Purpose and aims

Everybody needs texts adapted to their reading abilities, but some need it more than others (Lundberg & Reichenberg, 2008). Reading comprehension is often described in relation to two types of processes, decoding and language comprehension. Poor reading abilities are found in various populations, including individuals with intellectual disability (ID) and dyslexia. These groups have distinct cognitive and language profiles associated with the reading process. The different cognitive and language deficits selectively impair different aspects of reading (Elwér, Keenan, Olson, Byrne, & Samuelsson, 2013), such that reading comprehension is compromised but for many different reasons. Therefore, what is perceived as complicated text likely differs depending on the background of the readers. Textual features such as word and sentence length, vocabulary frequency, syntactic complexity and idea density affect reading comprehension in different ways depending on the prerequisites of the readers. Many teachers struggle in teaching heterogeneous groups and trying to find reading materials that fit every student is complicated and very time demanding. With readers who show specific difficulties such as individuals with ID and dyslexia, this is especially challenging, as these readers are commonly far from their grade level in reading achievement.

Perceived complexity of a text can be described on a general level, for instance by using the Swedish text complexity measurement LIX. Traditional readability measures, such as LIX, are, however, far too simplified to correctly assess a text's complexity. Modern language technology techniques and machine learning allow for development of much more sophisticated measures that can assess aspects of text complexity, c.f. Falkenjack et.al (2013) and Heimann Mühlenbock (2013) for Swedish initiatives. At the Department of Computer and Information Science in Linköping, several interactive tools have been developed that measure text complexity but also automatically adapt digital text from various perspectives including summarization, lexical and syntactic simplification (Falkenjack et al., 2019). The tools have been developed in collaboration with both writers of easy to read texts and people with reading and writing difficulties and can easily be modified to accommodate new user groups. The usefulness of the various text adaptation techniques and the measures of text complexity have, however, never been systematically evaluated for various groups of people with reading difficulties.

Reading performance is often described at either the individual level (the reader has a set of abilities), or at the text level, (complexities integrated within the text). The aim of the present study is twofold; to learn more about reading performance and reading disability by examining the relationship between comprehension and text complexity in unique controlled ways, and to determine if reading comprehension can be improved by customized automatic adaptation of texts. The following research questions will be addressed.

1. How are text complexity measures such as word and sentence length, vocabulary frequency, syntactic complexity and idea density associated with reading comprehension difficulties of adolescents with ID, dyslexia and typical readers?
2. To what extent do different types of automatic text adaptations based on group characteristics and preferences improve levels of reading comprehension in individuals with ID, dyslexia and typical readers?

State-of-the-art

The complexities of reading

Reading is a highly complex cognitive process that involves abilities ranging from the fine coordination of eye movements to the processing of semantic information. Evidence suggests that text is processed in the form of statements (loosely defined as a clause) (Kitsch & van Dijk, 1978), and understanding is building a framework of the relationships between these statements and knowledge of the reader i.e. making inferences. According to the cognitive text-processing view (Perfetti, 1985) the reader reads individual statements and

makes connections to different types of knowledge such as word meanings, knowledge about the context of the text and language conventions. As the reader encounters the next statement, he/she needs to decide how this information relates to previous text and form links between different pieces of information. The representation of the meaning of the text develops successively as the reader moves through the text and makes new connections.

Another way to describe the reading comprehension process is by a set of practices (Luke & Freebody 1999). These practices are: 1) To retrieve information that is explicitly stated in the text, 2) Make inferences that are straight forward (for instance connecting cause and effect), 3) Connect several ideas and integrate them, and 4) More elaborate reflection on textural elements and information including evaluating information. In the assessment of reading comprehension skills (in for instance PISA; see also the MASTER-project (Kanebrant et.al., 2015)) these practices have been used to formulate questions that assess different levels of comprehension.

