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Improving Reading Fluency: A Literature Review and an Empirical Study

Forbedring av leseflyt: En litteraturgjennomgang og en empirisk studie

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Approval Sheet

Supervisor recommends that the present master thesis is handed in for evaluation by the examination committee.

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Clarification of individual contribution in Article 2

Article 2 of the master thesis was executed in cooperation with Hildur Valdimarsdottir Both of us searched and gathered references and based on our findings from the literature we designed the intervention together. We contributed equally in implementation of all the phases of the study, i.e. the sessions for each participant were divided evenly between us. In addition, we split reliability and procedural integrity measures between us.

Finally, we processed the results, made the graphs, and wrote the whole manuscript of Article 2 in tight and complete cooperation.

Lilja Yr Halldorsdottir

Hildur Valdimarsdottir

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Abstract

In a modern society it is important to know how to read since reading is an essential part of almost every aspect of daily life. Despite increased literacy in Western Europe the last decades many children never become fluent readers. Article 1 starts with a brief introduction of the concept of reading fluency and an explanation of two theories of the establishment of fluent reading. The main purpose is to account for different forms of oral repeated reading (RR) interventions, both in traditional reading literature and in behavior analysis, and discuss their effects on reading fluency with regard to evidence-based practice (EBP). Besides, it is accounted for quality indicators and standards to identify EBP. Directions for future researches with respect to EBP are discussed. The purpose of the study reported in Article 2, was to implement a high quality study based on quality indicators, proposed by Horner et al. (2005)[1], by using a delayed multiple probe design across participants to evaluate the effects of a multicomponent intervention on reading fluency in three adult Norwegian slow reading students. Ten passages were trained during the intervention which consisted of a reading support, performance criterion, response prompts, RR, performance feedback, and error correction. The procedure was based on a study by Lokke, Lokke, and Arntzen (2009)[2]. Following the intervention, baseline passages were represented to evaluate generalization to untrained passages. Besides, other reading aspects were tested to evaluate learning outcomes of fluent performance. The main findings indicate that reading fluency of all the participants improved following the intervention. Results are discussed with regard to social validity, limitations of conducting a multicomponent intervention, and with respect to quality indicators for within-subject experimenters proposed by Horner et al. (2005)[2].

Key words: Evidence-based practice, multicomponent, multiple probe design, quality indicators, reading fluency, repeated reading, RESAA, stimulus control.

[1] Horner, R.H., Carr, E.G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165-179. Retrieved from www.cec.sped.org

[2] Lokke, G.E.H., Lokke, J.A., & Arntzen, E. (2009). Bruk av hurtiglesingsteknikker for å øke lesehastighet hos gutt med kognitiv svikt og reaktiv tilknytningsforstyrrelse. *Norsk Tidsskrift for Atferdsanalyse, 36* (4), 231-240. Retrieved from www.nta.atferd.no

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Repeated Reading Interventions and Evidence-Based Practice

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Abstract

In a modern society knowing how to read is important for many different situations. Even though most children in Western Europe nowadays learn to read in elementary school many of them never become fluent readers preventing them from having practical use of their reading. The purpose of the present article is to account for different forms of oral repeated reading interventions, both in traditional reading literature and in behavior analysis, and discuss their effects on reading fluency with respect to evidence-based practice based on existing research base. I will start with a brief introduction of the concept of reading fluency, which has been rather drifted in the reading literature. Then, two different theoretical explanations of the establishment of fluent reading will be explained. Following an account of oral repeated reading interventions and a discussion of their effects on reading fluency it will be accounted for quality indicators and standards to identify evidence-based practice. Directions for future researches with respect to evidence-based practice will be discussed.

Key words: Behavior analysis, cognitive psychology, evidence-based practice, quality indicators, reading fluency, repeated reading, stimulus control

Repeated Reading Interventions and Evidence-Based Practice

Knowing how to read is important for many aspects of daily life and as such reading studies have been a central area in behavior analysis, as in other educational practices, for prolonged time. Already in 1971, Sidman described different types of stimulus-response relations involved in reading acquisition and reported a stimulus equivalence account to teach reading. Nowadays, most children in Western Europe learn to read in elementary school; however, not nearly all become fluent readers. A non-fluent reader might have trouble with comprehending what he reads which interrupts job and school work and can result in misunderstanding of important complex texts such as job advertisements, manuals, and medicine instructions.

Almost 30 years ago, Allington (1983) referred to *reading fluency* as the neglected goal of reading. However, as from the publication of a report by the National Reading Panel (NRP) the year 2000 (NICHD, 2000) reading fluency has gained much attention. The NRP considered reading fluency a critical factor in reading instructions and recommended it should be evaluated on regular basis in the classroom. Two years later, the U.S Department of Education (2003) set an American federal law, called *No Child Left Behind Act*, in which reading fluency instructions were stated as one of five skills children should be taught in reading instructions in USA.

Despite increased attention on reading fluency there has not been unanimous consensus amongst reading practitioners about how to define the concept. Most agree that fluent reading includes fast and accurate reading (e.g., Binder, 1988; Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004;Chard, Vaughn, & Tyler, 2002; Samuels, 1979; Shinn, Good, Knutson, Tilly, & Collins, 1992; Torgesen, Rashotte, & Alexander, 2001) and oral reading rate of 150–250 words read correctly per minute with no more than 2 errors is typically said to define fluent reading (Kubina & Starlin, 2003). In addition, it is a general consensus that

fluent reading is characterized by being effortless, without hesitation, and contributes to the ultimate goal of reading; comprehension of the written text (e.g., Chard et al., 2002; NICHD, 2000; Kuhn & Stahl, 2003; Samuels, 1979; Schreiber, 1980). Furthermore, some add prosody/expression to the definition (e.g., Hudson, Lane, & Pullen, 2005; Kuhn & Stahl, 2003) and still others require special learning outcomes to be connected to fast and accurate reading to define it as fluent (Binder, 1996; Johnson & Layng, 1996).

Results of studies that have investigated correlation between reading fluency and comprehension have been indecisive. Some studies have revealed positive correlation such that following improvements in reading fluency the readers also showed improvements on comprehension tests (e.g., Lokke, Lokke, & Arntzen, 2009; Polk & Miller, 1994; Shinn et al., 1992; Sindelar, Monda, & O'Shea, 1990), while others have not resulted in increased comprehension following improved reading fluency (e.g., Levy, Abello, & Lysynchuk, 1997; Valleley & Shriver, 2003). Besides, in some studies changes in comprehension following reading fluency improvements have not been examined (e.g., Ardoin, Eckert, & Cole, 2008; Gortmaker, Daly, McCurdy, Persampieri, & Hergenrader, 2007; Malanga, 2003). The problem with most studies that have investigated correlation between reading fluency and comprehension is that comprehension has been considered a cognitive process that is neither observable nor countable and consequently have been measured indirectly, for example with questions from the text read or the reader reports the content of the text he read.

Prosody/expression and “effortless reading” are also problematic for measurement where those factors are not countable and can only be measured subjectively. However, this does not apply to speed and accuracy which can be measured objectively. Even though reading fluency may be characterized by more factors than speed and accuracy, those seem to be the only empirically valid components of the construct which has been an argument for defining it solely in terms of speed and accuracy when studying it (Torgesen et al., 2001). As a result,

when building reading fluency most experimenters measure the construct in terms of speed and accuracy by recording rate of words read correctly and number of errors (e.g., Chafouleas, et al., 2004; Lokke et al., 2009; Samuels, 1979; Shinn et al., 1992). Other characteristics of fluency can then be observed following increases in accurate reading speed.

The operational definition of reading fluency is not the only factor that has been drifting in the reading literature; different theoretical explanations have also been proposed to explain how fluent reading is established (e.g., Adams, 1990; LaBerge & Samuels, 1974; Schreiber, 1980; Skinner, 1957). Besides, it has been controversial what instructional approaches are best suitable when attempting to build reading fluency. In many countries there has been increased emphasis on using educational methods in schools that have been demonstrated scientifically to be effective and as such the choice of instructional approaches is important. In USA, it is for example legislated that instructional methods used in American schools shall be evidence-based (U.S. Department of Education et al., 2003). In psychology, the term *evidence-based practice* (EBP) is defined as "the integration of the best available research with clinical expertise in the context of patient characteristics, culture, and preferences" (American Psychological Association, 2006, p. 273) and the purpose of the movement is to encourage the use of empirically supported principles demonstrated with researches in the fields and thereby contribute to increased public health. As a contribution to EBP, many divisions within the American Psychological Association have established own task forces to identify treatments/interventions/assessments in their practice that are empirically supported and developed coding manuals for the same purpose, for example Division 12 in clinical psychology (American Psychological Association, 2006), Division 29 in psychotherapy (Norcross, 2001), and Division 16 in school psychology (Kratocwhill, 2007). *Oral repeated reading (RR) interventions* are often cited instructional practices intended to improve reading fluency and to many practitioners the practice is widely thought of as an evidence-based

(Chard, Ketterlin-Geller, Baker, Doabler, & Apichatabutra, 2009). Mutual to RR methods are out loud repeated readings of words or passages and some kind of feedback from a teacher or other literate person who guides the reading. The same passage/word list is read repeatedly either until predetermined performance criterion is reached or for fixed number of times (NICHD, 2000). RR interventions to improve reading fluency have been implemented in various forms both in traditional reading literature such as mainstream psychology, pedagogy, and special education (e.g., Chomsky, 1976; Samuels, 1979; Simmons, Fuchs, Fuchs, Mathes, & Hodge, 1995; Topping, 2006) and in behavior analysis (e.g., Ardoin et al., 2008; Hofstadter-Duke & Daly, 2011; Lokke et al., 2009; Malanga, 2003).

The purpose of the present article is to account for different forms of oral RR interventions and discuss the findings of existing reading literature about the effects of the practice on reading fluency with regard to EBP. I will start with a brief introduction of two different theoretical explanations of the establishment of fluent reading; a cognitive explanation called the *automaticity theory* and a behavior analytical explanation. Then, I will account for the origin of oral RR interventions and various other forms of the practice, both in traditional reading literature and in behavior analysis. At least one relevant study of each variant will be elaborated along with a brief review of the overall research base of RR studies to improve reading fluency. Directions for future researches, in an attempt to contribute to EBP in the field of reading fluency building, will be proposed.

Theoretical Explanations of Reading

Traditional View – Automaticity Theory

Automaticity theory (LaBerge & Samuels, 1974) is an example of a cognitive model of information processing in reading which describes the difference between non-fluent and fluent reading. According to the theory, three processes are involved in reading; *decoding*, *comprehension*, and *attention*. Decoding is when a reader sounds out the words of a written

text and comprehension refers to the cognitive process of constructing meaning from the decoded text. To implement both of these processes the reader needs attention, referring to cognitive energy that the reader possesses in limited amount. If much attention is required to decode the written words, little attention is left for comprehension. In the automaticity theory, the establishment of fluent reading is divided in three cognitive processing stages which the written words are transformed through before the reader reaches the ultimate goal of reading; comprehension of the written words. On the *non-accurate stage* the reader has much trouble with decoding and in fact the unit of visual recognition is smaller than words. As such, beginning readers decode units which include no meaning. The second stage is called the *accuracy stage* referring to that the reader is capable of accurate decoding of words but his reading is still slow, hesitant, and without expression. Even though the reader is more skilled than one on non-accurate stage he is still non-fluent and needs to attend to own decoding of the text which leaves less space for comprehension. The last stage, *the automatic stage,* is characterized by fast and accurate reading with expression and the reader is capable of decoding the printed words automatically or without attention. A reader on automatic stage is said to read fluently and is capable of using his attention to comprehend what he is reading since decoding is automatic (LaBerge & Samuels, 1974; Samuels, 1979, 2002).

