (Cohen, 1988) was used to estimate the effect of the reading intervention programme. It was calculated as the ratio of the change score and the standard deviation of the mean score of the T1, T2 and T4 tests in the pooled sample. Five one-way between-group analyses of variance (ANOVA) were conducted to explore the impact of three intervention methods, Omega, COMPHOT, and Omega and COMPHOT. To disclose differences in scores between T2, T3 and T4 for the word recognition test between the experimental group and the grade three class, an ANCOVA was used with the test score at T1 on the word recognition test as a covariant. A second aim was to analyse gender differences in gain scores and reading tests. An independent *t*-test was carried out by means of change scores (CS). A third aim was to analyse reading ability 4 years after the intervention. For the second follow-up (T5), the scores on the tests were compared to the norm group of the tests.

Results

There was agreement between the test scores at T1 and T2 (Cronbach's alpha of 0.82 or above) for all variables except reading comprehension (0.40). This was due to the obvious ceiling effect on the reading comprehension test. Table 1 shows that all the five reading tests disclose a significant difference ($P < 0.001$) between baseline (T1) and follow-up (T4). When a non-parametric test (Wilcoxon signed-rank test) was used, all the tests were still significant ($P < 0.001$). The effect value (Cohen's *d*) varied between 0.76 and 2.95 among the five tests at T4.

Of the 28 participants in the intervention group, 21 had a value above the 30th percentile (>64) on the reading fluency and word recognition tests (>17) at T4 (follow-up 1). Consequently, seven students had a value below the 30th percentile at T4. Four of the students performed below the 15th percentile, which was the cut-off for severe difficulties on at least one of the two tests at T4 compared to sixteen students who performed below the 15th percentile before the intervention (Table 2).

There were no significant differences in gains among the tests between the three intervention methods (Omega-IS, $n = 6$, COMPHOT, $n = 8$, and Omega-IS + COMPHOT, $n = 14$) at T4 except for the non-word reading test, where the group which obtained the COMPHOT intervention yielded a significantly higher gain ($P < 0.05$) than the combined group which had used both intervention methods.

Comparison group

Comparison data from the word recognition (Wordchains) test was collected from a grade three class ($n = 20$) in a compulsory school. The comparison group outperformed the experimental group on the word recognition test both at T1 and at T4. However, the gap was considerably less at T4 and there was a significant difference in the observed change score (CS) ($P < 0.001$) between the groups from T1 to T4, where the experimental group had a higher CS (8.5) than the comparison group (1.7). The differences in gains between the groups were still significant (<0.001) after the pre-intervention (T1) score on word recognition as a covariate had been used.

Figures 1 and 2 illustrate the gain and the distribution of the raw value on the word recognition test between T1 and T4 within the experimental and the comparison groups.

Gender differences

At T1, the girls had significantly higher results on three of the five reading tests (word recognition, non-word reading and reading fluency). After the interventions, no significant gain differences between genders were obtained in any of the tests. The gap between the girls and the boys after intervention T4 on the reading tests decreased even though there were no significant gain differences between the genders. Sixteen children (5 girls and 11 boys) received below the 15 percentile at T1 on at least one of the word recognition and reading fluency tests. After the intervention, at T4, there were four children (two boys and two girls) who failed to reach the 15th percentile on at least one of the two tests.

Results from follow-up 2 (4 years after the intervention)

In a 4-year follow-up (T5), 13 students (attending grade 7) out of the 28 students who had participated from the beginning carried out the same reading test again. There

Table 2: Mean, SD and change scores (CS) on all the reading tests. Effect sizes are presented as Cohen's *d* between post-test (T4) and pre-test (T1). Norm data presented as percentile values

$N = 28$	T1, M	T2, M	T3, M	T4, M	CS (T4 − T1)	*d*	Norm data Grade 3, 30th/15th percentile
Word recognition	13.9 (4.2)	16.8 (4.9)	20.0 (6.1)	22.3 (5.6)	8.4	1.7	17/14
Word reading	81.7 (23)	88.2 (24)	94.0 (27.5)	100.2 (25.9)	18.5	0.8	93/78
Non-word reading	42.8 (13.6)	49.3 (15)	54.0 (17.6)	55.9 (20.1)	13.1	0.8	45/33
Reading fluency	45.9 (11.9)	59.5 (16.4)	76.2 (21.7)	83.5 (19.4)	37.6	2.3	63/43
Reading comprehension	6.8 (3.3)	12.2 (3.1)	14 (2.1)	14.3 (1.5)	7.5	2.9	11/9

$P < 0.001$. Cohen's $d = (M$ at T4 $- M$ at T1)/pooled SD for T1 and T4. Norm data are presented as ≥15th and ≥30th percentile on all the tests.

