Current Biology 23, 462–466, March 18, 2013 ©2013 Elsevier Ltd All rights reserved http://dx.doi.org/10.1016/j.cub.2013.01.044

Report

Action Video Games Make Dyslexic Children Read Better

Sandro Franceschini,[1,3] Simone Gori,[1,2,3] Milena Ruffino,[2] Simona Viola,[1] Massimo Molteni,[2] and Andrea Facoetti[1,2,3,*]
[1]Developmental and Cognitive Neuroscience Lab,
Department of General Psychology, University of Padua,
Padua 35131, Italy
[2]Developmental Neuropsychology Unit, Scientific Institute
E. Medea, Bosisio Parini, Lecco 23842, Italy

Summary

Learning to read is extremely difficult for about 10% of children; they are affected by a neurodevelopmental disorder called dyslexia [1, 2]. The neurocognitive causes of dyslexia are still hotly debated [3–12]. Dyslexia remediation is far from being fully achieved [13], and the current treatments demand high levels of resources [1]. Here, we demonstrate that only 12 hr of playing action video games—not involving any direct phonological or orthographic training—drastically improve the reading abilities of children with dyslexia. We tested reading, phonological, and attentional skills in two matched groups of children with dyslexia before and after they played action or nonaction video games for nine sessions of 80 min per day. We found that only playing action video games improved children's reading speed, without any cost in accuracy, more so than 1 year of spontaneous reading development and more than or equal to highly demanding traditional reading treatments. Attentional skills also improved during action video game training. It has been demonstrated that action video games efficiently improve attention abilities [14, 15]; our results showed that this attention improvement can directly translate into better reading abilities, providing a new, fast, fun remediation of dyslexia that has theoretical relevance in unveiling the causal role of attention in reading acquisition.

Results

Dyslexia is a severely invalidating learning disability that affects literacy acquisition despite normal intelligence and adequate instruction [1, 2]. Dyslexia is often associated with undesirable outcomes, such as lower educational attainment and loss of self-confidence [1, 2], because reading is essential for all aspects of learning from using older school books to the latest technology (e.g., ebooks and smart phones).

Although an impaired auditory discrimination of spoken language (phonological processing) is widely assumed to characterize dyslexic individuals [1, 2, 7, 8], dyslexia remediation is far from being fully achieved [1]. Improvements in auditory-phonological processing do not automatically increase reading abilities [13]. Recent evidence suggests that dyslexia could arise from a basic crossmodal letter-to-speech sound integration deficit [4, 5]. Remediation based on explicit, systematic instruction on letter-to-speech integration (decoding strategies) appears to be the most efficient treatment [1, 2, 13]. However, all the existing treatments are controversial and demand high levels of resources. Moreover, the cognitive processes underlie the improvements in reading ability remain unclear [1, 4].

Attentional dysfunction is an important core deficit in dyslexic individuals [6, 9–12, 16–18]. Letters must be precisely selected from among other cluttering graphemes [19] by rapid orientation of visual attention [20] before the correct letter-to-speech sound integration applies [3–6, 9, 17]. Efficient attention improves the perception of stimuli [20] and increases the development of neural connections [21] between letter and speech sound [4, 5]. An attentional deficit reduces the success of traditional dyslexia treatments, because learning ability is hampered by spatial and temporal attention dysfunction. Thus, treatment of attentional deficits could be crucial in dyslexia remediation.

Since video game training has been proven to increase attention abilities [14, 15, 22], we investigated the effects of video games on children with dyslexia. In contrast to typical perceptual learning findings in which performance improvement for supra- or subliminal features is strictly stimulus specific [23, 24], attentional action video game (AVG) training should produce learning that transfers well beyond the task domain [22]. It is predicted that AVG training will improve letter-to-speech sound mapping (phonological decoding) and, consequently, reading abilities.

