DYSLEXIA
Published online in Wiley InterScience
(www.interscience.wiley.com) DOI: 10.1002/dys.359

Fluency Remediation in Dyslexic Children: Does Age Make a Difference?

Patrizio E. Tressoldi[1,*], Maria Luisa Lorusso[2], Federica Brenbati[3] and Roberta Donini[3]

[1] *Dipartimento di Psicologia Generale, Università di Padova, Padova, Italy*
[2] *Istituto Scientifico "E. Medea", Bosiso Parini (LC), Italy*
[3] *Studio Abilmente, Milano, Italy*

This study tested the hypothesis whether older dyslexic children may obtain fewer gains on fluency and accuracy with respect to their younger peers after specific remediation.

Changes in accuracy and fluency of a group of children with a diagnosis of dyslexia attending third and fourth grades were compared with those obtained by a group of children attending the sixth, seventh or eighth grade in two different treatments, one based on the Balance model (Bakker) and the second based on the automatization of syllable recognition (sublexical).

Among all comparisons between the gains in accuracy and fluency obtained by the two groups, only the younger group in the sublexical treatment obtained a statistically significant gain with respect to their older peers' accuracy in reading words.

These outcomes suggest that, at least for the chronological ages and types of treatments considered in this study, older children with dyslexia may obtain comparable gains to their younger peers, suggesting that 'it is never too late' to remediate reading fluency and accuracy. Copyright © 2007 John Wiley & Sons, Ltd.

Keywords: developmental dyslexia; fluency; accuracy; chronological age

There is a general agreement that 'earlier intervention to ameliorate reading is better than late intervention' (Forman & Moats, 2004; Nicolson, Fawcett, Moss, Nicolson, & Reason, 1999). However, it is not clear if this recommendation is important to prevent side effects on school motivation and achievement, or if it implies that, '*ceteris paribus*', younger children have a better capacity for improving their reading level because of an assumed better plasticity of their neurobiological condition (Draganski, Gaser, Busch, Schuierer, Bogdahn, & May, 2004; Green & Bavelier, 2003).

*Correspondence to: Patrizio E. Tressoldi, Dipartimento di Psicologia Generale, via Venezia 8, 35131 Padova, Italy. E-mail: patrizio.tressoldi@unipd.it

To test directly if there are differences in gains on accuracy and fluency between younger and older participants with a diagnosis of dyslexia after a specific treatment, it is necessary to compare directly gains obtained by different age groups.

The importance of fluency for efficient reading is well acknowledged (Allington, 1983). However, in the remediation of reading disabilities (RD), this characteristic has not been the first aim of many intervention studies, even if its importance has been widely recognized (Kame'enui & Simmons, 2001; Wolf & Katzir-Cohen, 2001). Very few clinical trials have reported on the efficacy of improving reading fluency in children with developmental dyslexia. As Lyon and Moats (1997) wrote, 'it also critical to recognize that in all of the NICHD intervention studies to date, improvements in decoding and word-reading accuracy have been far easier to obtain than improvements in reading fluency and automaticity' (p. 579). This situation was confirmed by the meta-analysis of Necoechea and Swanson (2003), where it was found that 90% of the studies included standardized dependent measures of real word-reading accuracy, whereas none included measures of fluency.

A recent meta-analysis by Chard, Vaughn, and Tyler (2002) on interventions to improve reading fluency in students with learning disabilities identified 24 studies from 1975 to 2000, including both group studies and single-case studies. The mean effect sizes for the different intervention categories were in the moderate range (0.68 for repeating reading without a model, an adult or a proficient peer; 0.71 for repeating reading with multiple features, i.e. modelling, listening audiotapes, apply strategies), according to Cohen's (1988) criteria. However, it is important to note that only a few studies used standardized instruments such as the *Gray Oral Reading Test* (Wiederholt & Bryant, 2002) or the *Schonell Word Recognition Test* (Schonell & Schonell, 1960) to document their results. The same problem was observed in Kuhn and Stahl's (2003) review of remedial practices for fluency with both low-achieving children and children with learning disabilities.

