Different letter-processing strategies in diagnostic subgroups of developmental dyslexia also occur in a transparent orthography: Reply to a commentary by Spinelli et al.

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Different letter-processing strategies in diagnostic subgroups of developmental dyslexia also occur in a transparent orthography:

Reply to a commentary by Spinelli et al.

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The article was motivated by a commentary of Spinelli et al. (2010), who commented on our experimental study with dyslexic children (Lachmann & van Leeuwen, 2008). They questioned the unusually large reversed lexicality effect we reported for three of our dyslexic children for which word reading times were considerably longer than nonword reading times. We argued that, in principle, in a transparent orthography, such as German, children exist who have significant problems in word reading, but for whom nonword reading is normal. The extreme reversed lexicality effect, however, may not be representative for the dyslexic population. Since we do not want to give the impression that our results were based on these three participants, we reran analyses on reaction times presented in Lachmann and van Leeuwen, this time excluding the data from the three individuals. Results were replicated. The constructive criticism has helped put both the diagnostics and our experimental results on even firmer ground. Both yield a consistent interpretation, in which two subgroups of dyslexics can be distinguished: one with generic activation problems; the other with a specific problem in phoneme-grapheme conversion.

Keywords: Developmental dyslexia; Letter recognition; Flanker; Reading development; Subgroups; Transparent orthography.

In this issue of Cognitive Neuropsychology, Donatella Spinelli and her colleagues (2010) comment on our recent experimental study with dyslexic children (Lachmann & van Leeuwen, 2008a). This study was based on earlier work showing the presence of a specific strategy for letter perception...
(Lachmann & van Leeuwen 2004, 2008b; van Leeuwen & Lachmann, 2004), which was identified for normal adult readers. Since this strategy might depend on reading experience (James, James, Jobard, Wong, & Gauthier, 2005), we investigated whether children who are learning to read already show the strategy and whether anomalous strategies can be observed in subgroups of children who have difficulties in learning to read.

To this end, we compared perceptual organization in German adults with that of primary school children. Within the latter population we compared three groups: normally reading children and two subgroups of developmental dyslexia. These subgroups were earlier classified as having different reading failure profiles. For transparent orthographies like German, reading time has been established as a more appropriate reading performance measure than accuracy (e.g., Landerl, Wimmer, & Frith, 1997a). Classification into subgroups was therefore performed according to reading times compared to the reference population. Frequent-word reading-impaired (FWRI) children were very slow in reading frequently used words but performed within the norms when reading nonwords. Nonword reading-impaired (NWRI) children were slow either in reading nonwords only or in reading both nonwords and frequently used words.

Our classification deviates from Boder (1973), who originally defined three subgroups—dyseidetics (our FWRI) and two categories of NWRI: dysphonetics (i.e., children exclusively impaired in NWR) and dysphoneidetics (i.e., children impaired in both NWR and FWR). Lachmann, Berti, Kujala, and Schröger (2005) tested Boder's hypothesis that dyseidetics/FWRI are specifically characterized by deficient visual Gestalt perception, while other dyslexics have a phonological processing deficit. In fact, exactly the opposite was found: FWRI were shown to be impaired in passive tone and syllable discrimination, whereas NWRI showed normal preattentive tone and syllable discrimination, as observed by mismatch negativity (see Bishop, 2007, for review). Both groups, however, showed deficits in sound reception. It was concluded that FWRI have either an auditory or a pansensory temporal processing problem.