Specific problems with reading are experienced by individuals with various diagnoses. In this study, we focus on students with dyslexia and intellectual disabilities (ID). Both these groups have problems decoding text. Individuals with dyslexia experience a relatively selective impairment in decoding skills. Depressed decoding skills are associated with problems establishing the grapheme-phoneme correspondences that are the basis of decoding, and hence individuals with dyslexia struggle immensely with reaching automatic decoding (Vellutino, Fletcher, Snowling, & Scanlon, 2004). As for the ID group, their decoding ability is often very limited. Lemons et al (2013) found that 55% of students with ID in grade 11 had a level of decoding that corresponded to grade 1 of typically developing children. About 13% passed the level corresponding to the average of grade 3. When decoding is demanding it seriously limits the ability to understand texts that require making inferences as the cognitive load of decoding is high (Perfetti, 2007). This may be a valid explanation for individuals with dyslexia but for the group with ID, several other deficits likely influence reading comprehension. Intellectual disability is defined by low IQ and is also associated with lower cognitive abilities in many areas e.g., working memory (Danielsson et al., 2015; 2016), and executive functions (Danielsson et al. 2010; 2012).

Production of easy-to-read text

There is a need for simplified texts to meet the needs of people with different types of reading problems. But how can we obtain such texts that are easier for readers with different reading profiles? Using manually produced easy to read texts is a common strategy when teaching persons with ID. However, as the amount of textual resources available for the target groups is limited, the teachers face challenges choosing teaching material and they often need to adapt the texts themselves, for instance using simple readability measures or writing new texts (Morgan & Moni, 2008). Individuals with dyslexia can listen to authentic texts without simplification as their listening comprehension is adequate (Lundberg & Reichenberg). But listening can never fully replace reading in our literate society and individuals with dyslexia needs to read texts that are at a reasonable level for their ability.

Easy-to-read text is commonly produced by professional writers, that write texts following easy to read guidelines. However, this procedure is expensive in both time and effort, which leads to limited availability of different types of texts. A promising solution to this problem is automatic text simplification: the process of automatically reducing text complexity while preserving meaning and content. Historically, the main motivation for automatic text simplification was as a pre-processing step prior to machine translation or text summarization (Chandrasekar et al. 1996). However, another goal of automatic text simplification is to aid individuals that benefit from simpler texts.

Text simplification has typically been used on news texts, and within public authorities, in order to ensure that important information reaches out to people with poor reading skills. As an aid for the text producers, as well as a way of ensuring uniformity of simplifications, guidelines for writing simple text have been developed. For Swedish, The Swedish Agency for Accessible Media (MTM) gives guidance on how to write simple text. The guidelines are often formulated rather vaguely, such as *“adapt the text to the reader that will read it”.*

Although these kinds of guidelines are helpful for a professional human writer, they are more difficult to use for automatic text simplification, since they cannot be operationalized in a concrete and unambiguous way. For this reason, it is more valuable to study the characteristics of already simplified texts and to compare these to their original counterparts in order to trace the simplification operations applied.

There have been several attempts to construct text simplification systems that simplify the text syntactically by the use of hand-crafted rules (e.g. Chandrasekar et al. 1996; Rennes & Jönsson, 2015), and automatic induction of simplification rules from parallel corpora (c.f. Chandrasekar et al., 1997). Lately, the growing availability of textual data has enabled more sophisticated data-driven methods. For example, recent approaches have often regarded text simplification as a task analogous to monolingual machine translation (e.g. Specia, 2010; Xu et al., 2016). Although such methods seem to make few errors, they tend to be very conservative, i.e. they do not simplify as much as rule-based methods.

To replace complex words with simpler synonyms, a process known as lexical simplification, is not a straightforward task. The replacing word needs to preserve the meaning and grammatical form of the original word. For synonym replacement in Swedish, different methods for choosing alternative synonyms have been evaluated. Keskisärkkä and Jönsson (2012) measured the success of the synonym replacement using readability metrics, average word length, the proportion of long words, and replacement error ratio. Johansson and Rennes (2016) explored the extraction of comprehensible synonyms to more complex words, and let humans evaluate whether the extracted synonyms were perceived as synonymous.