If fluency is considered an important goal in the treatment of RD in languages with irregular orthographies as suggested from all this literature, it represents the main goal for regular orthographies. Cross-linguistic comparisons between typical readers show clearly that accuracy is usually almost perfect after some months of general education for Italian and German readers, whereas English or Danish readers are still struggling to assimilate the orthography–phonology rules (Seymour, Aro, & Erskine, 2003). A direct comparison between German and English children with dyslexia by Landerl, Wimmer, and Frith (1997) showed that for English children with dyslexia, the average error rate was still as high as 30–40% for short one- and two-syllable words and nonwords. On the contrary, German children with dyslexia had an average error rate of less than 10% on a closely matched set of items.

Even though German children with RD could develop high reading accuracy, their reading remained slow and laborious (Wimmer, 1993, 1996). Wimmer and Mayringer (2002), for example, reported a standard word-reading rate of between 170 and 190 syllables per minute in typical 9-year-old German-speaking children, whereas different samples of children with RD only managed to read between 70 and 95 syllables per minute on the same set of words. Similar findings of high reading accuracy, but deficient reading fluency in children with dyslexia have

DOI: 10.1002/dys

also been reported for other languages with regular orthographies such as Norwegian (Lundberg & Hoien, 1990), Spanish (Rodrigo & Jimenez, 1999), Dutch (Yap & van der Leij, 1993), or Italian (Zoccolotti *et al.*, 1999).

The deficit in reading fluency is not only a serious impairment, but it is also highly persistent. Klicpera and Schabmann (1993) showed that the majority of German-speaking children with a reading fluency deficit in Grade 2 still presented seriously delayed reading speed in Grade 8. The most likely explanation for reading problems in German is the aforementioned deficit in the buildup of orthographic representations that would allow children to move on from accurate, but slow and laborious decoding to direct and, therefore, fast and effortless word recognition.

Such an association problem could be the consequence of a slow and inefficient phonological lexicon (Snowling, 2000) or of a more general neurological timing problem preventing visual and phonological areas from being activated at the same time (Breznitz, 2002; Breznitz & Lauren Berman, 2003; Paulesu *et al.*, 1996; Wolf & Bowers, 1999). According to this hypothesis, dysfluent readers have a deficit in storing words or parts of words in the orthographic lexicon as a consequence of a lack of multiple, redundant associations between the single graphemes and grapheme clusters of word spelling and the single phonemes or larger morphophonological segments (e.g. syllables, morphemes, onsets, rimes) of word phonology. If this explanation is correct, then it should be possible to help poor readers to build up orthographic representations by highlighting the correspondences between the visual/graphemic segments and the phonemic and phonological elements within words.

Tressoldi, Iozzino, and Vio (2007) demonstrate the efficacy of a reading method that facilitates the identification of syllables, the sublexical units that are more consistent in regular orthographies (Carreiras, Alvares, & De Vega, 1993; Carreiras & Grainger, 2004), to build up orthographic representations of recurrent syllables and automatizing their recognition to achieve accurate and faster word recognition, on two samples of Italian children from the second to eighth grade with a diagnosis of dyslexia. In Italian, the correspondence between syllables and phonology approximates to 99% regularity. For example, the syllable *pa* is pronounced /pa/ in whichever word and position, as in *patate* (potatoes), *scarpata* (escarpment), or *scarpa* (shoe).

The choice to present syllables within connected texts was justified by the evidence that supported better generalization if words are presented in context than in lists. Martin-Chang and Levy (2005), for example, showed that training words in context, as compared with training in isolation, led to the faster reading of those words when they were later encountered in a new context both for good and poor readers. Furthermore, Tressoldi, Vio, and Lonciari (2000), who trained Italian children with dyslexia to read isolated words faster, thus facilitating syllable recognition, did not obtain significant fluency generalization in reading text.