Thus, even though our FWRI subgroup corresponds to Boder's (1973) "dyseidetic" subtype, our theoretical understanding of this subgroup is more in line with the well-established "double-deficit hypothesis" by Bowers and Wolf (1993; Wolf & Bowers, 1999). These authors postulate besides a deficit in phonological processing a possible delay in naming speed as a second, independent, underlying cognitive impairment in dyslexia. In contrast to the double-deficit hypothesis, however, Lachmann et al. (2005) proposed that FWRI is a consequence of a more general, material-unspecific processing-speed deficit, which in turn results in a naming-speed delay. Accordingly, Lachmann and van Leeuwen (2008a) found for FWRI dyslexic children the same pattern of effects as that for normal reading children, but the response times of these children were much slower overall. This general slowing down thwarts the rapid activation of phonological codes (phonological Gestalts), which results in slow FWR. At least in the rather inexperienced readers in Lachmann and van Leeuwen (2008a), this has only little effect on NWR, which is performed still rather slowly in primary school children. For these dyslexics, word reading times are therefore below but nonword reading times still within the norms.

Since we (and others, e.g., Facoetti et al., 2006) found within NWRI only a few children exclusively impaired in NWR, the FWR problems in this group were considered a secondary effect of an underlying NWR impairment. In Lachmann and van Leeuwen (2008a) the NWRI group had about the same average response times as their normally reading peers, but they showed a strong dissociation between letters and nonletters: a normal congruence effect for nonletters but a negative congruence effect for letters. With letters, negative congruence effects have previously been observed in normal-reading adults (Lachmann & van Leeuwen, 2004; van Leeuwen & Lachmann, 2004), but only when the task required active suppression of the surrounding information (cf. Bavelier, Deruelle, & Proksch, 2000). NWRI dyslexics may rely on active
suppression of the surrounding information, because congruent nontargets surrounding letters are not helpful and may be particularly hard to ignore. Note that we propose that deficits in NWRI children occur only when linguistic material is presented visually. These children, we argued, show suboptimal functional coordination in grapheme-to-phoneme conversion (cf. Lachmann, 2002; Lachmann & van Leeuwen, 2007). The mapping is beset with interference from irrelevant visual flanking information. The anomalous strategy of actively suppressing the surrounding information, therefore, is a coping strategy. We may expect similar anomalies in processing of other visually presented linguistic material. As a secondary consequence, word-reading problems may arise.

In their commentary, Spinelli and her colleagues (2010) question the composition of our dyslexic subgroups, FWRI and NWRI. They found it puzzling that dyslexic children in a transparent orthography would be selectively impaired in frequent-word reading. In particular the authors were surprised that 3 of our 11 FWRI participants showed much longer reading times for words than for nonwords. Like German, Italian has a transparent orthography; Spinelli et al. plotted individual reading times for nonwords as a function of those for frequent words (such as in Lachmann & van Leeuwen, 2008a, Figure 2). In a sample of Italian dyslexic third-graders only a few of their participants’ data points fell below the diagonal, showing that absolute reading times seldom were longer for words than for nonwords. Moreover, they observed that none of their Italian dyslexics would be classified as FWRI by our criteria.

We consider separately two issues raised by Spinelli et al. (2010). The first issue is whether in a transparent orthography children exist who have significant problems in word reading, but for whom nonword reading is normal. The other issue is how to account for the presence of 3 of the FWRI participants in our experiment, for whom an unusually large reversed lexicality effect was observed—that is, word reading times were considerably longer than nonword reading times.

Do specific word-reading deficits occur in transparent orthographies?

We start with the question whether in a transparent orthography, deficits in word reading can occur while nonword reading remains intact, as is found in languages with opaque orthography, such as English (Boder’s dyseidetics; Boder, 1973). In fact, there is evidence that the lexical reading route is applied and can be impaired in transparent orthographies (see Jimenez Gonzalez, 2002, for an overview). A number of studies identified children in transparent orthographies who have intact nonword reading while word reading is impaired (Italian: Facoetti et al., 2006; Lorusso et al., 2004; Spanish: Jimenez Gonzales & Ramirez Santana, 2002; German: Lachmann et al., 2005; Lachmann & van Leeuwen, 2008a; Japanese: H. Sato, personal communication, November 24, 2009).

