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A Systematic Review of Reading Interventions for Secondary School students.

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Abstract

A systematic review of interventions designed to improve the reading skills of secondary school students summarized the evidence base regarding effectiveness. Studies conducted between 1999 and 2014 which used a randomised controlled design were included. Eight studies were categorised according to whether they targeted multiple component reading skills or reading comprehension skills only. Regarding the former, three of the four studies employed computer-aided instruction; the evidence base suggests that this method is not effective. In studies targeting reading comprehension skills only, the evidence indicates low effect sizes on reading comprehension outcomes when measured using standardised tests. Tutor led one-to one support in word recognition or decoding using an RCT design, and interventions which directly target student's language comprehension, are needed.

Keywords: Randomised Controlled Trial; Reading Intervention; Reading Comprehension; Decoding; Literature Review

1. Introduction

Poor reading ability is common in children and adolescents learning to read English. In 2014, the UK government reported that 22% of students did not have secure age appropriate reading skills on entering secondary school (Department for Education, 2014). In the U.S. in 2013, less than one third of grade 8 (14 – 15 year-old) students met the standard of reading "proficiently" for their grade level (National Assessment of Educational Progress; U.S. Department of Education, 2013). Many factors contribute to individual differences in

adolescent reading ability. For example, there is a correlation between behavioural and emotional difficulties and reading ability in adolescents (Arnold, et al., 2005), and a meta-analysis of studies investigating gender differences in reading achievement at the secondary school level suggests a gender gap in favour of girls (Lietz, 2006). Poor reading ability amongst adolescents has negative implications for psycho-social and educational development. A study by Daniel, et al. (2006) showed that fifteen-year old adolescents with poor reading ability were more likely to experience suicidal ideas or attempts, and drop out of school than typical readers, suggesting that adolescents with poor reading ability can be labelled as being at social risk.

Reading is a fundamental skill in today's society, and key to acquiring information from printed material and electronic sources. To access the secondary school curriculum a high level of reading competency is necessary (Kamil, 2003). Texts used at this level include domain specific academic vocabulary (Bauman & Graves, 2010) and if students are unable to decode these words and access their meanings this will likely impede their ability to learn important new concepts through reading experience. Roberts, Torgesen, Boardman, and Scammacca (2008) suggest that struggling adolescent readers can be categorised as those having little or poor early reading instruction or those provided with good early reading instruction but who are subsequently unable to acquire reading skills. Attention therefore needs to be paid to improving early identification and intervention as well as understanding the reading profiles of older learners and how best to support their needs later in development.

The goal of reading is to understand text. Reading success is supported by word recognition and oral language comprehension skills. The Simple View of Reading (Gough & Tunmer, 1986) argues that for successful reading to occur both components need to be mastered. This model has been used to characterise different reading profiles and can be used

as a starting point for making recommendations regarding effective intervention (Catts, Adlof and Weismer, 2006). The Construction-Integration (CI) model (Kintsch & Rawson, 2005) helps us to further examine the skills and processes necessary for reading. The CI model suggests that the reader forms mental representations of text. The first representation, the textbase, is constructed using information explicitly given in the text. The second representation, the situation model, is a richer personal interpretation created through integrating the textbase with prior knowledge. This theory therefore suggests that teaching and intervention designed to support reading needs to focus not only on decoding and understanding words and sentences but also on link making and the activation of students' life experiences and perspectives.

This systematic review focuses on how best to support adolescents' reading skills and the findings are summarised with reference to theoretical frameworks as appropriate. Our main aims were to provide researchers and practitioners with a concise, informative account of the current evidence base and to identify priorities for further intervention development, evaluation and research in this area.

The initial criterion for inclusion in this review was stringent; only evidence generated using a robust research design, the Randomised Controlled Trial (RCT) was included. An RCT involves groups being formed by random allocation of individuals, classes or schools (Torgerson, 2009). This method of allocation makes the RCT the only research method that can adequately control for all the unmeasured variables that may affect student outcomes (Brooks, Miles, Torgerson & Torgerson, 2006). That is, it ensures that potential confounding factors (e.g. school environment, classroom environment, classroom teacher, gender, socio-economic status) are distributed across groups. It is recommended that all RCTs follow the CONSORT statement (http://www.consort-statement.org/) to ensure consistency of reporting and rigorous safeguards against potential bias. In reality, reports of RCTs conducted in the

field of Education do not always conform to all parts of the CONSORT guidelines (Torgerson, Torgerson, Birks & Porthouse, 2005). In order to ensure that our systematic review would return a sufficient number of results we decided not to use complete CONSORT reporting as a criterion. However where key details are provided by the authors, for example relating to experimenter blinding, they will be reported.

It is recognised that the decision to focus solely on RCTs in this review does not reflect the wide range of research designs used to assess the effectiveness of reading interventions for secondary school students. A rapid review of 43 studies published between 2001 and 2012 by See and Gorard (2014) provides a useful summary of catch-up literacy interventions for students in the transition to secondary school using a less stringent criteria to the present review. They highlight the Response to Intervention (RTI) approach as a promising intervention design and highlight the potential for more RCTs to be conducted in this field. The present systematic review therefore provides a timely and focused examination of the RCTs that have been carried out to date; this should serve as a useful platform on which future research can be developed.