To test this hypothesis, we measured the phonological decoding of pseudowords and word text reading skills in 20 children with dyslexia before (T1) and after (T2) two video game trainings. Ten dyslexic children were assigned to AVG and ten to nonaction video game (NAVG) training (see the Supplemental Experimental Procedures available online). Chronological age, full intelligence quotient (IQ), reading severity (measured in speed and errors during reading of word and pseudoword clinical lists), and phonological skills were similar in the two groups (see Table S1). The two groups did not differ at T1 in both reading and attentional measurements (all p values >0.1). Each child was individually treated by playing a commercial Wii video game (*Rayman Raving Rabbids*) for a total of 12 hr. The single minigames were selected to create the action and nonaction treatments (see the Supplemental Experimental Procedures and Supplemental Results). Informed written consent was obtained from the parents of each child, and the Scientific Institute E. Medea ethic committee approved the research protocol. The entire research process was conducted according to the principles expressed in the Declaration of Helsinki.

Reading Improvements

The *reading inefficiency* was measured as a ratio between speed (defined as the time in seconds necessary to read the specific item, depending of the task) and accuracy (defined as the ratio between the correct response and the total number of items). This measure was chosen to control for the tradeoff between reading speed and accuracy. Training-related changes in reading inefficiency were analyzed by a 2 (task: pseudoword decoding and word text reading)

---

[3]These authors contributed equally to this work
*Correspondence: andreafacoetti@unipd.it

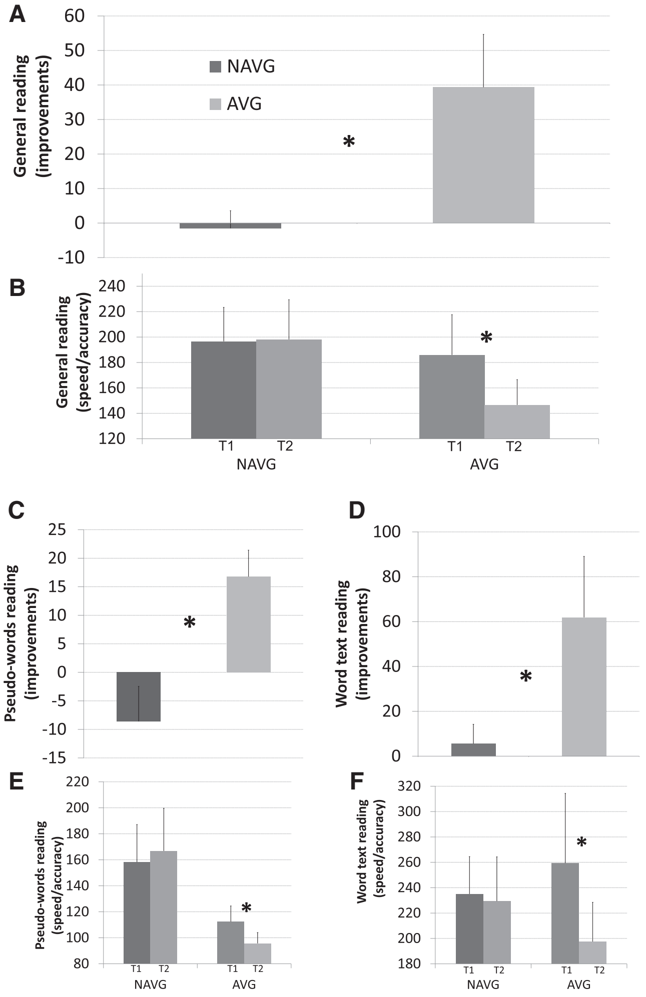

Figure 1. Training-Related Changes in Reading Abilities

Pseudoword and word text reading abilities were measured before (T1) and after (T2) NAVG and AVG treatment in children with dyslexia. The general reading improvement is the mean between the pseudoword and the word text reading inefficiency (speed/accuracy) that is reduced by the training. Only AVG players showed significant general reading improvements (A). The general reading inefficiency is showed before (T1) and after (T2) training in NAVG and AVG group (B). Pseudoword (C) and word text (D) reading improvements were significant only in AVG group. Pseudoword (E) and word text reading inefficiency (F) is showed before (T1) and after (T2) training in NAVG and AVG group. Pseudoword and word text reading inefficiency were both significantly reduced only in AVG players. The reading improvements—induced by the AVG training—involve both phonological decoding and lexical reading. The two groups did not differ at T1 in all the reading measurements. *, significant difference. Error bars represent the SE. See also Tables S1–S3, S5, and S6.