These studies are rather heterogeneous in methodology; in most of them, however, as well as in Lachmann and van Leeuwen (2008a), the distinction between subtypes has been made based on individual reading performance—for example, in FWR and NWR—relative to the reference population. A FWRI child, who is below norms in FWR but within norms of NWR, could, as a consequence, still have shorter absolute reading times for words than for nonwords, which is, for instance, the case for about half of the children in Lachmann and van Leeuwen (2008a). Vice versa, a child with longer FWR than NWR time does not necessarily reach the criterion for the FWRI group. We deliberately chose this norm-related method rather than direct comparison of absolute reading times or errors. Raw data should only be interpreted with caution for a number of reasons, including the following:

1. A direct comparison of raw reading scores for words and nonwords from a diagnostic test is not informative because of the important principle that in testing, the order of events (between items, subtests, and tests) should be kept identical across participants, rather than counterbalanced, as in experiments. Counterbalancing the order of
word reading and nonword reading trials would principally be more suitable for a direct comparison between reading times for word and nonword reading tasks, unbiased by the order of treatments. But this would, of course, distort individual scores on these tasks. This is why in the Salzburger Lese- und Rechtschreibtest (SLRT; Landerl, Wimmer, & Moser, 1997b), the German reading test we used, for every child the subtest Frequent-Word Reading (“Häufige Woerter”) is the first subtest, and Nonword Reading (“Wortunachnliche Pseudowoerter”) is the fourth in order. Thus, the NWR performance benefits from higher task familiarity, especially as the relevant measure is reading time. Hence, it is meaningless that, for instance in our diagnostic data, some FWRI children are faster in raw scores on NWR than on FWR tests. The advantage for FWR is, of course, discounted in the norms, on the basis of which the comparison between children should therefore be made.

2. Apart from the counterbalancing issue, the interpretation of raw scores between two tasks is problematic because they may not be equally difficult (as observed by Spinelli et al., 2010). The SLRT reading test balanced FWR and NWR task difficulty only with respect to the total number of letters that the test material contains. The subtests differ, however, in the number of words/nonwords used (30 words in FWR, 24 nonwords in NWR). Moreover the FWR subtest contains 3- to 6-letter items, but the NWR test contains 4- to 7-letter items. Most importantly, the items differ in word structure: Nonwords consist of chains of alternating single consonants and vowels, in which each letter corresponds to a grapheme (e.g., *talire*). The nonwords, therefore, have a high degree of predictability and simple grapheme–phoneme correspondences. Frequent words, by contrast, contain consonant clusters (e.g., *Straße*), letter clusters corresponding to single phonemes (e.g., <sch> for /ʃ/, <ie> for /iː/), and double consonants corresponding to a single consonantal phoneme, the function of which is to indicate the length of the preceding vowel (e.g., *Ball* = /bal/). In Form A of the SLRT, which we used, these more complex word structures or grapheme-to-phoneme mappings apply to two thirds of the words (Katze, Schule, jetzt, Stein, etc.). German is not as transparent as one might think! These rather complex word structures might pose particular problems for a beginning reader, who is not capable of a lexical reading strategy. If these readers apply a phonological strategy for the subtests in the SLRT, these complex structures will make FWR much harder than NWR.

3. Furthermore, raw data scores do not take into account that the relation between reading times for words and nonwords changes with age and reading experience (especially between Grades 3 and 4; Diaz et al., 2009; Zoccolotti, De Luca, Di Filippo, Judica, & Martelli, 2009), and thus the data are not suitable to adequately differentiate between dyslexic subtypes in children of different age/grade, as is the case in Lachmann and van Leeuwen (2008a). How word versus nonword reading skills develop in normal and in dyslexic children in transparent orthographies is still debated (Diaz et al., 2009; Landerl & Wimmer, 2000), but as previously illustrated, FWR can be more difficult than NWR for children who have not yet developed a lexical strategy, whereas it may be opposite once a lexical strategy has been acquired.