Previous reviews of reading interventions for adolescent readers have included exclusionary criteria relating to reading outcome measures (e.g. Edmonds et al., 2009) and disability status of participants (e.g. Galuschka, Ise, Krick, & Schulte-K¨orne, 2014; Reed, Sorrells, Cole, & Takakawa, 2013; Wanzek et al., 2013). They have also included criteria relating to either the number of intervention sessions delivered (e.g. Wanzek et al., 2013), or to the type of instructional intervention (Solis et al., 2012). The parameters relating to measures, participants and intervention in the present review were kept deliberately wide in acknowledgement of the complexities involved in reading assessment, the heterogeneity of students reading profiles, and the multicomponential nature of reading instruction. Whilst we

will not be controlling for these we will be reporting methodological details in full and highlighting any potential confounds and issues in the commentary of the review.

Research Questions

1. How effective are reading interventions in improving reading outcomes for secondary school students aged 11 – 18 years?
2. What features of reading interventions are associated with improved outcomes for secondary school students aged 11 – 18 years?

2. Method

2.1. Search Procedure

A database search of ScienceDirect, Scopus, Social Sciences Citation Index, ERIC, Australian Education Index, British Education Index, and PsycINFO to locate studies published between 1999 and 2014 was carried out.

The following search terms were used together (reading intervention OR randomised controlled trial OR decoding OR comprehension OR decoding intervention OR comprehension intervention OR reading accuracy OR reading fluency OR dyslexia OR reading difficulty OR reading disability OR reading delay OR struggling reader). The 'related terms' box was checked in each database and searches were refined by 'research domains', 'research areas', 'document types', 'languages', and 'publication years'. The initial search yielded 10844 results. The Abstracts of these studies were then screened. Studies had to meet the criteria below:

- All participants included in the study should be of secondary school age (11-18 years old).

- All types of secondary school (i.e. mainstream and special needs school) could be involved in the study.
- The studies could be conducted in any country. However, they must have been reported in English and the components of the intervention must have utilised the English language. In addition, the study must not solely be comprised of participants whose second language was English.
- They used an RCT design.
- They included pre-test (baseline) and post-test (outcome) measures.
- The reading intervention consisted of any type of reading training.
- The intervention was delivered in a school-based setting.
- They were reported in a peer-reviewed journal.

The literature search was carried out solely by the lead author. In total, 10734 Abstracts were identified as not meeting at least one of the criteria and therefore were not considered further. The remaining 110 studies were examined in-depth to determine whether they met all criteria. 102 articles did not meet criteria, leaving 8 studies in the review. The papers were coded by the lead author; where there was uncertainty with regard to which data to extract, the two authors both read the papers and met to discuss. In all cases, agreement was reached.

The eight studies were classified into two categories according to the type of intervention evaluated: 1) interventions which targeted one or more aspects of reading skill (e.g. decoding, fluency, speed, comprehension, etc.) and possibly other related skills such as spelling and listening comprehension. Here we have defined this category as 'multiple component reading skills'. 2) interventions which targeted reading comprehension skills only.

Tables 1 and 2 summarise the key features of the studies from the first and second categories respectively.

3. Results

3.1. Interventions targeting multiple component reading skills.

Insert Tables 1 and 2 about here

The first three studies in Table 1 examined the effectiveness of computer-aided instruction (CAI). Brooks et al. (2006) evaluated an unnamed computer-based intervention designed to improve adolescents' reading and spelling through developing phonological awareness/word attack skills. 155 students aged 11-12 years were randomly (and blindly) allocated to either an intervention group which received 10 hours of support via laptop computers (ICT group), or to a waiting-list control group which received standard literacy practice. The intervention group undertook dictation activities using their recorded voice; the rationale provided by the authors being that learners benefit from hearing themselves vocalise text as it provides immediate feedback and opportunity for self-correction. Table 1 details the reading and spelling tests administered at pre-test and at two post-test points by researchers who were blind to individual students' group membership. When controlling for pre-test scores, analyses of co-variance failed to show a significant difference between the intervention and the control group on the spelling measure ($p = .50$). However, with regards the reading test, a statistically significant difference was found with the intervention (ICT) group having lower scores than the control group at post-test ($p = 0.01$). The delayed post-test results showed that there were no significant differences between the groups on either the reading ($p = .32$) or spelling measures ($p = .37$). Effect sizes were not reported. The authors conclude that their study did not detect any benefit of ICT for improving reading; however, it

could be argued that instead the findings suggest that dictation activities are not effective. To investigate this further, the method of delivery (ICT) would need to be isolated from the dictation activities; a counter-balanced design with parallel versions of the intervention would enable this.

Given, Wasserman, Chari, Beattie, and Eden (2008) evaluated Fast ForWord (FFW), a type of CAI designed to improve reading and language through developing children's auditory temporal processing skills. They employed an active control group who also used CAI (SuccessMaker; SM) which targeted vocabulary development, contextual reading, spelling, and writing skills.