Another treatment with demonstrations of efficacy to improve accuracy and fluency with Italian children from the second to eighth grade with dyslexia is the Bakker or Balance method (Lorusso, Facoetti, & Molteni, 2004; Lorusso, Facoetti, Paganoni, Pezzani, & Molteni, 2006; Lorusso, Facoetti, Toraldo, & Molteni, 2005).

DOI: 10.1002/dys

The treatment used in this study was a variation of Bakker's methodology (1990). Bakker based his treatment program on the observation of a different hemispheric involvement in P-, L-, and M-type dyslexia on the grounds of their reading speed and type of errors on the text-reading test: slow reading with 'time-consuming' errors (fragmentations, repetitions, etc.) for P-types, rapid reading with 'substantive' errors (substitutions, omissions, etc.) for L-types, slow and inaccurate reading (both kinds of errors) for M-types (see Bakker, 1990; Lorusso *et al.*, 2004). Bakker developed the idea that selective stimulation of the underactivated hemisphere may induce a functional re-organization of the brain that could lead to a reduction in the reading disorders. Hemispheric stimulation can be carried out directly by the tachistoscopic presentation of words to a visual hemi-field or tactile presentation to the left or right hand, and/or indirectly, using specific stimuli and tasks in paper and pencil exercises to selectively stimulate right-hemisphere perceptual analysis or left-hemisphere linguistic anticipation. The first procedure (direct stimulation) is referred to as hemisphere-specific stimulation (HSS), while the second type of intervention (indirect stimulation) is called hemisphere-alluding stimulation (HAS). Only visual direct stimulation (VHSS) was used in this experiment given the available evidence of its efficacy (Lorusso *et al.*, 2005; Lorusso, Facoetti, Paganoni, Pezzani, & Molteni, 2006).

All these evidences demonstrate that fluency and accuracy could improve in children from the second to eighth grade. However, even if in all these studies no correlation between chronological age or initial reading level with accuracy and fluency gains was statistically significant, no direct comparison between younger and older participants was applied.

In this study, the gains in accuracy and fluency of two groups of children with a diagnosis of developmental dyslexia were directly compared. To better control if 'age matters', these gains were compared after two different treatments, one based on the Bakker or Balance method and the second based on the automatization of syllable recognition. Given the available evidence of efficacy of these two treatments, we expect that each age group will obtain significant gains, but it remains an open question if the younger group will outperform the older one.

METHOD

Participants

Fifty-five children (35 boys, 20 girls) attending primary and secondary school from the end of the second grade to the end of the fourth grade (young group) and from the sixth to the eighth grade (old group) were recruited for the study. Participants were enrolled if they satisfied the criteria for a diagnosis of dyslexia according to the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM-IV*; American Psychiatric Association, 1994), that is: Full-scale IQ (as assessed by the Wechsler Intelligence Scale for Children-Revised, Italian version, 1986) equal to, or higher than, 85; at least 2 SD below age mean for either accuracy or speed scores in reading a text aloud (MT test for speed and accuracy in reading, Cornoldi, Colpo, & Gruppo, 1998), the Italian normed test for the

DOI: 10.1002/dys

assessment of accuracy and fluency in reading text with the best psychometric properties.

The reading tests administered in the pre- and in the post-test sessions also included lists of words and nonwords reading from the 'Batteria per la Valutazione della Dislessia e Disortografia Evolutiva' (Battery for the assessment of Developmental Reading and Spelling Disorders, Sartori, Job, & Tressoldi, 1995). These tests assess speed and accuracy (expressed in number of errors) in reading printed word lists (four lists of 24 words) and nonwords lists (three lists of 16 nonwords), and provide grade norms from the second to the last grade of junior high school. They are commonly used in the assessment of RD in Italy and have satisfactory validity and reliability scores. A certified clinical psychologist completed this evaluation immediately before and after treatment.