Text adaptation for different types of readers

The research on the intercept between readers and texts is scarce, and especially regarding the types of text simplifications that are helpful for readers with different types of profiles. In a collaboration project, Begriplig text (https://begripligtext.se/) examined text preferences of different diagnostic groups. They found that the three most important aspects for the group with ID were 1) possibility to listen to the text 2) that the most important information is presented early in the text and 3) that the text contained a preamble. As for studies concerning the extent of increased comprehension as an effect of text adaptations, the results are mixed. Falk and Johansson (2006) found that easy to read authority texts were especially difficult to read for persons with ID, indicating that the conducted simplifications were not useful. Two studies have applied a set of (automatic) simplification operations and general easy to read guidelines on digital texts and showed that the modified texts increased reading comprehension for persons with ID (Fajardo et al. 2014; Karreman et al. 2007). But Fajardo (2014) questioned some of the guidelines for the design of easy to read material and emphasized the importance of further research.

Regarding dyslexia, some studies have examined which visual features, such as fonts and text size, that are preferred by individuals (see for example Rello et.al., (2012) and Begriplig text). Rello et.al. (2013), used different methods to show synonyms for this target group. The results showed that texts were more comprehensible when several synonyms were presented if the reader desired, as compared to versions where complex words were replaced with the most common synonym. Rello et al. (2013) examined eye movement and found that for persons with dyslexia, using more frequent words led to faster reading, while shorter words implicated better understanding.

On a more general level, different approaches to simplifications meeting different needs have been successful. Simplified text led to improved reading comprehension in second language learners, e.g. Gardner & Hansen (2007). However, it has been suggested that for this specific group, learning could be enhanced if the text is elaborated instead of shortened (Long & Ross, 1993). In addition, Caplan (1992) found that syntactic complexity such as passive voice influenced complicated reading understanding in aphasic readers. To sum up, the research on text simplifications on different target groups is at an early stage, and much experimental work is needed to examine the possibilities of the language technology and the aid it can be to individuals with reading disabilities.

Significance and scientific novelty

Although simplification of text is quite common in various contexts to customize for different types of readers, the procedures are done manually and are commonly not theory based (Wengelin, 2015). Only a few studies have examined factors that concern the linguistic form of the text such as word choice, sentence structure, and text binding and the effects of adaptation for different target groups (Carroll et al., 1998; Fajardo et al., 2013; Rello et al., 2013). Our study is an extension of these studies for several reasons. First, we take the perspective of the target group throughout, starting in theory, iterating adaptations and evaluating the results. Second, we take a holistic perspective on adaptations, whereas previous studies have examined types of simplifications separately. Third, we use text complexity measures to evaluate authentic texts and adapted texts. For these reasons the study has the potential to find adaptations that are more helpful for the target groups compared to previous initiatives. No studies of linguistic text adaptations have been done in Swedish, with the exception of Begriplig text where they did a survey on text comprehension. It was, however, not, as this project, a scientific study.

Our first study will show how text complexity is associated with reading difficulties in different groups which is important from an educational perspective. The description of the difficulties of the different types of readers will be more precise compared to the general account of cognitive and language deficits in the reading literature. We will learn more about the difficulties per se, for instance what specific grammatical features that cause problems for individuals with ID. In an educational setting such knowledge makes selection of reading materials easier and informs efforts to improve reading comprehension. Typical readers are included in the study so that we can compare their responses to text complexity and compare it to the responses of the poor readers. This contrast will show either that a) certain types of adaptations are helpful for all readers b) different cognitive and language deficits selectively impair reading such that different linguistic features are perceived as difficult. We expect that the second scenario will be true, but it has not been formally evaluated. We are examining if targeted text adaptations can compensate for depressed cognitive and language deficits completely or in part. Automatic text simplification techniques are potentially highly relevant to improve comprehension of text in poor readers. In this project, we want to explore this possibility with a combination of theory, behavioral assessment, and language technology.

Preliminary and previous results

The research on digital inclusion carried out in the group directed by professor Jönsson has resulted in a variety of techniques for making texts easier to understand through automatic text adaptation. This includes an automatic text summarizer (Smith & Jönsson, 2011a, b), syntactic- (Rennes & Jönsson, 2015) and lexical (Keskisärkkä & Jönsson, 2013; Johansson & Rennes, 2016) simplification, and a number of measures of text complexity (Falkenjack et.al., 13). The group also developed a web service of tools, TeCST.se, that integrated all these techniques and made them easily available for writers of text; writers who want to make texts easier to understand. Another web service, friendlyreader.se, is designed for end users that want to understand a text. All tools are available through a REST API (Fahlborg & Rennes, 2016).