The interventions were delivered five days a week for 88 minutes a day over 12 weeks. 65 struggling readers aged 11 – 13 years were randomly assigned to five groups. Group 1 received two six-week phases of FFW whilst group 2 received two phases of SM. Groups 3 and 4 received one phase of FFW and one phase of SM, group 3 began with FFW and group 4 began with SM. Group 5, were an untreated control group, who received the regular curriculum. Measures of phonological, language and reading skills were administered pre-and post-intervention by experienced psychometricians, who were blind to the students' group assignments (see Table 1). A Repeated Measures MANOVA revealed that phonological, reading and language skills significantly changed over the duration of the study $F(8, 53) = 12.24$, $p < .001$; the partial Eta squared statistic revealed that this effect size was large ($\acute{\eta}^2 = .65$). Within-subjects contrasts showed that students in all conditions demonstrated significant gains in phonological skills (WJ-R Auditory Processing; $p < .001$; $\acute{\eta}^2 = .33$), reading (WJ-R Letter-word Identification; $p < .001$; $\acute{\eta}^2 = .22$; WJ-R Word Attack; $p = .003$; $\acute{\eta}^2 = .14$; WJ-R Passage Comprehension; $p = .004$; $\acute{\eta}^2 = .13$) and language (CELF-3 Receptive Language; $p < .001$; $\acute{\eta}^2 = .23$; CELF-3 Expressive Language; $p < .001$; $\acute{\eta}^2 = .33$). However, there was no evidence of gains made in either spelling (WRAT-3 Spelling; $p =$

.105; $\acute{\eta}^2$ = .04) or in a measure of phonological retrieval (RAN Naming; p = .417; $\acute{\eta}^2$ = .01). A single Repeated Measures MANOVA, which included all eight variables for both pre-test and post-test scores, indicated no significant differences between the intervention groups in terms of the magnitude of gains, F(32, 197) = .708, p = .88. These results suggest that FFW does not offer any additional benefits for improving auditory processing, reading or language skills. A systematic meta-analytic review of FFW by Strong, Torgerson, Torgerson, and Hulme (2011) provides evidence to suggest that FFW may be effective in improving rapid auditory temporal processing skills, but that improvement in these skills are not associated with corresponding improvements in language or literacy skills.

Khan and Gorard (2012) evaluated an unnamed form of CAI for improving reading in 11 – 12 year olds (672 in total). The study used a clustered RCT design in which classes from 23 secondary schools were randomly allocated to either a treatment group (11 classes of 319 students in total) or a control group (12 classes of 346 students in total). The treatment group used the software in literacy lessons for 10 weeks, while the control group received standard practice in their literacy lessons. The software was multi-sensory and allowed students to progress at their own pace through a variety of text types, with immediate feedback. Both groups were given a pre-test and post-test of their literacy levels using a computer-based assessment (see Table 1) which targeted reading skills, reasoning, auditory memory, visual memory, phonic skills, and phonological processing. The scores for both groups increased following the intervention; the authors report a standardised improvement (calculated as the gain from pre- to post-test divided by the overall standard deviation at the pre-test) of 0.56 and 0.99 for the treatment and control groups respectively. Thus, the gains made by the control group were nearly twice as large as those made by the treatment group (ES = -0.37), suggesting that the CAI approach yields no benefit to reading. The authors however note that the CAI approach was not implemented as intended for one of the classes due to technical

difficulties; this could have had an impact on treatment fidelity and the efficacy of the training.

The studies reviewed thus far have utilised CAI to allow for individualised administration. The remaining studies evaluate training designed to be implemented at either group or whole-class level. One way of influencing whole-class provision is to provide specialist teaching training. This approach was used by Starling, Munro, Togher, and Arciuli (2012) who evaluated an intervention in which a speech-language pathologist (SLP) trained teachers to modify their oral and written instructional language. Two secondary schools were randomly assigned to either an intervention or a waiting control condition. In the intervention condition seven teachers received training and the control condition included six untrained teachers. 43 students aged 12 – 14 years with language impairments (criteria based on Diagnostic and statistical manual of mental disorders, 4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000) took part, 21 in the intervention condition and 22 in the control group. The training programme focused on techniques to modify teacher's written language (e.g. breaking down large amounts of information), teacher's oral language (e.g. repeating and rephrasing information), information processing (e.g. whole-class deconstruction of texts), and direct vocabulary instruction. Training was delivered via 50 minute meetings between the SLP and the teachers over ten weeks. The Levels of Use tool (LoU; Hall, Dirksen, & George, 2006), a structured interview, from the Concerns-Based Adoption Model (Hord, Rutherford, Huling-Austin, & Hall, 2006) was used by independent interviewers (who were blinded to the nature and testing phases of the study) to evaluate the teachers' changes in their use of the techniques over time. At baseline the two groups of teachers scored equivalently on this tool and were considered to be non-users of language modification techniques. To evaluate the impact on students' language-based learning abilities, the students were tested pre- and post-intervention, and after a 12 week delay (see