Behavior Analytical View

From behavior analytical perspective, reading also involves more than pronouncing written words. Skinner (1957) defined *textual behavior* as a vocal response controlled by corresponding non-auditory verbal stimulus such as written words, symbols, or signs. Even though there is not a formal similarity between the controlling stimulus and the response produced (i.e., they do not share the same sense mode and are physically unlike; one is vocal and the other is non-auditory) there is a point-to-point relationship between them referring to that the beginning, middle, and the end of the variables matches (Sundberg, 2007). In textual

behavior, the *stimulus control* of the non-auditory verbal stimulus over the vocal response is established by *differential reinforcement*; in the presence of a particular non-auditory verbal stimulus, for example *cat*, generalized conditioned reinforcers, such as attention or praise, are delivered by another person than the reader contingent on corresponding vocal response, here "cat" – other responses are on extinction (Skinner, 1957). From behavioral analytical point of view this is what happens when a person is learning to read, however, textual behavior is without understanding and corresponds to above mentioned term decoding so something more is needed. According to Skinner, a reader is a person that speaks under control of a text and his reactions to own textual behavior as a listener are described as *understanding*. For example, when a reader utters "run" consequent on the written stimuli *run* his utterance is a textual behavior, but actually running in response of the utterance is an indicator of reading with understanding. In behavior analysis, the third variable of the automaticity theory, attention, is also treated as behavior. Catania (2007) described attention as discriminative responding to a stimulus as a result of some particular properties of the stimulus; in the case of reading with comprehension the semantic properties of the non-auditory verbal stimuli affect the reader more than other properties of the stimuli, such as font, size, or how to combine and pronounce them. For people to become fluent readers who comprehend what they read, the reader must respond to the semantic properties of the text, the relationship between the target non-auditory stimulus (*cat*) and the corresponding vocal response ("cat") must compete with other responses (e.g., "cot", "catch" etc.), and the reader must be capable of reacting to own vocal response simultaneously. Sidman (1971) argued for three different stimulus-response relations involved in reading and one of them was *visual-visual word to object/object to word matching* referring to matching a printed word to a comparable picture and vice versa. Such *conditional discrimination* procedure can be used to test out elementary reading comprehension; an example is if showing a child the printed word *car* results in that

the child points to a picture of a car out of several different pictures, the child is reacting to own textual behavior and can be said to comprehend the printed word car. However, Sidman and Tailby (1982) underlined that mere conditional relations between the visual-visual stimuli are not enough; the child pointing to the car only indicates comprehension if the word car and the picture of a car are related by equivalence. In reading instructions, it is not only aimed at reading to become fluent in the sense of being such fast and accurate that it contributes to reading comprehension; it is also aimed at reading becoming automatically reinforced referring to that reading per se produces reinforcer. However, even though automatic reinforcement increases the probability of increased reading in the future, it cannot differentially reinforce correct reading, another person than the reader must deliver reinforcers contingent on correct reading for that to happen (Skinner, 1957). The establishment of automatic reinforcement of reading demands that the reader must attend to the semantic properties of the text, which again demands reading fast and accurately enough. As such, fluent reading is a prerequisite for reading to become automatically reinforced (Lokke et al., 2009).

Summary of Theoretical Explanations of Reading

In the automaticity theory, non-fluent reading is explained in terms of limited quantity of cognitive energy (attention) left for comprehension because so much of it is needed for decoding the words. A fluent reader, on the other hand, is capable of decoding and comprehending simultaneously since his reading is so fast and accurate that no attention is needed for decoding. However, a behavior analytical explanation is in terms of poor stimulus control of the text over the textual behavior of the reader. In other words, the rate of accurate reading of a non-fluent reader is low because the arrangement of the letters that make up the words and the sentences in the written text do not function as discriminative stimuli and thus

the reader's response must compete with other possible (incorrect) responses (E. J. Daly, Martens, Hamler, Dool, & Eckert, 1999).

As such, the different views of causation refer to the cognitivist using internal events, that is, attention in the form of cognitive energy, to explain changes in reading, versus the behavior analyst using environmental explanation where the changes in reading are controlled by the written stimuli because of history of differential reinforcement.

Oral Repeated Reading Interventions to Improve Reading Fluency

Traditional Reading Literature

In mainstream psychology, special education, and other traditional reading literature, oral repeated reading interventions include approaches such as the original *method of repeated readings (Samuels, 1979),* various *assisted reading* approaches (e.g., Carbo, 1978; Chomsky, 1976), and different types of *tutor-based reading* interventions (e.g., Simmons et al., 1995; Topping, 2006).

The method of repeated readings. The basic method of repeated readings, which most other RR interventions are rooted in, was developed by Samuels (1979) with theoretical basis in the automaticity theory of LaBerge and Samuels (1974). The method involves that a text of interest for the reader is divided into many, equally long passages. The reader reads aloud the first passage to a literate person who times the reading, marks errors simultaneously, and records rate of words read correctly and errors on a graph following the reading. This procedure is repeated with the same passage until the reader reaches predetermined performance criterion of words read correctly per minute and then the next passage is introduced with the same procedure. According to Samuels (1979), overemphasizing correct reading tends to prevent speed and thus he emphasized speed above accuracy even though accuracy was also measured.

When developing his method, Samuels (1979) tried it out on children with reading difficulties. Each of them chose a story to practice on. The stories were divided into passages of 50–200 words, depending on the reading level of each student. The students trained reading with the method of RRs and the performance criterion of 85 words per minute. The results for all the students were that each rereading of a passage was faster and more accurate. Besides, the first reading of each new passage was faster than the first reading of the previous passage, indicating generalization effects. This first study by Samuels was without control group and a *non-experimental* design, in which the effects of the intervention were compared to baseline data, was used to evaluate the effects. In spite of this limitation, the results were promising for future researches in the reading field.

Samuels described his method and reported his findings in an article published in the Reading Teacher in 1979 and reissued in 1997 as a classic study in reading. Following the first publication a new emphasis initiated in the reading field where repetition or practice was underlined; a hallmark of the original method and the basis for newer versions. Since then, many studies on Samuels' original method, and other varied forms of it, have been published and most of them have indicated improvements in reading fluency, and sometimes comprehension, following the interventions (Dowhower, 1997).

Assisted reading. Assisted readings are RR interventions rooted in an old reading approach by Heckelman (1969), called *neurological impress* (NI), which involves choral reading of a student and a teacher (no repetitions). The theoretical basis behind NI is cognitive and involves the reader learning through multiple sense-organs and the words read are said to be impressed into the brain of the reader. As in other oral RR interventions, performance criterion or fixed number of readings along with feedback from a literate person, are used in assisted reading methods. Besides, the reader has a fluent reading model to follow such as in NI (NICHD, 2000).

The most common form of assisted reading is called *reading while listening* or *tape-recording reading*, involving that the reader listens to a tape-recording of fluent reading of the passage simultaneously as he reads it by himself (e.g., Carbo, 1978; Chomsky, 1976). As an example, Chomsky used reading while listening on five third grade normal developing slow-reading students. Each child chose a tape-recorded story, ranging from second to fifth grade level, to practice on. The children were supposed to listen to the whole story once a day while reading it simultaneously. Besides, they chose part of the story to practice more attentively. Once a week, Chomsky monitored the progress of each child. One of the students reached the fluency criterion for the first story within 14 days, while the others needed approximately a month. The training kept on for three months and all the children needed less and less time to reach their fluency criteria. However, afterwards there was no special transfer gain; the children did not progress significantly on other reading material than used in the training. Another limitation is the lack of control group and the use of non-experimental design to evaluate data which makes it difficult to infer about *experimental control*, meaning that it is difficult to rule out confounding variables and infer about functional relationship between the intervention and changes in fluency. Despite, the study was socially valid; both the children and their parents reported a significant increase in reading interest — the children that previously never wanted to read were now picking up books voluntarily (Chomsky, 1976). Indeed, Chomsky was designing her reading while listening approach at the same time as Samuels was designing his method of RR without neither of them knowing about each other's developments until later on and thus Samuels cited her as "the other developer of repeated reading" (Samuels, 2002, p. 177).

Tutor-based reading. Tutor-based readings are RR methods in which more able readers help less able readers to improve reading, examples are *paired reading* (Topping, 2006) and *peer-tutoring* (Simmons et al., 1995).

In paired reading the child selects the reading material as an attempt to increase motivation for reading. The child reads the text chorally with his parent or another literate person which serves as a tutor. If making an error, the tutor reads the incorrectly read word correctly and the child repeats the correction. If the child makes no error for a while the tutor stops reading along such that the child reads alone until another error is made, then the same error correction procedure is repeated and the child and the tutor reads chorally again. Praise is delivered contingent on correct reading (Topping, 2006). According to Topping, the idea behind paired reading is that the tutor serves as a reading model and gives continuous prompt when the child is reading correctly whilst the child also practices independent reading. A review by Topping in 1995 (as cited in Topping, 2006) of the impact of paired reading on reading performance revealed uncertain results regarding fluency where some studies displayed improved reading fluency following paired reading while other resulted in no changes. However, the results for accuracy and comprehension were more promising.

In peer-tutoring, the dysfluent reader is instructed by a fluent reading peer, for example a classmate or a friend of the same age. Typical instructional components of peer-tutoring involve short repeated timings of reading, counting rate of words read correctly and errors, providing corrective feedback following errors, graph the performance and reinforce correct reading. Besides, the whole procedure is executed by a peer but not by an adult (Simmons et al., 1995). In a study by Simmons, a group of students scored significantly higher on reading fluency and comprehension tests after receiving peer-tutoring than two control groups receiving explicit teaching and traditional reading instruction, whereas no significant difference were between the control groups.

Behavior Analysis

Precision teaching (PT) is a behavior analytical practice in which reading fluency has been much studied and a typical PT approach resembles RR in many aspects. Besides PT,

behavioral analytical efforts to build reading fluency can be divided in two categories; procedures based on 1) manipulation of antecedents and 2) consequence arrangements (Eckert, Ardoin, Daly, & Martens, 2002).

Precision teaching. PT is a practice that consists in systematic methods to evaluate the effects of instructional strategies on students' performance and to base instructional decisions on (West, Young, & Spooner, 1990). The origin of PT is rooted back to 1965 when Ogden R. Lindsley took two of Skinner's major contributions to behavior analysis, the *cumulative recorder* and *rate* of responses, out of the laboratory and brought them into the classroom (Lindsley, 1992). The cumulative recorder was the base for the *Standard Celeration Chart* (SCC) (for detailed description of SCC see e.g., Calkin, 2005) which is one of the cornerstones of PT. Besides, Lindsley added speed to the traditional accuracy-based mastery criterion in instructions, claiming that rate of performance is what discriminates between beginners and fluent performers. For example, two children who solve equally many math examples with 100 % accuracy cannot be considered equally fluent in math if one of them uses two hours to solve the examples but the other one 20 min; this difference is not captured by traditional mastery criterion of accuracy.

There are some guiding principles in PT to base educational decisions on; the target behavior must be directly observable, environmental variables that influence behavior shall be systematically described and analyzed, frequency/rate of responses is used to measure performance which is recorded on a SCC, and the student knows best (White, 1986). The last mentioned guideline refers to that it is the student's progression which controls instructional decisions of the precision teacher; if the student's behavior is progressing the instructions used are appropriate, otherwise the instructional program must be changed.

The concept of fluency is important in PT. Binder (1996) described fluency as a metaphor that reflects the connection between response rate of accurate performance and

specific learning outcomes. In terms of reading fluency, a fluent reader reads with a certain speed and accuracy such that the performance; retains without practice, endures when read for prolonged time, is stable despite distraction, can be combined with other performances and applied to perform more complex skills even without any explicit instruction (Johnson & Layng, 1996). When fast and accurate reading is characterized by those learning outcomes precision teachers say that the reader has achieved “true mastery” of reading (Binder, 1988). Both speed and accuracy are highlighted in PT with more emphasis on speed; errors are considered learning opportunities since too much emphasize on errors can restrain learning (Binder, 1993).

Even though PT is not an instructional delivery system there are some practices that are encouraged when building fluency in PT. Generally, fluency building in PT is characterized by setting *frequency aims/performance criterion* and taking short repeated daily timings of the target behavior which is a *free operant* (i.e., the participant is free to respond independent of environmental restrains) measured with rate of responses. Besides, the student charts the performance on a SCC and the teacher systematically evaluates the progression based on the charted data concurrently (Binder, 1988). This description of a typical PT practice to build fluency resembles the method of RR; in both of the approaches performance criteria is usually used, the same passage is read repeatedly, fast and accurate reading is highlighted with more emphasis on speed, errors and reading speed are measured with rate of responses, and the reading performance is graphed. One mutual hallmark of PT and RR in fluency building is the emphasis on repeated practice. According to Binder (1993), reinforcement contingencies can only affect students‘ performances to some ceilings and when those ceilings are acquired more practice to gain increased response rate characterized by the above mentioned learning outcomes is what is needed to break through the ceilings. However, many school workbooks contain very few examples for the students to practice on such that they

are not given enough opportunities to practice and simultaneously prevented to become fluent in the target skill and achieve true mastery (Binder, 1988).

The results of published PT studies in which fluency building has been the subject matter look promising (e.g., Carroll, McCormick, & Cooper, 1991; P. M. Daly & Guldswog, 1992; Hughes, Beverley, & Whitehead, 2007; Malanga, 2003; Polk & Miller, 1994). As an example, in a study by Hughes et al. (2007) the colleagues compared the effects on reading performance of an intervention involved in repeated 30 sec/1-min timings and error correction procedure monitored with PT methods to a control group that got equal amount of traditional reading instructions from a personal teacher assistant. All the five children of the PT group improved their reading fluency and two also improved on standardized reading tests. However, neither of the two children that the control group was composed of showed improvements in neither reading fluency nor the other reading tests.

A limitation with many PT reading fluency studies is that they are *non-experimental* resulting in poor experimental control. However, Binder (1996) defended the practice of PT against this drawback by claiming that the amount of replications of the reported discoveries in PT is incredible.

