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DEVELOPMENTAL PSYCHOLOGY | RESEARCH ARTICLE

The alleged link between creativity and dyslexia: Identifying the specific process in which dyslexic students excel

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Abstract: It is often argued that individuals with developmental dyslexia (DD) are particularly creative. In order to test this claim, in Study 1 the WCR (widening, connecting and reorganizing) Creativity Test was administered to 52 junior high school students, 19 of whom diagnosed with DD. Results showed that students with DD performed significantly better in the connecting task, which consisted in carrying unusual combination of ideas out. This finding was supported by Study 2, involving a small sample of junior high school students with DD, where a negative correlation between connecting abilities and reading skills emerged. This investigation contributes to the understanding of the peculiar cognitive functioning of people with learning disabilities.

Subjects: Cognitive Psychology; Creativity; Developmental Psychology; Learning Disabilities

Keywords: creativity; dyslexia; learning disabilities; originality; WCR model

1. Introduction

According to a widespread opinion, people with developmental dyslexia (DD) are particularly creative (Davis & Braun, 1994; Eide & Eide, 2012; Jantzen, 2009; Wolfe, 2007). It is often pointed out that people who have provided original contributions in different domains (e.g., Christian Andersen and

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PUBLIC INTEREST STATEMENT

A creativity test that identifies the three basic skills of creative thinking (i.e. widening, connecting and reorganizing) was administered to a group of junior high school students, some of whom were diagnosed with dyslexia. It was found out that students with dyslexia had a statistically significantly higher propensity for unusual combination of ideas, which is an aspect of creative thinking, comparing with normally developing students. These findings are a contribution to the understanding of the peculiar cognitive functioning of people with learning disabilities. The results also suggest that dyslexia involves not only impairments, but it is also associated with cognitive peculiarities that can be useful and productive.

Agatha Christie in literature; Pablo Picasso and Walt Disney in visual and Giacomo Puccini in music artistic expressions; Thomas A. Edison and Albert Einstein in scientific and technical fields; Leonardo da Vinci in a variety of disciplines) probably had DD (Ehardt, 2009). However, more reliable are the biographical–psychological reconstructions conducted on living creative individuals with DD (Rack, 1981), such as the painter and photographer Robert Rauschenberg (Gobbo, 2010). The link between DD and creativity has been the topic of many theoretical speculations (Alexander-Passe, 2010; West, 2008), but it has been little investigated empirically.

1.1. Creativity in learning disabilities

A preliminary study of the creative potential of people with learning disabilities (LD), including DD, was carried out by Tarver, Buss, and Maggiore (1979). The researchers examined a sample of 24 students aged between 6 and 14. Considering selective attention as the ability of focusing on the relevant (central) information while filtering out the irrelevant (secondary) ones, the authors suggested that people with LD are able to learn and remember secondary information easily, therefore diverting attention from the primary task. This capacity is linked to creativity and was assessed through the *alternate uses* test by Wallach and Kogan (1965), in which participants were asked to generate as many uses for common objects as they can, and the *Torrance Tests of Creative Thinking* (TTCT: Torrance, 1974). Results showed a negative correlation between selective attention and creativity in students with DD, although the relationship varied according to age and type of creativity measures. In particular, in the group of children aged 7–9, figural originality was highly related to selective attention in the predicted direction. Conversely, the group aged 10–12 showed a positive correlation between selective attention and figural originality, but a negative relationship with the verbal originality/uniqueness measures. In the oldest age group, selective attention was mildly related to originality, but not to fluency.

A second study investigated the relationships between interpersonal problem-solving and creativity in boys with LD. Shondrick, Serafica, Clark, and Miller (1992) compared creative skills of 46 third- and fourth-grade students diagnosed with LD with a same size control group, using verbal and nonverbal measures of creativity and an interpersonal problem-solving test. LD students were less skilled than students without LD in analysing and formulating a problem considering its important components and in foreseeing possible consequences to different solutions. Verbal creativity was measured using the *alternate uses* test by Wallach and Kogan (1965), whereas nonverbal creativity was assessed using the *Test of remoteness* (Eisen, 1989), in which participants were asked to create as many picture as they can using some given geometric shapes. The two groups performed similarly in the two verbal tasks. Moreover, a positive correlation between creativity and interpersonal problem-solving was found: higher scores in verbal fluency were associated with a better ability to analyse the problem, generate alternative solutions and foresee the consequences to the chosen one.

More recently, Hong and Milgram (2010) studied the relationships between general and domain creativity (measured using the *Tel Aviv Creativity Test*) and specific-domain creativity (measured using the *Ariel Real-Life Problem-Solving*) in a sample of 130 university students, about the half of whom had a LD. Having a LD turned out not to affect the general creative thinking. However, LD students performed worse in a form of creative thinking, that is, the *academic problem-solving*, but better than controls in the visual and intuitive aspects of creative thinking. It is worth noting that in this study, creative skills were assessed only by reference to fluency, whereas it would be important to consider also other measures.

1.2. Creativity and DD

Regarding DD specifically, in LaFrance, 1997 widened a study conducted three years before by the University of Ottawa, involving three groups of students aged 9–14, i.e. gifted students without any cognitive disorders, gifted students with DD and not gifted students with DD. Both the visual tasks of TTCT and the *Future Scenario Writing* task were administered. Through both quantitative and qualitative analyses it emerged that students with DD had a higher propensity for intuitive aspects of

creative thinking. Furthermore, gifted students with DD were more open to new ideas and more willing to accept ambiguity.

Just few years later, Everatt, Steffert, and Smythe (1999) reported higher levels of creativity in figural tests of children with DD, a result that was later confirmed by other authors using a drawing task (Çorlu, Özcan, & Korkmazlar, 2007, 2009) in which subjects with DD showed a faster performance and a greater richness of details. However, it could be argued that these skills are not necessarily associated to creativity. Everatt (1997) and Pachalska, Bogdanowicz, Tomaszewska, Lockiewicz, and Bogdanowicz (2009) reported greater overall creativity in adults with DD. Tafti, Hameedy, and Baghal (2009) investigated positive and negative aspects of DD in the Iranian context. The authors compared memory and creative skills of students with and without DD. The sample, recruited in some primary schools of Tehran, included 26 children with DD and 26 normally developing children (mean age = 9). Participants' reading, verbal memory, visual–spatial skills and creativity (using TTCT) were assessed. Children with DD performed significantly lower than the control group in both reading and verbal memory tests. Conversely, DD children performed better in visual memory and creativity (limited to originality) tasks.