Table 1) by research assistants who were blinded to the nature of the intervention and to the condition each of the cohorts were allocated to. A series of 2 by 2 Repeated Measures ANOVA's revealed that the use of language modification techniques by the trained teachers significantly increased compared to the control group of untrained teachers: Knowledge, $F(1, 11) = 35.42$, $p < .001$, $\acute{\eta}^2 = .76$; Sharing, $F(1,11) = 18.49$, $p = .001$, $\acute{\eta}^2 = .63$; Assessing, $F(1,11) = 48.66$, $p < .001$, $\acute{\eta}^2 = .82$; Planning, $F(1, 11) = 9.49$, $p = .01$, $\acute{\eta}^2 = .46$; Status Reporting, $F(1,11) = 8.32$, $p = .02$, $\acute{\eta}^2 = .43$, and Performing, $F(1,11) = 38.26$, $p < .001$, $\acute{\eta}^2 = .78$. The increase in use of language modification techniques was maintained over time. With regard to the student outcomes, students in the trained condition showed a significant improvement in written expression, $F(1, 41) = 11.34$, $p = .002$, $\acute{\eta}^2 = .22$, and listening comprehension, $F(1, 41) = 4.86$, $p = .033$, $\acute{\eta}^2 = .11$, which was not evident for students in the control group. These improvements were not maintained over time: written expression, $t(19) = .117$, $p = .908$; listening comprehension, $t(19) = .000$, $p = 1.00$. The authors acknowledge that the intervention approach is novel as it targets the environment surrounding the child rather than the individual students' skills and needs. This is a promising avenue for future research, however further replication is required as the sample size was very small. Further research into whether the benefits of systemic changes in teachers' language use can be generalised to students without language impairment is needed.

3.2. Interventions targeting reading comprehension skills only.

Table 2 summarises the four studies targeting reading comprehension skills only. The first of these by Berkeley, Mastropieri, and Scruggs (2011), investigated the effects of reading comprehension strategy (RCS) instruction, with and without attribution retraining (AR), which aimed to strengthen student's beliefs about their academic achievement. 59 students (aged 12 – 15 years) who had either learning difficulties or other mild disabilities were stratified by class then randomly allocated to one of three conditions. Students received

12 x 30 minute group based sessions over four weeks, with a maximum of seven students per group. In the RCS condition (n=19), six reading comprehension strategies were taught: 1. setting a purpose; 2. previewing; 3. activating background knowledge; 4. self-questioning, 5. summarizing, and 6. strategy monitoring. The RCS + AR condition (n=20) included the same instructional materials as in the RCS condition but also included specific AR content in the form of reminders about attribution concepts taught in lessons: 1. I know lots of good strategies; 2. I will try hard to use the best ones; 3. I will only have positive thoughts. Students in a read naturally (RN) condition (n=20) completed reading practice without explicit teaching of reading comprehension strategies. All students were assessed pre-intervention, post-intervention and after a 6 week delay by researchers who were blinded to students' instructional condition. The outcome measures are shown in Table 2. ANOVA's with instructional groups as a within condition and pre-test as covariate, were used to test for differences among the experimental conditions. There was a significant main effect of condition for the summarization measure at post-test, $F(16,39) = .87$, $p = .60$. Post-hoc analyses using Bonferroni t-tests revealed that both the RCS+AR and RCS intervention groups outperformed the RN group on the summarization measure producing large Effect Sizes (ES): RCS + AR vs RN ($p < .001$; ES = 1.44) and RCS vs RN ($p = .005$; ES = .94). There was also a significant main effect of condition for the summarization measure after a 6-week delay, $F(2,38) = 9.99$, $p < .001$; with both intervention groups outperforming the RN group: RCS + AR vs RN ($p < .001$; ES = 1.21), and RCS vs RN ($p = .02$; ES = .71), although a large ES was maintained for the RCS+AR group only. With regard to the meta-comprehension strategy awareness (MSI) measure, again there was a significant effect for condition at post-test, $F(2,39) = 7.64$, $p = .002$); both the RCS+AR group and the RCS group outperformed the RN group: RCS+AR vs RN ($p = .005$; ES = 1.10); RCS vs RN ($p = .003$; ES = .93). Furthermore, there was a main effect of condition for the attributions for reading

success measure, F(2,39) = 10.85, p = <.001; RCS+AR students displayed higher attributions for reading success at post-test compared to the RCS (p =.001; ES = 1.01) and RN (p =.001; ES = .86) groups. There was also a main effect of condition for the delayed reading attribution post-test data, F(2,38) = 3.98, p = .03; attribution scores for the RCS+AR group remained significantly higher than the RN comparison group (p = .02; ES = .54). These findings confirm the effectiveness of reading strategy training and suggest that combining attribution retraining with reading strategies is an effective method.

Cantrell, Almase, Carter, Rintamaa, and Madden (2010) examined the impact of the Learning Strategies Curriculum (LSC; Tralli, Colombo, Deshler, & Schumaker, 1996), on the reading comprehension and strategy use of 655 adolescents in either grade 6 or grade 9 (age-range = 11 – 12 years, and 14 – 15 years), who had various learning needs (see Table 2). Teachers (n=25) from 23 schools took part in the study which employed a within-school iterative random sampling process to allocate students to either the LSC intervention condition or a control condition, thus producing a RCT design. 365 students (6^{th} grade n=171, 9^{th} grade n =194) received daily class based instruction in 6 LSC strategies: word identification, visual imagery, self-questioning, paraphrasing, vocabulary and sentence writing. This was implemented for 50 - 60 minutes per day over the course of a school year. The control group comprised 290 (6^{th} grade n=131, 9^{th} grade n =159) students who received "business as usual" instruction.