*2 (time: T1 and T2) *2 (group: AVG and NAVG) mixed ANOVA. The mean between the three pseudoword reading inefficiencies and the word text reading inefficiency (see Table S2) was labeled *general reading abilities*. The time main effect was significant [$F_{(1,18)} = 5.50$, $p = 0.03$, $\eta^2_p = 0.23$], showing an improvement in general reading abilities across the two groups. Crucially, the time*group interaction was also significant [$F_{(1,18)} = 6.40$, $p = 0.02$, $\eta^2_p = 0.26$]; general reading abilities improved in the AVG (mean = 39.33) but not the NAVG (mean = −1.5; see Figures 1A and 1B) players. Pseudoword phonological decoding and word text reading were both significantly improved in the AVG compared to the NAVG players [see Figure 1C, $t_{(18)} = 3.30$, $p < 0.01$ and Figure 1D, $t_{(18)} = 1.97$, $p = 0.03$, respectively; see also Figures 1E and 1F and Tables S2 and S3 for details]. The reading improvements after the AVG training were characterized by the increased reading speed without a cost in accuracy. This result is in agreement with the improved speed of processing already found associated with AVG [25].

To establish the reliability of these findings, we computed the analysis in syllables per seconds, which is an important clinical reading index used in both consistent and inconsistent orthographies [11]. In the reading speed of pseudoword-decoding tasks, the AVG group (mean 0.18 syllable [syll]/s) showed a bigger improvement [$t_{(18)} = 2.79$, $p = 0.01$] than the NAVG group (mean 0.05 syll/s). The relevance of this result can be fully appreciated by noting that the pseudoword-decoding improvements obtained after 12 hr of AVG training (mean 0.18 syll/s) were higher than the mean improvements expected in a dyslexic child (0.15 syll/s) after 1 year of spontaneous reading development. Similarly, the AVG group (mean 0.39 syll/s) posted a larger improvement [$t_{(18)} = 2.52$, $p = 0.02$] in word text reading skills than the NAVG group (mean 0.08 syll/s). Consistently, the improvement in word text reading speed obtained after 12 hr of AVG training (mean 0.39 syll/s) was higher than the improvement expected (0.3 syll/s) in a dyslexic child without treatment for one year. Moreover, the AVG speed reading improvements were bigger than those obtained by the highly demanding traditional phonological and orthographic treatments and equal to the letter-to-speech integration training (see the Supplemental Results).

Thus, AVG training improves not only the basic letter-to-speech sound integration—indexed by increased pseudoword reading efficiency—but also lexical recognition, measured by the word text reading as recently suggested by Vidyasagar and Pammer [6]. Finally, to quantify the reliability at individual level of this group improvement, we analyzed the improvement in the general reading abilities (see Figure 1A). Eight out of ten (80%) AVG players statistically differed from the NAVG group's mean improvements. In addition, seven out of ten (70%) AVG players were at least 1 SD above the mean of the NAVG in the general reading improvements.

Considering that children with dyslexia could present reading comprehension problems as consequence of the core reading decoding deficit, further studies could directly investigate the possible effect of AVG on this higher level reading parameter.

We also measured changes in phonological skills after treatment, using a phoneme-blending task (see Table S1 and the Supplemental Experimental Procedures). A 2 (time: T1 and T2) *2 (group: AVG and NAVG) mixed ANOVA revealed no significant main effects or interaction, suggesting that reading enhancement driven by AVG training is unrelated to phonological short-term memory improvements.

Two months after the end of the treatment (T3), we followed up on reading improvements induced by AVG training by retesting the phonological decoding skill in six out of ten dyslexic children that did not perform any treatment or training between T2 and T3. A dependent sample t test comparison revealed a nonsignificant difference in pseudoword-decoding skill between T2 and T3 performance, indicating a long-lasting reading improvement from AVG training (see Tables S2 and S3).