However, some studies did not find significant differences between people with and without DD in creativity (Alves & Nakano, 2014; Lockiewicz, Bogdanowicz, & Bogdanowicz, 2013). Recently, Mourgues, Preiss, and Grigorenko (2014) found a positive correlation between reading skills and creativity, which was assessed using visual (making as many drawings as possible in a given time) and verbal tasks (*alternate uses* test) in a large sample of university students aged 18–38 (no participant had DD), even though reading and creativity tests loaded two distinct factors, which were modestly correlated each other (r = .168), and correlations between creativity scores and reading measures were the lowest ones which were computed (in no case being higher than .30), as well as the differences in creativity scores between low and high reading achievers were lower than those recorded in the other measures.

1.3. Aim of the study

Literature suggests—with some exception—that individuals with LD have a creative potential, which is expressed especially in the form of visual and intuitive thinking. However, the propensity of people with DD to creative thinking remains controversial, since it has to be studied yet whether this propensity concerns some specific aspect of creativity or an overall attitude.

The aim of the present study is to investigate the relationship between DD and creativity in the Italian context, where no studies about this topic have been made yet. Two different studies have been carried out in order to address the question. Both studies involved junior high school students, corresponding to an age range little investigated internationally, and measured the different processes underling creative thinking separately (which is an approach seldom implemented).

2. Method

2.1. Widening, connecting and reorganizing (WCR) creativity test

As it is well known, creativity is a broad and multifaceted construct (Sternberg, 1998). In order to identify the specific components of creativity, a model that summarizes the various theories was developed (Antonietti & Colombo, 2013; Antonietti, Colombo, & Pizzingrilli, 2011). The model identifies three main mental operations underling creative thinking, namely:

- *Widening* the mental field through divergent thinking, which is activated under circumstances that provide multiple ways out and in situations where there are few constraints. Moreover, it involves changing dominant ideas and generating new ones in order to create a wide range of options.

- *Connecting* different mental fields through unusual combination of ideas, that support new possibilities and original solutions.
- *Reorganizing* the mental field, which allows one to get in touch with new properties of the situation's elements and to consider them from a different perspective. Therefore, a transformation of the point of view can take place and this supports the inclusion of available data into a new conceptual organization.

The *WCR Creativity Test* (Antonietti, Giorgetti, & Pizzingrilli, 2011) permits to identify the three basic skills of creative thinking mentioned above, namely:

- The ability to *widen* (W), consisting in knowing how to produce many different ideas and to broaden the perspective.
- The ability to *connect* (C), which concerns the ability to establish relationships between elements and to combine them beyond their appearances and similarities/differences.
- The ability to *reorganize* (R), that is, the ability to de-contextualize the elements of the situation, reconstruct them, and change the perspective.

The test is composed of nine items, consisting of both visual (pictures of objects, geometric figures and sketches) and verbal (words or short phrases) stimuli.

Each subtest is composed as follows:

- Three items for the W (*Widening*) subtest: The participant is asked to choose between four options, which differ gradually from the most to the less obvious interpretation of the stimulus. An example of stimulus is "A desk can be used …" and the proposed answers are: (a) for writing; (b) for reaching an object placed on a high shelf, climbing on it; (c) as a bookcase, placing a stack of books on it; (d) sheltering under it during an earthquake. The respondent has to choose one of these options;
- Three items for the C (*Connecting*) subtest: The participant is asked to choose, between a given list of words or images, three items to connect to a given stimulus. Response options differ for degree of originality. For example, a picture depicting a tennis match is showed and the task is: "Choose three things, between those described below, to include in the picture". The list of options (consisting in words and corresponding pictures) are: a wristband, a group of supporters, a scoreboard, a cloud with a lightning, a cake, some little balls, a book, a mobile phone, an elephant and a rock singer.
- Three items for the R (*Reorganizing*) subtest: After reading a sentence or looking at a picture describing a hypothetical situation, the participant is asked to choose, between some given options (from the most common to the most unusual ones), the one that completes the situation presented. For example, the respondent is asked: "What would happen if we saw in black and white?" The given consequences are: (a) you could not see the colours of Harlequin's dress; (b) everything would be much sadder; (c) we would not have problems to match clothes' colours; (d) painters would only have two colours on their palette; (e) it would feel like being in an old movie.

Score attributions to each option have been settled considering the frequency distribution of the answers given by the standardization sample (from 1 = uncreative to 3 = very creative). Specifically, we considered a criterion of gradual deviation from the most frequent response (in terms of percentage), based on the principle according to which infrequent answers are the most creative. This principle was often considered for measuring creativity and many creativity tests—including the TTCT (where the originality score is always considered, unlike other scores of the test, in experimental studies assessment of creativity) and the *Remote Associates Test* (Mednick & Mednick, 1967) (in which the less frequent associations of words gets the higher scores)—allow the evaluator to

compute the "originality" score according to it. Among the selected options, the ones corresponding to frequencies of less than 10% were given the highest creativity score (equal to 3); responses corresponding to frequencies of more than 60% were given the lower creativity score (equal to 1).

C and R subtests' items require also to provide a brief explanation for the choice made or to write a short story according to the selected option, in order to distinguish between justified responses and bizarre answers.

For each subtest an overall score is computed by adding the item's scores. Each item can get the score of 1, 2 or 3. A and R subtests involve multiple-choice items; whereas C subtest includes multiple answers items (three answers are required).

