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Mental retardation and reading rate: effects of precision teaching

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Abstract

This study evaluates the effectiveness of a brief intervention programme (word recognition) aimed at increasing the reading rates of two pupils with mental retardation. The program used frequency-building procedures aimed at increasing reading rates for either common words, the programme used Precision Teaching to monitor intervention effectiveness. Results showed that the two word recognition training participants made significant gains in overall reading skills. This study provides additional evidence for the effectiveness of Precision Teaching and frequency-building procedures, and word recognition as well as support for the idea that successful reading interventions need not require time-consuming resources.

Keywords: Precision Teaching, Words, Fluency, Retardation, Reading

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1. Introduction

Significant research advances have been made in recent years in the area of mental retardation (Perini & Bijou, 1993; Iwata, Bailey, Neef, Wacker, Repp, & Shook, 1997; Greer & Ross, 2007). Unfortunately, educational programs and teaching strategies have remained virtually untouched by these findings. There is still a general tendency to emphasize the development of physical and social skills, in the belief that children with mental retardation have very little potential for cognitive development. An incredible number of stereotyped clichés have grown up around this socially excluded group we call the "retarded" that they are "slow learners" needing slow teaching. In particular currently available curricula, do not take into account levels of learning such as fluency (Heward, 2003a, 2003b; Kubina, 2005). We propose that fluency increases the functionality of skills for students with mental retardation and should be systematically programmed into a curriculum. In general, the term fluency has entered into the vernacular for most people. When asking someone to provide synonyms for fluency (e.g., to describe a fluent speaker, dancer, or writer), words such as smooth, flowing, accurate, graceful, automatic, and effortless may be given.

How can teachers best provide fluency instruction for their students with mental retardation? One answer lies in a technique called Precision Teaching. Developed by Ogden Lindsley in the 1960s, Precision Teaching procedures have consistently demonstrated great potential for strengthening any school curriculum (Beck & Clement, 1991; Lindsley, 1992) and with children with mental retardation (Fabrizio, Pahl, & Moors, 2002; Cavallini, Berardo, & Perini, 2008) is a general approach that can help a teacher to determine whether their teaching is having the desired effects on learning. The concept of PT, rests on four founding principles: "(1) the child knows best: in the sense that a child's response to a task or learning approach is the best indicator of whether a given teaching method is working with that child; (2) Focus on observable behaviours: a practical rule that makes it possible to take accurate counts, to monitor whether a child is improving in response to the current teaching method; (3) Use frequency measures to monitor performance: PT focuses on rate, or frequency of responding, which can only be measured by using the number (or count) of correct and incorrect responses within a given timeframe; and (4) Use a standardised graphic display, standard celeration chart, to record performance measures and make instructional decisions" (Hughes, Beverley, & Whitehead, 2007, p. 2). The four principles have been described in greater detail in several publications (West, Young, & Spooner, 1990; White & Neely, 2004; Calkin, 2005).

Research shows that Precision Teaching can facilitate growth in reading fluency and other aspects of reading achievement (Adams, 1990; Therrien, 2004) also for children with mental retardation (Sulgrove, & McLaughlin, 2004; Cavallini *et al.*, 2008). A solid foundation for reading is created by sys-

tematically establishing the basic components of reading and then bringing those skills to fluent levels. In fact, if component skills are not fluent, moving on to tasks predicated on those skills makes learning more difficult and may ultimately lead to dysfluency in that subject (Kubina, Young, & Kilwein, 2004).

Reviews of the Italian reading literature for tipically developed children (Tressoldi, Vio, Lorusso, Facoetti, & Iozzino, 2003; Riccardi Ripamonti, Truzoli, & Salvatico, 2004; Cazzaniga, Re, Cornoldi, Poli, & Tressoldi, 2005) and for children with mental retardation (Fedeli & Meazzini, 2004; Cavallini *et al.*, 2008) point to two behaviours that most likely function as foundational skills for reading: syllable recognition and word recognition. The general notion is that if students are fluent in decoding skills, they will spend "less time and effort... directed to recognition activities" (Gunderson, 1984, p. 267). The correlation between fluency and reading comprehension was clearly established by a large-scale analysis of data from the National Assessment of Educational Progress in Reading (Pinnell, Pikulski, Wixson, Campbell, Gough, & Beatty, 1995). Reading fluency refers to rapid, efficient, accurate word recognition skills that permit a reader to construct the meaning of text. Fluency is also manifested in accurate, rapid, expressive oral reading and is applied during, and makes possible, silent reading comprehension. Precision Teaching represents an educational strategy for building reading fluency in which a student rereads words or syllables until meeting a criterion level (Cavallini *et al.*, 2008). Cavallini and Perini (2009), found that, in typically developed children, promotion of sublexical component fluency does not show evidence of influencing reading as a general performance. Conversely, the automatization of word recognition positively affected text reading. The current study evaluate the efficacy and efficiency (in term of educational time) of teaching frequent words to fluent levels in 2 children with mental retardation.