Repeated reading combined with antecedent strategies and/or consequence arrangements. Traditionally, behavior analysts use *antecedent manipulations* and/or *arrangement of consequences* to improve reading fluency. If the student is not capable of simple textual behavior, or is struggling with it and making many errors, antecedent strategies can be used to establish correct responses — then consequences can be arranged contingent on correct textual behavior as an attempt to improve the speed of accurate reading. Eventually, the correct reading responses of the reader hopefully prevail other responses and the reader reads fluently (E. J. Daly, Bonfiglio, Mattson, Persampieri, & Foreman-Yates, 2005). Antecedent teaching strategies involve instructions, for example in form of *modeling*,

drill/multiple opportunities to practice the same words/passages, and *response prompts*. However, consequence arrangement refers to arranging consequences contingent on fluent reading and generally involves *positive reinforcement* and *performance feedback*.

A traditional RR method, in which intervention passages are repeatedly read for fixed number of times or until certain performance criterion is reached, is an example of popular antecedent strategy in behavior analytical reading fluency studies which includes multiple opportunities to practice. In behavior analysis, improvements in reading fluency as a result of RR are not explained by a reference to the automaticity theory. However, after repeatedly reading the same words in the same sequence the text gains more control over the reading such that the reader can predict what words follow each other allowing for more accurate and faster reading of the target text (Ardoin et al., 2008). In other words, the improvements are explained with enhanced stimulus control.

In behavior analytical studies, traditional RR is generally used together with other antecedent manipulations and/or consequence arrangements when building reading fluency (e.g., Chafouleas et al., 2004; Eckert et al., 2002; Hofstadter-Duke, & Daly, 2011). Examples of other popular antecedent manipulations than traditional RR are *listening passage preview* (LPP) and *phrase drill*. LPP involves both a modeling- and drilling procedure and is similar to assisted reading approaches popular in traditional reading literature. In LPP, the student listens to a literate person read the training passage, either life or from a tape, while simultaneously following along with his finger on own example of the passage. Afterwards the student models the reading independently (E. J. Daly & Martens, 1994). The other person serves as a model of fluent reading, whereas the drill component is involved in the use of the student's finger, which is considered a sign that the student is reading along, and as such getting more than one opportunity to read the target passage.

Phrase drill is an *error-correction procedure* that also involves both modeling and drill. Following an error, the teacher models correct reading of the error word (i.e., *word supply*, see O'Shea, Munson, & O'Shea, 1984) either immediately after each error is made or after the reader has completed reading the whole passage. The reader repeats the corrections and then each error word is drilled in phrases along with the words around it, most often for fixed number of times (O'Shea et al., 1984). As such, all incorrectly read words, along with surrounding words, are repeatedly read.

The consequence arrangements most commonly used together with RR and/or other components of an intervention package to improve reading fluency are positive reinforcement and performance feedback. When positive reinforcement is used, some kind of *stimulus assessment test* to identify possible positive reinforcers is conducted prior to reading, for example by that the reader chooses a tangible item which he is told that he gets if meeting some predetermined performance criterion (Chafouleas et al., 2004; Eckert et al., 2002). Performance feedback includes informing the reader about his reading speed and accuracy right after each reading which can have various effects; it can 1) result in increased rate of accurate reading and thereby having reinforcement effect, 2) prompt correct future reading, 3) punish error reading, 4) have multiple function such as reinforcing correct reading and simultaneously punishing error reading, or 5) have no effect on future reading fluency (Cooper, Heron, & Heward, 2007).

Several studies that have examined multicomponent RR interventions, composed for example of a mixture of some of the antecedent- and/or consequence arrangements mentioned above, have demonstrated improved reading fluency on the practice passages following the particular intervention (e.g., Ardoin, Williams, Klubnik, & McCall, 2009; Bonfiglio, Daly, Martens, Lin, & Corsaut, 2004; Eckert et al., 2002; Gortmaker et al., 2007; Hofstadter-Duke & Daly, 2011) and some have also demonstrated generalized effects across

other passages than used in the intervention (e.g., Ardoin et al., 2009; E. J. Daly et al., 2005; Hofstadter-Duke & Daly, 2011). As an example, recently Hofstadter-Duke & Daly (2011) examined the effects of a multicomponent intervention composed of LPP, three RR of each passage, phrase drill, and positive reinforcement in form of tangible items chosen by the participant prior to reading, on reading fluency, in a 7-year-old girl with reading problems. *A multiple probe design* (Kazdin, 2011) across six passages was used to evaluate the effects of the intervention. The intervention was implemented by three peers; classmates of the participant that exceeded average reading performance of the children in the class. The results indicated that the intervention was effective since reading fluency increased across all passages following the intervention, the performance on baseline was rather stable for those passages on hold, and the performance was maintained in follow-up. Besides, generalization effects over passages of equal difficulty level, which were not used in the training but probed across baseline and intervention phases, were displayed.

A hallmark of most traditional behavior analytical studies on reading fluency (i.e., other than PT studies), which many of include a RR component, is the use of *within-subject designs* referring to a class of research designs in which the subject matter is used as his own control when analyzing behavior changes (Cooper et al., 2007). There are many types of within-subject designs (for detailed description of the various designs see e.g., Kazdin, 2011), but mutual to all of them are repeated measures of variability in the target behavior within the same participant when exposed to each condition in the study. By using within-subject designs the experimenter is more capable of reasoning about experimental control than when using non-experimental design. Another hallmark is the use of *brief experimental analysis* in many behavior analytical studies on reading fluency (e.g., Bonfiglio et al., 2004; E. J. Daly et al., 2005; E. J. Daly et al., 1999; Eckert et al., 2002; Gortmaker et al., 2007; Hofstadter-Duke & Daly, 2011). Brief experimental analysis is a procedure in which a within-subject design,

most often *alternating treatment design* or *multielement design* (Kazdin, 2011), with short phases and brief replications is used to recognize either simpler or more powerful intervention package to improve reading fluency, either by removing or adding instructional components (Gortmaker et al., 2007). In behavior analysis, no one is assumed to be average and thus is the use of within-subject designs preferred above group designs. Besides, the use of brief experimental analysis underlines the emphasis on each single participant even more. The results of some brief experimental analysis in reading fluency studies have displayed that the same intervention package is not necessarily relevant for all readers (e.g., E. J. Daly, Martens, Dool, & Hintze, 1998; Eckert et al., 2002). As such, conducting brief experimental analysis is a promising method in applied settings to guide the choice of efficient intervention to improve reading fluency for individuals in a rather quick manner.

Summary of Oral Repeated Reading Interventions to Improve Reading Fluency

Even though the present review of different versions of oral RR interventions is not exhaustive it is clear that many different variants exist. Most often the RR component has not been implemented alone, but as a part of a multicomponent intervention. This accounts for both traditional reading literature and behavior analysis. Besides, it is mutual to both of the disciplines that it varies what type of design is used to evaluate the effects of the given RR intervention each time. Traditionally, within-subject designs are used in traditional behavior analytical RR studies, but the practices of PT and traditional reading literature can be criticized for frequent, though not at all exclusive (e.g., Carroll, 1991; Hughes et al., 2007; Mathes & Fuchs, 1993; O'Shea et al., 1984), use of non-experimental designs which makes inference about experimental control difficult. The biggest difference regarding RR interventions between the disciplines is the explanation of how such approaches are supposed to affect fluent reading, but as Catania (2007) pointed out "The debate between psychologists who call themselves behaviorists and those who call themselves cognitivists or

mentalists…(is) to some extent … about appropriate ways of talking about psychological events" (p. 4).

The Research Base of Repeated Reading Studies

Research Synthesis Studies

What can be inferred from the overall research base of studies about the impact of oral RR interventions on reading fluency, is it EBP? Several practitioners have analyzed the literature with some kind of systematic research synthesis in an attempt to answer this question resulting in varied results (e.g., Chard et al., 2009; Chard et al., 2002; Kuhn & Stahl, 2003; Meyer & Felton, 1999; NICHD, 2000; Therrien, 2004). For example, the NRP implemented a broad and systematic literature synthesis in which 50 peer-reviewed studies, divided into four groups, met their criteria for inclusion; 1) studies without examining generalization effects (see Appendix A, p. 3-35 in NICHD, 2000), 2) group experiments (see Appendix B, p. 3-36 in NICHD, 2000), 3) within-subject studies (See Appendix C, p. 3-37 in NICHD, 2000), and 4) comparison of different variations of RR interventions (See Appendix D, p. 3-38 in NICHD, 2000). A *meta-analysis* was done on Group 2 and the data from the other studies were used to confirm or contradict the results of the meta-analysis. The NRP concluded that oral RR interventions were effective to improve reading fluency and comprehension, but still more researches were needed, preferably a longitudinal research in which the RR procedure used should be explicitly described regarding number of rereadings, nature of feedback, and difficulty level of passages. However, Kuhn and Stahl (2003) claimed that it is difficult to conclude in a reliable manner about the effectiveness of oral RR interventions on reading performance based on the results of the NRP because the studies analyzed had such dissimilar procedures in spite of all being a type of oral RR intervention. Kuhn and Stahl used *vote-counting* to review reading fluency interventions, but they did neither limit their studies to RR nor to peer-reviewed journals. The 58 studies that met their

criteria were divided in three narrower groups; 1) unassisted RR studies (See Table 2, pp. 10–11 in Kuhn & Stahl, 2003), 2) assisted reading in clinical settings (See Table 3, p. 12 in Kuhn & Stahl, 2003), and 3) classroom approaches. Kuhn and Stahl concluded that fluency instructions were generally effective to improve reading fluency and that assisted approaches were superior to unassisted. However, they were not convinced about the effects of the RR component and reasoned that monitoring or guidance from another person along with increased amount of time spent reading were explanatory factors for improvements following an effective RR intervention. These results are in contradiction to the outcome of a meta-analysis on 32 experimental RR studies by Therrien (2004) (no case-studies and within-subject design studies were included since it is difficult to calculate effect size for them), but he concluded that RR interventions are EBP to improve reading fluency and comprehension, both on practice and generalization passages in non-disabled students and students with learning disabilities.

Despite promising results of some published research synthesis studies it is impossible to ignore the fact that the results have not been entirely unanimous. The contradictory outcomes of those three examples accounted for here above can be attributed to dissimilar criteria for inclusion of studies in each research, which also explains different number of studies included in each analysis. As a result, it is not possible to conclude if oral RR interventions are EBP based on those research synthesis studies.

Quality Indicators and Evidence-Based Practice Standards

What can possibly be done to contribute to EBP in the field of oral RR interventions to build reading fluency? Horner et al. (2005) and Gersten et al. (2005) proposed some quality indicators, based on recommendations by the American Psychological Association Task Forces, Divisions 12 and 16, for experimental, quasi-experimental, and within-subject design studies to judge the quality of such researches. In addition, they offered standards to

determine EBP in special education. The quality indicators and the EBP standards were also supposed to function as guidelines for researchers when implementing studies. According to Gersten et al., the quality indicators for experimental and quasi-experimental studies were composed of description of participants, intervention, and comparison condition along with reports of outcome measures and data analysis. For a practice to be considered EBP, Gersten et al. required at least two high quality studies supporting the practice, or at least four acceptable quality studies, besides a weighted effect size significantly higher than zero. Regarding within-subject designs, Horner et al. (2005) proposed quality indicators involving the quality of the description of participants, settings and baseline; description and measurement of the dependent variable; description and manipulation of the independent variable; and evaluation of internal-, external-, and social validity. The EBP standards for within-subject designs required inclusion of; a) an operational definition of the practice, b) clear descriptions of settings and participants, c) integrity of the procedure, and d) functional relationship between the target intervention and changes in the dependent variable displayed with a within-subject design. Besides, the effects received must be replicated across at least five methodologically acceptable within-subject studies executed by a minimum of three different research teams, published in peer-reviewed journals, and with total number of at least 20 participants.

Using quality indicators and EBP standards can be helpful when implementing a research synthesis study to infer if a practice can be considered EBP. Chard et al. (2009) developed a 4-point Likert scale (See pp. 269–272 in Chard et al., 2009) to test out the quality indicators and EBP standards of Horner et al. (2005) and Gersten et al. (2005) on studies that examined the impacts of oral RR interventions on reading fluency in students with/at risk for learning disabilities. They did a research synthesis where they searched through five electronic databases. Despite a wide definition of RR intervention (i.e., all

procedures that require the participant to read a passage/word list more than once), only 11 studies met their final criteria of inclusion, but one of the criteria was that the intervention could not include instructional components assigned to other reading aspects which excluded many studies since practitioners often focus on more reading aspects simultaneously. Their research question was: “Is the research base supporting the effectiveness of repeated reading based on high-quality standards of single-subject and experimental/quasi-experimental research that would lead to the determination that repeated reading is an evidence-based practice?“ (Chard et al., 2009, p. 266). Chard et al. found out that no within-subject design study which they examined was evaluated as high quality and only one experimental/quasi experimental study (Mathes & Fuchs, 1993). As such, the colleagues concluded that RR interventions could not be considered an EBP for students with/at risk for learning disability based on the quality indicators and EBP standards used.