In the present study, the version of the WCR test addressed to junior high school students was used (Antonietti, Pizzingrilli, & Valenti, 2012), which was previously validated through the administration to a sample of 200 students. In this sample, alpha values of the three subscales varied from .567 to .681. A subgroup of 52 subjects belonging to the validation sample was administered the test again after three months: Scores resulted to be rather stable (test–retest correlation coefficients ranged between $r = .75$ and $r = .81$). Validation of the test is supported by (a) significant correlations (ranging from .43 to .60) of the WCR subtest scores with scores in the TTCT computed in a subsample who was administered both tests, (b) increases in WCR scores after an intervention where a training program—which had been previously showed to be effective in enhancing creativity skills (measured through a different test) in comparison to a control group—was applied, and (c) differences in WCR scores (as well as in TTCT) according to the features of the families, in agreement with the literature (Antonietti et al., 2012).

3. Study 1

3.1. Participants

The WCR test was administered to a group of students attending a public junior high school in Milan, which has a tradition of welcoming students with DD and promoting specific activities for them. Parents of dyslexic students are usually more prompt to enrol their sons in this specific school because of its particularly suitable teaching methods. This explains the higher prevalence of students with DD in the classrooms, which is lower in the Italian scholar population (Cornoldi & Tressoldi, 2007). Boys and girls were distributed similarly in first, second and third grade.

All students of the school were proposed to take part in the study. The aim and procedures of the investigation were explained to parents. Fifty-five students agreed to take part in the study with the consent of their parents. All of them were aged between 12 and15 and shared similar cultural and socio-economic status, as they all belonged to similar living environments (roughly 50% of the participants had graduated parents who were entrepreneurs, employees and traders).

Within the sample, 19 participants had been diagnosed with DD and 3 had a certification of disability. The latter were excluded from the analyses since in Italy the diagnosis of disability does not include learning disabilities and involves the presence of a support teacher in the classroom (according to the Italian Law n. 104/92). The remaining 33 participants constituted the control group since they did not have a diagnosis of any kind and no learning issues were reported by parents and teachers. Therefore, no indicators of a cognitive or learning impairment were present. Exclusion criteria for the diagnosis of DD (i.e. absence of emotional, relational, behavioural and intellectual disorders) were met by both controls and DD participants.

Diagnoses of DD had previously been made on the basis of standard inclusion and exclusion criteria (ICD-10: World Health Organization, 1992) by services accredited by the National Health System of Lombardy (in most cases, public Developmental Neuropsychiatry Units). Diagnosis included the assessment of the intellectual level (which was on average for all DD participants) and reading skills

(which were at least two SD below the mean value of the normative sample). Four students with DD had comorbidity with other LD (i.e. dyscalculia or dysorthography). No other psychological or neuropsychological disorder (e.g. specific language disorder, conduct disorder, oppositional defiant disorder, ADHD, etc.) were reported.

No significant difference was found between the clinical and the control group for gender [X^2 (52; N = 1) = .018; p = .894], grade [X^2 (52; N = 2) = .177; p = .915], and numbers of siblings [t_{50} = −.490; p = .626]. Therefore, subgroups were not created according to these characteristics that, as stated by literature, could have an effect on creativity.

3.2. Procedure

The administration of WCR test was collective and was scheduled during regular classes. No time limit was imposed, as usual in creativity testing, during the administration. Before the actual test, participants were given an informative booklet explaining the non-evaluating nature of the test, unlike traditional school assessment.

The administration of the test, as well as the scoring of all questions, was performed by a researcher previously trained to the use of the test.

3.3. Results

A comparison between the WCR scores of the clinical and control group was made, excluding the three participants with a diagnosis of disability, as previously reported.

The mean scores differed between the two groups only in the C (i.e. *Connecting*) scale, in which students with DD [M = 4.62, SD = .43] got statistically significant higher scores than those of the control group [M = 4.29, SD = .53; t_{50} = −2.10, p = .04]. Excluding from the analysis three outliers from the control group, the difference between the groups appeared to be even stronger [t_{47} = −4.19; p < .001]. As it is showed in the box plot (Figure. 1), most participants in the clinical group scored below the mean of the control group; Moreover, about 50% of the students with DD got a score 1.65 SD above the mean of the control group.

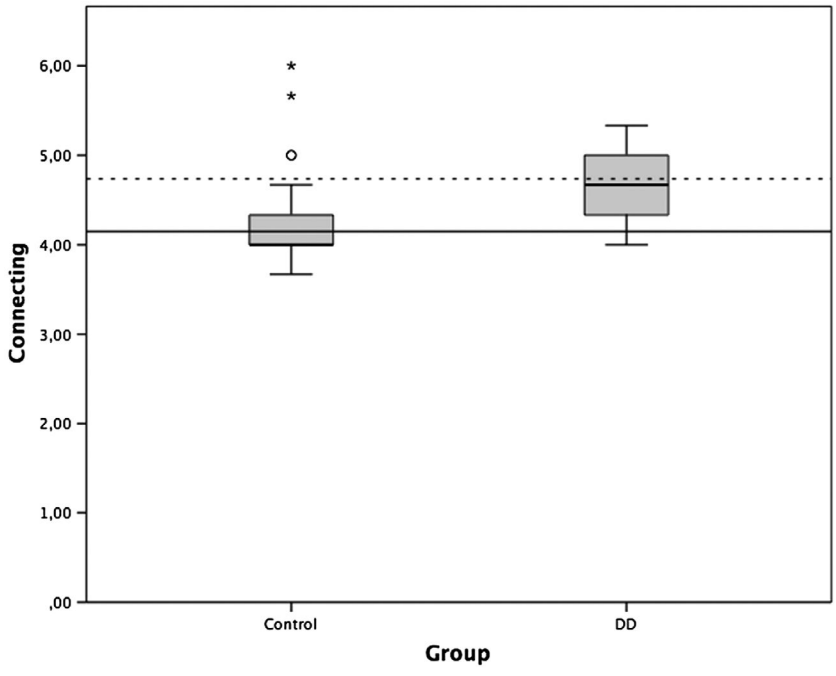

Figure 1. Study 1: Box plot representing the individual scores in the connecting scale.

Notes: The bottom and top of the box represent the first and third quartiles, while the band inside the box the median. The ends of the whiskers represent the minimum and maximum of all of the data. Outliers are plotted as individual points. The solid line indicates the control mean (excluding outlier values) and the dashed line the chosen deviance threshold (1.65 SD above the control mean).