From Issues 1–3 we can conclude that a direct comparison between raw nonword reading and word reading scores is suboptimal. Nevertheless, the question remains why some researchers find children in a transparent orthography who are selectively impaired in FWR (e.g., Facoetti et al., 2006; Lachmann et al., 2005; Lachmann & van Leeuwen, 2008a; Lorusso et al., 2004), while others do not (e.g., Spinelli et al., 2010; Zoccolotti et al., 1999). A main reason might be the differences in methodology: Some authors used reading speed (Lachmann et al., 2005), some used reading accuracy (Facoetti et al., 2006; Lorusso et al., 2004), and some used both measures (Zoccolotti et al., 1999). Concerning
their samples, some have studied third graders (Jimenez Gonzalez & Ramirez Santana, 2002), others also older children (Spinelli et al., 2010); some have tested homogeneous age groups (Spinelli et al., 2010), others a larger cluster (Facoetti et al., 2006; Lorusso et al., 2004); some used a rather large sample (Jimenez Gonzalez & Ramirez Santana, 2002), whereas other results are based on only 4 participants (Zoccolotti et al., 1999). For the distinction between subgroups, some researchers require a performance criterion of 2 standard deviations (Lachmann & van Leeuwen, 2008a; Spinelli et al., 2010), others a criterion of 1.5 standard deviations (Facoetti et al., 2006) below the reference population in one reading measure, along with normal-like behaviour on the other reading measure; yet other researchers even allow that children perform below the norms in the alternative reading measure as well (Lorusso et al., 2004). Besides reading, measures of intelligence are an important inclusion criterion for dyslexia. Also in this respect, criteria differ considerably. Only few studies use purely nonverbal intelligence tests (Lachmann & van Leeuwen, 2008a, Spinelli et al., 2010). Moreover, the IQ cut-offs for exclusion of participants differ across studies (e.g., 1 SD, IQ < 85 in Facoetti et al., 2006, and Lorusso et al., 2004; about 1.3 SDs, IQ < 81 in Spinelli et al., 2010; 2 SDs, IQ < 70 in Lachmann & van Leeuwen, 2008a). For example, using the IQ exclusion criterion of Spinelli et al. (2010) would lead to the exclusion of 3 of the 11 FWRI but only of 1 from the 10 NWRI children in Lachmann and van Leeuwen (2008a).

Thus, even though Spinelli et al. (2010) tried to meet the same criteria as those of Lachmann and van Leeuwen (2008a), the data cannot, strictly speaking, be compared directly. We completely agree with Spinelli and her colleagues that specific characteristics of the language under investigation other than transparency and syllabic complexity, as well as differences in sampling and in test materials, may explain why they found a different pattern than we did. Moreover, the experiment in Lachmann and van Leeuwen (2008a) was aimed at establishing the mechanisms underlying some identifiable diagnostic subgroups of dyslexia, rather than at the issue of how many subgroups of dyslexia can be distinguished in the population and what their precise incidence rate is. Such issues would have required a much larger sample and other differences in methodology. For instance, the selection should not be done in one state and one school, as it was in Lachmann and van Leeuwen, since dyslexia diagnosis, teaching methods, and treatment differ considerably between the states (Bundeslaender) even within Germany.

Taking all these issues together, Spinelli and her collaborators (2010) are right by stating that the search for subtypes of developmental dyslexia in transparent orthographies still constitutes an open question. In our view, it is essential to define subgroups based on well-researched and accepted criteria of discrepancy between NWR and FWR. It is also possible to use individually based statistics (e.g., Crawford & Howell, 1998; Willmes, 2009) rather than fixed a priori defined criteria. In this vein, it is of note that the variability in the predefined criteria for identifying a deficit (or a spared ability) is one of the major sources of variability across studies.