Parent's permission was obtained for each participant admitted to the study. Given the distances between the two clinics, it was not possible to assign participants randomly to the two methods of intervention. We thus assigned participants to the two intervention methods according to the ability to attend the clinic closest to their home. Each clinic delivered a different type of treatment.

Twenty-one participants were enrolled in the sublexical treatment (10 young and 11 old) and thirty-four (18 young and 16 old) in the Bakker one. The difference of participants in the two treatments was simply due to the numbers of children requesting a treatment in the two clinics.

The participants' chronological age and pre-treatment reading scores are presented in Table 1 separately for the samples assigned to the two treatments.

It is important to point out that the reading fluency of all participants was at least 2 SD below that of typical readers according to the norms of the standardized test used. A number of errors below five are considered within the normal limits.

For both treatments it is evident that older participants are always more fluent and accurate than younger ones, except in the accuracy reading a text and in the fluency reading nonwords but only in the sublexical treatment. These differences

Table 1. Means and standard deviations of demographic and initial reading fluency and accuracy scores of the four groups and their statistical comparison

Treatment age group	Sublexical young *n*.10	Sublexical old *n*.11	*t*	*p*	Bakker young *n*.18	Bakker old *n*.16	*t*	*p*
Chronological age	8.3 (1.2)	12.4 (1.9)	5.8	<0.001	8.6 (1.8)	12.9 (1.1)	8.2	<0.001
Text fluency (syll/s)	1.20 (0.54)	1.78 (0.51)	2.5	0.023	1.3 (0.41)	1.72 (0.59)	2.1	0.04
Text accuracy (errors)	17.9 (11.9)	13.09 (7.7)	1.1	ns	19.9 (8)	21.2 (9.6)	0.44	ns
Words fluency (syll/s)	1.06 (0.36)	1.69 (0.49)	3.4	0.002	1.1 (0.35)	1.68 (0.52)	4.4	0.0001
Words accuracy (errors)	22.3 (16.2)	8.09 (3.6)	2.8	0.01	16.7 (6)	9.6 (5.6)	3.5	0.001
Nowords fluency (syll/s)	0.91 (0.18)	1.05 (0.30)	1.2	ns	0.82 (0.26)	1.06 (0.33)	2.3	0.023
Nonwords accuracy (errors)	15.7 (5.9)	9.7 (5.7)	2.3	0.03	16.2 (5.9)	9.7 (5.2)	3.4	0.002

DOI: 10.1002/dys

are quite expected considering the different amounts of scholastic experience between the two groups and the consequent differences in reading experience.

Design

The study was a between-groups comparison of changes (gains) in reading accuracy and fluency of young and old participants after a specific intervention. In order to verify the reliability of the results, this comparison was tested with two different treatment methods. Direct comparison of the two treatments was not envisaged, due to basic differences between the two (private center vs public service, additional psychological support vs treatment only).

Procedure

Participants in the subsyllabic method were requested to attend the clinic twice a week for three months. During this time, a therapist, usually a certified psychologist, trained each participant individually. The exercises consisted of reading text using special software that allowed the presentation of texts of every length, difficulty level, and content, facilitating the visual identification of each syllable (i.e. inserted in a box or coloured differently). For example, with the word *giornata* (day), the identification of the three syllables could be facilitated as follows: *gior*nata, gior*na*ta, giorna*ta*. An important detail is that the shift of the target syllable from left to right could be obtained either at a self-paced speed, pressing the space bar of the computer keyboard, or automatically after a precise interval chosen by the therapist, taking into account the reading fluency of each participant. The participant was invited to read the text accurately and as fast as he or she could, but still pay attention to its content. If the advancement of the target syllables was self-paced, the participant was invited to aim for the reading speed defined by the therapist. If the syllable advancement was automatic, the participant was invited to maintain the fluency imposed by the computer. Reading errors were registered and used for subsequent feedback. When the participant met the fluency goal with an acceptable number of errors, usually less than 2% of words read, the therapist increased it, usually adding 0.2 syll/s at each increment. Each session lasted approximately 45 min.