Measures of reading and strategy-use (see Table 2) were administered at pre-test and post-test by teachers and research assistants and scored by the research team (whether scoring was conducted blindly was not specified). Hierarchical linear models (HLMs) were used to analyse the impact of the LSC on reading comprehension and reading strategies outcomes. After one school year, the 6^{th} grade students who received intervention scored significantly higher than the control group on reading comprehension (p = .03; ES = 0.22) and in the use

of problem solving strategies (p = .05; ES = 0.27). In contrast, the 9th grade students who received intervention did not show any statistically significant improvements compared to controls on any of the outcome measures (all p's > .05). LSC appears to be effective in improving reading comprehension skills in younger adolescents only. The authors speculate that this may be due to the changing nature of comprehension processes employed at these different ages. They relate their findings to the CI model (Kintsch & Kintsch, 2005) and suggest that the older students may need instruction which focuses more closely on building a situation model through elaboration and inference rather than an approach which centres on supporting students to construct a coherent textbase such as the LSC programme.

Vaughn et al. (2011) examined the effects of collaborative strategic reading (CSR) and metacognitive strategic learning on the reading comprehension of 7th and 8th grade adolescents (aged 12 – 14 years) in two American States. Students (782 in total) were randomly assigned to 61 classes and then classes were randomly assigned to intervention (n=34) or control conditions (n=27); 400 participants in the intervention condition and 382 in the "business-as-usual" control condition. The intervention was Collaborative Strategic Reading (CSR) which involved applying comprehension strategies (Previewing, Click and Clunk, Get the Gist and Reviewing) in collaborative groups for two 50 minute sessions per week over 18 weeks. After the participants developed proficiency using the strategies (after approximately 4-6 weeks), they were assigned to small cooperative learning groups (four to five students), during which, they were actively involved and had multiple opportunities to contribute to the group's understanding of text. Student involvement was documented in treatment fidelity observations and field notes.

A range of tests were administered at pre- and post-test (see Table 2) by researchers who were blind to students' condition. Multilevel modelling (with pre-test scores as a covariate) was used to analyse the treatment effects. The results indicated that the students in

the intervention condition significantly outperformed students in the control condition on the GMRT comprehension subtest ($p = .002$; $g = .12$). There were no significant differences between the groups at post-test on either the TORSEC or AIMSweb measures, thus, improvements did not extend beyond reading comprehension to fluency or to a curriculum based assessment. The authors raise the issue of how to identify which components of multi componential programmes are driving intervention effects and suggest that more work needs to be done to isolate specific impacts of different aspects of programmes like CSR.

Vaughn et al. (2013) evaluated the efficacy of a content acquisition and reading comprehension intervention delivered to students aged 13 - 14 years. The content acquisition focus responds to the need for students to understand domain specific academic vocabulary (Bauman & Graves, 2010) in secondary schools. 419 students were randomly assigned to one of 27 classes; classes were then randomly assigned to intervention (16 classes and 261 students in total) or to control (11 classes and 158 students in total) conditions. Five teachers delivered the same social studies content to all students in all classes. The intervention classes used specific instruction based on the Promoting Acceleration of Comprehension and Content Through Text (PACT) programme. PACT includes a comprehension canopy (an overarching question that guides the purpose of reading and knowledge acquisition), essential words/key vocabulary, knowledge acquisition, team-based learning (TBL) and comprehension checks, as well as TBL knowledge application. The intervention classes received 30 sessions of instruction (each lasting 50 – 54 minutes), over six to eight weeks.

Table 2 illustrates the tests administered to students at pre-test and post-test (by trained researchers who were uninformed of the students' conditions). Multilevel structural equation models were used to estimate treatment effects. At post-test, the students in the intervention condition statistically outperformed the students in the comparison condition on content acquisition, $z = 2.27$, $p = .023$; ES = .17, content reading comprehension, $z = 3.27$, p

< .001; ES = .29), and on the GMRT-4 comprehension subtest, z = 2.53, p = 0.11; ES = .20. This supports the use of PACT as a useful and promising programme for improving reading comprehension in adolescents.

4. Discussion

This paper has reported a systematic review to investigate the effectiveness of interventions designed to support the reading skills of secondary school students. It has focused only on studies which have used RCTs. The paucity of research is striking; only eight studies met our inclusion criteria. Five of the studies were conducted in the US, two in the UK and one in Australia. This is consistent with the findings of a review conducted by Slavin, Cheung, Groff, and Lake (2008) which argued that more large scale methodologically rigorous studies are needed in this area.

With regards multiple component training, three of the four studies reviewed were evaluations of individualised CAI and in each case the findings did not support the use of this approach. Slavin, Lake, Davis, and Madden (2009) in reviewing approaches for struggling readers in grades K-5, concluded that CIA generally had few effects on reading. Furthermore, Khan and Gorard (2012) reported that previous studies have failed to demonstrate the effectiveness of computer based instruction as a means of improving reading skills. Taken together the evidence suggests that CAI should not be relied on to produce gains in reading ability in secondary school aged students and that in some circumstances using these programmes may have a negative impact on student's progress (Gorard & Taylor, 2004). An avenue for future intervention design could be to combine computer administered tasks with face-to-face instruction.

