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Lindebladl, E., Nilsson, S., Gustafson, S. et al (2019). Self-concepts and psychological health in children and adolescents with reading difficulties and the impact of assistive technology to compensate and facilitate reading ability. *Cogent Psychology*, 6(1). <http://dx.doi.org/10.1080/23311908.2019.1647601>

N.B. When citing this work, cite the original published paper.



Received: 14 August 2018
Accepted: 10 July 2019
First Published: 23 July 2019

*Corresponding author: Emma Lindeblad, Department of Psychology, Linnæus University, Växjö 35195, Sweden
E-mail: emma.lindeblad@lnu.se

Reviewing editor:
Sebastiano Costa, Università degli Studi della Campania Luigi Vanvitelli, Italy

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APPLIED PSYCHOLOGY | RESEARCH ARTICLE

Self-concepts and psychological health in children and adolescents with reading difficulties and the impact of assistive technology to compensate and facilitate reading ability

Emma Lindeblad^{1*}, Staffan Nilsson², Stefan Gustafson³ and Idor Svensson¹

Abstract: This study investigated self-image, psychological health, and the impact of Assistive Technology (AT) on self-concept and psychological health in 137 children and adolescents with reading difficulties during a systematic intervention program and in a one-year follow-up. Participants were randomly assigned to a control or an intervention group. The interventions aimed to teach participants how to understand texts using AT. The control group received no intervention. To investigate self-esteem, self-image, anxiety, and depression, all participants were assessed with the Cultural Free Self-Esteem Inventory, 3rd edition (CFSEI-3) before intervention and one year post-interventions. Forty-one participants were also assessed on the Beck Youth Inventory (BYI). The AT was found to have no impact on participants' self-esteem. The CFSEI-3 showed similar values for self-esteem in a norm group and the study groups at pre-intervention, which made an increase from using AT less expected. The results are discussed in terms of contextual explanatory factors, such as educators' increased knowledge of reading difficulties and dyslexia. The results on the BYI were somewhat inconclusive since the younger group of participants showed more anxiety than the norm group, but the adolescent

ABOUT THE AUTHOR

Emma Lindeblad is lecturer in psychology, health care developer and a clinical psychologist with more than fourteen years of experience treating children and adolescents. Presently she is teaching subjects as psychiatric diagnosis, developmental psychology and learning disabilities and she has been the Student Director of the Psychologist Programme in Linnæus University. She also holds a PhD in Clinical Psychology and the main focus of her research has been on evaluating interventions where digital assistive means for pupils with reading disabilities have been used and the pupils' self-development and psychological health been investigated. All authors of this paper collaborate in a research group where the main interests are to increase knowledge about the psychology of reading, dyslexia and reading difficulties as well as the process of digitalising learning aids for children that are struggling with their learning.

PUBLIC INTEREST STATEMENT

Smartphone apps can actually help children read by the program reading the text aloud. The apps are then making sure that children with dyslexia are given equal opportunities to learn. Previous research has shown that reading difficulties have led children to develop poor self-esteem and confidence as well low motivation in school. Researchers have assumed that this has been due to a continuous feeling of failure; children with dyslexia, for example, feel failure when they practice reading without any progress. This study investigates whether this is still true and if apps in smartphones and tablets can help children to make progress in school. The results show that at the present, children with reading problems are feeling somewhat better with themselves than before and that this could have many reasons, the technical revolution introducing smartphones and tablets is being one of them and teachers being more knowledgeable being another.

group did not. This may be due to small sample size, so further research is recommended.

Subjects: Reading, Psychology of; Educational Psychology; Child & Adolescent Psychiatry & Clinical Psychology

Keywords: Dyslexia; self-esteem; assistive technology; children; adolescents; self image; special education

1. Introduction

Reading ability is considered essential in most educational settings to reach learning goals and academic success. Although advancement in school is well known to relate to well-being, motivation, and self-worth (Harter, 1999; Humphrey, 2002; Imram, 2013) research on the impact of reading difficulties on psychological health including self-concept, depressive symptoms, and anxiety is inconclusive. In this study, we investigated the connection between reading difficulties, psychological well-being, and self-concepts before and after the introduction of Assistive Technology (AT). We wanted to investigate how AT could bridge and even hinder the negative development proven in previous studies for children with reading difficulties regarding psychological well-being and self-concepts.

The Simple View of Reading (SVR) model states that the cognitive act of gaining information via written text is described as a formula where decoding and language comprehension equals reading, $\text{Reading} = \text{Decoding} \times \text{Language comprehension}$ (Gough & Tunmer, 1986; Gustafson, Samuelsson, Johansson, & Wallmann, 2013; Hoover & Gough, 1990; Kirby & Savage, 2008). Decoding is within the SVR described as the ability to connect a symbol with a speech sound and to summarize these symbols into words, sentences and texts (Lundberg & Austad, 1999; Snowling, 2001). Language comprehension is the complex cognitive process of understanding the meaning of words and larger units of language such as sentences, stories or texts (Gustafson et al., 2013).

Reading difficulties can be defined as a lower reading ability than expected in age-equivalent peers in the same educational setting (Lyon, Shaywitz, & Shaywitz, 2003; Snow, Burns, & Griffin, 1998). Dyslexia is a specific learning disability defined as a cognitive deficit in phonological processing (DSM-5; American Psychiatric Association, 2013; Tunmer & Greaney, 2010), which primarily generates difficulties in connecting letter-sound combinations when decoding texts (Lundberg & Austad, 1999; SBU, 2014) and has a scientifically confirmed heritability (Mascheretti et al., 2017). Reading difficulties and Dyslexia may also induce writing difficulties and a limitation of organizational skills such as time management and planning (Barden, 2014; Humphrey, 2002; Tunmer & Greaney, 2010). In the theoretical perspective of Simple view of Reading.