The Bakker treatment was carried out in individual sessions taking place twice a week and lasting 45 min each, over a four-month period. Treatment took place in an outpatients' clinic and was carried out by trained speech therapists. The children's parents and teachers were contacted to ensure that no other specific activity for remediation of the reading difficulty was conducted during the study.

All the children were classified as P- (perceptual), L- (linguistic), or M- (mixed) type dyslexic. Accordingly, 15 children classified as M-types, 12 as P-types, and 7 as L-types were present in the sample.

A computerized program ('Flash Word,' Masutto & Fabbro, 1995) was used. In this application, ocular fixation is monitored by asking the child to follow a luminous dot oscillating between the top and the bottom of the screen, at an adjustable speed. The word is flashed only if the child clicks on the mouse at the exact moment that the dot is crossing the central target. Before the beginning of each block of trials, criteria for word presentation were set (font type and

DOI: 10.1002/dys

presentation times, which varied between 250 and 100 ms). The longest presentation times were used in the first sessions (the initial presentation time was set so as to allow the child to read 60% of the word list correctly), and later, when more complex stimuli were presented for the first time. As the child's reading performance improved, presentation times were shortened in the following sessions to keep the tasks always challenging. Children belonging to the different subtypes of dyslexia received visual stimulation, in line with suggestions made by Bakker and colleagues (Bakker, 1990; Bakker, Licht, & Kappers, 1995): for P dyslexics, left-hemisphere stimulation by tachistoscopic presentation of perceptually linear, high-frequency (easy to anticipate) words/short sentences; for L dyslexics, tachistoscopic presentation of perceptually complex, low-frequency (difficult to anticipate) words/short sentences. Children with M dyslexia received presentation of L-type materials first (two months), and presentation of P-type materials later (following two months). According to the VHSS methodology, L-type materials are flashed in the left visual field, while P-type materials are flashed in the right visual field. The children's task was to read the words flashed on the PC monitor; if the child's response was not correct, the therapist could give feedback on the kind of error, direct the child's attention to a specific part or feature of the word and repeat the presentation of the word, or go on to the next word. The therapist manually paced presentation of the next word.

The dependent variables were reading fluency and accuracy, always assessed using normed passages of the *MT Battery*. Each participant was tested individually and required to read the passage selected according to his or her grade level, 'as fast and accurate as possible paying attention to the content.' Each passage consisted of a text of about 200 words. The maximum reading time allowed was 4 min. Fluency is expressed in syllables per second (syll/s[†]) as is customary in Italy; accuracy is expressed as percentages of errors corresponding to words read violating the correspondences between orthography and phonology.

RESULTS

Given the main goal of the study, to maximize the power to detect a statistical difference, we chose planned comparisons between the two age groups using fluency and accuracy gain scores (post-treatment minus pre-treatment scores) instead of a factorial design 2 (age groups) $\times$ 2 (type of treatment) (Furr & Rosenthal, 2003).

The mean improvements in fluency and accuracy reading a text, isolated words and nonwords, of each age group, are presented in Figures 1 and 2 with their corresponding CIs.

Using a *t*-test for independent groups,[‡] contrasting gains in fluency and accuracy for each of the three reading variables, and rejecting the null hypothesis when $p \leqslant 0.05$, the only statistical difference observed is that related

[†] To convert syllables per second to words per minute (wpm), multiply by 60 and divide by 2.1 (average number of syllables per word).
[‡] A nonparametric comparison using the Mann–Whitney statistic yielded the same results.