Reanalysis including a subsample of FWRI children

Besides the existence of a specific FWRI in transparent orthographies, Spinelli et al. (2010) found surprising the extreme reversed lexicality effects that we observed for 3 out of our 11 FWRI children, who showed an approximately 150% higher reading time for frequent words than for nonwords (see Figure 2 of Lachmann & van Leeuwen, 2008a). Could it be that this simply reflects a measurement error? Plotting text reading times of all participants (Subtest 3 of SLRT) against nonword reading times revealed a nearly identical pattern: Not only is the group distinction the same, but the 3 FWRI children are also among the slowest 4 in text reading (all percentage rank, PR < 1). The reversed lexicality effect in these children is therefore unlikely to result from measurement errors.
We have no qualitative observations available on the 3 FWRI children in Lachmann and van Leeuwen (2008a). In our more recent diagnostic data (N = 14) from Grades 2 to 4, however, we found 1 more boy (Grade 2) who also showed considerably longer FWR than NWR times (121 ms, PR < 3; 101 ms, PR < 16, respectively; cf. Table 8 in the SLRT test manual). The experimenter noticed that the boy specifically had problems with reading letter clusters representing single phonemes (e.g., <sch>, corresponding to /ʃ/, or <ei> corresponding to the diphthong /ai/). The boy split these letter clusters up into their constituent letters and used a phonological strategy to read them. The resulting phoneme strings were sometimes unpronounceable as they did not obey German phonotactic rules. As the boy was aware that the subtest was about reading meaningful words he then shifted to word guessing, mostly with success, and was finally able to report the target word without further reading errors. In this respect, results from an ongoing study are interesting. We measured articulation times for individually presented words from SLRT. Within the normally reading population (n = 32, Grade 3) we found only moderate differences in articulation times between the words, depending on word length—for example, 740 ms for “Hut” and 826 ms for “Katze”. One FWRI boy, in contrast, showed dramatically increased articulation times for “Katze” (2,330 ms) as compared to “Hut” (772 ms). Such behaviour is more likely in younger primary school children. Interestingly in this respect, the sample in Lachmann and van Leeuwen (2008a) was tested at the beginning of Grades 3 and 4.

Altogether, however, in our more recent samples, much longer FWR than NWR times are rather rare. In Lachmann, Schumacher, and van Leeuwen (2009), for instance, all of the 22 dyslexics were either slower in NWR than in FWR or had about equal reading times in both tests, including the FWRI (subgroups were originally not considered in this study). From the 14 dyslexics in a recently finished study we found only 1 child (Grade 3), had longer reading times in FWR (82 ms, PR < 3) than in NWR (67 ms, PR > 16). Thus, we may consider that cases with extreme reversed lexicality effect are overrepresented in the FWRI group of Lachmann and van Leeuwen (2008a). Since we do not want to give the impression that the results of this study are based on the 3 FWRI participants that Spinelli et al. (2010) had identified as having an atypically large reversed lexicality effect, we reran the omnibus analysis of variance (ANOVA) and relevant post hoc analyses on response time (RT) presented in Lachmann and van Leeuwen (2008a), this time excluding the data from these 3 individuals. The results and more detailed discussion are reported in the Appendix.

In sum, the ANOVA confirmed all effects found in the original study, except that the Response Type × Group interaction decreased to 10% level. This effect returned in the form of a triple interaction with surrounding. Most importantly, the central finding of our earlier study, the Group × Material × Surrounding interaction, was reconfirmed by our present analyses. Normal-reading and FWRI children preferred congruent over incongruent surroundings for letters; NWRI showed an opposite preference. Separate analyses for the new FWRI group revealed that response times were still enhanced compared to normal-reading children, though less than in the original study as a result of leaving out some of the slowest participants. This means that our interpretation still stands, that FWRI dyslexics have a problem in fast functional activation, resulting in overall response time delays.