Summary of the Research Base of Repeated Reading Studies

Despite promising results of some single studies of RR to improve reading fluency across the disciplines, outcomes of meta-analyzes and other research syntheses have been indecisive regarding the question if oral RR interventions can be considered EBP for building reading fluency. Quality indicators to evaluate the quality of existing studies and guide researches when designing and reporting results of new studies have been proposed as an attempt to determine if RR interventions can be classified as EBP to improve reading fluency.

Conclusion

To contribute to the movement of EBP, future researchers in the field should have quality indicators comparable to Horner et al.’s (2005) and/or Gersten et al.’s (2005) in mind when designing and implementing RR studies in an attempt to improve reading fluency. In 2002, the organization of What Works Clearinghouse (WWC) was created with the purpose

of being a reliable foundation of EBP in education (WWC, 2008). Recently, the WWC published a handbook (last updated in 2010) that includes similar objective standards as Horner et al.'s (2005) and Gersten et al.'s (2005) intended to guide practitioners in identifying and evaluating the quality of existing experimental, quasi-experimental, and within-subject design researches. Because of exemplary scientific work behind the handbook of WWC and easy access to it, future researches on RR and reading fluency is recommended to use the standards of the handbook.

Another conclusion of the present article is that it can be deceptive to put all the various types of oral RR interventions/multicomponent RR interventions under the same umbrella when evaluating effects of single interventions which makes a research synthesis difficult. If the goal of future research is to find the most parsimonious intervention for a particular participant brief experimental analysis is recommended. However, if the goal is to evaluate if a particular type of RR intervention/multicomponent RR intervention to improve reading fluency is EBP, future researches are recommended to attempt to implement a high quality study which makes it suitable for other researchers to replicate, and as such makes it a candidate for being evaluated as EBP to improve reading fluency based on above mentioned standards.

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Delayed Multiple Probe Design to Evaluate the Effects of a Multicomponent Intervention to Improve Reading Fluency in Adult Students

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HØGSKOLEN I OSLO
OG AKERSHUS

Abstract

It is socially important for people who read slowly to improve their reading fluency since reading is an essential part of almost every aspect of daily life. The literature for building reading fluency consists of many studies that are often non-experimental or not of high quality. The purpose of the present study was to implement a high quality study, based on quality indicators proposed by Horner et al. (2005), by using a delayed multiple probe design across participants to evaluate the effects of a multicomponent intervention on reading fluency in adult Norwegian students. Prior to the study all the participants read below average reading speed and one had the diagnosis dyslexia. The procedure was based on a study by Lokke, Lokke, and Arntzen (2009) and consisted of a reading support, performance criterion, response prompts, repeated reading, performance feedback, and error correction procedure. Training consisted of 1-min timings implemented every weekday and each passage was read four times in each session or until a predetermined performance criterion was reached, whichever occurred first. The performance criterion for each participant was set as 1,5x acceleration or 50% increase, from average reading speed on baseline. When the performance criterion was reached a new passage was introduced in the following session. After the intervention, baseline passages were represented to evaluate generalization to untrained passages. In addition, other aspects of reading were tested to evaluate learning outcomes of fluent performance. The main findings indicate that reading fluency of all the participants improved after receiving the intervention. Results are discussed with regard to social validity of the study, limitations of conducting a multicomponent intervention, and in terms of whether the present study can be considered as a high quality within-subject experiment according to the quality indicators by Horner et al. (2005).

Key words: Multicomponent, multiple probe design, quality indicators, reading fluency, repeated reading, RESAA, stimulus control

Delayed Multiple Probe Design to Evaluate the Effects of a Multicomponent Intervention to Improve Reading Fluency in Adult Students

In a modern society which requires its members to have good reading skills in almost every aspect of daily life it is socially important for people who read slowly to improve their *reading fluency* to prevent them from falling behind. Reading fluency includes reading fast and accurately (Binder, 1988) and is generally considered one of the most important components of reading. Many studies concerning improvement of reading fluency have been published across different disciplines (e.g., Alber-Morgan, Ramp, Anderson, & Martin, 2007; S.P. Ardoin, Eckert, & Cole, 2008; Carroll, McCormick, & Cooper, 1991; Chafouleas, Martens, Dobson, Weinstein, & Gardner, 2004; Conte & Hintze, 2000; Hughes, Beverley, & Whitehead, 2007; Lokke et al., 2009; Polk & Miller, 1994; Samuels, 1979; Teigen, Malanga, & Sweeney, 2001).

Precision teachers have been tenacious in fluency studies, but *precision teaching* (PT) is a behavioral analytical method rooted in Skinner's free operant conditioning laboratories. Before fluency building in PT starts *fluency aims* are set but the aims predict the response rate at which the student will achieve specific learning outcomes that have been identified with various acronyms, for example *RESAA* (Johnson & Layng, 1996). RESAA stands for; *retention* (maintenance of performance between two points in time without practice), *endurance* (the ability to perform for prolonged periods of time), *stability* (the performance is not easily distracted), *application* (a composite behavior is more easily acquired when its subcomponents are fluent), and *adduction* (a fluent performance facilitates the occurrence of a non-trained skill), which are the characteristics of fluent responding (Johnson & Layng, 1996). Fluency building in PT typically consists of short repeated daily timings (sprints) of the target behavior until fluency aims have been reached. The target behavior is a *free operant* measured with *rate* (i.e., frequency or count per minute) of responses rather than

percent correct based on the notion that rate is more sensitive to changes in the environment than percents (Lindsley, 1992). The student records his/her own response rate on a *standard celeration chart* (SCC) and changes in rate over time are denoted as *celeration* (derived from acceleration and deceleration). Instructional decisions are based on systematic evaluation of the student's performance that is displayed on the chart. A typical sprint is 1-min timing, but timings can last for longer or shorter intervals. It has been documented (Binder, Haughton, & Eyk, 1990) that sprints even shorter than 1-min can help building fluency if longer timings have not been effective. After achieving fluency at a shorter interval the timing period can be increased systematically to build endurance (Binder et al., 1990).

The methods typically used in reading fluency building in PT resemble in many aspects *oral repeated reading* (RR) *interventions*, which are the most referred fluency building strategies used across distinct disciplines (e.g., Kuhn & Stahl, 2003; Therrien, 2004). One of the oldest oral RR intervention is Samuels' *method of repeated readings* (Samuels, 1979), involving that the same passage is read repeatedly until a certain *performance criterion* is reached, then a new passage is introduced and the same procedure implemented again. Ardoin et al. (2008) explained the improvement in reading fluency after RRs such that the behavior is brought under greater stimulus control of the text, where repeated exposure to a text establishes each word as a *discriminative stimulus* (S^D) for the next word. Many modified versions of Samuels' method have been developed, for example in which a passage is read repeatedly for fixed number of times without performance criterion (e.g., S.P. Ardoin, Williams, Klubnik, & McCall, 2009). However, studies have shown that including performance criterion provides better results when building reading fluency (e.g., Chard, Vaughn, & Tyler, 2002; Therrien, 2004). Other versions include different multicomponent intervention packages that involve RR. Most often those packages include *response prompts* (e.g., Alber-Morgan et al., 2007), some kind of *performance feedback* (e.g., Alber-Morgan et

al., 2007), and some type of *error correction procedure* (e.g., S. P. Ardoin, McCall, & Klubnik, 2007).

Response prompts are additional antecedent stimuli that operate directly on the target response to aid correct responding in the presence of a specific S^D (Cooper, Heron, & Heward, 2007). In RR studies response prompts are verbal instructions that are delivered to the reader prior to each reading (e.g., Alber-Morgan et al., 2007; S. P. Ardoin et al., 2007). In some publications the instructions have not been specified (e.g., Chafouleas et al., 2004; O'Shea, Munson, & O'Shea, 1984; Teigen et al., 2001) but it has been documented that the content of the instructions can be important with regard to the purpose of the given study (e.g., Binder & Watkins, 1990; Samuels, 1979; Therrien, 2004). For example, the practice of PT has revealed that emphasizing accuracy can prevent the student from progressing and emphasizing speed has been shown to result in increased learning (Binder & Watkins, 1990).

Performance feedback in RR interventions involves providing information about the reader's performance immediately after reading a passage and it has been documented to positively affect oral reading fluency (Conte & Hintze, 2000; Eckert, Ardoin, Daly, & Martens, 2002). Performance feedback is most often provided orally but can also be delivered graphically. In PT, oral- and graphic performance feedbacks are combined such that the student gets oral information about his/her fluency score and then charts it on a SCC (Binder, 1996).

Studies have shown that RR with some kind of error correction procedure is superior to RR without error correction to improve reading fluency (Chard et al., 2002; Hardardottir, 2007; Therrien, 2004). W*ord drill* and *phrase drill* are examples of error correction procedures that have been shown to be effective (O'Shea et al., 1984). When using phrase drill the reader is provided with contextual cues (i.e., the words surrounding the error word) to recognize the target word in context and thereby increases stimulus control of the text

above when a single word is drilled. Errors can either be drilled right from the text or by using physical- or electronic flashcards (Levy, Abello, & Lysynchuk, 1997; O'Shea et al., 1984). With persistent errors, using *stimulus prompts* can possibly increase stimulus control. To the best of our knowledge, stimulus prompts have not been used as a part of error-correction procedure in fluency studies but it would be interesting to incorporate such prompts when the reader repeatedly makes the same errors.

Another strategy that has been developed to improve reading fluency is *speed reading* but that is a collection of techniques that are generally accepted in popular science. One of the techniques is called *meta-guidance* and it consists of using a reading support, such as a finger or a pen, to control the eye movements of the reader (Stangeland & Forsth, 2001). According to Stangeland and Forsth (2001), low reading rate is often related to high number of eye-fixations and they claim that meta-guidance can be helpful in controlling the reader's eye movements. Even though it is often claimed that speed reading techniques are effective few studies have been published to manifest it. However, speed reading studies that have been published have documented remarkable effects (e.g., Calef, Pieper, & Coffey, 1999; Macalister, 2010; Stangeland, 1998). Unfortunately, the description of the procedure in published studies is often deficient which raises problems for demonstration of external validity. In addition, internal validity is often threatened because those studies are often *non-experimental* (e.g., Calef et al., 1999; Stangeland, 1998) and the same applies to other types of reading fluency studies (e.g., Legault, Maloney, & Giroux, 2001; Malanga, 2003; Teigen et al., 2001). However, in some reading fluency studies *within-subject designs* (e.g., Bonfiglio, Daly, Martens, Lin, & Corsaut, 2004; Chafouleas et al., 2004; Daly & Martens, 1994; Valleley & Shriver, 2003) or group designs (e.g., Berends & Reitsma, 2006; Tan & Nicholson, 1997) have been used but despite of that many of the studies still have some methodological flaws (Chard, Ketterlin-Geller, Baker, Doabler, & Apichatabutra, 2009; Lyon

& Moats, 1997) which results in difficulties with replication and evaluation of *experimental control*. Horner et al. (2005) proposed some quality indicators for within-subject designs to identify *evidence-based practice* in special education. Those indicators include description of participants, settings and baseline, description and measurement of the dependent variable, description and manipulation of the independent variables, along with evaluation of internal-, external-, and social validity (see details in Horner et al., 2005). Chard et al. (2009) created a 4-point Likert scale (see pp. 269-270) to evaluate to which degree experimenters fulfill the quality indicators of Horner et al. (2005). They applied the Likert scale to examine the quality of a sample of within-subject design studies that used RR with participants with, or at risk for, learning disabilities (LD). Even though it has been claimed that RR is an evidence-based strategy (e.g., Therrien, 2004), Chard et al. (2009) found out that no study that they examined met the criterion for being of a high quality and thus concluded that RR could not be considered as an evidence-based practice for students with LD.

In the present study the rating scale of Chard et al. will be used to evaluate to which degree the experiment fulfills the quality indicators of Horner et al. (2005). The main purpose of the study is to improve reading fluency in adult students with the use of a multicomponent intervention consisting of a reading support, performance criterion, response prompts, repeated reading, performance feedback and error correction procedure. The procedure is based on a study by Lokke et al. (2009). They used PT methods to evaluate the effects of an intervention package combined of speed reading techniques (meta-guidance) and repeated reading with an error correction procedure, to improve reading fluency of a 14-year-old boy with reactive attachment disorder, with promising results. The procedure of the present study differs in several ways from Lokke et al.'s procedure. First, another type of error correction procedure will be used. Even though Barbetta, Heward, Bradley, and Miller (1994) found out that immediate error correction (such as Lokke et al. used) gave better results in reducing

errors than delayed error correction, we choose to use delayed error correction because as Binder and Watkins (1990) highlighted emphasizing accuracy above speed can prevent learning. In addition, the average reading rate of the participants in the present study is faster than in the study by Lokke et al. (2009) and therefore it is considered more difficult to correct errors during reading. Stimulus prompts will also be used with persistent errors. Second, Lokke et al. used non-experimental design and SCC to evaluate the progress, but even though we use a procedure that is similar to methods often used in PT we choose to use *delayed multiple probe design* (Cooper et al., 2007) across participants, both for evaluation of the participants' progress and to base instructional decisions on, in an attempt to increase experimental control. The SCC will only be used as a part of the performance feedback, but not as an evaluation tool to base instructional decisions on. This will limit the possibility of making changes in the procedure on individualized level but in an attempt to deal with this limitation some predetermined criteria will be set to decide when to implement different parts of the intervention allowing changes based on each individual performance. In other respects, the procedure of the present study is similar to the procedure of Lokke et al. (2009). Additional reading measurements will also be taken to evaluate learning outcomes of fluent performance or what precision teachers talk about as RESAA.