DOI: 10.1002/dys

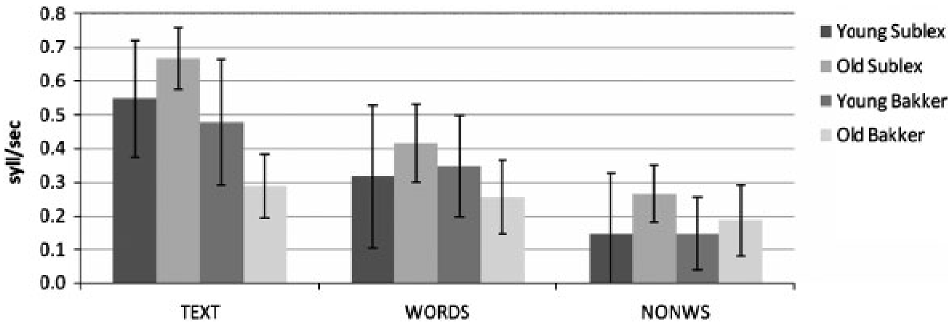

Figure 1. Mean and CI: 95% of fluency gains obtained with the sublexical and Bakker treatment in the two age groups.

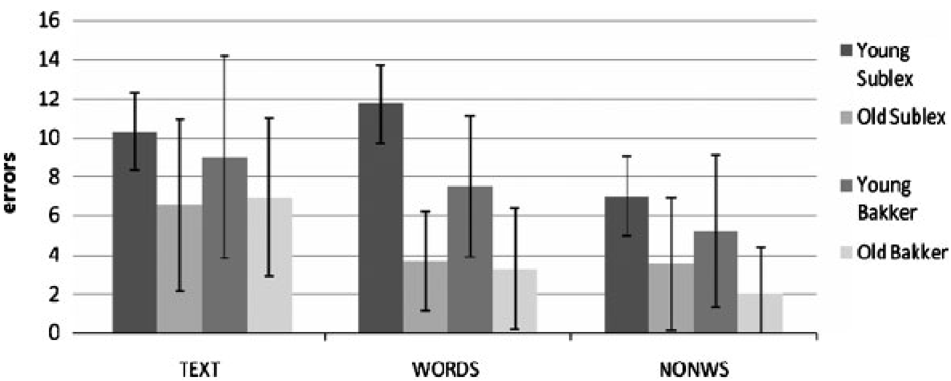

Figure 2. Mean and CI: 95% of accuracy gains obtained with the sublexical and Bakker treatment in the two age groups.

to accuracy gains in reading words. In this case younger group in the sublexical treatment obtained a better gain with respect to their older peers: $t(20) = 2.5$; $p = 0.02$.

DISCUSSION

The answer to the question if older dyslexic children may improve less than younger ones in fluency and accuracy after a specific treatment seems to be a clear 'No', at least with respect to the two treatments and the chronological ages considered in the study. Even if it is not correct to generalize on other treatments and other age differences, our results seem to suggest that 'it is never too late' to improve fluency and accuracy.

From a statistical point of view, it is disputable to draw inferences after a failure to reject the null hypothesis when the sample sizes are low as in our case (Altman and Bland, 1995). However, if we are interested in detecting differences of clinical interest (effectssizes > 0.80), our sample sizes are sufficient to obtain a statistical power to accept the hypothesis that older participants obtain equivalent gains in accuracy and fluency as younger ones.

Apart from better improvement after the sublexical treatment of the younger group on accuracy reading isolated words, it is interesting to observe that equivalent changes are obtained by the young and older participants, even if at pre-treatment (see Table 1) younger children were less accurate and fluent with respect to the older ones. The expectation that younger children can improve more than older ones, because of an assumed, but never demonstrated, better recovery potential, perhaps of a neurobiological nature, does not seem to be supported by our data, adding further support to the evidence obtained by Lorusso *et al*. (2005, 2006) and Tressoldi *et al*. (2000, 2007).

The demonstration that not only accuracy but even fluency may be improved at relatively older ages is an encouraging perspective given its nature of 'core symptom' in dyslexia, particularly in regular orthographies (Lundberg & Hoien, 1990; Rodrigo & Jimenez, 1999; Wimmer, 1993; Zoccolotti *et al*., 1999).

This evidence offers all those children receiving a late diagnosis or treatment, a hope to improve their reading accuracy and fluency.

Further studies should verify if our findings could be observed in other age groups, other types of treatment and orthographies.