It is of note that these studies, which all included some focus on word recognition and decoding skills, were delivered to individual students via computer programmes. There is therefore no evidence from RCTs to show the possible effectiveness of tutor led one-to-one instruction in this essential component of reading at secondary school level. This is in contrast to a review of evidence from primary schools which highlights the effectiveness of one-to-one tutor delivered phonics based support for struggling readers (Slavin, et al., 2009). It remains to be seen whether such an approach can be shown to be successful in secondary schools. For those aiming to address this gap a range of factors will need to be considered including, timetabling of one-to-one support, access to specialist teachers and teaching assistants, the availability of specialist training for staff and the identification of suitable reading materials.

The remaining study (Starling et al., 2012) which targeted multiple components used a very different approach in that teachers were trained to make modifications to their instructional language use. Whilst immediately following intervention, improvements were shown in written expression and listening comprehension, no gains were made on the reading comprehension outcome. The authors argue that systems-based whole population approaches may only be effective for certain components and that reading comprehension may require additional individualised support. According to the Simple View (Gough & Tunmer, 1986), we can predict that this individualised support may need to be in the area of word recognition and decoding. The word recognition and phonological skills of the students in the Starling et al. (2012) were not provided. The possibility that the students had difficulties in these specific domains cannot be ruled out, considering the well-established relationship between reading difficulties and language impairments (Pennington & Bishop, 2009).

Interestingly, none of the studies reviewed here specifically targeting reading comprehension used an individualised approach; rather the interventions were delivered to

whole classes or groups. In their synthesis of available evidence relating to reading at the transition between primary and secondary school (conducted for the Sutton Trust and the Education Endowment Foundation), Higgins, et al. (2014) report a weighted mean effect size of .31 for the effectiveness of small group tuition on reading, .42 for 1-1 tuition, and .42 for approaches specifically targeting reading comprehension. The large effect sizes reported by Berkeley et al. (2011) in Table 2 (1.21 and .71) in relation to intervention gains, are therefore of greater magnitude than one would expect based on the previous research. Furthermore, gains were maintained after a six-week delay. As Table 2 shows, this was the only study to measure maintenance effects. This evidence is promising and highlights the importance of building students' beliefs in their reading ability as well as targeting specific comprehension strategies. The comprehension assessment used was a bespoke summarisation test and summarisation primarily involves forming and communicating a gist representation of text. It remains to be seen to what extent this type of training has an impact on other elements of reading comprehension central to the processes outlined in the CI model (Kintsch & Rawson, 2005) (e.g. inference making).

With regards the other three studies reported in Table 2 (Cantrell et al., 2010; Vaughn et al., 2011; Vaughn et al., 2013) it is noteworthy that all produced similar (low) effect sizes on reading comprehension outcomes. The intervention reported by Cantrell et al. was intensive and delivered for 50 – 60 minutes per day over the course of a year. It is important to question whether this duration and intensity is necessary in order to achieve gains. The authors acknowledge that 50 minutes a day may not be essential, and report that the LSC curriculum was not fully implemented across the full year as within this time, teachers were still learning how to use the approach. However, in order to make significant impact on reading comprehension, Vaughn, et al. (2012) suggest that an intensive intervention is necessary. Using a response-to-intervention (RTI) approach (outside the criteria of this

review), they demonstrated that students who received intervention 50 minutes a day for three years made large gains in reading comprehension when measured using a standardised test (ES = 1.20). The extent to which this level of intensive support is feasible and affordable for secondary schools does however need to be further considered. It is also important to note that the intervention was delivered by two specialist teachers (researchers with Masters level training and 60 hours of professional development training) which reinforces the need to consider the extent to which secondary schools have access to such specialist teachers and training if such approaches are to be rolled out more widely and sustained over time.

The remaining two studies by Vaughn et al. (2011) and Vaughn et al. (2013) were broadly equivalent in terms of the intensity of the interventions delivered. Both studies demonstrated gains on reading comprehension using a standardised measure. Acknowledging that the effect sizes were small, Vaughn et al. (2011), suggested that we need to question whether multi-component-based approaches are the most beneficial, and instead consider the impact of specific training focussed on vocabulary-building and/or background knowledge. This is a dilemma for those designing intervention approaches intended for use with a heterogeneous sample of students who are struggling with reading. The theories of reading referred to in this paper highlight a wide range of skills and processes needed to read successfully. Some students may have difficulties spanning a number of these components whereas others may have more isolated impairments; different intervention approaches will be more beneficial than others in supporting the underlying components of reading (Duff & Clarke, 2011). If an intervention is created to broadly target struggling readers then it will need to be flexible enough to ensure that a level of personalisation is possible.

Taking into account the Simple View of Reading (Gough & Tunmer, 1986) it can be predicted that as well as training in word recognition and decoding, intervention to support underlying oral language skills should have an impact on reading comprehension ability. The

synthesis of evidence from Higgins et al. (2014), suggests that at the transition between primary and secondary school, oral language training has a small impact (weighted mean effect size = .20), however, looking at studies with a wider age-range, the effects on reading were higher (weighted mean effect size = .41). Three of the four studies reviewed in Table 2 focus primarily on teaching comprehension strategies, only one (Vaughn et al., 2013) targeted oral language directly (content vocabulary). There is therefore a significant gap in the evidence base from RCT's concerning the efficacy of language comprehension intervention. Clarke et al. (2010) demonstrated using an RCT the effectiveness of an oral language intervention (comprising strategy use, vocabulary, figurative language and spoken narrative) in improving the reading comprehension skills of primary school students. To date such an approach has not been evaluated using an RCT in secondary schools.