Controlling for the speed/accuracy tradeoff, the reading improvements demonstrate that AVG training did not simply result in a trigger-happy behavior. The explanation of these

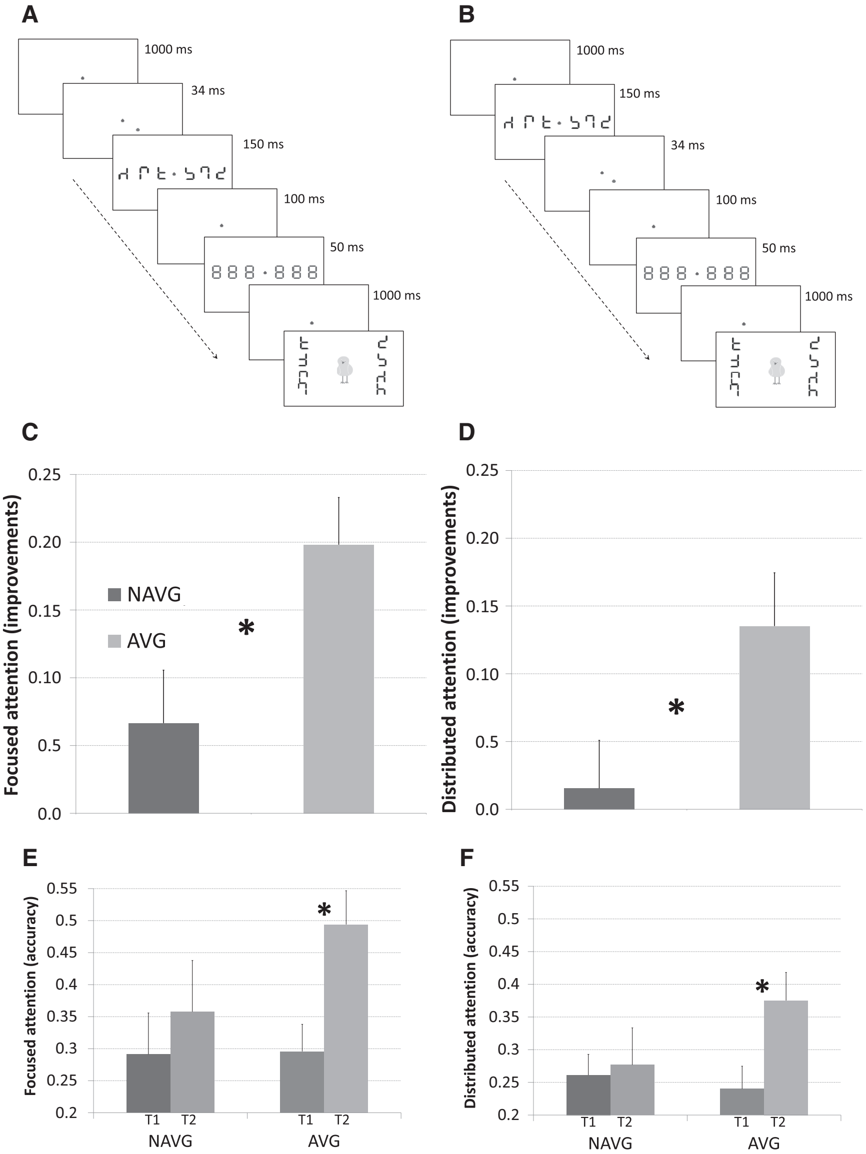

Figure 2. Focused and Distributed Spatial Attention Tasks and Results

In a single-report task, participants were instructed to keep their eyes on the fixation point and identify the target symbol that appeared above the red dot as accurately as possible and without time limit. The red dot was displayed before (focused spatial attention, A) or after (distributed spatial attention, B) the string of symbols. Dyslexic children treated with AVGs showed significantly greater improvement (accuracy difference between T2 and T1) in both focused (C) and distributed (D) spatial attention tasks. Accuracy in focused (E) and distributed (F) spatial attention tasks are showed before (T1) and after (T2) training, in the NAVG and AVG groups. Accuracy in both focused and distributed spatial attention was significantly increased only in AVG players. The two groups did not differ at T1 in focused and distributed spatial attention. *, significant difference. Error bars represent the SE. See also Tables S4–S6.

results includes the possibility that video games with specific characteristics increase abilities to allocate attentional resources in space and time [14, 15, 22, 25, 26].