These tools have been used by typical readers in the MASTER project, (Kanebrant et al., 2015). The MASTER project was directed by professor Jönsson, participating in this application. The overall aim was to test students' reading ability and automatically generate a reading profile in the form of a table showing his/her results concerning the three reading practices for texts of various degrees of linguistic difficulties in various subject areas. Based on the profile it should be able to choose texts that are more suitable for a student's reading ability. The language adaptation techniques have not been evaluated on atypical reading which we intend to do in this project.

Elwér has experience in test construction and writing questions that assess different reading skills. Elwér has been involved with development of the reading test LäSt (Elwér,

Fridolfsson, Samuelsson &, Wiklund, 2016). With the test LäSt, performance on decoding efficiency is measured using words and non-words. In addition, the test assess spelling and reading comprehension.

Project description

Theory and methods

The aims of the present study are to learn more about reading difficulties in relation to textual features and to determine if automatically adapted texts can improve reading comprehension. Our evaluation of the text adaptations rest upon two different theoretical frameworks. First, in a cognitive text-processing view (Kintsch & van Dijk, 1978; Perfetti 1985) failure to understand is caused by lack of knowledge of word meanings, of the topic or what information is relevant to use to make connections (Beck & McKeown, 1991). Looking at the text, certain features make it harder to make connections between pieces of information. References may be ambiguous, distant or indirect and these factors will influence how comprehensive the text is (Hua & Keenan, 2014). The text can also be more or less clear in signaling what appropriate knowledge base is needed to understand the text. Other features influencing perceived complexity are unclear connections between events and a high density of text ideas. Most of these features can be assessed and adapted to accommodate needs and wishes of the readers by automatic text adaptation techniques which we will use in this study. The other theoretical framework is Luke and Freebody's 4 resources model (1999), which in this study will be used when formulating questions to assure that comprehension at different complexity levels are assessed.

The project comprises two studies. Study 1 consists of assessment of the reading related abilities, textual preferences and reading comprehension in three groups: adolescents with intellectual disability, dyslexia and typical readers. Text adaptations will be evaluated based on an iterative procedure, to meet the needs of the different reader groups. In study 2, the text adaptations from study 1 will be evaluated.

Inclusion criteria in the poor reader groups will be 1) ability to decode simple words, 2) age 13–17, and 3) having one of the following diagnoses: ID or dyslexia. The control group will consist of adolescents in the same age group with no reported reading difficulty. One set of texts will be used for participants with dyslexia and typical readers and another set for participants with ID as these individuals typically read at levels comparable to grade 1–3 (Lemons et.al. 2013). We will use schoolbook texts dealing with different subject areas which are adapted for the age groups for typical readers and students with dyslexia. For students with ID we will use texts appropriate for their mental age. The same questions (on four levels) will be used to assess reading comprehension independently of which version of the text that is presented to the participants.

Study 1 Data collection and program development

In the first study, we will include several types of data collection (A–C) to determine how text complexity features relate to reading comprehension difficulties (research question 1) and to use this information to make text adaptations that are suitable for the different cognitive profiles.

A. Test of reading, cognitive and language skills.

Reading comprehension is influenced by many cognitive and language skills (Perfetti, 1985). Individual performance levels on some of these skills are useful information when trying to adapt texts for different needs, as skill level can be matched to different types and degree of adaptations. In this study we will include measures of decoding, grammar, vocabulary and working memory. Decoding will be assessed using the test LäSt (Elwér et al., 2016). This test will determine whether our participants are at a grade level 6 or lower, which is important information especially for poor reading groups. In addition, we will assess receptive vocabulary (Dunn & Dunn, 1997), grammatical understanding (Bishop, 1989), and working memory span test (Danielsson et al., 2016).