5. Conclusion

There is a significant number of students entering secondary school with very poor reading skills but a paucity of rigorous research into effective interventions for these students. Interventions which focus on improving reading skills via CAI appear to have no benefit. No studies have investigated the impact of tutor led one-to one support in word recognition or decoding using an RCT design. Interventions focussing specifically on reading comprehension skills produce gains in these abilities but effect sizes are small. These studies mostly use strategy based techniques; only one directly targets student's language comprehension. The feasibility of scaling up interventions in secondary schools needs more consideration, paying attention to such factors as availability of specialist training and cost effectiveness of intensive support.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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Table 1. Studies targeting multiple component reading skills.

Study	Number of participants	Age	Diagnosis	Specific skills targeted	Type of intervention	Method of delivery	Design	Total hours intervention	Measures and Blinding	Results	Effect Sizes
Brooks et al. (2006).	155 (77 in ICT; 78 in control group).	11 – 12 years.	Diagnostics not given.	Literacy (reading and spelling).	Computer-based literacy support. Information and Communication Technology (ICT) vs. control group.	Computer. Students individually used an ICT programme.	RCT: 1 treatment group + control.	1 hour per day for 10 days (= 10 hours).	The Group Reading Test and British Spelling Test Series[1]. Administered 'blindly' by researchers.	Control group obtained significantly higher reading scores than ICT group.	Not reported.
Given et al. (2008).	65 (12 in FFW; 15 in SM + FFW; 11 in SM + FFW; 14 in SM control; 13 in control group).	11 – 13 years.	ARR.	FFW = Auditory processing; linguistic skills; phonological awareness; word recognition; listening comprehension.	Fast For Word (FFW; a computer-based intervention consisting of a series of games). FFW only vs. FFW followed by Success Maker	Computer.	RCT: 3 treatment groups + 2 control groups.	5 x 88 minutes every week for12 weeks (= 88 hours).	Auditory Processing, Letter-Word Identification, Word Attack, and Passage Comprehension subtests of the WJ-	All five groups demonstrated significant gains in reading, phonemic awareness, and language skills, with no differences between groups.	For all five groups combined: Reading: Letter-word Identification: $\acute{\eta}^2$ = .22; Word Attack: $\acute{\eta}^2$ = .14; Passage

[1] Published by nfer-Nelson; http://www.nfer.ac.uk/schools/nfer-tests/

				SM = vocabulary; context reading; spelling; writing.	(SM) vs. SM followed by FFW; vs. SM only (active control group) vs. control group.				R[2]; RAN[3]; CELF-3[4]; WRAT-3[5]. Administered 'blindly' by psychometricians.		Comprehension: $\acute{\eta}^2$ = .13. Phonemic awareness: Auditory Processing: $\acute{\eta}^2$ =.33. Language: Receptive Language: $\acute{\eta}^2$ = .23; Expressive Language: $\acute{\eta}^2$ = .33.
Khan and Gorard (2012).	672 (319 in treatment group; 346 in control group).	11 – 12 years.	ARR.	Reading speed; fluency; comprehension; decoding; single word reading; sentence reading; vocabulary; reading stamina.	Computer-based literacy support system vs. control group.	Computer.	RCT: 1 treatment group + control.	Not specified.	Computer-based assessment of reading skills (Lucid Assessment System for Schools[6]), a reasoning test, and four diagnostic tests.	Literacy scores for both groups significantly increased; gains made by control group were nearly double those	Treatment group: Standardised improvement = .56; Control group: Standardised improvement =

[2] Woodcock et al. (2001).
[3] Denckla & Rudel (1974).
[4] Semel et al. (1995).
[5] Wilkinson (1993a).
[6] https://www.lucid-research.com/documents/manuals/manual_ls_tg.pdf

										obtained for treatment group.	.99. Overall effect size = -.37.
Starling et al. (2012).	43 (21 students in trained group; 22 students in control group).	12 – 14 years.	LI.	Teachers' oral and written language instruction.	Teachers trained to make modifications to instructional language techniques vs. no training (control group).	Delivered to teachers by a Speech-Language Pathologist.	RCT: 1 treatment group + control.	Students received 10 x 50 minute sessions (= 8.3 hours).	Reading Comprehension, Written Expression, Listening Comprehension, and Oral Expression subtests of WIAT–II[7]. Administered 'blindly' by research assistants.	Trained group showed significant improvements in written expression and listening comprehension.	Trained group: Written expression: $\acute{\eta}^2$ = .22; Listening comprehension: $\acute{\eta}^2$ = .11.

Notes. ARR = at-risk readers; LI = Language Impairment; RCT = randomised controlled trial; WJ-R = Woodcock–Johnson Psycho-Educational Battery, Revised; RAN = Rapid Automatized Naming; CELF-3= Clinical Evaluation of Language Fundamentals, 3rd Edition; WRAT-3 = The Wide Range Achievement Test, 3rd Edition; WIAT-II = Wechsler Individual Achievement Test.