Method

Participants

Three Norwegian speaking bachelor students at the university participated in the study. The participants did not know each other and had no contact prior or during the experiment. All the participants volunteered to participate after having seen an announcement at the university website where students with reading problems were requested. Before the volunteers were accepted as participants each of them was interviewed about relevant background information concerning his/her reading problems and asked about preferences

for reading material to be used in the experiment. After the interview each volunteer read a passage based on his/her reading preferences and the passage was used as a reading test to determine reading speed. The criterion for participation was reading slower than 150 words per minute on the reading test but fluency is often achieved when the reading rate is between 150–250 words per minute with 0–2 errors (Kubina & Starlin, 2003). If the volunteer met this criterion baseline probe measures started for him/her immediately. The first volunteer that met the criterion was assigned as Participant 1 and was first to receive intervention.

Participant 1. Josh, a 35-year-old male, was diagnosed with dyslexia, according to the *Aston Index test,* in high school by the *Educational Psychological Service* in Norway (*Pedogogisk-psykologisk tjeneste*/PPT). In the interview, Josh reported that his slow reading both affected his study and his free time reading, that is, he never succeeded to read through the entire reading list in school and almost never read in his free time due to his slow reading. When taking exams in school, Josh was permitted to use computer with a correction program and was allowed extra time. For Josh, the reading test in the experiment was a passage from a crime novel and he read 144 words per minute.

Participant 2. Rose, 22-year-old female. In the interview Rose reported that she had gone through a diagnostic process for dyslexia via the student foundation at the university (*Studentsamskipnaden i Oslo og Akershus*/SIO) because of reading problems and suspicion of dyslexia, but according to *LOGOS* diagnostic test she did not reach the criteria. Rose informed that her reading problem consisted of slow reading, “jumping” back and forth in the text, and lack of reading comprehension and she meant that those problems had affected her grades in school. In college, she had been allowed extra time when taking exams and at the university some of the exams were read aloud to her. In the experiment, the reading test for Rose was a passage from her current reading list and she read 138 words per minute.

Participant 3. Annie, 42-year-old female. In the interview Annie informed that when she was in college she had gone through dyslexia diagnostic process performed by the PPT, but did not reach the criteria for diagnosis of dyslexia according to the Aston Index test. Annie reported that due to her slow reading she never had time to read through the entire reading list in school and thus she wanted to increase her reading speed. The reading test in the experiment was a passage from her current reading list and she read 142 words per minute.

None of the participants had tried any methods to increase their reading speed.

Before the experiment started the participants received information about the study. The information included; the purpose of the study (i.e., increasing reading speed and accuracy), methods of data collection and registration, that the study was a part of the experimenters' master theses at the university, voluntary participation and anonymity, that the experimenters were bound to secrecy, and that the study was reported to the *Norwegian Social Science Data Services* (NSD). All of the participants signed an informed consent (Appendix A).

Apparatus and Settings

All the reading passages were texts on white A4 sheets with the font Verdana, size 14 pt. and 1.5 spacing. Each passage was around 300 words to ensure reading to be a free operant.

A digital timer was used to time 1-min or 30 s reading sprints and all sessions were recorded on a digital dictaphone. A computerized PowerPoint 2007 slideshow was used to practice errors. The slideshow was programmed such that each slide was present until pressed Enter and it looped continuously until pressed Esc.

Errors were recorded with a pencil on the experimenter's own exemplar of the target passage. Microsoft Word 2007 documents of each passage were used to find out number of words read each time. In addition, a data recording sheet (Appendix B) was used to record all important data from each session; the participants' initials, date, the name of the passage,

words read per minute (WRM), number of words read correctly per minute (WRCM), number of errors, what errors were made, type of error correction procedure, type of reading support, and the initials of the experimenter. Daily per minute SCCs were used to record the best reading of each session for each participant.

In some instances the reading sessions were executed through the Internet via Skype ™ communication program and a hardwired web cam was used to monitor the participant's use of the reading support.

All the phases of the experiment took place in a quiet room that included at least one table and two chairs, so that the experimenter and the participant had a proper working situation, and a laptop to record data and train errors. An exception from this setting was when sessions were implemented through Skype, but then the experimenter and the participant were in separate quiet rooms similar to the other setting.

Dependent Variable

The dependent variable was reading fluency, that is, speed and accuracy, measured with WRCM and errors. A word was scored correct if there was a point-to-point correspondence between the textual stimuli and the vocal response. Self-corrections were also scored as correct. A vocal response without point-to-point correspondence to the textual stimuli was scored as an error, including word omissions and word insertions. WRCM were calculated by subtracting the errors from the total number of WRM.

Design

A delayed multiple probe design across participants was used to evaluate the effects of a multicomponent intervention package that consisted of a reading support, performance criterion, response prompts in form of vocal instructions (faded in a predetermined way during the intervention, see procedure), repeated reading, performance feedback, and an error correction procedure composed of a drill and stimulus prompt, on reading fluency. All the

parts of the intervention package were implemented concurrently when the intervention started for each participant. The design was delayed such that baseline measures did not start concurrently for the participants but as soon as each of them was accepted as a participant in the experiment. The intervention started for Participant 1 when three acceptable participants had been approved for the project. For Participant 2 the intervention started two weeks later and four weeks later for Participant 3. After the intervention phase the intervention package was withdrawn twice, with three months apart, where the procedure used in the baseline phase was repeated. The last phase of the design was follow-up.

Procedure

The type of reading material that was used in baseline-, intervention-, and withdrawal phases was decided in cooperation with each participant. The experimenters selected reading passages by convenience based on each participant's reading material preferences. All the passages used in the experiment were in the participants' native language, Norwegian. The passages that were used in baseline- and withdrawal phases were given the names Test probes 1–5 and the passages that were used in intervention- and follow-up phases were named Passages 1–10. All the passages that each participant read during baseline-, intervention-, and withdrawal phases were from the same book/article and had therefore greater overlap in content words than if they had been from different books/articles. The test probes were also used in the withdrawal phases to evaluate generalization to untrained passages. To make sure that all the passages which each participant read were of similar difficulty level the experimenters estimated the difficulty of the passages based on average word length of each passage (Evensen & Vagle, 2003). The passages selected for Josh were all from a crime novel, and were customized to have the average word length between 4.2–4.8 letters per word (LW). The passages for Rose and Annie were from separate articles on

their reading lists at the university and were customized to have average word length between 5.0–5.7 LW for Rose and between 5.2–5.6 LW for Annie.

Baseline probes. In each baseline session the experimenter set the timer to one minute, gave the participant a test probe and the following instructions:”Read out loud as fast as you can until the timer rings. Read all the words and try not to do errors. You can start when you are ready.” When the participant started reading, the experimenter started the timer and followed the reading on his own exemplar of the text and marked errors if occurred. Then the experimenter registered WRCM and number of errors without any comments to the participant.

The duration of the baseline phase was four months for Josh, three months for Rose, and one and a half month for Annie. Five probes, with varied interval, were taken during the baseline phase for each participant. Because both the instructions used on baseline and 1-min timings were also part of the intervention package the number of probes was limited to five to prevent *practice effect* (Cooper et al., 2007), provisionally that the baseline was stable or trended downwards. The probes were used as pretests for the withdrawal phases.

Intervention. On the first intervention day each participant was informed about his/her personal performance criterion which was predetermined as 1.5x acceleration of the average reading rate (which is a 50% increase in rate) during baseline rounded to the next whole number with three or less errors for each passage. The experimenter gave the participant a choice between different types of reading supports that is; a pen, a Mikado pin, a knitting needle, or own index finger. All the participants choose to use their index finger as a reading support in all the sessions, except for Josh who used a pen in the first session but his finger in all the other sessions. The experimenters roughly explained the main characteristics of the SCC.

In the beginning of each session eye movements were trained with the reading support. The participant received one page with a text that was irrelevant for the fluency building and was instructed how to use the reading support. A correct use was defined as holding the reading support under the first line of the passage, moving it from left to right, having the eyes focused on the text, and letting them follow the support but not vice versa. At the end of each line the support was supposed to be moved fast and gently, with the eyes following it, to the beginning of the next line and then continuing with the same procedure through the whole text. The participant did the reading support training three times before the first reading in the first three sessions with instructions from the experimenter to increase the speed each time. To maintain training of correct eye movements reading support training was also done at least once in the beginning of all other sessions.

After the reading support training the experimenter set the timer to one minute and gave the participant relevant passage and instructions. Before the first reading of the first three sessions the instructions were:

> Read out loud until the timer rings. Read as fast as you can, read all the words and try not to do errors. Hold the reading support under the line you are reading, move it a little bit faster than you read such that your eyes follow the support but not vice versa. You can start reading when you are ready.

Before the first reading of other sessions the instructions emphasized speed, accuracy, and correct use of the reading support, but prior to all other readings it was sufficient to only emphasize speed. As soon as the participant started reading the experimenter started the timer and followed the reading on his own exemplar of the text, marked errors if occurred without the participant seeing the markings, and marked how far the participant read.

After the 1-min timing, the experimenter gave the participant performance feedback about total WRM, accuracy, and speed contingent on his reading and recorded it on a

registration sheet. If the participant had made any errors in the reading sprint the experimenter informed him/her immediately about the errors and modeled them correctly. Before rereading the passage, errors from previous reading sprint were drilled, that is, the participant repeatedly read the errors. Phrase drill was used if the error was an incorrectly read word from another word class than noun, a word insertion, or a word omission. In phrase drill a phrase of two to four words from the text, containing the error, was drilled. However, if the error was a noun that was read incorrectly then word drill was considered sufficient. If the participant made three or less errors, each word/phrase was drilled right from the text until read correctly five times successively. However, if the number of errors exceeded three, the words/phrases were drilled on PowerPoint slides in a computer, until all the words/phrases were correctly read five times successively.

After the drill or performance feedback, whichever was relevant (dependent on whether errors were made in previous reading or not), the same passage was read again (RR) and was followed by the same procedure; performance feedback, pointed at errors, modeling, and error correction, whichever was relevant each time. If the participant made any of the same errors in two sequential readings a stimulus prompt was provided by underlining the particular error with a pencil after the drill. Then the passage was read again with the prompt present. The prompt was erased from the text when the target word/phrase had been read correctly.

When a passage was read for the first time the session consisted of only one reading (Polk & Miller, 1994), performance feedback, and modeling of errors. Other sessions also included error correction procedure and RR, where the whole procedure was repeated four times or until the predetermined criterion was reached, whichever occurred first. When the criterion for a passage had been reached, the number of times the participant had read the passage was recorded on the registration sheet and a new passage was introduced in the

following session. The whole procedure was replicated with ten different passages for each participant. If the same passage had been read 15 times without reaching the performance criterion the same procedure was used with 30 s timings, instead of 1-min timings, until the criterion was reached. When training of all the ten passages was finished the passages that had been trained with 30 s timings were introduced again for 1-min timings until the criterion was reached again.

In the end of each session the participant recorded the best reading of the session on a SCC. Intervention sessions took place once a day on working days for all the participants and were 31 sessions for Josh, 24 for Rose, and 38 for Annie.

Withdrawal 1. The first withdrawal phase was implemented right after the intervention ended. A posttest was implemented, that is the test probes from baseline were represented with the same procedure as in baseline to evaluate generalization effects of the intervention to untrained passages.

Withdrawal 2. A second posttest was implemented approximately three months after the intervention phase ended, that is, all the test probes were tested once again with the same procedure as used in baseline and withdrawal phase 1.

Additional reading measurements. Different aspects of reading were also tested to evaluate the characteristics of fluent reading; RESAA.

Follow-up/retention. Follow up measures were used to evaluate retention. For each participant, three random passages from the intervention phase were tested again, once each in a randomized order, with the same procedure as in the intervention phase except without error correction and repeated reading. Follow-up was carried out about three months after the intervention ended.

Application. Application was tested with the same procedure as used during baseline. Each participant read the same passage three times; once before the intervention started

(pretest), once right after the intervention ended (posttest 1), and once approximately three months after the intervention (posttest 2) (exact timing decided by convenient). The passages that were used were more difficult than the passages used in baseline- and intervention phases with the average word lengths of 5.1 LW for Josh, 6.0 LW for Rose, and 6.2 LW for Annie. Those passages were also from another book/article than the other passages and had therefore less overlap in content words.