Although often a target of theories and investigations, self-concept is not a unitary notion (Humphrey, 2002). Self-concept may involve both self-descriptions and self-evaluations depending on the theoretical standpoint, and cognitive constructions of “who I am” are interconnected with emotionally-laden values generated in a given context (Harter, 1999). In this study self-concept is defined and investigated from two theoretical perspectives: first, as the abstract depiction of “who I am”: the *self-image* (Beck, Beck, & Jolly, 2001); and secondly in terms of *self-esteem*, the evaluation of one’s own abilities and *self-worth* (Battle, 2002; Humphrey, 2002). Following the theoretical approach of Shavelson, Hubner, and Stanton (1976), the concept of self-image (or self-concept) may be divided into more specific domains under global or general self-image (Burden, 2008; Shavelson et al., 1976). In this study, several levels of domain-specific self-image, related both to learning situations and life in general, were of interest (Battle, 2002; Beck et al., 2001).

Imram (2013) showed in a large study ($n = 512$) that general self-esteem did not differ between participants with reading difficulties and their age equivalent peers without reading difficulties.

However, this study showed that pupils with reading disabilities scored significantly lower on academic achievement. Novita (2016) found similar results in a study of children aged 8–11 years ($n = 124$) that showed global self-esteem to remain intact in the control group, but to diminish in children in the reading impaired group, who showed specific school or learning issues related to anxiety and self-esteem (Novita, 2016).

Psychological health is a comprehensive term for symptoms of psychological or psychiatric problems, and its connections with reading difficulties have been investigated in several previous studies (e.g., Alesi, Rappo, & Pepi, 2014; Alexander-Passe, 2015; Dahle & Knivsberg, 2013; Mugnaini, Lassi, La Malfa, & Albertini, 2009; Novita, 2016). In the present study, levels of *Anxiety* and *Depression* were investigated and regarded as interconnected and reciprocal influences on psychological health, and supposedly promoted by the reading difficulties known in the participants.

Mugnaini et al. (2009) conducted a literature review of studies about psychological health issues and reading difficulties and/or dyslexia, concluding that “dyslexia and reading problems consistently contribute to higher depressive and anxiety symptoms in students from first grade to university” (p. 260). Repeated academic failures, perceived inadequacy despite extensive training on reading, feelings of being stupid, being accused of laziness by teachers, and having to put extra effort into reading-related activities were identified as influencing the reading-impaired child’s negative self-concepts (Burden, 2008; Denhart, 2008; Humphrey, 2002; Glazzard, 2010). Studies approximately 10 years and older from today’s date (2017) commonly show a relationship between reading difficulties and psychological ill-health (Alexander-Passe, 2006; Burden, 2008; Burden & Snowling, 2005; Carroll & Ilse, 2006; Heivervang, Lund, Stevenson, & Hugdahl, 2001; Hellendoorn & Ruijsenaars, 2000; Humphrey & Mullins, 2002; Riddick, 1996). However, during the recent decade some studies of psychological health and self-concept have shown contradictory results, indicating that children with reading difficulties do not always perceive themselves or are considered by others as more inclined to develop depression, anxiety, or a negative self-concept (Jordan, McGladdery, & Dyer, 2014; Lindeblad, Gustafson, & Svensson, 2015; Lockiewicz, Bogdanowicz, & Bogdanowicz, 2014; Taylor, Hume, Welsh, & Marie, 2010).

Other recent studies, however, have shown that people with reading difficulties, including dyslexia, show greater risk of psychological ill-health, such as anxiety, depression, and negative self-concepts than their peers with an age-expected reading ability (Alesi et al., 2014; Dale, Knivsberg, & Andreassen, 2011; Fälth, Svensson, Carlsson, & Gustafson, 2014; Ghisi, Bottesi, Re, Cerea, & Mammarella, 2016; Glazzard & Dale, 2013; Green, 2014; Imram, 2013; Zakopoulou & Georgiou, 2016). Alexander-Passe (2015) suggests in his study of adults that repeated experiences of failure during school years may be traumatizing and suggests that these experiences may cause adults with dyslexia to show diagnosable signs of post-traumatic stress disorder (PTSD). The author further suggests that failure to meet reading-impaired pupils’ needs induces frustration in them that subsequently influences their self-esteem: a negative spiral of events creates psychological problems, resulting even in psychiatric diagnoses such as depression, anxiety, and/or PTSD (Alexander-Passe, 2015).

Different national school systems may have different impacts on pupils with reading difficulties because of differences in the administration of special education, educational levels of teachers, and financial resources. The present study was conducted in Sweden, so in this national context, previous research results may also be seen as relatively inconsistent.