References

Allington, R. L. (1983). Fluency: The neglected reading goal in reading instruction. *The Reading Teacher*, *36*, 556–561.

Altman, D. G., & Bland, J. M. (1995). Statistics notes: Absence of evidence is not evidence of absence. *British Medical Journal*, *311*, 485.

Bakker, D. J. (1990). *Neuropsychological treatment of dyslexia*. New York: Oxford University Press.

Bakker, D. J., Licht, R., & Kappers, E. J. (1995). Hemisphere-specific treatment of dyslexia. In G. Tramontana, & S. R. Hooper (Eds.), *Advances in child neuropsychology* (Vol. 3, pp. 144–177). New York: Springer.

Breznitz, Z. (2002). Asynchrony of visual–orthographic and auditory–phonological word recognition processes: An underlying factor in dyslexia. *Reading and Writing*: *An Interdisciplinary Journal*, *15*, 15–42.

Breznitz, Z., & Lauren Berman, L. (2003). The underlying factors of word reading rate. *Educational Psychology Review*, *15*, 247–265.

Carreiras, M., & Grainger, J. (2004). Sublexical representations and the 'front end' of visual word recognition. *Language and Cognitive Processes*, *19*, 321–331.

Carreiras, M., Alvares, C. J., & De Vega, M. (1993). Syllable frequency and visual word recognition in Spanish. *Journal of Memory and Language*, *32*, 766–780.

Chard, D. J., Vaughn, S., & Tyler, B. (2002). A synthesis of research on effective interventions for building reading fluency with elementary students with learning disabilities. *Journal of Learning Disabilities*, *35*, 386–406.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.

Cornoldi, C., Colpo, M., & Gruppo, M. T. (1998). *La valutazione oggettiva della lettura* [*The objective assessment of reading*]. Firenze, Italy: Edizioni Organizzazioni Speciali.

DSM-IV. (1994). *Diagnostic and statistical manual of mental disorders*. Washington, DC: American Psychiatric Association.

Draganski, G., Gaser, C., Busch, V., Schuierer, G., Bogdahn, U., & May, A. (2004). Neuroplasticity: Changes in grey matter induced by training. *Nature*, *427*(6972), 311–312.

DOI: 10.1002/dys

Forman, B. R., & Moats, L. C. (2004). Conditions for sustaining research-based practices in early reading instruction. *Remedial and Special Education*, *25*(1), 51–60.

Furr, R. M., & Rosenthal, R. (2003). Evaluating theories efficiently: the nuts and bolts of contrast analysis. *Understanding Statistics*, *2*(1), 45–67.

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, *423*(6939), 534–537.

Kame'enui, E. J., & Simmons, D. C. (2001). The DNA of reading fluency. *Scientific Studies of Reading*, *5*, 203–210.

Klicpera, C., & Schabmann, A. (1993). Do German speaking children have a chance to overcome reading and spelling difficulties? A longitudinal survey from the second to the eighth grade. *European Journal of Psychology of Education*, *8*, 307–323.

Kuhn, M. R., & Stahl, S. A. (2003). Fluency: A review of developmental and remedial practices. *Journal of Educational Psychology, 95*, 3–21.

Landerl, K., Wimmer, H., & Frith, U. (1997). The impact of orthographic consistency on dyslexia: A German–English comparison. *Cognition*, *63*, 315–334.

Lorusso, M. L., Facoetti, A, Toraldo, A., & Molteni, M. (2005). Tachistoscopic treatment of dyslexia changes the distribution of visual–spatial attention. *Brain and Cognition*, *57*, 135–142.

Lorusso, M. L., Facoetti, A., & Molteni, M. (2004). Hemispheric, attentional and processing speed factors in the treatment of developmental dyslexia. *Brain and Cognition*, *55*, 341–348.

Lorusso, M. L., Facoetti, A., Paganoni, P. L., Pezzani, M., & Molteni, M. (2006). Effects of visual hemisphere-specific stimulation versus reading-focused training in dyslexic children. *Neuropsychological Rehabilitation*, *16*(2), 194–212.