B. Questionnaires of text use and preferences.

We will also assess what type of texts that our participants read, their own description of what makes a text difficult and coping strategies to deal with difficult texts. These questionnaires will be done in writing or orally by the experimenter depending on the group. In addition, we will use a web questionnaire to examine textual preferences in syntax. Short segments of text will be presented in two versions one original text and one with a certain type of text adaptation. All adaptations will be done using the tools for text adaptation which ensures control and consistency. The participant will read both versions and determine which of the two texts he/she likes best and the strength of this preference. The aim of this last task is to determine what adaptations the participants find useful.

C. Tests of reading comprehension of adapted and authentic texts.

Reading comprehension performance will be assessed with texts and questions on four levels of complexity a) knowledge of the meaning of words in the text b) ability to retrieve explicitly stated information and make simple inferences c) ability to integrate and interpret information and d) ability to integrate ideas and evaluate content. Levels b–d are based on Luke and Freebody's (1999) theoretical framework (for a similar procedure see Kanebrant et al., (2015)). The results will show reading profiles of the participants, i.e. at what level of comprehension the participant performs on a text of a certain degree of difficulty. The participants will read 9 texts about different topics. Each text will be available in three versions: the original text, a text with minor adaptations, a text with major adaptations. Each participant will read a text in one version only and answer questions. The texts will be balanced so that each participant read texts on all three levels.

Analysis

In this study we will test individuals in an iterative manner such that 10 participants in each group are tested in each cycle. We will assess a) reading, cognitive and language skills b) information about use and preferences and c) reading comprehension of adapted and authentic texts. The adaptations (c) used in the first cycle will be *theory based*. From previous studies of cognitive and language skills of our groups along with previous studies of adaptations, we will make educated guesses of how to adapt the texts. Mapping the cognitive abilities to actual adaptations in texts is an important aspect of this study. The adaptations will also be highly controlled as they are done by the language technology tools and not humans.

In cycles 2–3, we will use knowledge from previous testing cycles to improve the adaptations to be more responsive to the needs and preferences of the different types of readers. For each new text, we also assess its complexity. On a variety of dimensions as calculated using the text complexity tool. This procedure will determine if the adaptations lead to better understanding and, to calibrate the extent of adaptation needed. The iteration will end after the third round of testing. At this stage, we have reached a new set of adaptations for each group which gives us a *test-based version*.

Study 2 Evaluation of text adaptations

In this second study we examine if automatic text adaptations based on group characteristics and preferences improve levels of reading comprehension in adolescents with ID, dyslexia and typical readers (research question 2). We will use three different levels of text adaptations 1) authentic texts with no adaptations 2) theory-based adapted versions and 3) test-based adapted versions. 50 individuals per group will read these different types of texts (balanced across individuals) and we will assess comprehension by letting the individuals answer questions on the four complexity levels.

Analysis

Research question 2 will be answered using 3 analyses of variance, one for each group. Within group factors will be type of texts (authentic with no adaptations, theory-based adaptations, test-based adaptations) and question complexity type (a–d). This analysis will determine if the adaptations improved reading comprehension performance with questions at the different complexity levels. Study 2 will be conducted in an Open science way following "A Practical Guide for Transparency in Psychological Science" (Klein et al., 2018). This will

include publication of an anonymized dataset, analysis code, pre-registration of hypotheses, and analysis plan.

Time plan and implementation

During 2021, January–March we will write an ethics application and submit it to the ethics committee. This will be jointly done by Elwér, Jönsson and Rennes. The materials used in the project consist of schoolbook texts used in grades 7–10, or 1–3 in the case of participants with ID. Finding texts and constructing the questions will be done January–June by Elwér and Rennes. Once identified, the texts and questions need to be tested on typically developing children. Selection of texts, formulation of questions and pilot work will be done the fall of 2021 with all project members. In addition, meetings with different stakeholders will take place, to get knowledge on how to organize testing with their focus groups.

During 2022 study 1 will take place. In study 1 we will conduct studies on reading abilities and preferences of the groups. These will be conducted by Elwér and Rennes. This involves contacting schools which have possible participants. The researchers have networks which involve teachers working in special education and we also intend to ask stakeholders to help recruiting participants. We will work on one group at a time and our estimate is that each group will take about 4 months, including 3 cycles of testing with program development between cycles. In parallel with user testing, Rennes and Jönsson will refine the techniques for automatic adaptation. This will not be conducted as a separate activity, instead it will be an integral part of user testing where we will test the models for adaptation on the user groups. In this project we will only use the adapted texts produced by the tools. The tools will not be used by the users.