Attentional Improvements

Focused and distributed *spatial attention* were also measured (accuracy) in T1 and T2 with a single-report task. A red dot appeared before (cue condition) or after (probe condition) a multielement display [27] composed of nonverbal stimuli (see Figures 2A and 2B, respectively). Two separate 2 (time: T1 and T2) *2 (group: AVG and NAVG) mixed ANOVAs were conducted for the cue and probe conditions. In the cue condition, the time main effect [$F_{(1,18)} = 25.56$, $p < 0.001$, $\eta^2_p = 0.59$] and the time*group interaction [$F_{(1,18)} = 6.32$, $p = 0.02$, $\eta^2_p = 0.26$] were significant, demonstrating that only dyslexic children treated with AVGs improved their focused attention (see Figures 2C and 2E, Table S4, and the Supplemental Experimental Procedures). Similarly, in the probe condition, both the time main effect [$F_{(1,18)} = 8.12$, $p = 0.01$, $\eta^2_p = 0.31$] and the time*group interaction [$F_{(1,18)} = 5.12$, $p = 0.03$, $\eta^2_p = 0.22$] were significant, showing that only dyslexic children treated with AVGs improved their distributed attention (see Figures 2D and 2F, Table S4, and the Supplemental Experimental Procedures).

Crossmodal attention was also measured, with an uninformative, peripheral auditory cue [26] that preceded (by 50 or 100 ms) the display of a visual target at a correct (valid condition) or incorrect (invalid condition) spatial location. Bilateral auditory cues (neutral condition) were also used to distribute attention (see Figure 3A and the Supplemental Experimental Procedures). *Temporal attention* indexed by reductions in the reaction time needed to localize the left or right visual target at longer (100 ms) versus shorter (50 ms) cue-target interval was analyzed by a 3 (cue type: valid, neutral, and invalid) *2 (time: T1 and T2) *2 (group: AVG and NAVG) mixed ANOVA. Importantly, the Time*Group interaction was significant [$F_{(1,18)} = 4.32$, $p = 0.05$, $\eta^2_p = 0.19$], showing a larger crossmodal alerting improvement in AVG than in NAVG players (see Figures 3B and 3C, Table S4, and the Supplemental Results).

These findings are in agreement with several reports documenting the beneficial effects of playing video games for attention [22]. In particular, previous studies have demonstrated that AVG-controlled training was causally linked to enhancements in spatial (e.g., peripheral target recognition) and temporal (e.g., attentional blink and backward masking reduction) attention [15, 22]. AVGs are distinguished by NAVGs by such characteristics as game speed, a high sensory-motor load, and presentation of multiple, peripheral stimuli [22]. AVG players constantly receive both external and internal feedback on their performance, producing learning [21]. AVG players perform better at tasks requiring both distributed and focused visual spatial attention [14]. They also react more quickly to stimulus targets preceded by spatiotemporal cues [28], suggesting a more efficient alerting system.