Concerning the other subtests, no statistical difference was found between the groups (W scale: $t_{50} = 1.09$, $p = .28$; R scale: $t_{50} = -.67$, $p = .50$). Scores in the R subtest were similar in the two groups (control: $M = 4.64$, SD = .74; DD: $M = 4.82$, SD = 1.24), especially excluding two outliers from the DD group), and the typically developing students obtained slightly higher scores in the W subtest (control: $M = 4.06$, SD = .93; DD: $M = 3.75$, SD = .93) (Figures 2 and 3).

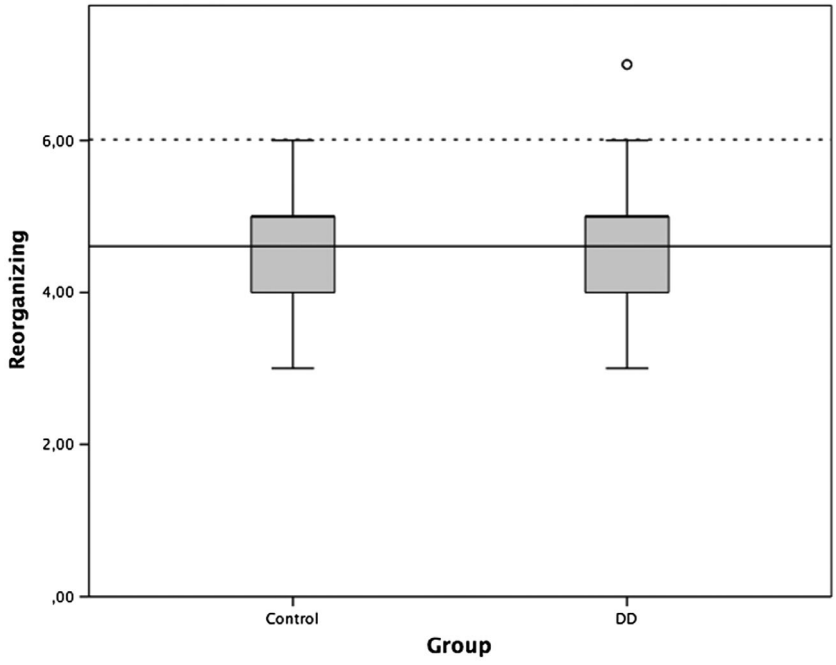

Figure 2. Study 1: Box plot representing the individual scores in the reorganizing scale.

Notes: Outliers are plotted as individual points. The solid line indicates the control mean (excluding outlier values) and the dashed line the chosen deviance threshold (1.65 SD above the control mean).

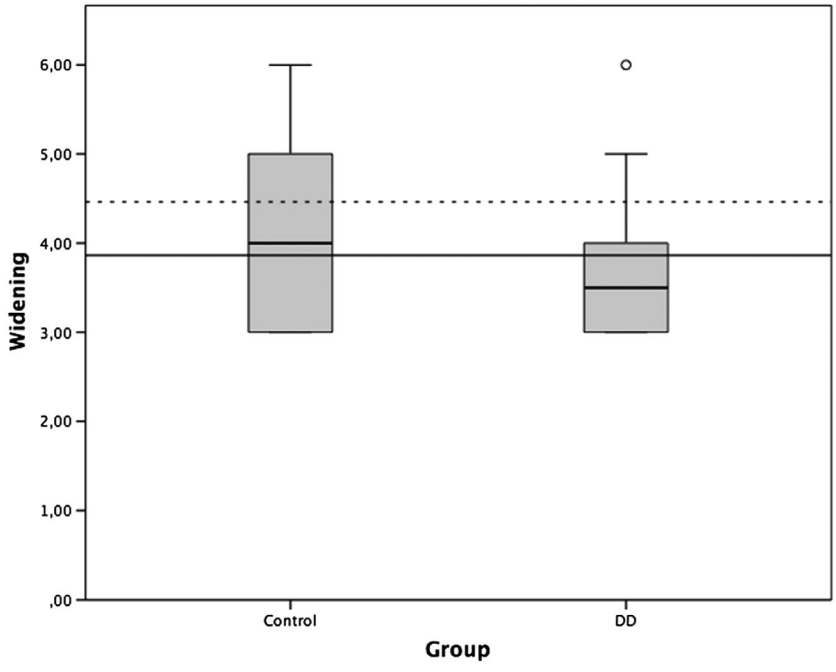

Figure 3. Study 1: Box plot representing the individual scores in the widening scale.

Notes: Outliers are plotted as individual points. The solid line indicates the control mean (excluding outlier values) and the dashed line the chosen deviance threshold (1.65 SD above the control mean).

4. Study 2

According to the results of the first study, individuals with DD are particularly inclined to establish connections between disparate elements. This finding might induce someone to wonder if such a skill is associated to the degree of reading disability, hypothesizing that higher the language impairment is, higher this creative tendency is. Furthermore, the role of general intelligence in supporting the creative mechanism in question should be highlighted. A second study, involving a different group of junior high school students with DD, was carried out to address these issues.

4.1. Participants

A group of 10 students (5 girls) with a diagnosis of DD, attending junior high school and aged between 10 and 13, participated in the second study. They were recruited among the patients of the Neuropsychiatry Units of two institutions in Milan. The parents of the eligible participants were contacted by the researcher. Participants had to have been previously diagnosed with DD (ICD-10 code: F81.0) on the basis of standard inclusion and exclusion criteria (ICD-10: World Health Organization, 1992) and of the diagnosis procedure followed in the Italian context. Subjects who had comorbidity with other neuropsychiatric or psychological conditions were excluded from the study (whereas comorbidity with other LD was allowed). Participants TIQ scores (i.e. Total Intellectual Quotient measured by Wechsler Intelligence Scale for Children-III edition) ranged between 86 and 128 (M = 99.7; SD = 11.52).

4.2. Procedure

The administration of WCR test was individual and took place in a quiet room of the Neuropsychiatry Units where participant have been recruited. No time limit was imposed during the administration. Before the actual test, participants were given a talk about the non-evaluating nature of the test. As in the previous study, the administration of the test, as well as the scoring of all questions, was performed by a researcher previously trained to the use of the test.