Study 2 will take place during 2023 and the first half of 2024. At this stage we will have texts and batteries of questions which have been identified and created in study 1. However, it is likely that we need to identify some new texts and write questions before starting study 2. Fifty participants per group will be tested. This study, will be jointly organized with all applicants, taking responsibility as in the first study. We will use students in special education and cognitive science to help with data collection.

The second part of 2024 and January–March of 2025 will be used for analysis, writing of research articles and presenting the results. The results of the studies will lead to further knowledge on reading abilities amongst the user groups and refined techniques that handles the special requirements of the user groups as well as effects of adapted texts on reading comprehension. We expect to publish several articles which concern cognitive and language profiles of groups and on tools for text adaptation. One article will present results on which adaptation techniques that help the various user groups. Another article concerns the relation between the text complexity measures and the user groups. Three articles will concern in-depth descriptions of text complexity measures associated with reading difficulties in our three groups respectively. At least one article will describe effects of the text adaptations on reading comprehension in the three groups.

Project organization

The main applicant, Åsa Elwér, is lecturer in education at Linköping University. She wrote her PhD thesis on reading comprehension and has expertise in different types of reading problems, their causes and their consequences. In her research she has focused on reading comprehension difficulties in children with and without adequate decoding in the ages 5–13 years of age. This includes children with dyslexia or specific comprehension deficits. Underlying cognitive and language skills of these readers in the beginning school years have been the focus of this research. Elwér is currently involved in a large-scale project examining reading abilities in adolescents with ID. Elwér is in the project responsible for issues on test of language and reading, readability and how to assess group and individual readability of simplified texts. She is also coordinating the whole project.

Co-applicant Arne Jönsson is professor in computer science at Linköping University and has for more than ten years conducted research on various aspects of means to increase

digital inclusion. He has published research articles and organized workshops on the subject. Results of the research include tools for the use of language technology to summarize and simplify texts, publicly available. He was also involved in the development of an infrastructure to conduct readability studies. Jönsson is responsible for all software development to refine the text simplification techniques.

The project will also include a PhD student (and future post doc), Evelina Rennes, having a background in cognitive science that comprises both the ability to conduct empirical investigations and customize the adaptations. During her time as a PhD student, she has focused on techniques for automatic text adaptation, with a special interest in adapting the text to specific target audiences. She has also been a part of several projects aiming at the adaptation of text for both readers and writers, where she has had the main responsibility for the text simplification modules.

In summary, the research group has experience on all the relevant theoretical aspects including theory about reading and reading difficulties, cognitive skills of individuals with intellectual disability and language technology. In addition, the research team also have experience of the methodological aspects such as conducting studies involving persons with intellectual disabilities, analyze results on readability, running statistical analyses and developing software techniques to automatically adapt texts in various ways. Elwér will continuously coordinate the project to monitor progress and coordinate deviations. The researchers already have close contacts, so this mainly includes external stakeholders and collaborating researchers. Public and popular dissemination of results will be carried out with all three applicants depending on activity. Elwér will be responsible for activities related to reading skills, whereas Jönsson and Rennes handles activities related to language technology.

Equipment

The equipment available to the researchers at present is sufficient for the project.

Need for research infrastructure

We will utilize the resources at Nationella språkbanken and Swe-CLARIN.

International and national collaboration

Åsa Elwér has collaborations regarding reading research with Stefan Samuelsson, Linköping University, Brian Byrne University of New England Australia, Richard Olson at the University of Colorado, Boulder, Janice Keenan at the University of Denver and Bjarte Furnes University of Bergen. Regarding reading in individuals with ID, she collaborates with Henrik Danielsson, (Linköping university), Lucy Henry (City University, London) and David Messer (Open university, London).

Arne Jönsson is director of the Linköping branch of the VR funded infrastructure SWE-CLARIN, the Common Language Resources and Technology Infrastructure. SWE-CLARIN is part of the CLARIN infrastructure which is fully operational in many countries, and many participating centers are offering access services and experiences to data, tools and expertise in form of databanks, workshops and conferences. The project's language technology analyses will profit from the expertise of the network. Jönsson is a member of the scientific advisory board of MTM.