Endurance and stability. For Annie, one 2 min timing with a random passage of approximately 600 words composed of two sequential intervention passages was used to test endurance. Annie was also exposed to a stability test where she read a random passage that had been used in the intervention for 1-min with the radio playing in the background. Except for the duration of the timing of the endurance test and the noise in the background during the stability test, the procedure for those tests was the same as used in baseline.

Reading comprehension/adduction. Adduction was evaluated with reading comprehension tests. The participants were exposed to two types of comprehension tests; recall measure- and question answering tests. The recall measure test included a 1-min reading of a novel text (that was not related to other passages used in the experiment) and a 1-min recall of facts from the text, measured by the number of correct recalled facts (e.g., Beneke, 1991; McDowell, McIntyre, Owen, & Keenan, 1998; Polk & Miller, 1994). A correct fact was defined as a word, phrase, or a sentence that involved correct information from the text such as names, dates, subject-verb-object relation (e.g., “John ate fish”), and adjective-noun relation (e.g., “yellow car”). Repetitions of correct facts and words or sentences that had no informative value (e.g., “that had been”) and incorrect information were not scored. Before implementation of the recall measure tests the experimenter informed the participant that after reading the text he/she would have 1-min to write down any recalled facts. The experimenter gave the same instructions as before readings in baseline

and after the test he recorded number of WRM and number of correct facts. The recall measure test was implemented immediately after a 1-min timing of a test probe, once during the baseline phase, and another similar recall measure test was carried out once during withdrawal phase 1. The exact timing of the execution of these tests was decided by convenience.

The question answering tests included 20 multiple choice questions from the Norwegian novels *Mayday Mayday* and *Sitt livs chanse* (Stangeland & Forsth, 2001). The experimenter instructed the participant to read the novel silently and informed him/her that after the reading he/she was supposed to answer multiple choice questions from the text. The experimenter timed the reading and recorded number of WRM afterwards. After the reading the experimenter gave the participant 20 written multiple choice questions about the novel, which he/she answered independently by marking with a pencil. The experimenter then recorded the number of correct answers. The question answering tests were carried out immediately after a 1-min timing of a test probe; the test from *Mayday Mayday* was implemented during the baseline phase and the one from *Sitt livs chanse* during the withdrawal phase. The exact timing of the tests was decided by convenience.

Reliability and procedural integrity. Reliability was evaluated by taking interobserver agreement (IOA) scores; a second observer independently recorded number of correct words and errors while listening to an audio tape recording of sessions. Agreement was defined as both experimenter and observer agreeing on whether a word was correctly or incorrectly read. IOA was calculated by dividing the total number of agreements by total number of agreements plus disagreements and multiplied by 100 %. IOA data was collected for each participant by using a randomized sample of 33% of all the sessions in each phase. The average IOA for all the participants across phases was 99% with the range of 97% to 100%.

A procedural integrity protocol (Appendix C) was developed and a procedural integrity checklist (Appendix D) was made based on the protocol. To assess the experimenters' adherence of the procedure, procedural integrity (PI) was observed regarding correct implementation of; instructions, reading support, error correction, recording of time, and performance feedback. A second observer independently scored whether the experimenter correctly implemented the procedure according to the checklist or not by listening to an audiotape of the session. PI was assessed from a randomized sample of 33 % of all the sessions in each phase for all the participants. PI was calculated by dividing the number of steps implemented correctly (by the experimenter) by total number of opportunities and multiplying it by 100 %. The average PI was 97%, with range from 89 % to 100 %. The PI score was only once lower than 90% and that low value occurred when the experimenter failed to start the timer on time before all the readings in a single intervention session. Thus, it is possible that WRM in this particular session was incorrectly recorded.

Social validity. After the last session of the follow-up phase social validity was evaluated based on the three social validity criteria suggested in a milestone article by Wolf (1978). The three criteria concern whether the target behavior is of social importance, whether the procedure is socially accepted, and whether the results are of social importance. The evaluation was carried out such that the experimenters interviewed the participants about their acceptability of the intervention and satisfaction of the results. The Interview contained eight open-ended questions (Appendix E) concerning the participants' likeability of the different components of the procedure, whether they noticed effects of the intervention in general reading (i.e., generalized effects), and whether they planned to continue using some of the intervention components when reading in general.

Results

The average reading rate of the test probes during baseline was 143 WRCM and 2 errors (range 0–5 errors) for Josh, 131 WRCM and 2 errors (range 1–3 errors) for Rose, and 140 WRCM and 1 error. This resulted in performance criterion of 214, 197, and 210 WRCM, for each participant respectively.

In the first intervention session Josh read 120 words correctly per minute (WRCM) and 5 errors while using a pen as a reading support, but in the first reading of session 2 he read 172 WRCM and 3 errors while using his finger as a reading support for the first time.

During the intervention phase the average reading rate and number of errors of the first readings of each passage for Josh was 166 WRCM (range 120–179) and 3 errors (range 0–6). However, in the first reading of the intervention Josh read only 120 WRCM which is much lower than all the other scores and without this outlier the average reading rate was 171 WRCM (range 159–179). For Rose the average reading rate and number of errors of the first readings was 168 WRCM (range 149–204) and 2 errors (range 0–3) and for Annie it was 175 WRCM (range 166–192) and 2 errors (range 0–8). Rose and Annie read faster in all the first readings in the intervention phase than during all the test probes on baseline, but Josh read slower in the first reading of Passage 1 and Passage 7 than during baseline but faster in the first reading of all the other passages used in the intervention.

When rereading a passage, the number of WRCM was always higher than in the previous session except in one session for Josh (Intervention session 23) and two sessions for Annie (Intervention sessions 3 and 24). To reach the performance criterion for the passages used in the intervention Josh read each passage at the average of 8.7 times, with eight to nine readings of the four first passages, 19 readings (15x 1-min timings + one 30 s timing + three 1-min timings) of the fifth passage, but only four to five readings of the last three passages. Rose read the passages at the average of 5.9 times to reach the criterion with the range of five

to nine readings for the first eight passages, except for the fifth passage where she reached the criterion in the first reading. Rose reached the criterion for the last two passages in four readings. The average number of readings for Annie was 10.8 times. She needed seven to 15 readings to reach the criterion for Passages 2 to 5, 19 readings (15x 1-min timings + one 30 s timing + three 1-min timings in both cases) for Passages 1 and 6, and four to five readings for the rest of the passages except for the last one which she read 12 times.

Figure 1 displays number of WRCM and errors during baseline-, withdrawal-, and follow-up phases, and the best reading of each session plus errors during the intervention phase for all the participants.

Insert Figure 1

During the intervention phase a stimulus prompt was used four times for Josh and Rose, and two times for Annie. None of the participants needed stimulus prompt for the same error in two sequential readings.

On posttest 1 during the first withdrawal phase the average reading rate for Josh was 172 WRCM and 3 errors (range 2–4 errors), which equals 1.21x acceleration or increase of 29 words from the average reading rate on the pretests on baseline (i.e., the test probes). For Rose the average reading rate was 178 WRCM and 1 error (range 0–2 errors), that is 1.36x acceleration or increase of 47 words, and for Annie it was 177 WRCM and 1 error (range 1–2 errors), which equals 1.28x acceleration or increase of 37 words between the pre- and posttests.

On the second posttest during the later withdrawal phase Josh had the average reading rate of 173 WRCM and 3 errors (range 2–5 errors) which equals acceleration of 1.21x or increase of 30 words from the pretest on baseline. The average reading rate for Rose was 184 WRCM

and 1 error (range 0–3 errors) or 1.40x acceleration which equals increase of 53 words, and 171 WRCM for Annie and 2 errors (range 1–3 errors) or acceleration of 1.22x or increase of 31 words.

In the follow-up phase, Josh read Passages 2, 5, and 8 at the average rate of 190 WRCM and 2 errors. Rose read Passages 6, 7, and 8 at the average rate of 185 WRCM and 1 error, and Annie read Passages 4, 6, and 10 at the average rate of 189 WRCM and 1 error.

For Josh, the reading rate of the application passage was 136 WRCM (1 error) on the pretest and 156 WRCM (0 errors) on the first posttest which equals 1.15x acceleration or 20 words increase. On the second posttest, the reading rate for the same passage was 153 WRCM (1 error), or 1.13x acceleration which equals an increase of 17 words from the pretest. Rose read her application passage for the first time (pretest) at the rate of 120 WRCM (1 error). The second time (posttest 1) the rate was 152 WRCM (0 errors) which is a 1.27x acceleration or an increase of 32 words, and the last time (posttest 2) she read 136 WRCM (2 errors) which is a 1.13x acceleration or 16 words increase from the first reading. The reading rate of the application passage for Annie was 128 WRCM (1 error) on the pretest. In the first posttest, she read the passage at 154 WRCM (1 error) which equals 1.20x acceleration or an increase of 26 words from the pretest. In the last reading Annie read 158 WRCM (4 errors), or 1.23x acceleration which is a 30 word increase from the pretest.

A comparison, of the pretest and the two posttests of all the untrained passages (i.e., the test probes and the application passages), for each participant is displayed in Figure 2.

Insert Figure 2

Annie read 188 WRCM and 1 error in the endurance test and 195 WRCM with no error in the stability test.

On the pre-recall measure test Josh read 138 words/min and recalled 5 correct facts, but on the post-recall measure test he read 154 words/min and recalled 4 correct facts. Josh answered 18 questions correct on both of the question answering tests, but had the reading speed of 141 WRM and 187 WRM on the pre- and posttests, respectively. Rose read 152 words/min on the pre-recall measure test and 194 words/min on the post-recall measure test, and recalled 6 correct facts on both of the tests. On the pre-question answering test she read 159 words/min and answered 16 questions correct, but on the posttest she read 267 words/min and answered 17 questions correct. On the pre-recall measure test, Annie read 162 words/min and recalled 6 correct facts, but on the post-recall measure test she read 190 words/min and recalled 8 correct facts. Annie answered 18 and 17 correct questions, respectively on the question answering tests and had the reading speed of 165 words/min and 216 words/min, respectively.

The results of the interview, that was used to evaluate social validity, were that the participants overall liked the intervention procedure and would recommend it to others. They all stated that they had continued to use the reading support when reading difficult texts and planned to continue using it. Concerning the social importance of the results, Rose and Annie reported noticeable increase in reading fluency when reading in other settings than in the present study. In addition, both of them mentioned being more confident when reading out loud for others and both had received positive feedbacks about their reading presentation from their classmates. Rose also felt like she comprehended more of the content of what she read outside of the present study. Josh reported faster reading after the intervention when using a reading support but did not notice any remarkable difference in neither accuracy nor comprehension. The only drawback the participants mentioned was the demand of daily attendance.

Discussion

The purpose of the present study was to improve reading fluency, that is, speed and accuracy, in three adult students with the use of a multicomponent intervention. The intervention consisted of a reading support, performance criterion, response prompts, repeated reading (RR), performance feedback, and error correction procedure. The main findings indicate that all the participants' reading fluency improved following the intervention and they were overall pleased with the results.

Regarding accuracy, the number of errors was low and relatively stable for all the participants through all the phases, including the baseline phase, indicating floor effect. As a result of low number of errors during baseline an error correction procedure might have been unnecessary. However, the participants rarely made the same errors in two sequential readings during the intervention, and when stimulus prompts were used they never made the same error in the following reading. This implies that the error correction procedure was effective for specific errors even though overall number of errors did not decrease.

During baseline the reading rate of the test probes was stable for Rose and Annie. The baseline was not as stable for Josh whereas the score of Test probe 4 was considerably higher than the scores of the other test probes, but because Test probe 5 trended sharply in the opposite direction of the performance criterion it was considered acceptable to start the intervention. It should be mentioned that Test probe 4 had the fewest letters per word (LW) of all the test probes and based on its high score it can be inferred that number of LW was a good estimator of the difficulty level of the passages.

Before reading Passage 1 in the intervention for the first time the procedure was distinct from baseline by the use of a reading support and corresponding changes in instructions. Rose and Annie read faster in their first reading of the intervention than they did on all the test probes during baseline which indicates that the reading support and the changes in the

instructions might have been contributing factors to increase their reading speed. However, Josh read slower in the first reading of the intervention than during all the test probes on baseline and all the subsequent intervention sessions. A plausible explanation is that it was difficult to move the pen, which he used as a reading support in the first session, in a right way and at right pace such that the pen might have disrupted him rather than helped him. According to a self-report, Josh informed that he had more control when using his finger than a pen as a reading support. Together, those factors indicate that using a finger as a reading support contributed to increased reading speed for all the participants. However, an individualized performance criterion of a specific rate was also set prior to the first reading of the first intervention session. As studies have shown, setting such a performance criterion/specific goal is superior to not setting a performance criterion or only a general goal, such as “read as fast as you can”, regarding behavior improvement (Chard et al., 2002; Locke & Latham, 2002; Therrien, 2004). In the present study, setting a specific performance criterion might have functioned as an *evocative altering establishing operation* (Michael, 2000). In future research it might be interesting to examine further the mere effects of a reading support and the mere effects of performance criterion on reading speed, for example by using *alternating treatment design* (Kazdin, 2011).