Lundberg, I., & Hoien, T. (1990). Patterns of information processing skills and word recognition strategies in developmental dyslexia. *Scandinavian Journal of Educational Research*, *34*, 231–240.

Lyon, G. R., & Moats, L. C. (1997). Critical conceptual and methodological considerations in reading intervention research. *Journal of Learning Disabilities*, *30*, 578–588.

Martin-Chang, S. L., & Levy, B. A. (2005). Fluency transfer: Differential gains in reading speed and accuracy following isolated word and context training. *Reading and Writing*, *18*, 343–376.

Masutto, C., & Fabbro, F. (1995). *FlashWord*: *Training neuropsicologico per la dislessia*. [*FlashWord: neuropsychological training for dyslexia*]. Gorizia: Ed. Tecnoscuola.

Necoechea, D. M., & Swanson, H. L. (2003). The role of reading intervention research in the identification of children with reading difficulties: A meta-analysis of the literature funded by the NICHD. *Advances in Learning and Behavioral Disabilities*, *16*, 83–161.

Nicolson, R. I., Fawcett, A. J., Moss, H. , Nicolson, M. K., & Reason, R. (1999). Early reading intervention can be effective and cost-effective. *British Journal of Educational Psychology, 69*(1), 47–62.

Paulesu, E., Frith, U., Snowling, M., Gallagher, A., Morton, J., Frackowiak, R. S. J., & Frith, C. D. (1996). Is developmental dyslexia a disconnection syndrome? Evidence from PET scanning. *Brain*, *119*, 143–157.

Rodrigo, M., & Jimenez, J. E. (1999). An analysis of the word naming errors of normal readers and reading disabled children in Spanish. *Journal of Research in Reading*, *22*, 180–197.

Sartori, G., Job, R., & Tressoldi, P. E. (1995). *Batteria per la valutazione della dislessia e della disortografia evolutiva* [*Battery for the assessment of developmental dyslexia and dysorthographia*]. Firenze, Italy: Edizioni Organizzazioni Speciali.

Schonell, F. J., & Schonell, P. E. (1960). *Diagnostic and attainment testing.* Edinburgh: Oliver and Boyd.

Seymour, P. H. K., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *The British Journal of Psychology, 94*, 143–174.

DOI: 10.1002/dys

Snowling, M. (2000). *Dyslexia* (2nd ed.). Oxford: Blackwell.

Tressoldi, P. E., Vio, C., & Lonciari, I. (2000). Treatment of specific developmental reading disorders, derived from single- and dual-route models. *Journal of Learning Disabilities*, *33*, 278–285.

Tressoldi, P. E., Iozzino, R., & Vio, C. (2007). Efficacy of an intervention to improve fluency in children with developmental dyslexia in a regular orthography. *Journal of Learning Disabilities*, *40*, 245–256.

Wiederholt, J. L., & Bryant, B. R. (2002). *Gray oral reading tests.* Austin, TX: Pro-Ed.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics*, *14*, 1–33.

Wimmer, H. (1996). The early manifestation of developmental dyslexia: Evidence from German children. *Reading and Writing*: *An Interdisciplinary Journal*, *8*, 171–188.

Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: A specific disability in regular orthographies. *Journal of Educational Psychology*, *94*, 272–277.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology*, *91*, 415–438.

Wolf, M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading*, *5*, 211–239.

Yap, R., & van der Leij, A. (1993). Word processing in dyslexics. An automatic decoding deficit? *Reading and Writing*, *5*, 261–279.

Zoccolotti, P., De Luca, M., Di Pace, E., Judica, A., Orlandi, M., & Spinelli, D. (1999). Markers of developmental surface dyslexia in a language (Italian) with high grapheme–phoneme correspondence. *Applied Psycholinguistics*, *20*, 191–216.

DOI: 10.1002/dys