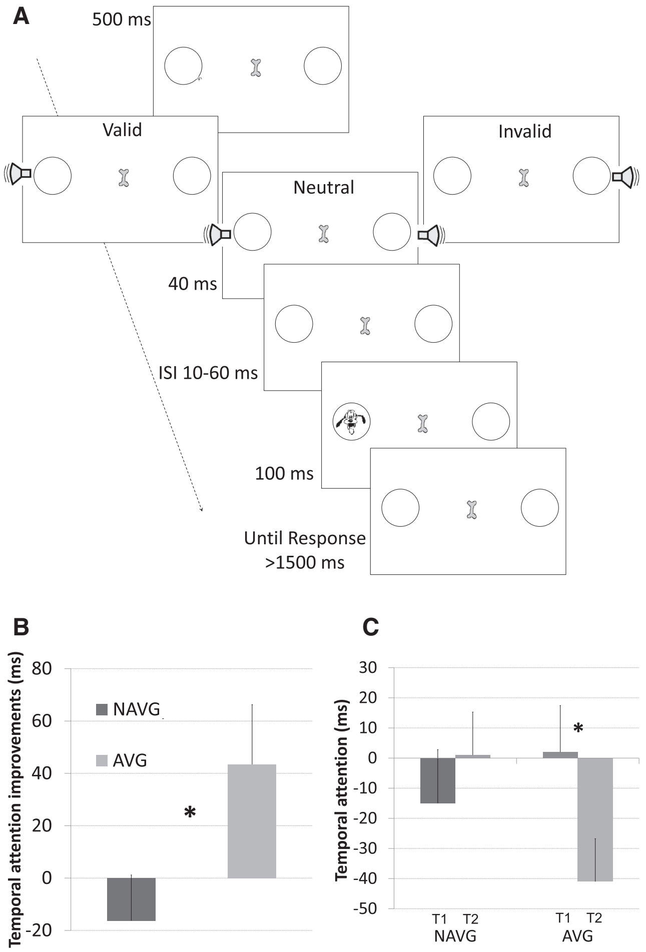

Figure 3. Crossmodal Temporal Attention Task and Results

An auditory spatial-temporal cue was presented in the left, right, or both loudspeakers placed on either side of the screen. A dog appearing in one of the two circles was the target stimulus. Children had to press one of two buttons on the keyboard to indicate whether the target appeared in the left or the right circle (A). Crossmodal temporal attention improvements refer to the improvements between T1 and T2 in the reaction time needed to correctly localize the target at second cue-target interval (100 ms) in comparison to the first cue-target interval (50 ms). AVG players showed a significant improvement in temporal attention compared to NAVG players (B). Temporal attention (reaction time difference between second and first cue-target interval) is showed before (T1) and after (T2) training in the NAVG and AVG groups (C). Temporal attention was significantly increased only in AVG players. The two groups did not differ at T1. *, significant difference. Error bars represent the SE. See also Tables S4–S6.

AVG players have faster response times without a loss of accuracy [25].

Relationship between Attentional and Reading Improvements

The improvements in spatial and temporal attention correlated with those in general reading abilities (r = 0.52, p = 0.02 and r = 0.49, p = 0.03, respectively). To determine the predictive relationships between attentional and reading improvements, we performed a three-step, fixed-entry, multiple regression analysis on the entire sample of children with dyslexia (n = 20). The dependent variable was the general reading ability improvements, and the predictors were (1) age and full IQ, (2) phonological changes, and (3) spatial and temporal attention improvements (for details, see Table S5). The attentional enhancements accounted for about 50% of the unique variance of reading improvement (r^2 change = 0.48, p = 0.01; see Table S6), demonstrating a clear, causal link between attentional functioning and reading remediation. AVG training could directly reduce reading disorders in children with dyslexia, increasing the efficiency of their attentional orienting [14, 15, 22, 25] and alerting systems [28].

Discussion

Previous studies have suggested that visual attention could be crucial for learning letter identities and their relative positions (orthographic processing) independently of language knowledge [6, 10, 12, 29]. In agreement with our causal results, studies have shown that visual attention is impaired not only in dyslexic children [16, 17] but also in prereaders at familial risk for dyslexia [18], indicating that attentional disorders are present before reading acquisition. In addition, a recent longitudinal study demonstrated that prereading visual attention predicts future reading acquisition skills in second grade, controlling not only for age, IQ, and phonological processing, but also for nonalphabetic, visual-to-phonological mapping [10]. About 60% of future poor readers displayed visual attention deficits as prereaders [10]. The importance of the visual attention and the phonological factors could vary across languages based on their orthographic transparency degree. However, visual attention deficit in dyslexia was found in both consistent and inconsistent orthographies [30–36]. Accordingly, extra-large spacing between letters improves reading efficiency in dyslexic children with consistent and inconsistent orthographies [11], helping to focus attention [37] on each successive letter within a written word [3].

Since all AVGs share an extraordinary speed in terms of transient events and moving objects, a high degree of perceptual and motor load, and an emphasis on peripheral processing, AVG training might mainly improve the efficiency of the magnocellular-dorsal pathway or "action" stream [6, 9, 12, 17]. Although further studies are necessary to investigate the specific role of the "action" stream in reading acquisition, our results demonstrate the causal role of visual spatial and crossmodal temporal attention in dyslexia.

Our findings—supported by results showing that attention can be studied [38] and efficiently trained [39] during infancy—pave the way for low-resource-demanding early prevention programs that could drastically reduce the incidence of reading disorders.

Supplemental Information

Supplemental Information includes seven tables and Supplemental Experimental Procedures and can be found with this article online at http://dx.doi.org/10.1016/j.cub.2013.01.044.