Reading performance scores and the IQ scores were collected from the clinical documentation of each patient. In particular, reading speed and accuracy scores reported in the diagnosis were obtained from the administration of the following Italian standardized tests: *New MT reading tests for junior high school* (Nuove prove di lettura MT per la scuola media inferiore: Cornoldi & Colpo, 1995), which provides accuracy and speed scores in reading aloud age-normed texts; *Assessment battery for DD and Dysorthography*—(Batteria per la valutazione della Dislessia e Disortografia Evolutiva—DDE-2: Sartori & Job, 2007), in which speed and accuracy scores were computed for words (four lists of 28 words each with different lengths and frequency of use) and pseudo-words reading (two lists of 16 pseudo-words each with different lengths). In order to control if other neuropsychological factors could intervene in the relation between reading and creativity, measures of visual attention, auditory attention and verbal working memory abilities were also collected from the clinical reports. Attention and working memory scores were obtained from the following Italian standardized tests. The Short Verbal Memory Test from the *Neuropsychological Assessment Battery for Developmental Age* (Batteria di valutazione neuropsicologica per l'età evolutiva, BVN: Bisiacchi, Cedron, Gugliotta, Tressoldi, & Vio, 2005), which consists in a digit span task (forward and backward); visual sustained and selective attention abilities were assessed using the *Bells Test* (Test delle campanelle: Biancardi & Stoppa, 1997), which is a paper and pencil barrage test; auditory selective attention was assessed using the Selective Auditory Attention Test from the *Neuropsychological Assessment Battery for Developmental Age*. Participants mean scores in these measures were on average compared to the normative sample (above the −1.65 SD cut-off).

4.3. Results

Considering the limited number of participants, non-parametric correlations have been computed. Concerning general intelligence, no significant correlation between WCR scores and TIQ was

recorded [Widening: $r_s = -.19$; Connecting: $r_s = -.53$; Reorganizing: $r_s = -.15$]. Hence, the level of general intelligence fails to be related to creativity in any of its component.

Reading performances measured by the different tests considered (text, words and pseudo-words reading) appeared to be coherent with each other: some significant positive correlations between reading speed and accuracy scores for each of the three tests emerged, and in particular between: words speed and words accuracy [$r_s = .74$; $p = .01$], words speed and pseudo-words speed [$r_s = .87$; $p < .001$]; words speed and text speed [$r_s = .85$; $p < .001$]; words accuracy and text speed [$r_s = .65$; $p = .04$]; pseudo-words speed and text speed [$r_s = .79$; $p < .001$]; pseudo-words accuracy and text accuracy [$r_s = .66$; $p = .04$].

No statistically significant correlation between reading measures and the scores in the W [$-.49 < r_s < .00$] and R [$.14 < r_s < .55$] subtests were found. By contrast, results consistent with the previous Study emerged from the correlations between reading accuracy and connecting abilities: A significant negative correlation was found between word reading accuracy *z*-scores and C subtest scores [$r_s = -.77$; $p = .01$] (Figure 4). Moreover, a trend towards a significant negative correlation was found between C scores and text reading speed *z*-scores [$r_s = -.64$; $p = .06$] (Figure 5). As it is showed in the scatter plots, reading skills showed a negative relation with connecting abilities: lower reading performances corresponded to higher skills in connecting different elements.

Finally, no significant correlations between WCR subtests and attention and working memory scores were found [W: $.37 < r_s < .65$; C: $-.40 < r_s < .08$; R: $-.27 < r_s < .27$]. Therefore, it seems implausible that attention and working memory could have had an involvement in the relation between reading and creativity.

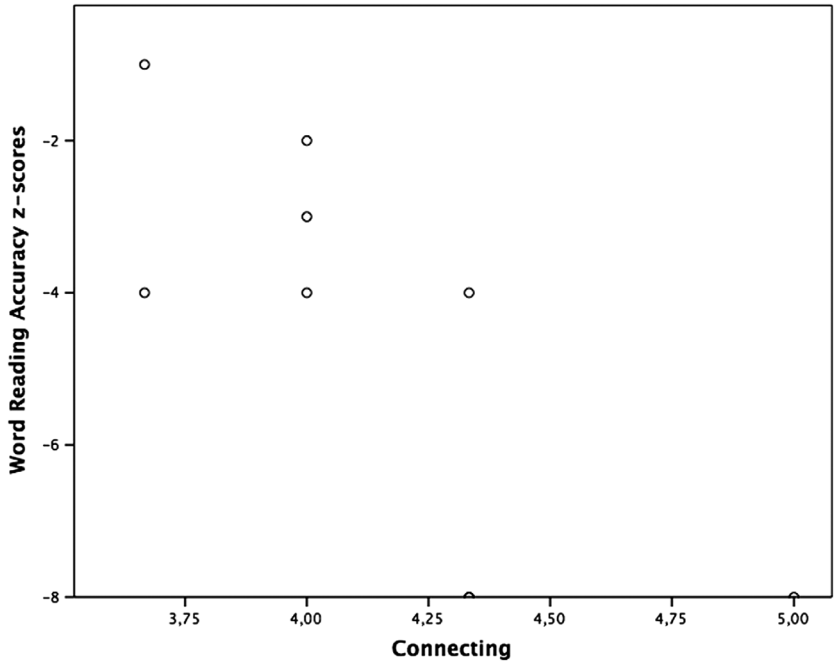

Figure 4. Study 2: Scatter plot representing the relation between word reading accuracy *z*-scores and the scores in the connecting scale.