Dåderman, Nilvang, and Levander (2014) found that young adult women (mean age 19) with dyslexia scored lower on questionnaires that investigated self-esteem than a norm group provided by the test manual. Fälth, Svensson et al. (2014) investigated reading development in Grade 2 pupils (8 years old) and found that pupils with reading difficulties showed lower self-esteem than the typical reader at an equivalent age. Ingesson (2007) concluded in her study that the group of participants with dyslexia showed indications of psychological ill-health regarding aspects such as

“well-being, educational achievement, self-esteem, poor peer relations and future beliefs (...) and secondary emotional problems” (p. 4). Furthermore, Ingesson argued that dyslexia could be related to low global self-worth when a lack of parental support and insufficient peer relations also occurred (Ingesson, 2007). Lindeblad et al. (2015) assessed and compared 67 pupils aged 10–16 years to a norm group on psychological health and self-image. Results showed no significant differences between the reading-impaired and norms on self-image, depressive symptoms, or anxiety. Time may explain the discrepancy between the results in the studies cited above, since during the decade that differs between the two studies lots of societal changes in both structures and attitudes may have taken place. Although conducted in a similar national educational context, knowledge about reading difficulties and dyslexia may have improved in Sweden due to changes in school laws on how to treat children with reading difficulties and other disabilities. Since those changes teachers may have developed a more supportive attitude towards reading-impaired children. Participants in the study conducted by Dåderman et al. (2014) were older ($M = 19$ years) than those in the study by Lindeblad et al. (2015) (10 – 16 years) and had thus been exposed to the eventual constraints of having a reading difficulties for a longer time, whereas the participants in Fälth, Gustafson, Svensson, and Tjus (2014) were younger (8 years) and thus could have been too young to fully grasp the consequences of their reading difficulties. Different instruments were used in these studies, which could also imply that different aspects of self-concepts were investigated.

In this study, we investigated self-concept and psychological health in a randomized controlled trial study of 137 children and adolescents aged 10–19 years compared with norms. We also investigated whether using Assistive Technology AT to accommodate reading affected self-concepts and psychological health by conducting pre- and post-intervention assessments. AT was introduced to avoid or facilitate the strenuous situations and the continuous failures mentioned above and that has been held as reasons why children and adolescents have shown higher scores on psychological health measures and negative self-concepts in previous studies.

Assistive Technology (AT) is defined as devices or means that have the potential to enable people with disabilities to live, learn, and work more independently through the application of specialized technologies that reduce, eliminate, or minimize the impact of disability (Edyburn, 2015, p.1). The concept of AT includes devices, equipment, instruments, and software to protect, support, train, measure, or substitute for body functions/structures and activities or to prevent impairments or limitations to activity or participation (International Organization for Standardization, 2011). For instance, the AT program, Kurzweil®, may scan texts and read them aloud or assist children with spelling by reading the words aloud and correctly while the words are written on a tablet, as in the application Skolstil®. Most smartphones and tablets now have a voice recognition function, which can be used as AT for various functions such as help with text messages.

To our knowledge, few, if any previous studies have systematically investigated the impact of AT on self-concepts and psychological health. Focus has instead been on reading development, the effect of AT on reading ability, and wider impacts such as increased motivation, independence, and social functioning (Fälth & Svensson, 2015; Gasparini & Culen, 2012; Roberts & Stodden, 2014; White & Robertson, 2014). The Swedish Council on Health Technology Assessment conducted a systematic review of available international scientific literature until 2014 and concluded that there was not enough scientific proof that AT improves reading development and that many studies had methodological shortcomings (SBU (Statens beredning för medicinsk och social utvärdering). [The Swedish Council on Health Technology Assessment], 2014).

Wider impacts of AT interventions reading-impaired children and adolescents were investigated by Lindeblad, Nilsson, Gustafson, and Svensson (2016). In this study, participants received intense interventions over 6 weeks. These interventions focused on the use of tablet applications to compensate for reading difficulties and facilitate reading ability. Results showed a similar increase

in decoding ability to an age-equivalent norm group. The results from this study also included reports from participants, their parents, and teachers that were analyzed and categorized. The reports showed that factors such as motivation, independence, and family climate improved after using AT to improve reading ability (Lindeblad et al., 2016). In this study, we wanted to investigate whether using AT could affect self-esteem in a direct way.

Self-concepts may be assessed several ways (Battle, 2002; Beck et al., 2001; Harter, 1999). In this study, as in previous studies (Alexander-Passe, 2006; Lindeblad et al., 2015), we used the Beck Youth Inventory (BYI) (Beck et al., 2001), the child and adolescent version of a clinical test used to assess anxiety, depression, and self-image before the cognitive theory made an impact in the field (Clark & Beck, 1999).

This study also used the Cultural Free Self-Esteem Inventory-3 (CFSEI-3), a self-esteem questionnaire adapted for children and adolescents that divides self-esteem into the domains of academic, parental, social, and personal (Battle, 2002). The CFSEI-3 has been used in previous studies of self-esteem in participants with reading difficulties (Alexander-Passe, 2006; Nalavany, Carawan, & Sauber, 2013; Ntshangase, Mdikana, & Cronk, 2008; Taylor et al., 2010).

1.1. Aims

The aim of this study was to investigate whether self-concept and psychological health in reading-impaired children and adolescents differ from age-equivalent norm groups. Another aim was to investigate the effect on self-concepts and psychological health in reading-impaired pupils who used AT applications on tablets to facilitate reading and compensate for reading deficits.

2. Method

2.1. Participants

Participants were selected by special education teachers who volunteered for a project focused on the effects of AT on reading progress and on self-concepts and psychological health. The inclusion criteria were documented reading and writing difficulties and scores on the reading ability tests *Word Chains*, *Word Reading*, and *Non-word Reading* at least 1 standard deviation below expected results for chronological age as provided by test manuals (Elwér, Fridolfsson, Samulesson, & Wiklund, 2011; Jacobson, 2001). The participating schools were in different parts in Sweden and represented rural and urban areas and different socio-economic groups.

In this study, 137 children and adolescents conducted pre-test assessments and 79 of these completed post-tests.