Figure 1: Differences in gain raw value among the measure points between the intervention group and the grade three class comparison group on the word recognition test

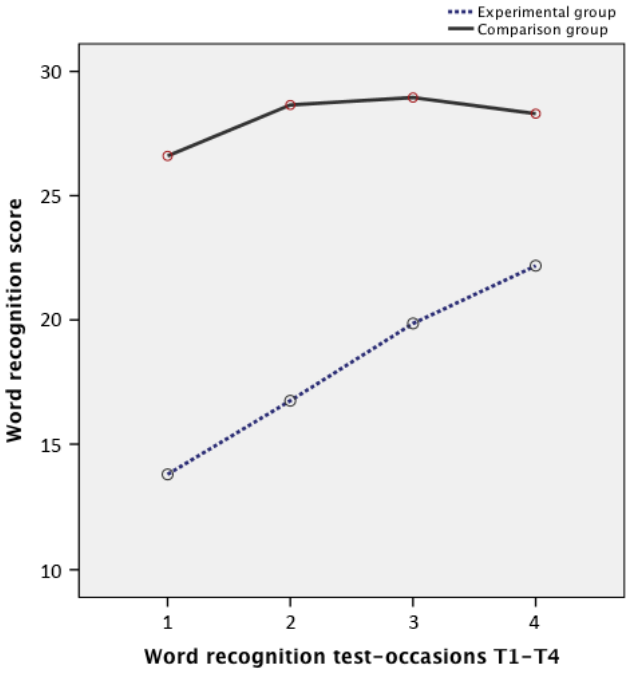
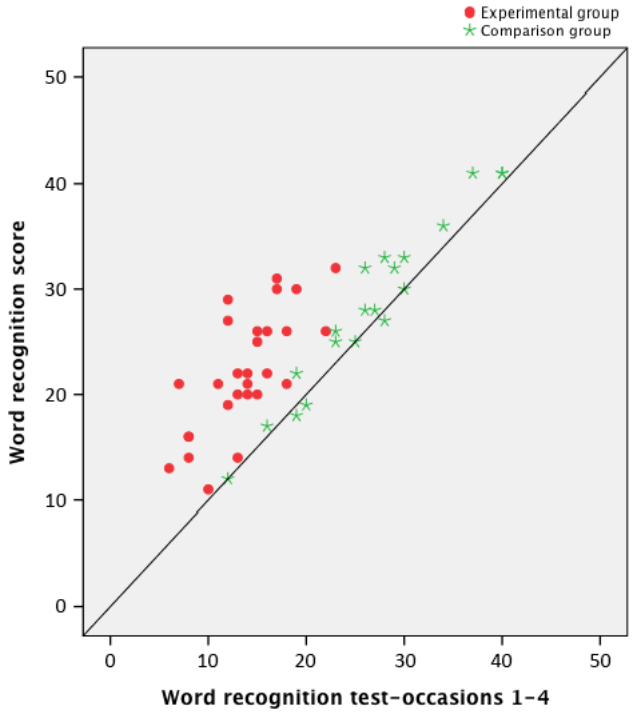


Figure 2: Distribution of the word recognition scores in the experiment and comparison groups between test occasions 1 and 4



were no significant differences at T1 on the word recognition and reading fluency tests between the 13 students that did carry out the tests at T5 and the 15 that did not. At this second follow-up, 8 out of the 13 students still performed a result above the 30th percentile on the word recognition test and the reading fluency test. Four (all boys) of the 13 students were noted for a value below the 15th percentile on at least one of the two tests. Two of the children performing below the 15th percentile on at least one of the two tests were the same children as at T5.

Discussion

This study has investigated the impact of a two-step intervention for students in grade three with low ability in fluent reading (below the 30th percentile). Initially, all participants received 10 sessions with the same interventions. After a break of 2 weeks, they continued with 10 additional training sessions, but this time these were individualised on the basis of the students' progress during the first 10 weeks. All the students gained on all the aspects of reading that were measured, 21 of whom (75%) had a reading fluency value, the main outcome variable, above the 30th percentile after the interventions (T4). The intervention group outperformed in growth the ordinary grade three classes on the word recognition test. Although they still had a lower result on the test, the gap was, however, considerably narrower at T4 than at T1. In an earlier study, it was reported that reading fluency is an essential measure in predicting later RD, not least for those who do not respond despite intensive remediation of this ability (Parker, Zaslofsky, Burns, et al., 2015). In the present study the participants in the experimental group gained between 0.78 and 2.95 (Cohen's *d*) on the reading tests and on the reading fluency test they gained 2.3. This is a notably high gain compared to earlier studies where it was reported that word fluency seems to be resistant against remediation at least for pupils with severe reading difficulties (Rasinski, Rikli and Johnston, 2009). One reason why the present study gave somewhat higher gains as compared to earlier studies (see Scammacca, Roberts, Vaughn, et al., 2015) on the reading variables, might be due to the rather liberal cut-off used for those regarded as having some reading difficulties. The majority of the participating children appeared to just need a short intensive effort to 'push them over the edge'. Another reason may have been that the researchers very thoroughly specified which kind of intervention suited each child after the first wave of interventions. Two of the authors with considerable experience of reading interventions determined the intervention by the way each child responded on the reading tests after the first ten sessions of intervention. This approach might have produced more effective interventions despite the relatively few sessions.