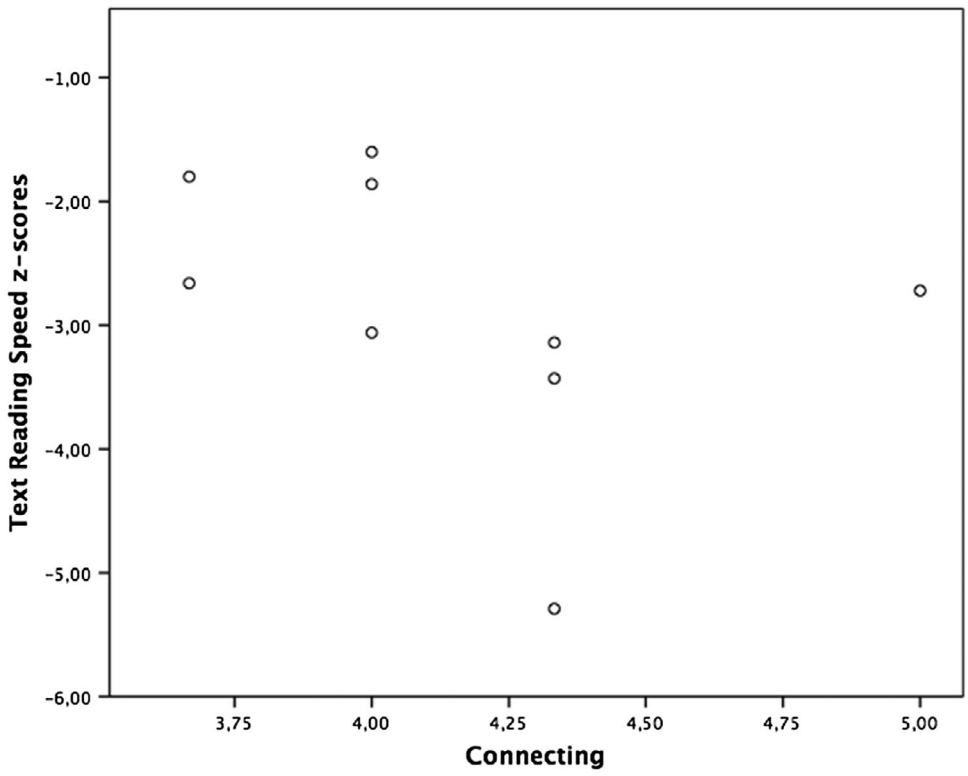

Figure 5. Study 2: Scatter plot representing the relation between text reading speed z-scores and the scores in the connecting scale.

5. Discussion and conclusions

Anecdotal information and historical—biographical reconstructions suggest that people with DD have a peculiar tendency to creative thinking. This would be a consequence of their preference for visual representations processing (West, 2009) and intuitive strategies, characteristics often associated with creativity (Gunnel Ingesson, 2006; Roskos-Ewoldsen, Intons-Peterson, & Anderson, 1992; Zhang, Qiu, & Cao, 2004). According to a different hypothesis, people with DD prefer a global, instead of local, information processing and this holistic processing would be associated to a creative way of thinking (Schneps, Brockmole, Sonnert, & Pomplun, 2012). Another possible explanation considers the verbal code as the main path for established and usual thinking (Shepard, 1978); the impairment in the use of the verbal code would enhance unconventional ways of thinking (Vail, 1990; Yewchuk, 1983).

Despite these hypotheses, there are few empirical findings about the creative potential of people with DD. The present study aimed at investigating this topic in the Italian context and at overcoming the limits of creativity measures, usually focussed on the quantity of given answers, but assessing the propensity for unconventional processing according to different cognitive mechanisms involved. Through the administration of a creativity test that allows scorers to identify the three basic skills of creative thinking, we found out that students with DD had a statistically significantly higher propensity for unusual combination of ideas. Moreover, consistent negative correlation patterns between this creativity component and the level of reading abilities have been found in a sample of students with DD, confirming that the ability to connect different elements is related with the level of reading impairment. Interestingly, general intellectual level does not appear to support the relationships in question, and neither do attention and working memory abilities.

These results provide evidence of the creative attitude by individuals with DD. However, this propensity involves only one specific aspect of creativity, thus allowing us to identify the peculiar intellectual functioning associated with DD. Most likely, the inconsistent results provided by previous

research on this topic depended on differences in measuring individuals with DD: traditional ways of assessing creative skills—such as measuring the number of responses generated, the number of categories they belong to, and so—might not be relevant to allow more fine-grained aspects of creative thinking to emerge. Our results suggested that people with DD use creative thinking especially when the situation requires to establish relationships between different or opposite elements, and finding alternative solutions. Making connections is in fact recognized as a process which persons with DD like and excel in Eide and Eide (2012). We can conjecture that, because of the impairment they experience, individuals with DD are induced to face reading-related tasks in a manner which is different than that most persons follow and this leads them to apply original strategies. A type of strategies which allow people to succeed in that is relating the current problem or difficulty to a domain which is easily managed. For instance, if I perform motor jobs well if I listen to a rhythmical background, I can come up to speak aloud in a rhythmical way and transfer this procedure to reading school materials. This tendency of relating disparate experiences, if recurrently applied, might favour the acquisition of a divergent mode of thinking which is generalized to other kinds of situations. On the other hand, an innate disposition—presumably grounded on an atypical brain architecture, facilitating connections between distant cortical modules (Casanova, Buxhoeveden, Cohen, Switala, & Roy, 2002), or functioning (Shaywitz & Shaywitz, 2008)—towards an holistic way of thinking, which is preferred by people with DD (Schneps et al., 2012) and which is based on the construction of a broad set of mental connections, cannot be discarded.

The small sample size and the presence of cases of comorbidity are the main limitations of this study. The fact that all participants attended the same school on the one hand ensures homogeneity of sociocultural and educational variables, but on the other hand reduces results' generalizability.

In order to understand better the relationships between DD and creativity, it would be useful to replicate the investigation involving a larger and more representative samples. Finally, it should be remarked that the creativity test used is based on the principle according to which answers chosen by a minority of individuals are indicative of a creative propensity. The perspective that considers originality as the distinctive feature of creativity, as widely assumed, could be a partial interpretation.

Despite these limitations, results suggest that DD involves not only impairments, but it is also associated with cognitive peculiarities that can be, in certain circumstances, useful and productive. Among these features, the ability to connect realities apparently distant from each other seems to be enhanced in individuals with DD. A survey conducted by Lowe (2003) involving five subjects with DD detected their ability to grasp the shared meaning between disparate elements. This way of thinking can promote originality in information processing (which is a required skill in school learning), an unconventional expression of feelings and opinions, and can also support daily life's problem-solving.