Participants were in school years 4 or 8 or in high school in the Swedish school system following the curriculum of an ordinary integrated class with peers with or without learning disabilities. Mean age in school year 4 ($n = 87$) was just over 10 years (123.2 months, $SD = 4.8$), in school year 8 ($n = 35$) about 14 (172.6 months, $SD = 5.7$), and in high school ($n = 15$) around 16 years (199.7 months, $SD = 8.9$). There were no significant differences in group level between the high-school group and school year 8 on any of the assessments, hence the merging of the two groups in the analysis. This was further motivated by the participants being too few in the high-school group to support internal comparisons. Also, the two groups were administered the same version of CFSEI-3 (see below).

Years in school may be of greater interest than age in the context of reading since it indicates years of practicing reading skills. In Sweden, most children start school at the age of 6. After 9 years of mandatory school pupils can choose either a theoretical or a vocational educational program. Age-equivalent reading skills are necessary for both programs. In pre-test assessments, 87 year-4 pupils and 50 year-8 and high-school pupils completed the CFSEI-3, and 20 year-4 and 21 year-8/high-school pupils completed the BYI. At the follow-up assessment, 54 pupils took the

CFESI-3 in school year 4 and 25 in year 8 and high school. The BYI was administered at follow-up but those results demonstrated descriptively below, were excluded from the analysis due to the small group size.

Participants were randomly assigned to a control or intervention group. In the randomization, they were matched by school year, gender, and scores on reading ability tests. After randomization, a few pupils chose not to participate in the project. This affected the balance of the two groups somewhat, but not enough to influence the results.

2.2. Drop-outs in the follow-up test trial

In total, 58% of the participants were not assessed in the follow-up test trial, mainly because of the one-year interval between the finished interventions and the post-tests. Teachers responsible for participants who did not complete the study cited changing schools, moving to another town, or personal events as the most common reasons for pupils' withdrawal. Changing work positions, becoming ill, or other personal reasons were cited as causes for teachers not enabling a participant to follow through the study. The drop-outs did not differ significantly from those participants that responded in the follow-up, neither in the ability tests nor in the CFSEI-3 scores.

2.3. Instruments

The third edition of *Cultural Free Self-Esteem inventory* (CFSEI-3) was used to measure participants' self-esteem at pre-test and at one-year follow-up. The CFSEI-3 was constructed by Battle (2002) to assess self-esteem in children and adolescents through 64 or 67 yes/no questions taking approximately 10–15 min to perform. This instrument is commonly used by practitioners and in research (Ntshangase et al., 2008; Taylor et al., 2010).

The CFSEI-3 has age-adjusted questions and participants were therefore distributed to two different versions according to age: *Intermediate* (school year 4) and *Adolescent* (school year 8 and high school). The versions are designed to assess equivalent constructs of self-image, but some questions are formulated to fit different life stages responders may be undergoing. The CFSEI-3 contains five subscales of self-esteem: *Academic* measures self-esteem in academic situations; *Parental/Home* measures self-esteem in the family unit; *Social* measures self-esteem in interpersonal relationships and social situations; *General* measures self-esteem from a broad perspective; *Personal* measures anxiety and self-worth and is measured only in the adolescent test (Battle, 2002, p. 4). All the CFSEI-3 assessments were read aloud to participants to compensate for their reading difficulties.

The CFSEI-3 was normed on a sample of 1727, 51% were male and 49% were female. The test-retest reliability on the different subscales was between .70 and .98 (Battle, 2002). The validity of the test is investigated in several studies and thoroughly discussed in the manual, reporting considerable amount of evidence to show that the CFSEI-3 is a valid measure of self-esteem (Battle, 2002).

The BYI was used at pre-test to assess self-image and psychological well-being in 41 participants. Participants (19 from school year 4 and 22 from school year 8) at pre-test and 27 participants at post-test by one of the authors who, as required by the BYI manual, was a licensed psychologist with more than 10 years of clinical experience. Fewer participants were therefore assessed on the BYI because of limited resources. The pupils were selected from nearby areas. Mean ages were similar to those in the CFSEI-3 groups. The BYI is a self-report instrument with a norm reference commonly used in clinical settings in Sweden and consisting of five scales, three of which, *Anxiety*, *Depression*, and *Self Image* (Beck, Beck, & Jolly, 2001), were used in this study. Each scale is represented by 20 statements with four answer alternatives: never, sometimes, often, and always. In consideration of possible reading difficulties, all BYI questions were read aloud to participants. The norms were based on the results of 2358 children, 1112 girls and 1246 boys. The reliability coefficient varied for

different subscales between $r = .86$ and $r = .91$. The BYI relies on Beck's (2002) cognitive theory of depression that defines cognitive content as representative of psychological health: thoughts symbolize both inner states and outward behavior. Given these assumptions, questionnaires can be used to measure maladaptive thoughts and feelings, i.e. symptoms of psychiatric states, that signal psychological ill-health (Beck, 2002; Clark & Beck, 1999).

In the assessment battery, several reading tests were also used to cover decoding, listening, and reading comprehension: *Word Chains* and *Sentence Chains* (Jacobson, 2001) investigate aspects of decoding skills (Jacobson, 1999). The results were compared to norm groups provided by the test manual. In total of 2246 pupils (1105 girls and 1139 boys) participated in the standardization process which took place in Sweden and the test-retest reliability was assessed with an interval of 3 months between measurements of $r = .85$, and the sentence chains test had a test-retest reliability of $r = .80$ (Jacobson, 2001).