Reading is a very complex process, involving the functional coordination of visual and phonological representations. Disruptions in any of the involved subfunctions as well as in their coordination may compromise the process of learning to read (Lachmann, 2002), and any of these disruptions may give rise to a variety of primary and secondary symptoms. We are under no illusion that our current typology would exhaust the possible subtypes and profiles that might be distinguished in dyslexic children (e.g., Heim et al., 2008; Kar & Tripathi, 2008). Eventually, we must admit that after more than a century of scientific study of reading disabilities, both questions
remain open: What is the nature of developmental dyslexia, and what subgroups can be distinguished? We should bear in mind that these questions are not independent of each other.

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APPENDIX

Rerun of analyses in Lachmann and van Leeuwen (2008a) excluding 3 participants with an extreme reversed lexicality effect

In Lachmann and van Leeuwen (2008a) normally reading adults and children and two diagnostic subgroups of children with developmental dyslexia—frequent-word reading-impaired (FWRI) and nonword reading-impaired (NWRI) children—performed a successive same–different task with pairs of either letters or nonletters. The first one was always presented in isolation; the second, presented half a second after the first one had disappeared, could be isolated or surrounded by a task-irrelevant form-congruent or form-incongruent geometric shape. Adults showed congruence effects with nonletters but not with letters.
and children with both types of stimuli. FWRI children in addition showed dramatically slower overall reaction time (RT). NWRI dyslexics showed congruence effects with nonletters but negative congruence effects with letters. The results support the notion that normal readers have established a special processing strategy for letters (Dehaene et al., 2009; Lachmann & van Leeuwen, 2004, 2007; van Leeuwen & Lachmann, 2004). Processing speed rather than reading expertise seems crucial for this strategy to emerge. The contrasting effects between subgroups of dyslexics reveal their specific underlying deficits. As observed by Spinelli et al. (2010), 3 children of the FWRI group showed an extreme reversed lexicality effect. To assure that the distinct RT profile of the FWRI group is not based only on the data of these 3 children, the analyses in Lachmann and van Leeuwen (2008a) were rerun with these 3 participants excluded.

The analysis of variance (ANOVA) included the within-subject factors response type (same vs. different), material (letters, pseudoletters, shapes), and surrounding of the second target (isolated, congruent, incongruent), and the between-subjects factor group (normally reading adults, normally reading children, the new FWRI dyslexics, and NWRI dyslexics). As in Lachmann and van Leeuwen (2008a), we performed parametric analyses for response speed (1/RT) and presented RT averages as arithmetic means. As in the original study, the ANOVA revealed main effects for all factors. Table A1 presents results for the new FWRI group.

Table A1. Mean reaction time for letters, pseudoletters, and shapes, presented isolated or with irrelevant congruent or incongruent surroundings to children with a specific frequent-word reading impairment

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<tr>
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<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Letters</td>
<td>969.21</td>
<td>521.42</td>
<td>913.70</td>
<td>454.11</td>
<td>1,000.59</td>
</tr>
<tr>
<td>Pseudoletters</td>
<td>976.11</td>
<td>442.08</td>
<td>973.18</td>
<td>407.29</td>
<td>1,018.16</td>
</tr>
<tr>
<td>Shapes</td>
<td>973.06</td>
<td>468.44</td>
<td>967.87</td>
<td>496.73</td>
<td>1,035.82</td>
</tr>
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Note: Reaction time and standard deviations in ms.

different responses ($M = 736$ ms), which reflects the expected fast–same effect (Lachmann & van Leeuwen, 2005; Proctor, 1981). An interaction between response type and surrounding, $F(2, 106) = 3.8, p < .05$, and a triple interaction of response type, surrounding, and group were found, $F(6, 212) = 2.69, p < .05$. These findings correspond with the original analysis, except that the earlier Response Type × Group interaction is no longer significant at .05 level, $F(1, 53) = 2.39, p = .08$. The interactions result from an exceptionally large fast–same effect for NWRI dyslexics in congruent conditions (143 ms). The fast–same effect was explained in terms of visual object recognition strategies (Eviatar, Zaidel & Wickens, 1994; Lachmann & van Leeuwen, 2005; Proctor, 1981). The size of the effect in the congruent condition in the NWRI group, therefore, indicates a strong reliance on visual object recognition strategies.