Acknowledgments

We thank Elena Olgiati for help in collecting data. This work was funded with grants from the CARIPARO Foundation (Borse di Dottorato CARIPARO 2009 to S.F.; Progetti di Eccellenza CARIPARO, 2011–2012 to A.F.) and the University of Padua (Assegni di Ricerca 2009 and 2011 and Senior Researcher to S.G.; Progetto di Ateneo 2009 and 2011 to A.F.).

Received: November 7, 2012
Revised: January 4, 2013
Accepted: January 15, 2013
Published: February 28, 2013

References

1. Gabrieli, J.D. (2009). Dyslexia: a new synergy between education and cognitive neuroscience. Science *325*, 280–283.
2. Peterson, R.L., and Pennington, B.F. (2012). Developmental dyslexia. Lancet *379*, 1997–2007.
3. McCandliss, B.D., Cohen, L., and Dehaene, S. (2003). The visual word form area: expertise for reading in the fusiform gyrus. Trends Cogn. Sci. *7*, 293–299.
4. Dehaene, S., Pegado, F., Braga, L.W., Ventura, P., Nunes Filho, G., Jobert, A., Dehaene-Lambertz, G., Kolinsky, R., Morais, J., and Cohen, L. (2010). How learning to read changes the cortical networks for vision and language. Science *330*, 1359–1364.
5. Blau, V., van Atteveldt, N., Ekkebus, M., Goebel, R., and Blomert, L. (2009). Reduced neural integration of letters and speech sounds links phonological and reading deficits in adult dyslexia. Curr. Biol. *19*, 503–508.
6. Vidyasagar, T.R., and Pammer, K. (2010). Dyslexia: a deficit in visuo-spatial attention, not in phonological processing. Trends Cogn. Sci. *14*, 57–63.
7. Goswami, U. (2011). A temporal sampling framework for developmental dyslexia. Trends Cogn. Sci. *15*, 3–10.
8. Bradley, L., and Bryant, P. (1983). Categorizing sound and learning to read: a casual connection. Nature *301*, 419–421.
9. Hari, R., and Renvall, H. (2001). Impaired processing of rapid stimulus sequences in dyslexia. Trends Cogn. Sci. *5*, 525–532.
10. Franceschini, S., Gori, S., Ruffino, M., Pedrolli, K., and Facoetti, A. (2012). A causal link between visual spatial attention and reading acquisition. Curr. Biol. *22*, 814–819.
11. Zorzi, M., Barbiero, C., Facoetti, A., Lonciari, I., Carrozzi, M., Montico, M., Bravar, L., George, F., Pech-Georgel, C., and Ziegler, J.C. (2012). Extra-large letter spacing improves reading in dyslexia. Proc. Natl. Acad. Sci. USA *109*, 11455–11459.
12. Stein, J., and Walsh, V. (1997). To see but not to read; the magnocellular theory of dyslexia. Trends Neurosci. *20*, 147–152.
13. Strong, G.K., Torgerson, C.J., Torgerson, D., and Hulme, C. (2011). A systematic meta-analytic review of evidence for the effectiveness of the 'Fast ForWord' language intervention program. J. Child Psychol. Psychiatry *52*, 224–235.
14. Green, C.S., and Bavelier, D. (2003). Action video game modifies visual selective attention. Nature *423*, 534–537.
15. Green, C.S., Pouget, A., and Bavelier, D. (2010). Improved probabilistic inference as a general learning mechanism with action video games. Curr. Biol. *20*, 1573–1579.
16. Lallier, M., Tainturier, M.J., Dering, B., Donnadieu, S., Valdois, S., and Thierry, G. (2010). Behavioral and ERP evidence for amodal sluggish attentional shifting in developmental dyslexia. Neuropsychologia *48*, 4125–4135.
17. Facoetti, A., Trussardi, A.N., Ruffino, M., Lorusso, M.L., Cattaneo, C., Galli, R., Molteni, M., and Zorzi, M. (2010). Multisensory spatial attention deficits are predictive of phonological decoding skills in developmental dyslexia. J. Cogn. Neurosci. *22*, 1011–1025.