Overall, this is an encouraging message for students with DD, whose peculiarity could be recognized in positive terms, with a consequential benefit on self-esteem (Kiziewicz, 2012). Furthermore, teachers (Burrows & Wolf, 1983) and trainers (Poole, 2003) should take advantage of LD students' strengths, developing activities and intervention methods which involve their specific creative abilities (Taylor, 2014), thus improving their motivation and learning skills. An example of intervention method for DD involving creative skills of children struggling with reading is the *Rhythmic Reading Training* (Bonacina, Cancer, Lanzi, Lorusso, & Antonietti, 2015; Cancer, Bonacina, Lorusso, Lanzi, & Antonietti, 2016). This rehabilitation program engages children in music and rhythmic activities designed for enhancing reading skills. Therefore, reading training is not experienced as tiring and boring, but instead music ensures an increase of children's motivation and self-efficacy.

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References

Alexander-Passe, N. (2010). *Dyslexia and creativity. Investigations from different perspectives*. Happauge, NY: Nova Science.

Alves, R. J. R., & Nakano, T. C. (2014). Creativity and intelligence in children with and without developmental dyslexia. *Paideia, 24*, 361–369.

Antonietti, A., & Colombo, B. (2013). Three creative operations. In A.-G. Tan (Ed.), *Creativity, talent and excellence* (pp. 13–26). New York, NY: Springer. http://dx.doi.org/10.1007/978-981-4021-93-7

Antonietti, A., Colombo, B., & Pizzingrilli, P. (2011). The WCR model of creativity. From concept to application. *The Open Education Journal, 4*, 80–89. http://dx.doi.org/10.2174/1874920801104010080

Antonietti, A., Giorgetti, M., & Pizzingrilli, P. (2011). *Io penso creativo. Valutare e potenziare gli aspetti creativi del pensiero* [I think creative. Assess and improve creative aspects of thinking]. Firenze: Giunti.

Antonietti, A., Pizzingrilli, P, & Valenti, C. (2012). *Il test ACR: versione per la scuola secondaria di primo grado* [The WCR test: Junior high school version]. Milano: Servizio di Psicologia dell'Apprendimento e dell'Educazione in Età Evolutiva, Università Cattolica del Sacro Cuore.

Biancardi, A., & Stoppa, E. (1997). *Batteria di valutazione neuropsicologica per l'eta evolutia (BVN)* [Modified Bell Test: A proposal for the study of attention in developmental age]. *Psichiatria dell'Infanzia e dell'Adolescenza, 64*, 73–84.

Bisiacchi, P. S., Cedron, M., Gugliotta, M., Tressoldi, P. E., & Vio, C. (2005). *Il test delle campanellemodificato: Una proposta per lo studio dell'attenzione in età evolutiva* [Neuropsychological assessment battery for developmental age]. Gardolo: Erikson.

Bonacina, S., Cancer, A., Lanzi, P. L., Lorusso, M. L., & Antonietti, A. (2015). Improving reading skills in students with dyslexia: The efficacy of a sublexical training with rhythmic background. *Frontiers in Psychology, 6*, 1510. doi:10.3389/fpsyg

Burrows, D., & Wolf, B. (1983). Creativity and the dyslexic child: A classroom view. *Annals of Dyslexia, 33*, 269–274. http://dx.doi.org/10.1007/BF02648011

Cancer, A., Bonacina, S., Lorusso, M. L., Lanzi, P. L., & Antonietti, A. (2016). Rhythmic reading training (RRT): A computer-assisted intervention program for dyslexia. In S. Serino, A. Matic, D. Giakoumis, G. Lopez, & P. Cipresso (Eds.), *Pervarsive computing paradigms for mental health* (Communications in Computer and Information Science, 604, pp. 249–258). Cham: Springer. doi:10.1007/978-3-319-32270-4_25

Casanova, M. F., Buxhoeveden, D. P., Cohen, M., Switala, A. E., & Roy, E. L. (2002). Minicolumnar pathology in dyslexia. *Annals of Neurology, 52*, 108–110. http://dx.doi.org/10.1002/(ISSN)1531-8249

Çorlu, M., Özcan, O., & Korkmazlar, Ü. (2007). The potential of dyslexic individuals in communication design education. *Behavioural Neurology, 18*, 217–222.

Çorlu, M., Özcan, O., & Korkmazlar, Ü. (2009). The meaning of dyslexic's drawings in communication design. *Dyslexia, 15*, 147–154.

Cornoldi, C., & Colpo, G. (1995). *Nuove prove di lettura MT per la scuola media inferiore* [New MT reading test for junior high school]. Firenze: Giunti OS Organizzazioni speciali.

Cornoldi, C., & Tressoldi, P. (2007). *Definizione, criteri e classificazion* [Definition, criteria and classification]. In C. Cornoldi (Ed.), *Difficolta e Disturbi Dell'apprendimento* [Learning difficulties and disorders] (pp. 9–52). Bologna: Il Mulino.

Davis, R. D., & Braun, E. (1994). *The gift of dyslexia: Why some of the smartest people can't read and how they can learn*. New York, NY: Perigee Books.

Ehardt, K. (2009). Dyslexia, not disorder. *Dyslexia, 15*, 363–366. http://dx.doi.org/10.1002/dys.v15:4

Eide, B. L., & Eide, F. F. (2012). *The dyslexic advantage. Unlocking the hidden potential of the dyslexic brain*. London: Plume Printing.