Other applications or grants

Elwér is currently working in two projects funded by VR (2019-03873) which is a study of reading and math intervention in early school age and VR (2016-0421) which is a study of reading abilities in adolescents with intellectual disability. The project presented here is independent from those two projects.

Reference list for project description

Chandrasekar, R., Doran, C., & Srinivas, B. (1996), Motivations and methods for text simplification. *In Proceedings of the 16th International Conference on Computational Linguistics* (COLING '96), pages 1041–1044

Chandrasekar, R., & Srinivas, B. (1997) Automatic induction of rules for text simplification. *Knowledge-Based Systems* 10(3), 183–190.

Danielsson, H., Henry, L., Messer, D., & Rönnberg, J. (2012). Strengths and weaknesses in executive functioning in children with intellectual disability. *Developmental Disabilities*, 33, 600–607.

Danielsson, H., Henry, L., Messer, D., Carney, D. P. J., & Rönnberg, J. (2016). Research in Developmental Disabilities Developmental delays in phonological recoding among children and adolescents with Down syndrome and Williams syndrome. *Research in Developmental Disabilities*, *55*, 64–76.

Danielsson, H., Henry, L., Rönnberg, J., & Nilsson, L.-G. (2010). Executive functions in individuals with intellectual disability. *Research in Developmental Disabilities*, 31(6), 1299–1304.

Elwér, Å., Keenan, J. M., Olson, R. K., Byrne, B., & Samuelsson, S. (2013). Longitudinal stability and predictors of poor oral comprehenders and poor decoders. *Journal of Experimental Child Psychology*, 115(3), 497–516.

Elwér, Åsa, Fridolfsson, I., Samuelsson, S., & Wiklund, C. (2016). *Läst-test i läsförståelse, läsning och stavning för årskurs 1–6*. Stockholm: Hogrefe.

Fahlborg, D., & Rennes, E. Introducing SAPIS - an API service for text analysis and simplification, *The second national Swe-Clarin workshop: Research collaborations for the digital age,* Umeå, Sweden, 2016

Fajardo, I., Avila, V., Ferrer, A., Tavares, G., Gomez, M., & Hernandez, A. (2014). Easy-to-read texts for students with intellectual disability: Linguistic factors affecting comprehension. *Journal of Applied Research in Intellectual Disabilities*, 27.

Falkenjack, J., Rennes, E., Fahlborg, D., Johansson, V., & Jönsson, A., (2017) Services for text simplification and analysis, *Proceedings of the 21st Nordic Conference on Computational Linguistics, NoDaLiDa*, Gothenburg, Sweden (No. 131, pp. 309-313). Linköping University Electronic Press

Falkenjack, J., Heimann Mühlenbock, K., & Jönsson, A. (2013). Features indicating readabilityin Swedish text. In *Proceedings of the 19th Nordic Conference of Computational Linguistics(NoDaLiDa-2013*), Oslo, Norway (pp. 27–40).

Gardner, D., & Hansen, E. C. (2007). Effects of Lexical Simplification During Unaided Reading of English Informational Texts, *TESL Reporter,* 40(2), 27-59

Guthrie, J. T., Klauda, S. L., & Ho, A. N. (2013). Modeling the relationships among reading instruction, motivation, engagement and achievement for adolescents. *Reading Research Quarterly*, 48, 9–26.

Guthrie, J. T., Wigfield, A., Barbosa, P., Perencevich, K. C., Taboada, A., Davis, M. H., … Tonks, S. (2004). Increasing Reading Comprehension and Engagement Through Concept-Oriented Reading Instruction. *Journal of Educational Psychology*, 96(3), 403–423

Hua, A., & Keenan, J. (2014). The role of text memory in inferencing and in comprehension deficits. *Scientific Studies of Reading*, 18(6), 415–431.

Johansson, V., & Rennes, E. (2016). Automatic extraction of synonyms from an easy-to-readcorpus. In *Proceedings of the Sixth Swedish Language Technology Conference (SLTC-16), Umeå*, Sweden.