Three intervention methods were implemented in this study. The results revealed no differences in gain among the reading tests due to the way the intervention was allocated. In a study by Fälth, Gustafson, Tjus, et al. (2013), the students who received the combined method, which included both phonological and orthographic aspects, showed the highest gain. In that study, they received the

combined intervention during all sessions. However, in this study, it went one step further, that is both methods were used in the first 10 sessions, while the next 10 sessions contained the intervention the students needed most (as decided by the researchers in the present study on the basis of test scores at T2). Thus, the current results, which indicate no differences between the various methods, may call for a more optimised way of using different intervention approaches that is an intensive individualised method. The result of the present study confirms the reasoning by several other studies (Elbaum, Vaughn, Tejero Hughes, et al., 2000; Fuchs, Fuchs, and Vaughn, 2014; Stecker, 2007) stating that intensive shorter one-to-one individualised instruction that meets a student's learning needs has the best outcome.

The intention of the present study was to select an equal number of girls and boys to participate. However, this was not entirely possible, since in one of the classes the teacher could not identify three girls with any difficulties in reading. The reason why the researchers chose this approach was to obtain a more thorough view regarding gender differences in reading. Earlier studies have shown that girls in middle school often have higher results on reading tests such as word recognition and reading fluency than boys (Jacobson, 1999, 2001). Therefore, the present study used separate norms for girls and boys, wherever possible. Through this approach, more boys than girls were found to belong to the group with severe difficulties (below the 15th percentile at T1). Furthermore, it also emerged clearly that the boys who performed below the 15th percentile at T1 obtained the lowest results on the reading tests except on reading comprehension. This is in line with earlier studies (Flannery, Liederman, Daly, et al., 2000; Rutter, Caspi, Fergusson, et al., 2004) that is that there are differences between genders with regard to the prevalence of reading difficulties. However, after the intervention, at follow-up 1, there were only four children, two girls and two boys who performed below the 15th percentile on the word recognition test and the reading fluency test. Even if this was not significant, boys seemed to gain on average more from the interventions than the girls. Nine of the 11 boys performing below the 15th percentile at T1 reached a value on the reading recognition and fluency tests that lay above the 15th percentile after follow-up 1 (T4). As for girls, a similar change was observed in three out of five girls. Consequently, after the intervention periods, the gap between the genders in reading ability seems to fade out. Thus, it could be called into question whether the gender gap as regards severe reading difficulties, such as dyslexia, is as big as some studies have shown and that have been questioned by earlier studies (Jiménez, de la Cadena, Siegel, et al., 2011; Siegel and Smythe, 2005; Wheldall and Limbrick, 2010).

Since the interventions in the present study were carried out in two steps, they might single out those pupils that show low or no RTI, for example those with indicators of dyslexia. Earlier studies have advocated using RTI as a way of diagnosing reading difficulties (Andrade, Andrade, and Capellini, 2015; Catts, Nielsen, Bridges, et al., 2015). However, studies have also shown that RTI is an uncertain tool for identifying RD (Elliott and Grigorenko, 2014; Fletcher and Vaughn, 2009; Tran, Sanchez, Arellano, et al., 2011). Beach and O'Connor (2015) maintain that predicting RD on the basis of early interventions depends on the choice of predictors and criteria and the definition of RD. There is thus no consensus in the field about RTI as a method for diagnosing RD and LD.

Nevertheless, although the boys gained at least as much as the girls, or even more, the girls seem to be better at sustaining the results of the interventions when reaching middle school (grade seven). At T5 4 years after the interventions, the group with severe difficulties in reading contained boys only. The reason could be that in the present study the girls had, on average, higher results on the decoding tests. Consequently, children who have reached a certain level in fluent decoding probably catch up more quickly. Another reason could be linked to social expectations that is girls having higher demands than boys from the surroundings to manage schoolwork. Boys with severe reading difficulties might also be more prone to show acting-out behaviour and, as a consequence, experience different demands from the environment regarding the priority of school work (Grigorenko, 2006; Shaywitz, 2003).