Non-Word Reading and *Word Reading* (Elwér et al., 2011) include two time-limited tests, each with increasingly longer and more difficult words to read correctly and quickly. The results were compared to norm groups provided by the test manual. When producing the norms representation of socio-economical status was taken into consideration and 1043 Swedish pupils (404 girls and 419 boys) participated in the standardization process (Elwér et al., 2011). The test-re-test reliability coefficient in this test was calculated by assessing pupils in school year 4 twice within a month. Adding the A and B versions, the reliability for non-word reading was .74 and .78 and for word reading .91 and .88. (Elwér et al., 2011). *What picture is correct?* Is a reading comprehension test that shows pictures and asks children to choose between several written descriptions of the event that differ from each other in a small detail (Lundberg, 2001). *Sentence sequences* tests reading comprehension by requiring four or five sentences to be ordered correctly to create a logical story (Hammill, Mather, & Roberts, 2001).

The reading ability assessments were performed to monitor the effect of applications such as AT to train, compensate for difficulties, and facilitate the assimilation and generation of texts. These results are accounted for and further discussed in Svensson et al. (submitted, Svensson, Nordström, Lindeblad, Gustafson, & Nilsson, 2019). In the present study, the reading assessments were used to facilitate interpretation and to further our understanding of the results of CFSEI-3 and BYI. The scores on the reading tests were used to calculate the composite scores used in the analysis.

2.4. Procedure

This study was part of a larger project investigating reading progression in reading-impaired children and adolescents using reading-facilitating AT in one-to-one teaching situations (Svensson et al., 2019). The aspects of self-concept and psychological health in children with reading difficulties are presented in this paper and the study design of the main project is displayed in Figure 1.

2.5. Assessments and interventions

Participants were randomly assigned to two groups, control or intervention. The intervention group received sessions focused on reading ability and how to compensate for and facilitate the use of text-based information using AT applications on smartphones or tablets. The AT interventions were

Figure 1. Study design of the main project and the study of self-concepts and psychological health and the use of AT in reading impaired children and adolescents.

Time	Week 1	Week5	Weeks 6-8	9-10	Week 11-13	Week 14	1 year
Activity	Assessment 1	Assessment 2	Interventions	Break	Interventions	Assessment 3	Assessment 4
Reading assessments	Inclusion test	Pre-test				Post test	Follow-up
Self-concepts and psychological health assessments		CFSEI-3 BYI					CFSEI-3 BYI

conducted in one-to-one teaching situations 24 times over 6 weeks, with a two-week break. This interval was based on previous research that stated it was enough to create an improvement in reading ability given that the interventions were conducted as intensely as at least 4 times a week, 40–60 min á session (Fälth et al., 2013, Fälth & Svensson, 2015). We chose to follow this recommendation to prevent children from fatigue and boredom. In the Swedish school year, there are two midterm breaks and due to the period of interventions was designed so that the scheduled interruption and the motivational pause will come at the same time.

The systematic and structured interventions served two purposes: to teach the participants how to manage the apps to support and compensate reading and writing activities; and secondly to train reading skills and any learning-related information gathering processes. To achieve this, the pupils practiced in using apps when listening to texts and answering questions about it, summarized and dictated information in apps from different data sources and similar exercises that imitated everyday learning activities in the classroom. The intervention leaders encourage the participants to bring assignments or homework to the AT intervention sessions. Further details are provided in Svensson, Nordström, Lindeblad, Gustafson, & Nilsson, submitted, (2019).

The participants were instructed to use the devices that provided AT in learning situations at school and to follow the systematic intervention program. Most of the pupils left the tablets with their teachers so they would not be lost or forgotten at home. The participants had their tablets at home in order to listen to audiobooks, which was in line with the intervention program and therefore permitted. The control group was instructed not to use AT at all.

The applications used in this study were selected by their functions and ability to support or accommodate the reading process for a pupil in different ways, for instance, text to voice functions after photographing texts. The apps supplying these functions were chosen based on advice from the National Agency for Education in Sweden — who regularly issue recommendations after testing different educational materials. These recommendations are targeted at educators and researchers.

Special education teachers received precise instructions from the research group emphasizing the emotional content of the test administered the CFSEI-3. Those teachers did not execute the interventions or assessments. The assessor was, whenever possible, a teacher unfamiliar to the participant. The control group followed the curriculum and received special education as usual.

This project was vetted by the Swedish Ethical Board on Research and permission was formally granted for the research to be conducted. Written consent has been provided by all research participants for the results to be reported and published.

2.6. Statistical analysis

Change score between pre- and post-test for the different CFSEI-3 domains was calculated. Mann-Whitney U test was used to compare the change scores between the control and intervention groups. This method was selected due to the data not meeting parametric methods' requirements of normal distribution. The significance threshold was set at .05.

The raw scores were transformed to standard scores according to the CFSEI-3 manual and these standard scores were compared to the norm mean 10 with Wilcoxon signed rank test. The relationship between CFSEI-3 and BYI and the composite score were examined using Pearson correlation. Pre- and post-test CFSEI-3 scores were compared using the Wilcoxon signed rank test.

The composite score was calculated first by transforming the pre- and post-test scores to z-scores. Two partial scores were then created, one for words by averaging the z-scores for Word Chains, Non-Word Reading, and Word Reading, and one for whole sentences by averaging

the z-cores for Sentence Reading, What Picture Is Correct, and Meaning Sequences. The means of these two scores formed the composite score.

3. Results

3.1. CFSEI-3 results compared with an age-equivalent norm group

In comparing the results of the CFSEI-3 pre-test with norms provided in the manual (Table 1) neither the intervention nor the control group in school year 4 showed statistically significant differences with norms on the scales *Academic*, *General*, or *Home*, but scored significantly higher than norms on the *Social* scale.

In the year 8 and high-school groups participants scored statistically significantly lower than the norms on the subscale *General*, but higher on the subscales *Home* and *Social*.