The reading rate of the first readings of new passages displayed an upward trend toward the individualized performance criterion which confirms the findings of Lokke et al. (2009). The present results also displayed that RR of the same passage most often resulted in increased reading rate from the previous session for all the participants which is in accordance to the results of many other RR interventions studies (e.g., Polk & Miller, 1994; Samuels, 1979; Teigen et al., 2001). This indicates that when presenting the same sequences of words repeatedly for the participants a stronger stimulus control of the text was developed (S.P. Ardoin et al., 2008).

In the end of the intervention, fewer readings of each passage were required to reach the individualized performance criterion (an exception is the last passage for Annie) which is in concordance to the findings of Samuels (1979). Ardoin et al. (2007) pointed out that when people get multiple opportunities to read the same words, but in different passages, it contributes to stronger stimulus control of those words, and promotes the development of generalization of those words when they appear in new passages. We consider this a reasonable explanation for the results of the present study.

During the intervention, Josh and Annie did not reach their performance criteria after 15 readings for one and two passages, respectively. When they read those passages with 30 s timing they both reached the criteria after only one reading. When those passages were introduced again with 1-min timing (after training of all the passages was finished) they both reached their criteria after three readings. For Josh, this particular passage had the highest difficulty level (4.7 LW) of the passages that he read during the intervention which is likely to have affected his performance. The same accounts for one of the passages (5.6 LW) for Annie which, in addition, was the first passage used in the intervention. The other passage that Annie had trouble with was at a moderate difficulty level (5.4 LW) compared to other passages used in the intervention. However, with closer examination the experimenters found out that the first quarter of the passage was much more difficult (5.8 LW) than the rest. This indicates that the difficulty level of a passage seems to be an important factor in fluency building which is in accordance to the findings of other researchers on reading fluency (S.P. Ardoin et al., 2009; Christ & Ardoin, 2009). Even though we made an effort to control for the difficulty level of the passages an even smaller difference in difficulty level might have been necessary. Many procedures have been developed to estimate the difficulty level of texts (Evensen & Vagle, 2003; McShane, 2005), but it is very difficult to ensure that all the passages used in a single study are of the exact same difficulty level and no procedures

currently exist to do so (Christ & Ardoin, 2009). Annie needed 12 readings for Passage 10 even though that passage had rather low difficulty level (5.3 LW). The reason for this decreased performance in the end of the intervention is puzzling, especially because she only needed four to five readings for the previous three passages. It is most likely that some confounding variables affected Annie's performance; she mentioned for example being eager to finish the intervention because of upcoming exams in her study program at the university. To increase experimental control it would have been more suited to train passages until reaching stable performance for each participant rather than terminating the intervention after predetermined number of passages.

When the test probes were introduced again during the first withdrawal phase all the participants increased the reading rate of each passage compared to baseline measures. Besides, the average reading rate was also higher in the first withdrawal phase than the average rate of the first readings of the intervention phase. This further indicates stimulus control of single words when the participants read untrained passages with great word overlap. Moreover this strongly indicates generalization effect, that is, that the intervention was effective in increasing the reading rate of untrained passages (i.e., the test probes). For all the participants, the increase in reading rate of untrained passages was also maintained when the test probes were introduced again in the second withdrawal phase, which further supports generalization effects. Interestingly, on few test probes (twice for Josh and three times for Rose) the reading rate on the second withdrawal phase was slightly higher (23 and 7 words for Josh and 16, 3, and 6 words for Rose) than in the first withdrawal phase. This could be an example of practice effects since it was the third time the participants were exposed to the same passages, but because a significant time gap was between each exposure we consider it unlikely. However, it should be mentioned that the difference in reading rate

between the two withdrawal phases was only 1 and 6 words on average for Josh and Rose, respectively, and thus the average difference is insignificant.

For each participant, the reading rate of the passages tested during follow-up (retention) was not entirely maintained. However, even though the rate during the follow-up phase was not as high as the performance criterion it was both significantly higher than the baseline measures and the first readings of the passages used in the intervention. As such, compared to baseline all the participants showed increased reading rate of the passages that were directly trained during the intervention after a period of time had elapsed from the end of the intervention. This is in accordance with the findings of Hughes et al. (2007), that tested for RESAA after an implementation of PT intervention to improve reading fluency. Annie's reading rate on both the endurance and the stability tests was higher than the average reading rate of the first readings of all the passages during intervention although it was not as high as the performance criteria. For all the participants, the results of the application test following the intervention showed an increase in reading rate of untrained and more difficult passages with less overlap in content words than the passages used in the intervention. This supports the findings of Therrien (2004) which reviewed RR studies and found out that RR can be effective in improving reading fluency of untrained passages. In addition, the present results were maintained three months later for Josh and Annie. The results of the pre- and post comprehension (adduction) tests (i.e., the recall- and comprehension tests) indicate that there was not a remarkable change in general reading comprehension for any of the participants. Those findings do not confirm the results of Therrien's (2004) meta-analysis which indicated the potential of repeated reading interventions to increase comprehension in regard to new passages. Even though the participants of the present study were all slow readers, compared to average reading rate for adults, they had longer learning history and read faster than typical participants of RR intervention studies. Studies have shown that people that begin

intervention at higher reading level gain less improvement in comprehension than those that begin at lower level (Kuhn & Stahl, 2003) and that can explain the present results. The present results are also in concordance with the results of Vallely and Shriver (2003) which studied generalized effects of RR intervention on comprehension in secondary students, and did not obtain remarkable change. Besides, it is also worth mentioning that even though there was not an improvement in reading comprehension after the intervention, the comprehension level was maintained (i.e., the number of correct answers/recalled facts were similar) despite the increased reading speed of all the participants. That is, increased reading speed was not at the expense of reading comprehension. It is possible that ceiling effects can explain why the number of correct answers/recalled facts did not increase; regarding the question answering tests the participants answered majority of the questions correct in the pretest and therefore had little opportunity to improve on the posttest, and regarding the recall measure tests studies have shown (Gleitman, Fridlund, & Reisberg, 1999) that on average people are only able to recall 7 ± 2 items, which applies to the present results. In summary, the results of all those additional reading measurements (i.e., the RESAA tests) indicate that the performance criteria used in the present study were suitable to predict the specific learning outcomes of fluency or RESAA.

Even though all the participants improved their reading fluency on trained- (follow-up) and untrained (withdrawal and application) passages after the intervention the effects size was rather small; or from 1.13x to1.40x acceleration (while it was 1.5x for each passage during the intervention phase). It is possible that an emphasis on error correction restrained increases in speed, but as mentioned before an emphasis on accuracy can prevent learning (Binder & Watkins, 1990). This further supports our conclusion that the error correction procedure might have been too extensive or even unnecessary.

A limitation of the present study is that the intervention was multicomponent making it difficult to determine which components were essential in producing the observed effects. However, the components used in the intervention were decided after detailed research of the reading fluency literature (e.g., Alber-Morgan et al., 2007; S. P. Ardoin et al., 2007; Chard et al., 2002; Eckert et al., 2002; Hardardottir, 2007; Lokke et al., 2009; O'Shea et al., 1984; Polk & Miller, 1994; Samuels, 1979; Stangeland & Forsth, 2001; Therrien, 2004). Despite, it would be interesting for future research to either do a functional analysis, for example by using an alternating treatment design , or to use a *decreasing intensity design* (Barnett, Daly, Jones, & Lentz, 2004), to find out what factors are essential for the target behavior change and thereby to increase experimental control. In this case the use of decreasing intensity design would include that the whole multicomponent package would be implemented in the beginning to gain control over reading fluency relatively quickly and then single components of the package would systematically be withdrawn to reveal what components are essential for the behavior change.

Additional goal of this study was to implement a high quality within-subject experiment according to the quality indicators proposed by Horner et al. (2005). We applied the rating scale created by Chard et al. (2009) to evaluate the quality of the present study. Chard et al. required an average score of 3 on each indicator to evaluate a study to be of a high quality. According to our ratings the present study had the average of 3–4 points on each quality indicator proposed by Horner et al. (2005) and thus met the standards for high quality research. However, it is important to mention that no objective external raters rated the present study but only the experimenters that conducted it and thus the ratings might be subjective. On the social validity component of the rating scale the present study had the average score of 3, but only two points on two of the subcomponents. Despite, the participants were overall satisfied with the intervention procedure. Rose and Annie made

more positive remarks concerning the generalized effects of the intervention than Josh, but it is possible that those remarks were provided to please the experimenters. However, we consider it more likely that more intense intervention would have been required for Josh since he had more extensive reading problems from the beginning. It might be interesting to further investigate the difference between adult slow readers, with and without confirmed diagnosis of dyslexia, when using the procedure in the present study but studies have for example shown that people diagnosed with dyslexia have more eye fixations while reading than normal readers (De Luca, Borrelli, Judica, Spinelli, & Zoccolotti, 2002). Whereas the target behavior was considered socially important and the participants' reports provide support for both social acceptance of the procedure and social importance of the results, the present study can be determined as overall socially valid according to the three evaluation criteria mentioned in Wolf (1978).

The present study extends previous studies on reading fluency by that the participants were normally developed adult students since not many reading fluency studies have been published with that target population (Kruidenier, 2002; Strong, Wehby, Falk, & Lane, 2004). Another extension is that it was tested for all the aspects of RESAA, but according to Doughty, Chase, and O'Shields (2004) few published fluency studies have done that. In addition, the study improves the reading fluency literature by being evaluated as a high quality within-subject research according to the rating scale developed by Chard et al. (2009) which is based on the quality indicators to identify evidence-based practice for special education by Horner et al. (2005). It would be interesting to have objective raters rate the present study with the rating scale to see whether their ratings would result in similar scores. We recommend future researchers in reading fluency studies to make an effort to conduct high quality within-subject studies, for example by using the quality indicators proposed by Horner et al., in an attempt to increase experimental control and strengthen the research base.

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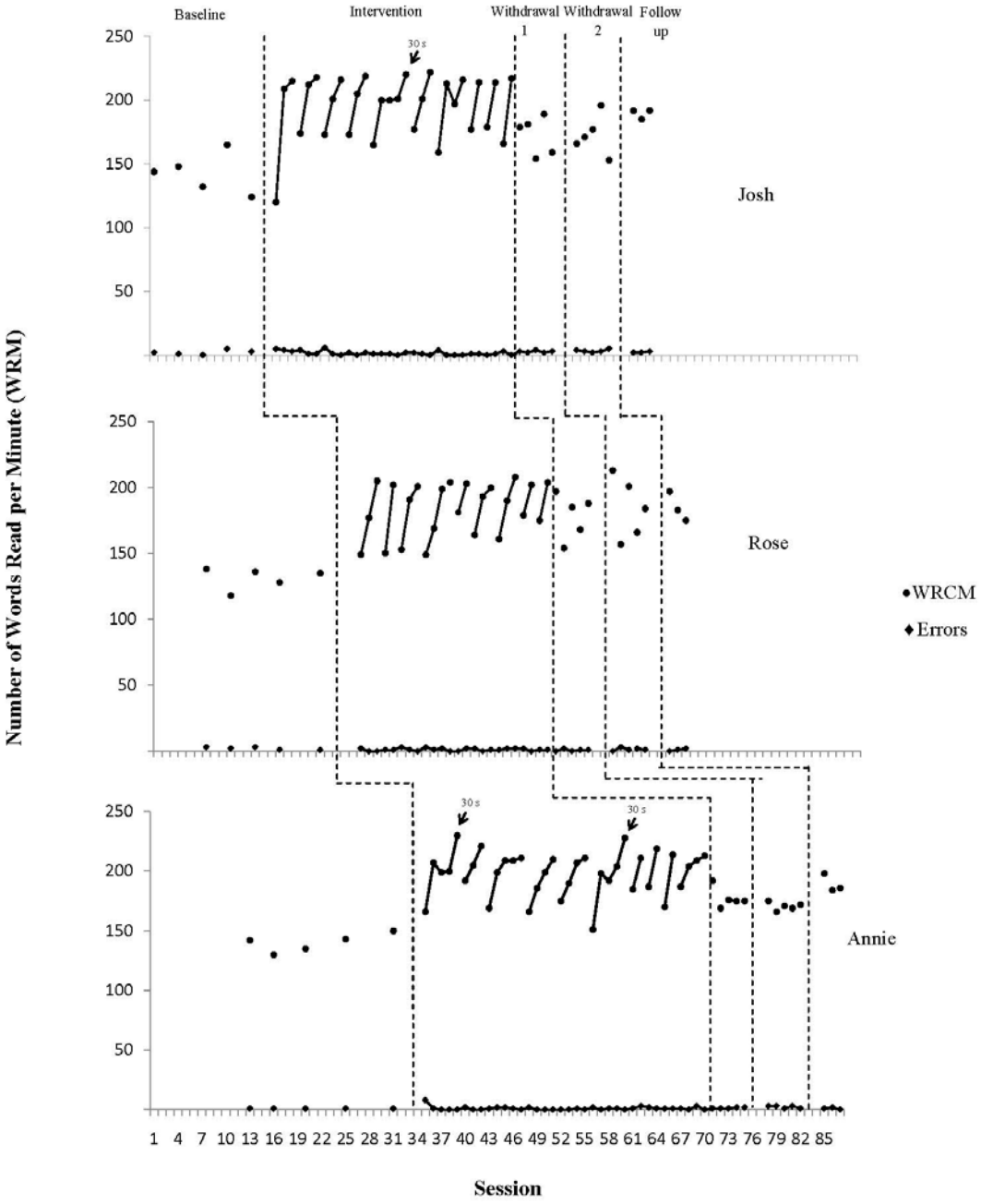

Figure 1. Number of words read correct per minute (WRCM) and errors on the test probes during baseline and withdrawal phases, along with the best reading of each session during intervention- and follow-up phases, for all the participants. The 30 s markings indicate sessions with 30 s timing.