Methodological issues

A sensitive enough cut-off that is choosing those who may be in the risk zone of developing reading difficulties later, has been discussed in a large number of research papers (Barth, Stuebing, Anthony, et al., 2008; Compton, Fuchs, Fuchs, et al., 2010). If a cut-off is set at the 30th percentile, which is a mild cut-off, it might capture students that are falsely negative. In one-way, this could be regarded as a waste of school resources which could have been used for other aims. However, too strict criteria heighten the risk that students who need intensive interventions (falsely positive) are not going to receive any interventions whatsoever, which might lead to problems later in life. In the present study, a mild criterion was chosen, since the researchers regarded it as a better alternative to avoid the risk of excluding anyone with possible difficulties in reading. In our view, this perspective is, in the long run, more cost-effective, at least in a human perspective. The length and number of the interventions in the present study fall considerably short of several other studies (see Tran, Sanchez, Arellano, et al., 2011) and are therefore probably less costly. In fact, the children in the present study received 20 sessions, which is fairly little in comparison with earlier studies. This might indicate that even rather few sessions can have a great potential to close the gap between children with reading difficulties and typical readers, especially if the interventions are sufficiently individualised, as in the present study. A

majority of the students that participated at T5 still had a reading ability above the 30th percentile, whereas a few had regressed in reading ability to below the 30th percentile (especially boys). However, if the children do not continue to be monitored and scaffolded in reading after an intensive intervention period, there is a risk that their reading ability will drop to small or no development at all during their future schooling as was also reported in Vaughn, Linan-Thompson, and Hickman (2003). However, this does not mean that pupils who are still non-responders should, after several waves of intensive and individualised interventions, continue with more waves of intervention. It is important to ensure that these pupils can also use assistive technology to scaffold their difficulties with the written language. Today, there are applications (apps) to tablets and smart phones that are quite good at compensating for difficulties in decoding and formulating text (Lindeblad, Nilsson, Gustafson, et al., 2017). For pupils with severe dyslexia, these apps are necessary 'trying hard(er) will not help a child with dyslexia' (Siegel, 2013, p. 24).

Limitations

The most obvious limitation in the present study is the lack of a comparison group. Only on the word recognition test was it possible to compare the result over the four test occasions.

However, from an ethical perspective, it is hazardous to allow one group to receive and another group not to receive interventions during such a crucial time of a child's schooling (grade three), especially in reading development. Another limitation is the low number of participating children, especially when divided into different subgroups such as gender and intervention methods. A further limitation is the low number of participants at follow-up 2 (T5). The proportionately high attrition rate was mainly due to the children's change in schools and move to another municipality. Some of them did not want to carry out the T5 assessments, because they did not experience having reading difficulties any more. However, since the attrition rate was high, it might also be possible that some of those children that did not carry out the follow-up 2 assessments still had reading problems. The special education teacher that carried out all the tests collected information about what kinds of reading remediation the children received after the intervention. Very few of them had received such an intensive and individualised remediation as the one they obtained in this study. In a forthcoming study, it is essential to include more participants and to start the intervention as early as grade one, and also to monitor them more often than has been done in this investigation.

Conclusions

All the children in the present investigation gained to some extent from the implemented two-step interventions. On average, the effect value on the reading tests was *d* 1.7. Only 4 out of 16 children at T4 performed below the 15th percentile after the interventions. When comparing the word recognition development between the experimental and the comparison groups there was a strong significant increase in gain for the reading disabled children. This result actually underlines the positive effect of the intervention programme and strengthens the benefit of a short, intensive and individualised effort for reaching an average level in reading. Even though there was a clear overrepresentation of boys with severe reading difficulties at the onset of the intervention, this gap disappeared after the interventions suggesting that an intensive RTI intervention might target those with resistant reading difficulties. Consequently, the differences in reading difficulties between the genders might not be as big as has been reported in earlier studies, at least not when separate norms are used for girls and boys and after an intensive RTI intervention. Four years after the intervention, the majority of the children are still average readers. However, boys seem to have the greatest problems to sustain their increased reading ability after the intervention. After 4 years, there were only boys having severe difficulties with reading. Thus, even a short intensive and individualised RTI reading intervention seems to have an obvious impact on children's reading ability. However, an individualised approach has to extend over a longer period than 5 weeks, or there is a risk that the children cannot develop or even retain their increased reading ability gained from the intervention period during their schooling.

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