[7] Wechsler (2007).

Table 2. Studies targeting reading comprehension skills.

Study	Number of participants	Age	Diagnosis	Specific skills targeted.	Type of intervention	Method of delivery	Design	Total hours intervention	Measures and Blinding	Results	Effect Sizes
Berkeley et al. (2011).	59 (19 in RCS; 20 in RCS + AR; 20 in RN).	12 – 15 years.	RCS = 17 with LD; 2 with OHI. RCS + AR = 16 with LD; 4 with OHI. RN = 12 with LD; 8 with OHI.	Reading comprehension; attributions for reading comprehension success and failure.	Reading Comprehension Strategy (RCS) vs. RCS + Attribution Retraining (RCS + AR) vs. Read Naturally (RN; control).	Delivered by teachers to groups.	RCT: 2 treatment groups + control.	12 x 30 minutes for 4 weeks (=6 hours).	Bespoke comprehension summarization test; Meta-comprehension Strategy Index (MSI)[8]; Reading Attribute Scale (RAS)[9]. Administered 'blindly' by researchers.	Both treatment groups significantly outperformed RN group on summarization and MSI; RCS+AR group displayed significantly higher attributions for reading success than RCS and RN groups.	Summarization: RCS + AR vs RN (ES = 1.44); RCS vs RN (ES = .94). Meta-comprehension: RCS + AR vs RN (ES = 1.10); RCS vs RN (ES = .93). Reading attributes: RCS + AR vs RN (ES = .86); RCS + AR vs RCS (ES = 1.01).
Cantrell et al. (2010).	655 (365 in LSC; 290 in control group).	11 – 12 years and	LSC = 88 in SE; 240 = ARR; 37 either LEP or EBD.	Reading comprehension	Strategy-based intervention.	Delivered by teachers to	RCT: 1 treatment	50 - 60 minutes per day over 1	Vocabulary, sentence comprehension, passage comprehension, and	The 6th-grade LSC group significantly outperformed the	6th grade LSC group vs control group: (Reading

[8] Schmitt (1990).
[9] Shell et al. (1995).

	302 6th grades + 353 9th grades.	14 – 15 years.	Control group = 46 in SE; 220 = ARR; 24 either LEP or EBD.	strategy acquisition.	Learning Strategies Curriculum (LSC) vs. no strategy.	whole classes.	group + control.	year (total no. of hours unspecified).	listening comprehension GRADE[10] subtests; Metacognitive Awareness of Reading Strategies Inventory (MARSI). Details regarding 'blinding' were not given.	control group on reading comprehension (GRADE) and used more problem-solving strategies in reading. No differences between 9th grade LSC group and control group.	comprehension; ES = 0.22; problem solving strategies; ES = 0.27).
Vaughn et al. (2011).	782 (400 in treatment group; 382 in control group).	12 – 14 years.	Treatment = 52 in SE; 348 typical readers. Control = 28 in SE; 354 typical readers.	Reading comprehension.	Collaborative Strategic Reading (CSR) and Metacognitive Strategic Learning vs. control group.	Delivered by teachers to whole classes; then to small groups within class.	RCT: 1 treatment group + control.	24 – 48 x 50 minute sessions (= 20 – 40 hours).	GMRT-4[11] Comprehension subtest; AIMSweb Reading Curriculum Based Measure[12]; TOSREC[13]. Administered 'blindly' by researchers.	Treatment group significantly outperformed control group on the GMRT-4 Comprehension Test.	GMRT Comprehension: treatment vs control group (g = .12).

[10] Williams (2001).
[11] Gates & MacGinitie (2000).
[12] http://www.aimsweb.com/
[13] Wagner et al. (2010).

Vaughn et al. (2013).	419 (261 in treatment group; 158 in control group).	13 – 14 years.	Treatment = 10 in S.E.; 3 = LEP; 248 typical readers. Control = 10 in S.E.; 8 = LEP; 140 typical readers.	Reading comprehension; content acquisition.	Reading comprehension and content acquisition (Promoting Acceleration of Comprehension and Content Through Text; PACT) vs. control group.	Delivered by teachers to whole classes.	RCT: 1 treatment group + control.	30 x 50 – 54 minute sessions (= 25 – 27 hours).	GMRT Reading comprehension Subtest; Assessment of Social Studies Knowledge (ASK; a researcher-developed measure for assessing content knowledge and content reading comprehension). Administered 'blindly' by researchers.	Treatment group significantly outperformed control group on all outcome measures.	Treatment vs control group: ASK content knowledge (ES = .17); ASK reading comprehension (ES = .29); GMRT reading comprehension (ES = .20).

Notes. LD = learning difficulties; SE = special education; OHI = other health impairment; EBD = emotional-behaviour disability; LEP = limited English proficiency; ARR = at-risk readers; RCT = randomised controlled trial; GRADE = Group Reading and Diagnostic Evaluation test; GMRT-4 = Gates-MacGinitie Reading Tests (4^{th} Ed.); TOSREC = Test of Silent Reading Efficiency and Comprehension; GMRT = Gates-MacGinitie Reading Tests.