3.2. The impact of using AT as shown by pre-intervention and follow-up tests

The CFSEI-3 was administered before and one year after interventions were finished in both the intervention and the control group (Figure 1). As shown in Table 2, the control and intervention groups were not statistically significantly different. Means in the subscales *General* and *Academic* for the school year 8/high-school group, however, were significantly higher ($p \leq 0.05$).

3.3. Self-esteem in relation to reading ability

A composite score from the reading tests was made to investigate variation between aspects of using AT, as in the present study, and self-esteem scores. The results are presented in Table 3 and show no statistically significant correlations between reading ability and participants' scores on the CFSEI-3.

3.4. BYI results

Because of the small group size, the BYI results are presented by mean group values taken from the raw scores, as shown in Table 4. The *Self-image* scale, in contrast to the other scales, ranks high values to indicate a positive, rather than a negative, self-image. The scores were compared to norm values from the test manual. On the subscale *Anxiety* in school year 4, values were significantly higher than the norm groups. It showed after further investigation that there were a few individuals scoring high and that these individuals were girls.

The BYI subscales were significantly correlated to all CFSEI-3 domains in all grades as shown in Table 5.

4. Discussion

In this study, participants in school year 4 had no significant negative differences in self-esteem measured by the CFSEI-3 from an age-equivalent norm group. The adolescent group of

Table 1. Pre-test CFSEI-3 scores for intervention and control groups in year 4 and year 8/high-school groups compared with norms ($M = 10$)

Standard scores at pre-test trial				
	School Year 4 ($n = 87$)		School Year 8/HS ($n = 50$)	
	<i>M</i>	<i>p</i> ¹	<i>M</i>	<i>p</i>
Academic	9.3	0.18	9.7	0.58
General	9.8	0.58	8.6	0.01
Home	10.3	0.09	12.4	<0.001
Social	10.4	0.003	10.9	0.004
Personal			9.8	0.88

Note: ¹ Two decimals are used to show *p*-value

Table 2. Means of pre-test and one-year follow-up tests on CFSEI-3 presented in groups of year 4 and year 8/high school, control and intervention group and on subscale level

	Pre-test		One year follow-up		Pre-test vs Follow-up p^1	Change score Control vs Intervention p		
	Control (n = 41)		Intervention (n = 27)					
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)				
School year 4								
Domain								
Academic	7.3	1.8	7.2	2.1	6.6	2.4	0.06	0.08
General	8.4	3.2	8.7	3.5	8.6	4.3	0.66	0.95
Home	10.3	1.3	10.1	0.3	10.5	0.9	0.13	0.15
Social	15.3	2.1	14.9	2.8	15.6	2.3	0.67	0.06
School year 8/High school								
Domain								
Academic	7.0	2.6	6.4	3.0	7.4	2.6	0.04	0.13
General	8.0	2.5	7.1	3.1	8.6	2.0	0.02	0.07
Home	10.7	1.4	10.2	2.5	10.6	1.2	0.80	0.49
Social	10.3	2.3	9.8	2.4	10.1	2.3	0.72	0.45
Personal	9.6	3.0	8.5	4.0	8.5	3.8	0.32	0.23

Note: ¹ Two decimals are used to show p-value

Table 3. Correlations of reading ability composite score and CFSEI-3 in school-year 4 and school-year 8/high school

	School year 4 (n = 87)		School year 8/HS (n = 50)	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Domain				
Academic	0.17	0.13	0.00	0.99
General	0.17	0.13	0.05	0.74
Home	0.09	0.44	-0.21	0.71
Social	0.21	0.06	0.00	0.98
Personal			-0.05	0.73

participants in school year 8 and high school, however, had statistically significant lower general self-esteem compared with a norm group. Other subscales on the CFSEI-3 showed similar or higher results than the norm group.

The results further showed that interventions with reading-facilitating and compensation applications in tablets did not affect self-concepts of the participants. The effect of AT on reading abilities may not have been shown because of participants' relatively positive self-esteem at pre-intervention tests, which would make an increase less expected.

The results also showed that scores on reading ability assessments do not correlate with scores on self-concept tests.

Several previous studies have reached different results about self-concepts than this study, concluding that reading-impaired children and adolescents have lower self-esteem and at more risk to develop psychological ill-health than people not experiencing a reading impairment (Alesi et al., 2014; Alexander-Passe, 2006; 2015; Burden, 2008; Burden & Burdett, 2005; Fälth et al., 2014; Ghisi et al., 2016; Humphrey, 2002; Humphrey & Mullins, 1999). The context in which the studies were conducted could partly explain the different results and will be discussed further below. The introduction of AT and the overall improvement of AT may have facilitated the educational setting for reading-impaired children and adolescents (Edyburn, 2006; Nuttal, 2014) by for instance making these children less exposed to feelings of stigmatization and/or experiences of unfair conditions.

Teachers' attitudes have been suggested to have a great impact on the child's development of self-concepts (Burden, 2008; Bandura et al., 1996; Glazzard, 2010). Teachers are sometimes even held responsible for inadequately understanding the problems a reading-impaired child might be confronted with (Green, 2016; Glazzard & Dale, 2013; Glazzard, 2010; Humphrey, 2002; Troia, Shankland, & Wolbers, 2012). In this study, we can only speculate that the teaching of our young participants did not negatively impact their self-concepts. A positive change in societal attitudes towards reading difficulties including dyslexia may have contributed to a positive school context. In a positive school context, we include helpful attitudes among teachers that do not stigmatize the child when asking for accommodation such as AT.