18. Facoetti, A., Corradi, N., Ruffino, M., Gori, S., and Zorzi, M. (2010). Visual spatial attention and speech segmentation are both impaired in preschoolers at familial risk for developmental dyslexia. Dyslexia *16*, 226–239.
19. Bouma, H. (1970). Interaction effects in parafoveal letter recognition. Nature *226*, 177–178.
20. Yeshurun, Y., and Rashal, E. (2010). Precueing attention to the target location diminishes crowding and reduces the critical distance. J. Vis. *10*, 16.
21. Roelfsema, P.R., van Ooyen, A., and Watanabe, T. (2010). Perceptual learning rules based on reinforcers and attention. Trends Cogn. Sci. *14*, 64–71.
22. Green, C.S., and Bavelier, D. (2012). Learning, attentional control, and action video games. Curr. Biol. *22*, R197–R206.
23. Watanabe, T., Náñez, J.E., and Sasaki, Y. (2001). Perceptual learning without perception. Nature *413*, 844–848.
24. Seitz, A.R., Protopapas, A., Tsushima, Y., Vlahou, E.L., Gori, S., Grossberg, S., and Watanabe, T. (2010). Unattended exposure to components of speech sounds yields same benefits as explicit auditory training. Cognition *115*, 435–443.
25. Dye, M.W.G., Green, C.S., and Bavelier, D. (2009). Increasing speed of processing with action video games. Curr. Dir. Psychol. Sci. *18*, 321–326.
26. Petersen, S.E., and Posner, M.I. (2012). The attention system of the human brain: 20 years after. Annu. Rev. Neurosci. *35*, 73–89.
27. Bosse, M.L., Tainturier, M.J., and Valdois, S. (2007). Developmental dyslexia: the visual attention span deficit hypothesis. Cognition *104*, 198–230.
28. West, G.L., Stevens, S.A., Pun, C., and Pratt, J. (2008). Visuospatial experience modulates attentional capture: evidence from action video game players. J. Vis. *8*, 13.
29. Grainger, J., Dufau, S., Montant, M., Ziegler, J.C., and Fagot, J. (2012). Orthographic processing in baboons (Papio papio). Science *336*, 245–248.
30. Laasonen, M., Salomaa, J., Cousineau, D., Leppämäki, S., Tani, P., Hokkanen, L., and Dye, M. (2012). Project DyAdd: visual attention in adult dyslexia and ADHD. Brain Cogn. *80*, 311–327.
31. Roach, N.W., and Hogben, J.H. (2007). Impaired filtering of behaviourally irrelevant visual information in dyslexia. Brain *130*, 771–785.
32. Brunswick, N., Neil Martin, G., and Rippon, G. (2012). Early cognitive profiles of emergent readers: a longitudinal study. J. Exp. Child Psychol. *111*, 268–285.
33. Plaza, M., and Cohen, H. (2007). The contribution of phonological awareness and visual attention in early reading and spelling. Dyslexia *13*, 67–76.
34. Ruffino, M., Trussardi, A.N., Gori, S., Finzi, A., Giovagnoli, S., Menghini, D., Benassi, M., Molteni, M., Bolzani, R., Vicari, S., and Facoetti, A. (2010). Attentional engagement deficits in dyslexic children. Neuropsychologia *48*, 3793–3801.
35. Facoetti, A., Lorusso, M.L., Paganoni, P., Umiltà, C., and Mascetti, G.G. (2003). The role of visuospatial attention in developmental dyslexia: evidence from a rehabilitation study. Brain Res. Cogn. Brain Res. *15*, 154–164.
36. Geiger, G., Lettvin, J.Y., and Fahle, M. (1994). Dyslexic children learn a new visual strategy for reading: a controlled experiment. Vision Res. *34*, 1223–1233.
37. Ronconi, L., Basso, D., Gori, S., and Facoetti, A. (2012). TMS on right frontal eye fields induces an inflexible focus of attention. Cereb. Cortex, in press.
38. Bulf, H., and Valenza, E. (2012). Object-based visual attention in 8-month-old Infants: evidence from an eye-tracking study. Dev. Psychol., in press.
39. Wass, S., Porayska-Pomsta, K., and Johnson, M.H. (2011). Training attentional control in infancy. Curr. Biol. *21*, 1543–1547.