2. Method

2.1 Participants

Two children participated: Mara was 8 years old girl with Down Syndrome, she had a mental age equivalent score of 4 years 9 month on the WISC-R (Wechsler, 1974) and was enrolled in an elementary school, Nicolò was 8 years old, with mental retardation due to cerebral palsy, he had a mental age equivalent of 5 years 2 months on the WISC-R (and was enrolled in an elementary school in San Damiano (PV). Both participants could name all of the Italian-language letters and syllables.

The children's parents gave informed consent for their children's participation in the study. Each child was assigned a teacher-researcher who

worked daily with the child, and a supervisor who evaluated the pupils' progress once a week.

The research setting was a room at the Tice Learning Centre, a learning center near Piacenza, presenting a unidirectional mirror, a desk, and two chairs.

2.2 Stimuli and apparatus

During the experimental phase a digital timer was used for practice sprints. The children's performance data were entered on a standard celeration chart and on a registration sheet. Specifically, the participants' best trial performances were recorded on the single subtask standard celeration charts, but the children's mean score for three age-graded reading scores (see below) was registered on a specific, age-graded-text reading standard celeration chart. A data collection sheet was used to guide the teaching. The data collection sheet, contained the teacher indications concerning appropriate instructions, correction procedures, etc., was used to define curricula (see below), trial number, trial duration, and errors (including instructions on how give the pupils feedback on them).

2.3 Instructional and testing materials

Curriculum: the material used for the experimental phase, the word-fluency programme, was a "curriculum" developed by the Tice Learning Center (Cavallini, Andolfi, Berardo, & Pignoli, in press). The curriculum lists the 1,000 most frequent words in the Italian lexicon (Marconi, Ott, Pesenti, Ratti, & Tavella, 1994) subdivided by length (from 3 to 12 letters). Specifically, the curriculum contains 35 three-letter words, 104 four-letter words, 184 five-letter words, 202 six-letter words, 180 seven-letter words, 139 eight-letter words, 71 nine-letter words, 64 ten-letter words, and 21 eleven- and twelve-letter words. The words are presented on worksheets listing 10 (same-length) words on each, which are randomly ordered into 10 x 10 tables.

2.4 Measures

The study used a single-participant experimental design in which the two pupils receiving were monitored throughout the programme in terms of number of words correctly read per minute and numbers of learning opportunities; a multiple baseline across participants was used to evaluate the effectiveness of the training. This design addresses the impact of the treatment of the independent variable on the dependent variable, the same behavior, for different participants. Once a baseline has been established, the treatment or independent variable was applied to one of the participants. During this time, baseline was maintained for the other participants. Once improvement is seen for the first participant, the treatment is started with the second subject.

Test were conducted before, during and following the intervention for the two participants before, during, and at the end of training, to analyse the effects of training on age-graded text reading speed. The tests were conducted according to procedures (Curriculum Based Measurement; Deno, 1985); that is, conducted by presenting the participants with three different texts, in different times, selected from a reading series written for third-form children (third-grade reading level).

2.5 Procedure

The two children participated in two 40-minute sessions per week, for a period of approximately 5 months. During the training period, the participants conducted brief practice sprints (duration approximately 10 seconds) aimed at increasing fluency in frequent word recognition. The two pupils participated each session in 18 sprints (range 12-20 secs.); that is, two sprints per worksheet (3, 4, 5, 6, 7, 8, 9, 10, 11 letter words).

Each child worked with a single teacher-researcher in a Tice Centre training room, while another researcher observed the session through the two-way mirror and verified the validity of the teacher-researcher's recordings. Before beginning the worksheet sprints, the children were informed of the fluency aims relative to each series of words, and the experimenter prompted each child to do his/her best on each trial (e.g., "Come on; you can beat the record!"; "Now, try to be as fast as lightning!"). The conditions for receiving positive reinforcement were explained to the children (a token was given each time they beat their own record); their attention was drawn thereby to the idea of "competing with, and outdoing" themselves. Indeed, these are examples of some specific aspects of Precision Teaching that help children focus on their own learning progress (considered as a positive difference in successive performances) and on their own improvement. The children were instructed to read as fast as possible, to skip words that were too difficult, and to continue working until the timer sounded. In line with Precision Teaching procedures, the number of words presented per page in a given session was higher than the number of words that each participant could have managed to read in that session. Each child read the words from right to left and went through the two or three practice sprints for each group of words, as described above (At the end of each sprint, the word list was substituted by a different version that had the same words, but in a different order).