In this study, the adolescent group scored lower on the subscale *General*, possibly because of their inadequate individual resources. The subscale *General* aims to indicate a broad sense of self-esteem (Battle, 2002), but this adolescent group may not have felt the expected change of attitude in response to their reading difficulties, dyslexia, and/or increase in knowledge. Instead, the older, hence adolescent, participants in this study may confirm previous studies that may have been conducted in similar educational settings. The increase on the subscale *General* from pre-test to

Table 4. Mean values of BYI subscales presented in raw scores in school year 4 and 8/high school

BYI Subscale	Pre-test assessment									
	School year 4 n = 19					School year 8/High school n = 22				
	M	SD	Norm ¹	p ²	min- max value ³	M	SD	Norm ¹	p ²	min-max value
Depression	10.9	7.7	8.6	0.21	2-31	12.2	8.8	8.6	0.33	3-27
Self-image	42.4	9.6	42.7	0.91	24-67	41.5	9.3	39.5	0.34	25-58
Anxiety	16.7	8.0	9.1	0.001	4-31	12.9	10.2	9.3	0.11	1-39

Note: ¹Weighted mean of girls and boys. ²One sample t-test ³The min-max value of the participants' results

Table 5. Correlations between subscales included in BIY and CFSEI-3

		CFSEI-3				
	BIY	Academic	General	Home	Social	Personal
School year 4 (n = 19)	Depression	-0.68**	-0.53***	0.67**	-0.78***	
	Self-Image	0.55*	0.52*	0.56*	0.65**	
	Anxiety	-0.73***	-0.59**	-0.56*	-0.74***	
Year 8/High School (n = 22)	Depression	-0.71***	-0.84***	-0.57***	-0.82***	-0.91***
	Self-Image	0.56***	0.78***	0.65***	0.81***	0.81***
	Anxiety	-0.71***	-0.76***	-0.65***	-0.85***	-0.88***

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

one-year follow-up may have been related to participants' attention during one-to-one teaching situations, giving the teacher opportunities to encourage the participant's positive self-concepts. It may also be that the use of AT made a difference by presenting new ways of managing everyday life. The use of AT can avoid the strenuous situations that people of all ages with reading difficulties may meet on a daily basis, and this easy access assistance could generate a more positive self-esteem.

Several authors argue for early detection of reading difficulties to prevent negative impacts on self-concept and psychological health (Bandura et al., 1996; Burden & Snowling, 2005; Hellendoorn & Ruijsenaars, 2000) mostly meaning as early as possible in their academic career. Most participants in the present study were relatively young in that aspect and had several years left in the educational system with better circumstances than if their reading difficulties had remained undetected. Humphrey (2002) discusses the different behaviors of denial in handling low self-esteem that may be sprung from reading difficulties. These behaviors are overcompensation, displacement, sublimation, and discharging (Humphrey, 2002) and are suggested to increase the risk of delinquency in the reading-impaired group (Bandura et al., 1996; Svensson, 2011; Svensson, Lundberg, & Jacobson, 2001). Participants in the present study could have shown signs of acceptance, which might have arisen from their early integration of difficulties in their self-images. Behaviors born of the acceptance of one's diagnosis could perhaps create inclinations to ask for help, feelings of integration among peers, resilience toward bullying and teasing, and an ability to explain and openly discuss reading-related problems. The connections and interrelationships between the degree of acceptance with self-esteem, school performance, or both would be interesting topics for future studies. AT may also be recommended as intervention for children to ease their integration and acceptance and shield them from stigmatization (Edyburn, 2006). AT could motivate children to compensate their difficulties since it is discreet and does not draw unwanted attention to the child when it is being used. The two age groups in this study enabled us to detect possible differences between ages or life stages in the use of AT, but such differences were not found.

A child aged 8 or over can construct a global self-esteem (Harter, 1999) and hierarchically range their abilities according to what is important to that child as a person. Following the original thoughts of James (1890), a child from this age can keep its global self-esteem intact even while realistically appreciating an area of their own competence, for instance, reading, as low. Shavelson et al. (1976) discuss this as an academic self-image, and mention the possibility of different statuses in different domains. Battle (2002), the constructor of the CFSEI instrument used in this study, may have constructed this instrument based largely on these assumptions (Battle, 2002). In the present study, the results show no difference between academic and global self-esteem, nor between any other areas of self-esteem in the year 4 group. On the other hand, the adolescent group of participants in this study showed some inconsistencies as mentioned above. Some

previous studies have also shown incongruous results, in which academic self-esteem was lower in participants with dyslexia than in peers without reading difficulties (Alesi et al., 2014; Fredericksen, & Jacobs, 2001; Novita, 2016). However, it could be that children with a strong sense of general self-esteem have also developed resilience towards negative impacts on hierarchically defined domains. Or, it may be that children who participated in our study rarely faced the challenges often described in similar studies because they had knowledgeable teachers, parents, or friends with empathetic and supportive ways to help their individual learning processes.

However, the results on the BYI in this study in the younger group of participants contradict these statements, since their results showed higher levels on the subscale *Anxiety* than the norms, and results showing positive self-concept and higher than expected levels of anxiety symptoms are incongruous and challenging to explain. In the school year 8/high school group, the scores on the BYI subscale *Depression* were not showing statistical significant differences in comparison to a norm group but the results indicate that a few individuals may have had higher levels that increased the overall mean value. On the subscale *Self-image*, none of the groups showed any deviance from the norm group values.

Due to the small sample size in the BYI investigation in this study, results should be interpreted with caution. These results are not completely consistent with a previous assessment using BYI in a group with reading difficulties, where no deviance from the norm group was shown in the results among reading impaired pupils (Lindeblad et al., 2015). This has raised further questions and could be addressed in future studies.