Kanebrant, E., Heimann Mühlenbock, K., Johansson Kokkinakis, S., Jönsson, A., Liberg, C., af Geijerstam, Å., Wiksten Folkeryd, J., & Falkenjack, J., T-MASTER -- A tool for assessing students' reading abilities, *Proceedings of the 7th International Conference on Computer Supported Education (CSEDU 2015),* Lisbon, Portugal, 2015.

Karreman, J., Van Der Geest, T., & Buursink, E. (2007). Accessible website content guidelines for users with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities,* 20(6):510–518.

Keskisärkkä, R., & Jönsson, A. (2013). Investigations of Synonym Replacement for Swedish. *Northern European Journal of Language Technology*, 3(3), 41–59

Kintsch, Walter, & Dijk, T. A. van. (1978). Toward a model of text comprehension and production. *Psychological Review*, 85, 363–394.

Klein, O., Hardwicke, T. E., Aust, F., Breuer, J., Danielsson, H., Hofelich Mohr, A., … Frank, M. C. (2018). A Practical Guide for Transparency in Psychological Science. Collabra: *Psychology*, 4(1), 20.

Lemons, C. J., Zigmond, N., Kloo, A. M., Hill, D. R., Mrachko, A. a., Paterra, M. F., … Davis, S. M. (2013). Performance of students with significant cognitive disabilities on early-grade curriculum-based measures of word and passage reading fluency. *Exceptional Children*, 79(4), 408–426.

Long, M. H., & Ross, S. (1993). *Modifications that preserve language and content*. Technical report, ERIC.

Luke, A., & Freebody, P. (1999). Further notes on the four resources model. Readingonline.Org, 8. Retrieved from papers://8823b2b3-0f26-4eac-b58e-76a95997f0e0/Paper/p122

Lundberg, I. & Reichenberg, M. (2008). *Vad är lättläst?* Härnösand: Specialpedagogiska skolmyndigheten.

Morgan, M. F. & Moni, K. B. (2008). Meeting the challenge of limited literacy resources for adolescents and adults with intellectual disabilities. *British Journal of Special Education*, 35(2):91–101.

Perfetti, C. (1985). *Reading ability*. New York: Oxford University Press.

Perfetti, C. (2007). Lexical Quality to Comprehension Reading Ability: Lexical Quality to Comprehension. *Scientific Studies of Reading*, 11(4), 37–41.

Rello, L., Baeza-Yates, R., Bott, S., & Saggion, H. (2013). Simplify or help? Text simplification strategies for people with dyslexia. *W4A 2013 - International Cross-Disciplinary Conference on Web Accessibility.*

Rello, L., Kanvinde, G., & Baeza-Yates, R. (2012). Layout guidelines for web text and a web service to improve accessibility for dyslexics*. W4A 2012 - International Cross-Disciplinary Conference on Web Accessibility.*

Rennes, E., & Jönsson, A.: A tool for automatic simplification of Swedish texts, In: *Proceedings of the 20th Nordic Conference of Computational Linguistics (NoDaLiDa2015)*, Vilnius, Lithuania (2015)

Smith, C., & Jönsson, A. (2011a). Automatic Summarization As Means Of Simplifying Texts, An Evaluation For Swedish. In *Proceedings of the 18th Nordic Conference of Computational Linguistics (NoDaLiDa-2010),* Riga, Latvia.

Smith, C. & Jönsson, A.(2011b). Enhancing extraction based summarization with outside word space, *Proceedings of the 5th International Joint Conference on Natural Language Processing (IJCNLP)*, Chiang Mai, Thailand, 2011.

Lucia Specia. (2010). Translating from Complex to Simplified Sentences. *In Proceedings of the 9th international conference on Computational Processing of the Portuguese Language (PROPOR*), pages 30–39.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J., & Scanlon, D. M. (2004). Specific reading disability (dyslexia): what have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 45(1), 2–40.

Wei Xu, Courtney Napoles, Ellie Pavlick, Quanze Chen, & Chris Callison-Burch. (2016). Optimizing statistical machine translation for text simplification. *Transactions of the Association for Computational Linguistics*, 4:401–415.