Fluency aims were determined by using White's (1985) procedure; that is, by taking the average score of 6 competent peers (7 years old) carrying out the same task. A frequency range comprising 60 and 100 words per minute was chosen for words.

When children made errors during the sprints, the experimenters wrote the word on a flashcard. At the end of the sprints, and after having given the pupils feedback on their performance, the teacher-researchers helped the

pupils read the error flashcards (word/syllable). The children were prompted to sound the error word out (e.g., "okay, this card says az-zur-ro [light-blue]; now you try") then, the experimenters marked down the highest score for the three word drills on the children's standard celeration chart, showed them their progress, and commented on the results. To evaluate the efficacy of training with respect to speed improvement in age-graded text reading (i.e., observed in composite skills after practicing component skills and defined as "application"; Kubina *et al.,* 2004; Hughes, Beverley, & Whitehead *et al.*, 2007; Cavallini & Perini, 2009), the participants were presented with three different texts per week, and specifically, the CBM tests taken from a book series written for 6- to 7-year-old children. During evaluation, the texts were presented to the children without illustrations, on an A4-size sheet of paper; the teacher-experimenters worked with a copy of the same page, upon which they marked the child's reading errors. The children read each of the three texts aloud for one minute and, upon conclusion of the three trials, the experimenters recorded each child's mean error- and correct syllables score calculated by adding the number of correct or wrong syllables and dividing them by 3 on his standard celeration chart. The children were not corrected or given feedback on their performance during these tests. The first test was administered one month before training had begun; the final trial was conducted one month upon conclusion of the training programme; and the experimental-phase CMB tests were administered each week until the end of the school (for a total of 20 trials), because both of the children were supposed to leave after the end of the school.

3. Results

The children's individual results for the component skill (words) were registered on their standard celeration charts; the participants had 9 standard celeration charts (one for each set of different word lengths). Figure 1 shows a typical example of standard celeration charts relative to 3-letter-word reading. Standard celeration charts were used for the dual purposes of monitoring pupil progress and making immediate learning decisions (White, 1985). Table 1 lists the two participants' first- and last- session results for the single word sets.

Figure 1 - *Example of Standard Celeration Chart for 3-letter word reading (Participant 1)*

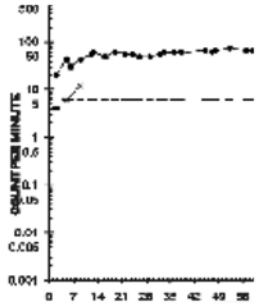

Table 1 - *Correct rate scores at first and last session on different lenght words (from 3 to 11), the number of practice sprints and the total active time (seconds)*

	PARTICIPANT 1				PARTICIPANT 2			
Letters for word	FIRST SESSION	LAST SESSION	NUMBER PRACTICE SPRINT	TOTAL ACTIVE TIME: seconds	FIRST SESSION	LAST SESSION	NUMBER PRACTICE SPRINT	TOTAL ACTIVE TIME: seconds
3	7	19	80	800	6	19	48	480
4	8	20	82	820	9	18	50	500
5	7	15	92	920	5	13	48	480
6	7	16	90	900	6	15	52	520
7	5	15	110	1100	4	13	64	640
8	6	16	108	1080	3	10	71	710
9	4	12	108	1080	4	9	70	700
10	4	10	110	1100	2	6	64	640
11	2	11	110	1100	3	8	70	700
Total			890	8900			537	5370

3.1 Age-graded text reading

The frequency of age-graded text reading (expressed as the number of correct syllables per minute) increased for the participant 1 during the word-fluency program phase but remain at the same level for the other child (participant 2), until she began the program and her reading frequency jumped up. Table 1 summarises each participant's training duration, initial frequency, and final frequency. Figure 2 shows the trend on the age-graded text reading frequencies obtained by the two participants at the beginning, midway through, and at the end of the study.