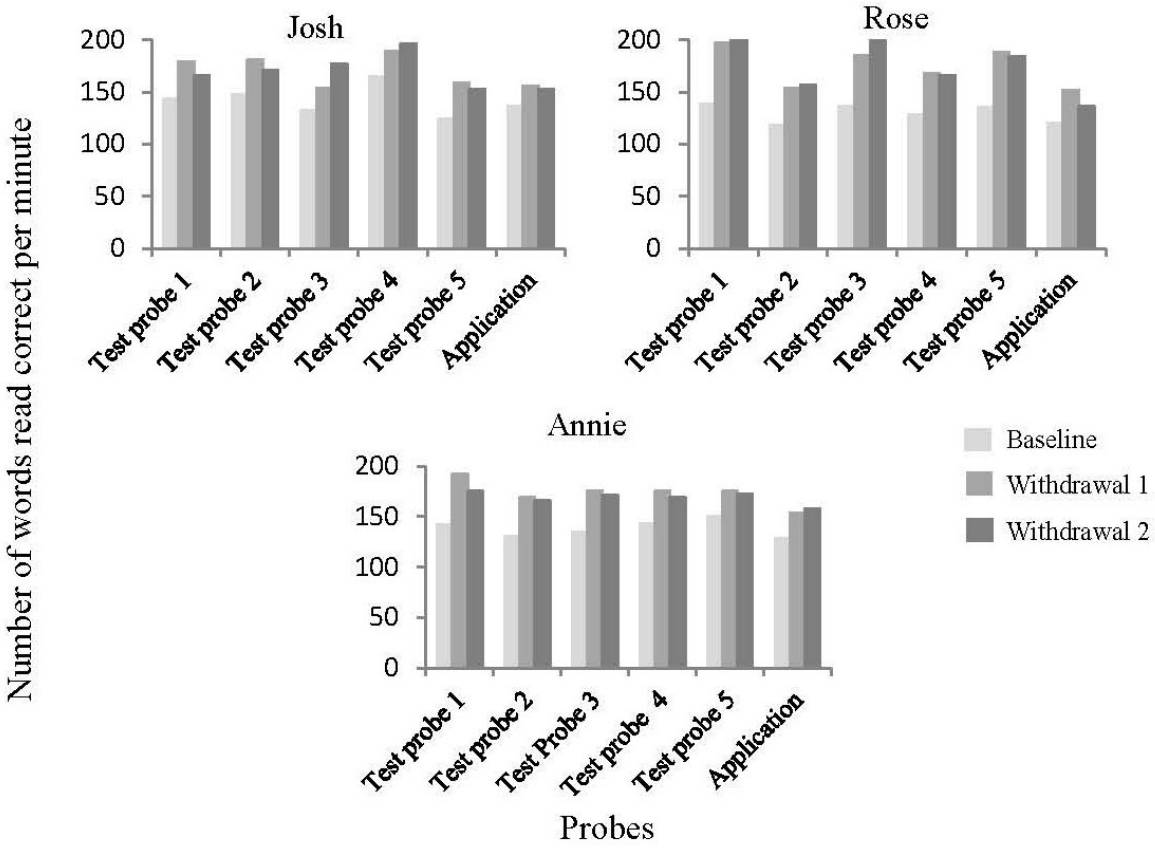

Figure 2. Number of words read correct per minute on the five test probes and the application passages during baseline, withdrawal phase 1, and withdrawal phase 2 for all the participants.

Appendix A
Informed consent

Kjeller, _____2010

Jeg _____ undertegner herved samtykke å delta i et forskningsprosjekt som er en del av mastergradsprosjektet til Hildur Valdimarsdottir og Lilja Yr Halldorsdottir ved studiet Master i læring i komplekse systemer ved Høgskolen i Akershus. Jeg har fått forklaring av målet og metodene som blir brukt i forskningen. Jeg har blitt informert om at jeg kan trekke meg ut av prosjektet på hvilket som helst tidspunkt uten noen konsekvenser for meg.

Jeg gir mitt samtykke til at data som blir samlet inn blir brukt og publisert i mastergradsoppgaven til Hildur Valdimarsdottir og Lilja Yr Halldorsdottir ved Høgskolen i Akershus og i en artikkel i et fagtidsskrift. Jeg er klar over at jeg har lov til å se alle data angående meg som blir samlet inn i forskningen og at dataene blir anonymisert ved prosjektslutt.

_____ _____

Signatur Dato

Initials:

Appendix B

Data Recording Sheet

Date																				
WRM																				
WRCM																				
ERROR																				
What error																				
Correction procedure																				
Reading support																				
Passage																				
Researcher																				
NB																				

Date																				
WRM																				
WRCM																				
ERROR																				
What error																				
Correction procedure																				
Reading support																				
Passage																				
Researcher																				
NB																				

Appendix C

Procedural Integrity Protocol

A comment: Whenever an item is irrelevant color the corresponding box grey

1. **Reading support instructions**
    a. The instructions are provided before the first reading support training in the first three sessions. The instructions must emphasize:
        i. Holding the reading support under the line, if not, do not check this.
        ii. Letting the eyes follow the reading support, if not, do not check this.
2. **Reading support training**
    a. At least three trainings in the beginning of the first three sessions, if fewer trainings, do not check this.
    b. At least one training in the beginning of other sessions, if no training, do not check this.
3. **Performance criterion**
    a. The personalized performance criterion stated in the beginning of relevant session, if not, do not check this.
4. **Error correction procedure**
    a. Points at errors from last reading; if not, do not check this
    b. Models the correct reading of the errors; if not, do not check this
    c. Drill
        i. If there are more than three errors, the errors shall be put on a power point slides but if there are three or less errors the errors are drilled right from the text but not put on slides. If this is done in another way; do not check this.
        ii. Rereading implemented correctly; if not, do not check this. Correct rereading includes:
            1. If **not** on slides each error is read independently at least five times correctly in a row.
            2. If on slides all the words/phrases are read in a sequence and all of them are read correctly five times in a row.
        iii. Words/phrase drill used appropriately; if not, do not check this**.**
            1. If the error is an incorrectly read noun only the noun must be drilled.
            2. If the error is a word omission, insertion of a word, replacement of a word or an incorrectly read word in another word class then a noun, a phrase of two to four words including the error is drilled.
    d. **Prompt** used appropriately; if not, do not check this.
        i. If the same error is made in two consecutive readings the error is highlighted on the participant's copy of the text before next reading.
5. **Instructions correctly given**.
    a. The instructions given in the baseline-, withdrawal- and follow-up phases are:

1. **Norsk: ”**Les høyt til stoppeklokken ringer. Les så fort som du kan, les alle ordene og prøv ikke å gjøre feil. Du kan begynne å lese når du er klar”.
2. **English:** ”Read out loud as fast as you can until the timer rings. Read all the words and try not to do errors. You can start when you are ready.”

ii. The instructions do not have to have point to point correspondence, but all the items on the procedural integrity checklist for those phases must be said.

b. The instructions given before the first reading on the first three intervention sessions are:
    1. **Norsk:**”Les høyt til stoppeklokken ringer. Les så fort som du, les alle ordene og prøv ikke å gjøre feil. Hold lesepinnen under linjen som du leser, flytt pinnen litt fortere enn du leser så at øynene følger pinnen men ikke omvent. Du kan begynne å lese når du er klar”.
    2. **English:”**Read out loud until the timer rings. Read as fast as you can, read all the words and try not to do errors. Hold the reading support under the line you are reading, move it a little bit faster than you read so your eyes follow the support but not vice verse. You can start reading when you are ready”.

ii. The instructions do not have to have point to point correspondence, but all the items on the procedural integrity checklist for the first three intervention sessions must be said.

c. Before the first reading of other sessions speed, accuracy, and reading support must be emphasized, otherwise, do not check this.
d. Before all other readings the instructions must emphasize speed, otherwise, do not check this.

Other components of the instructions above can be mentioned but are not necessary.

6. **Starts the timer before the second word of the text has been read.**
    a. If the participant has finished reading the second word, do not check this.
7. **Timing**
    a. All timings shall be 1 min except if the participant has read the same passage 15 times then the timing shall be 30 s, otherwise, do not check this.
8. **Marks errors while the participant is reading**
    a. If errors are marked afterwards, e.g. by listening to a recording or discussing errors afterwards with another observer or the participant, do not check this.
9. **Performance feedback**
    a. Gives feedback based on performance, i.e. **provides the number of words read;**
        i. Total read words; if not, do not check this

ii. **Correct read words**; if not, do not check this
iii. **Errors**; if not, do not check this

10. SCC

a. The participant records the best score of the session on a Standard Celeration Chart, if not, do not check this.

Appendix D

Procedural Integrity Checklists

Procedural integrity checklist for baseline-, withdrawal-, and follow-up phases:

Instructions correct	
Read out loud	
Read as fast as you can	
Read all the words	
Try not to do errors	
Timer started on time (see protocol)	
Error marked during reading	

Procedural integrity checklist for the first three intervention sessions:

Int. *part.****,*** *date* ***(session), int.*** *obs.*	**YES**			
Reading support instructions	If not relevant color the boxes grey			
Reading support under the line				
Eyes follow support				
Reading support training				
At least three trainings before reading				
Performance criterion stated				
Error correction procedure	If not relevant color the boxes grey			
Points out errors from last reading				
Models error correctly				
Appropriate drill procedure (slides or not, see protocol)				
Rereading correctly implemented (see protocol)				
Words or phrases drilled appropriately. (see protocol)				
Prompt used when relevant/prompt not used if irrelevant (see protocol)				
Instructions correct				
Read out loud				
Read as fast as you can				
Read all the words				
Try not to do errors				
Reading support under the line				
Reading support faster than reading				
Eyes follow support				
Timer started on time (see protocol)				
Timing for 1 min/30 s (see protocol)				
Error marked during reading				
Performance feedback / Number of words read				
Total words				
Correct words				

Errors				
About errors	If not relevant color the boxes grey			
Points out errors from last reading				
Models error correctly				
SCC				

Procedural integrity checklist for all the intervention sessions from session four:

Int. *part.*, *date* ***(session), int.*** *obs.*	**YES**			
Reading support training				
At least one training before reading				
Error correction procedure	If not relevant color the boxes grey.			
Points at errors from last reading				
Models errors from last reading correctly				
Appropriate drill procedure (slides or not, see protocol)				
Rereading correctly implemented (see protocol)				
Words or phrases drilled appropriately (see protocol)				
Prompt used when relevant/prompt not used if irrelevant (see protocol)				
Instructions correct				
Speed emphasized				
Accuracy emphasized				
Remember the reading support				
Timer started on time (see protocol)				
Timing for 1 min/30 s (see protocol)				
Error marked during reading				
Performance feedback/ Number of words read				
Total words				
Correct words				
Errors				
About errors	If not relevant color the boxes grey			
Points at errors from reading				
Models errors from reading correctly				
SCC				

Appendix E

Interview guide

1. Legger du merke til noen endringer i forbindelse med lesing etter du startet i prosjektet?

   a) Leser du fortere?
   b) Leser du nøyaktigere?
   c) Husker du mer av det som du leser?
   d) Forstår du mer av det som du leser?

2. Var deltakelsen i prosjektet nyttig på noen måte?

   a) Hvis ja, på hvilke måter da?
   b) Hva synes du er den største fordelen ved deltakelsen i prosjektet?

3. Var det noen ulemper ved deltakelsen i prosjektet?

   a) Hvis ja, hvilke ulemper?

4. Hvis du fikk tilbud til å fortsette med treningen ville du takke ja til det?

5. Kommer du til å trene videre selvstendig?

6. Ville du anbefale andre å trene leseflyt på denne måten (dvs. lese samme teksten ofte, trene på feil og bruke lesestøtte)?

7. Hva synes du om bruken av lesestøtten?

   a) Tror du at du kommer til med å fortsette å bruke lesestøtte hvis du skal lese en tekst fort?

8. Hva synes du om bruken av Standard endringsskjemaet?

   a) Var det nyttig å registrere selv?