According to the BYI manual results for school year 4 were indicating levels of psychological symptoms that would be likely to require further attention (Beck, Beck, & Jolly, 2001). Through further review of the results, it is possible to state that girls showed higher levels of symptoms of anxiety than boys in this study. Plausible reasons for these results may not be as associated with reading ability as with other circumstances in their lives. To investigate the contributing factor of gender and the different circumstances of tackling reading disability created due to different gender affiliations are not in the scope of this study, but an interesting subject to return to in future projects. However, due to small sample size it is also conceivable to understand and interpret the results as reflecting the participants' individual state of health and that the results were not related to their reading ability or use of AT, since few questions in the BYI address these areas.

Taylor et al. (2010) found similar results to this study as children with dyslexia in their study did not show any lower self-esteem. However, children identified as having Special Educational Needs (SEN) showed lower self-esteem than the control group and the group of children diagnosed with dyslexia (Taylor et al., 2010). Taylor et al. (2010) and several other studies (Firth, Frydenberg, Steeg, & Bond, 2013; Glazzard, 2010; Green, 2016; Riddick, Sterling, Farmer, & Morgan, 1999) argue that the generic labeling of "reading impairment", rather than dyslexia, is the main reason why children's self-esteem is negatively impacted in the SEN group. Self-esteem in children diagnosed with dyslexia was unaffected, and may be explained by an increase in awareness of dyslexia in pedagogical groups and the general public (Taylor et al., 2010).

Several studies have discussed separating children with SEN from their peers versus integrating their tutoring in their classroom (Casserly, 2013; Glazzard, 2010; Green, 2016; Humphrey, 2002; Taylor et al., 2010). Separating pupils may stigmatize and negatively impact the self-concepts and psychological health of those assigned to an SEN group, while knowledgeable and specially trained teachers may provide the understanding, support, and study technique that would benefit these pupils. In Sweden, where the present study was conducted, the overall ambition is usually not to exclude reading-impaired children from the school, classroom, or educational setting where non-impaired pupils are tutored. To create an equal chance to learn for the reading-impaired pupil, the reading impairment needs to be compensated for in some way. If not, there is a risk of creating

a learning situation that is neither optimal for learning nor healthy and supportive for the child. We argue that applications in tablets or smartphones could bridge the need of special education by providing a less evident way of supporting the learning process by using AT. This could subsequently help the child to develop a positive self-esteem and self-confidence in academic setting as well as provide resilience toward psychological ill-health that originate from repeated academic failures due to unattended reading impairment. The attitudes amongst teachers towards AT may contribute to its effect both on reaching academic goals and implementing AT in the regular tutoring and classroom environment, and hence affect children's self-concepts and psychological health. The pedagogical strategies, including AT and supportive attitudes, implemented by teachers in Sweden or similar educational settings that aim to integrate all pupils and create a helpful environment for reading-impaired pupils would be an interesting topic for future research.

5. Limitations

This study suffered from drop-outs between pre-tests and follow-ups for various reasons. Several children and teachers may have moved to another town or changed schools. Participants' motivation may also have diminished. Because the control group had to wait until after the follow-up test to begin using AT, some teachers may have dropped out of the project to begin using AT immediately. This attrition rate may have reduced the generalizability of our results. Also, the selection of volunteers before randomization may have affected the results by favoring already interested and engaged teachers and parents who may not be representative of all schools in Sweden.

The small sample size in the BYI group may have affected the results because even a few individuals' psychological health may have negatively influenced the mean group value and thus its generalizability. The BYI assessment did not seem to contribute to the Research question but recreated more suggestions for future research.

6. Conclusion

The results of this study did not show any major differences in self-esteem, self-image, or psychological health in children and adolescents with reading difficulties compared with age-equivalent norms. However, some results may be inconclusive, showing higher levels of anxiety in the younger group and, in line with previous research. These contradictions could be explained by the cultural context, study design, and various instruments used in different studies.

This study also investigated the impact of AT on self-image, self-esteem, and psychological health and no immediate positive effects were found. However, because the pre-test showed only small, and perhaps doubtful, negative differences from an age-equivalent norm group, it is reasonable to expect little or no impact on self-concepts. The contexts of society, school, peers, and family seem not to have created feelings of low self-worth or unambiguous psychological ill-health from reading difficulties. We argue for the continuous use of AT to compensate for reading disabilities and to facilitate reading-impaired children's assimilation and creation of text activities, since this may help to eliminate factors previously attributed to low self-concept and psychological ill-health in reading-impaired children.

Funding

This work was supported by the Marcus and Amalia Wallenberg foundation [Wallenbergsstiftelsen (no number issued)];

Competing interests

The authors declare no competing interests.

Author details

Emma Lindeblad¹
E-mail: emma.lindeblad@lnu.se
ORCID ID: <http://orcid.org/0000-0001-6811-1960>
Staffan Nilsson²
E-mail: staffan.nilsson@chalmers.se
ORCID ID: <http://orcid.org/0000-0003-4748-0446>

Stefan Gustafson³

E-mail: stefan.gustafson@liu.se
ORCID ID: <http://orcid.org/0000-0001-9350-2955>
Idor Svensson¹
E-mail: idor.svensson@lnu.se

ORCID ID: <http://orcid.org/0000-0003-2608-6204>

¹ Department of Psychology, Linnaeus University, Växjö, Sweden.

² Chalmers University of Technology, Gothenburg, Sweden.

³ Linköping University, Linköping, Sweden.

Citation information

Cite this article as: Self-concepts and psychological health in children and adolescents with reading difficulties and the impact of assistive technology to compensate and

facilitate reading ability, Emma Lindeblad, Staffan Nilsson, Stefan Gustafson & Idor Svensson, *Cogent Psychology* (2019), 6: 1647601.

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