Figure 2 - *Pre-post test difference expressed in terms of syllables per minute in age-graded text reading for the study's two participants. The Y-axis indicates frequency (count per minute) on an interval scale ranging from 0 per minute to 70 per minute. For each participant the fluency scores (correct and errors) for the start rate, the end rate*

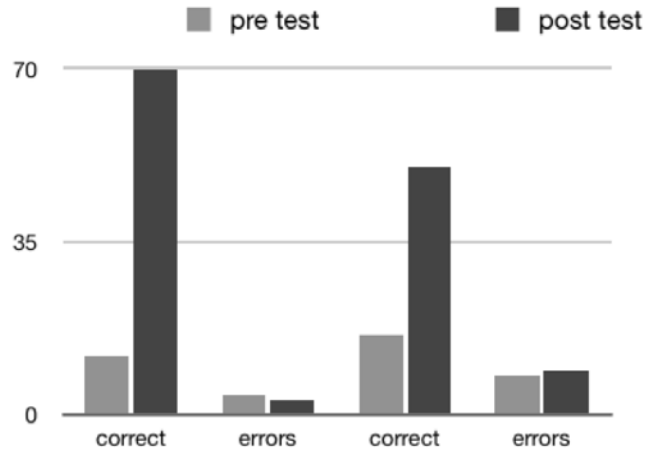

Table 2 - *Training duration, initial frequency, and final frequency of age-graded text reading (expressed as the number of correct syllables per minute)*

Participant	Total time	Pre-test correct	Post-test correct	Pre-test errors	Post-test errors
1	148 min	12	70	8	4
2	89 min	16	50	9	3

3.1 Age-graded text reading

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The C test (Caracciolo, Larcan, & Cammà, 1986) is a statistical test allowing for verification of the significance of the efficacy of an intervention. The table 3 summarises the C- and Z-scores relative to the data obtained by the two participants in the text reading trials. The scores obtained with the C-statistic, were transformed into Z-scores and then used to verify the significance indices for each participant series obtained in the text reading trials. Figure 3 shows each participant's progress in age-graded reading (composite ability). It is evident that, although reading frequencies increased significantly for the child who had received word-fluency program, the other child had no significant effects on text reading before the beginning of the training. As you can see from the graph, the frequency of learning opportunities (errors) do not significantly decrease for the two children during the intervention.

Figure 3 - *Best score pairs for participants on CBM probes, expressed in terms of number of correct syllables per minute. The Y-axis indicates frequency (count per minute) on an interval scale ranging from 0 per minute to 70 syllables per minute, the X-axis represents practice sessions*

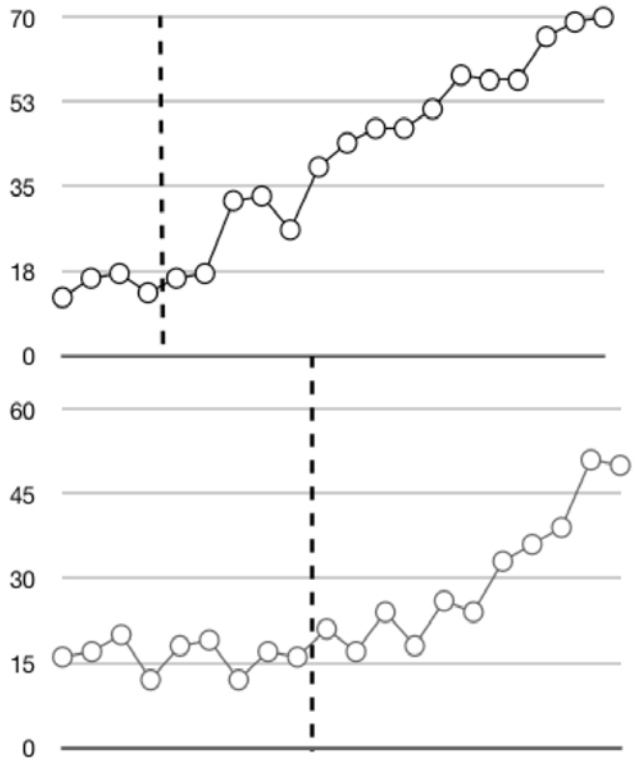
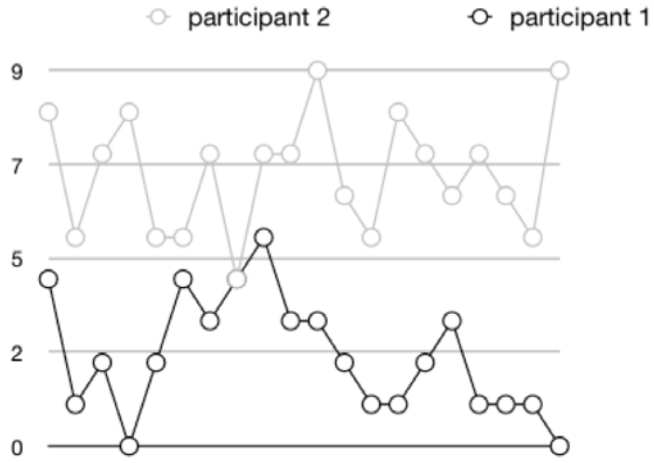