For material, $F(2, 106) = 12.63, p < .01$, faster responses were given to letters ($M = 683$ ms) than to shapes ($M = 699$ ms) and to pseudoletters ($M = 711$ ms); all pair-wise differences were found to be significant (in the original analysis pseudoletters did not differ from shapes). This effect reproduces the letter superiority effect (Ambler & Proctor, 1976; Burgund, Schlaggar, & Petersen, 2006; van Leeuwen & Lachmann, 2004), which reflects the automatized character of letter processing.

The factor surrounding, $F(2, 106) = 28.18, p < .01$, revealed a robust congruence effect. Responses for isolated targets ($M = 679$ ms) were faster than those with congruent surroundings ($M = 693$ ms), which, in turn, were faster than those with incongruent surroundings ($M = 721$ ms). The surrounding reduces target detectability, and this effect is
counteracted by congruence. The interaction between material and surrounding, $F(4, 212) = 2.82, p < .01$, revealed higher congruence effects for shapes than for other material conditions. These results are consistent with the original analysis and confirm the predicted dissociation of congruence effects between letters and nonletters.

The group main effect, $F(3, 53) = 12.87, p < .01$, was further explored by a post hoc test, which revealed that normally reading adults ($M = 490$ ms) were faster than all children groups, as we would expect. Due to the exclusion of the 3 participants from the FWRI group, who all had relatively large mean RTs, no further group differences were found in the omnibus ANOVA. However, restricting the analysis to the children groups revealed significantly slower RTs for FWRI children ($M = 980$ ms) than for normally reading children ($M = 717$ ms). This is in accordance with the observation in the original study of specifically long RT for FWRI children. Importantly, the Surrounding $\times$ Group interaction found in the original study is confirmed, $F(6, 106) = 2.5, p < .05$. This interaction is due to a congruence effect present in all groups except in NWRI. This group shows a negative congruence effects for letters, which cancels out the congruence effects in nonletters. As in the original analysis, this effect was revealed by the triple interaction of material, surrounding, and group, $F(12, 224) = 2.23, p = .01$, which in the original study was significant only at the .05 level.

**Conclusion**

Normally reading adults and children and two diagnostic subtypes of dyslexics all showed congruence effects in nonletters. These effects are typically understood as resulting from perceptual feature integration between the target and its surrounding (Boenke, Ohl, Nikolaev, Lachmann, & van Leeuwen, 2009; Pomerantz & Pristach, 1989). For letters, the effects of these subgroups diverge. In our reanalysis, for which 3 children were excluded because of their extreme reversed lexicality effect, we confirmed the earlier observed dissociation between subgroups of dyslexics. NWRI children who, we supposed, find single grapheme–phoneme conversion difficult, showed active suppression of the surrounding information, leading to negative congruence effects for letters (Bavelier et al., 2000). In accordance with our theoretical characterization, NWRI children showed such anomalous response patterns only with linguistic material. FWRI dyslexics showed congruence effects for letters, just like normally reading children, but were much slower overall. We consider them to have generic difficulties with activation speed.

The reanalysis was motivated by a commentary of Spinelli et al. (2010). They questioned the extreme reversed lexicality effect in a subsample of FWRI dyslexics. The subsample was shown not to be responsible for the contrast between NWRI and FWRI dyslexics. The constructive criticism, therefore, has helped put both the diagnostics and our experimental results on even firmer ground. Both yield a consistent interpretation, in which two subgroups of dyslexic children can be distinguished: one with generic activation problems; the other with a specific problem in phoneme–grapheme conversion.