Table 3 - *C and Z-scores relative to the data obtained by the two participants in the text reading trials*

Participant	C	sc	Z	p
1	.929	.234	3.964	.01
2	.851	.284	2.796	.001

Figure 4 - *Best score pairs for participants on CBM probes, expressed in terms of number of incorrect syllables per minute. The Y-axis indicates frequency (count per minute) on an interval scale ranging from 0 per minute to 9 syllables per minute, the X-axis represents practice sessions*



3.2 Intervention duration

Each participant's Precision Teaching programme duration was calculated by summing the times (in minutes) during which the participants were actively involved in practice sprints. The mean was 89.5 minutes (range 99-80), subdivided into 10-second drills (range 594 - 480 total drills).

4. Discussion

One of the aims of the present study was to evaluate the extent to which fluency training in the component elements of reading would promote

greater improvement in age-graded text reading, an ability considered by Precision Teachers to be a composite skill (Kubina *et al.*, 2004; Cavallini & Perini, 2009) in two children with mental retardation. Despite the present study's limitations (small number of participants, no control), the data gathered and the results obtained lend themselves to a timely and interesting discussion. In our study, not only did the participants who became 'automatic' in reading frequent word recognition improve in the single curricula, they also developed a significant difference between their pre- and post-test scores (approximately 45 syllables per minute) as well as a significant improvement trend during the experimental phase (C=.929 for participant 1 and C=.851 for participant 2): in both applications, the series obtained is verified with the C statistic, the result is statistically significant and the presence of a trend change is inferred (DeCarlo & Tryon, 1993). The second consideration concerns the participants' errors: despite improvement in world reading frequency, the two children showed no significant improvement in accuracy, expressed either as a pre- to post-test difference or in terms of a significant trend observed during the treatment phase (as evaluated by the C-test). It seems that the training is very useful in increasing correct words reading frequency but we need other intervention to build accuracy. In general, results are in line with studies conducted with typically developed slow readers of English (Hughes *et al.*, 2007) and Italian (Cavallini & Perini, 2009) and appear to be of marked interest for children with mental retardation. Conversely, the automatization of word recognition positively affected text reading. A closer examination of this observed effect reveals the efficacy of Precision Teaching methodology, both as a clinical effect (an improvement, on average, of 45 syllables per minute) and in terms of intervention duration: in little more than an hour and half of practice, the two participants showed improvement that went beyond that typically achieved by normal readers in an entire school year of normal children. If we consider the effects correlated with an increase in reading speed, such as text comprehension (Fuchs & Fuchs, 1986; Nathan & Stanovich, 1991; Therrien, 2004), it appears evident that Precision Teaching used in association with a word-recognition curriculum can represent an effective intervention instrument for teachers and educators. The use of brief practice sprints, constant monitoring of results, and the promotion of a sense of fun during repetitive practice (sprints) offers a new effective way to exercise many instrumental abilities that are typically considered to be "boring", but are crucial to achieving academic goals for children with mental retardation. As we discuss in the introduction a related piece of wisdom goes like this: students with disabilities can learn, but they learn more slowly; therefore, they should be given extra time and instruction should be given at a slower pace. Although this reasoning possesses a degree of logic and common sense, research has found that slowing the pace of instruction makes things worse, not better, for students with mental retardation

(Heward, 2003a, 2003b). For example, Carnine (1976) conducted an experiment in which instruction was presented to four first-grade remedial reading student at two paces: slow (interval 5 seconds) and fast (interval 1 seconds). Fast-paced instruction resulted in more learning trials presented by the teacher, more responses per lesson by the students, better accuracy of students responses, and better on-task behavior. Systematic replication of this study yielded a similar pattern of results (e.g. Carnine & Fink, 1978; Koegel, Dunlap, & Dyer, 1980; Darch & Gersten, 1985; Williams, 1993).

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