Eisen, M. L. (1989). Assessing differences in children with learning disabilities and normally achieving students with a new measure of creativity. *Journal of Learning Disabilities, 22*, 451, 462–464. http://dx.doi.org/10.1177/002221948902200715

Everatt, J. (1997). The abilities and disabilities associated with adult developmental dyslexia. *Journal of Research in Reading, 20*, 13–21. http://dx.doi.org/10.1111/1467-9817.00016

Everatt, J., Steffert, B., & Smythe, I. (1999). An eye for the unusual: Creative thinking in dyslexics. *Dyslexia, 5*, 28–46. http://dx.doi.org/10.1002/(ISSN)1099-0909

Gobbo, K. (2010). Dyslexia and creativity: The education and work of Robert Rauschenberg. *Disability Studies Quarterly, 30*(3–4). Retrieved from http://dsq-sds.org/article/view/1268/1298

Gunnel Ingesson, S. G. (2006). Stability of IQ measures in teenagers and young adults with developmental dyslexia. *Dyslexia, 12*, 81–95. http://dx.doi.org/10.1002/(ISSN)1099-0909

Hong, E., & Milgram, R. M. (2010). Creative thinking ability: Domain generality and specificity. *Creativity Research Journal, 22*, 272–287. http://dx.doi.org/10.1080/10400419.2010.503535

Jantzen, C. (2009). *Dyslexia. Learning disorder or creative gift?*. Edinburgh: Floris Books.

Kiziewicz, M. (2012). Dyslexia and creativity: Tapping the creative strengths of dyslexic people. In N. Brunswick (Ed.), *Supporting dyslexic adults in higher education and the workplace* (pp. 197–206). New York, NY: Wiley-Blackwell. http://dx.doi.org/10.1002/9781119945000

LaFrance, E. B. (1997). The gifted/dyslexic child: Characterizing and addressing strengths and weaknesses. *Annals of Dyslexia, 47*, 163–182. http://dx.doi.org/10.1007/s11881-997-0025-7

Lockiewicz, M., Bogdanowicz, K., & Bogdanowicz, M. (2013). Psychological resources in adults with developmental dyslexia. *Journal of Learning Disabilities, 47*, 543–555.

Lowe, M. R. (2003). Dyslexia, a different ability: A phenomenological study. *Dissertation Abstracts International: Section B, 63*, 4376.

Mednick, S. A., & Mednick, M. T. (1967). *Manual for the remote associates test, Form 1*. Boston, MA: Houghton-Mifflin.

Mourgues, C. V., Preiss, D. D., & Grigorenko, E. L. (2014). Reading skills, creativity, and insight: Exploring the connections. *The Spanish Journal of Psychology, 17*, e58. doi:10.1017/sjp.2014.59

Pachalska, M., Bogdanowicz, K., Tomaszewska, K., Lockiewicz, M., & Bogdanowicz, M. (2009). The stimulation of creative activity in dyslexic adults. *Acta Neuropsychologica, 7*, 113–130.
Poole, J. (2003). Dyslexia: A wider view. The contribution of an ecological paradigm to current issues. *Educational Research, 45*, 167–180. http://dx.doi.org/10.1080/0013880320001032 53
Rack, L. (1981). Developmental dyslexia and literary creativity: Creativity in the area of deficit. *Journal of Learning Disabilities, 14*, 262–263. http://dx.doi.org/10.1177/002221948101400506
Roskos-Ewoldsen, B., Intons-Peterson, P. F., & Anderson, R. E. (Eds.). (1992). *Imagery, creativity, and discovery*. Amsterdam: North Holland.
Sartori, G., & Job, R. (2007). *DDE-2: Batteria per la valutazione della dislessia e della disortografia evolutiva-2* [DDE-2: Assessment battery for developmental dyslexia and dysorthography -2]. Firenze: Giunti O. S. Organizzazioni Speciali.
Schneps, M. H., Brockmole, J. R., Sonnert, G., & Pomplun, M. (2012). History of reading struggles linked to enhanced learning in low spatial frequency scenes. *PLoS ONE, 7*. doi:10.1371/journal.pone.0035724
Shaywitz, S. E., & Shaywitz, B. A. (2008). Paying attention to reading: The neurobiology of reading and dyslexia. *Development and Psychopathology, 20*, 1329–1349. http://dx.doi.org/10.1017/S0954579408000631
Shepard, R. N. (1978). Externalization of mental images and the act of creation. In B. S. Randhawa & W. E. Coffman (Eds.), *Visual learning, thinking and communication* (pp. 133–189). San Francisco, CA: Academic Press.
Shondrick, D. D., Serafica, F. C., Clark, P., & Miller, K. G. (1992). Interpersonal problem solving and creativity in boys with and boys without learning disabilities. *Learning Disability Quarterly, 15*, 95–102. http://dx.doi.org/10.2307/1511011
Sternberg, R. J. (Ed.). (1998). *Handbook of creativity*. Cambridge, MA: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511807916
Tafti, M. A., Hameedy, M. A., & Baghal, N. M. (2009). Dyslexia, a deficit or a difference: Comparing the creativity and memory skills of dyslexic and nondyslexic students in Iran. *Social Behavior and Personality: An International Journal, 37*, 1009–1016. http://dx.doi.org/10.2224/sbp.2009.37.8.1009
Tarver, S. G., Buss, b. R, & Maggiore, R. P. (1979). The relationship between creativity and selective attention in LD boys. *Learning Disability Quarterly, 2*, 53–59. http://dx.doi.org/10.2307/1510839
Taylor, M. J. (Ed.). (2014). *Fostering creativity in rehabilitation*. Hauppauge, NY: Nova Science.
Torrance, E. P. (1974). *Tests of creative thinking: streamlined scoring guide - Figural and Verbal A and B*. Bensenville, IL: Scholastic Testing Service.
Vail, P. L. (1990). Gift, talents and the dyslexias: Wellsprings, springboards, and finding Foley's rocks. *Annals of Dyslexia, 40*, 3–17.
Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children: A study of the creativity-intelligence distinction*. New York, NY: Holt, Rinehart & Winston.
West, T. G. (2008). It is time to get serious about the talents of dyslexics. *Perspectives on Language and Literacy, 34*, 9–11.
West, T. G. (2009). *In the mind's eye: Creative visual thinkers, gifted dyslexics and the rise of visual technologies*. Amherst, NY: Prometheus Books.
Wolfe, M. (2007). *Proust e il calamaro* [Proust and the squid (Milano: Vita e Pensiero, 2009)]. New York, NY: Harper and Collins.
World Health Organization. (1992). *The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines*. Geneva: World Health Organization.
Yewchuk, C. (1983). Learning disabled/gifted children: Characteristic features. *Mental Retardation and Learning Disability Bulletin, 11*, 128–133.
Zhang, Q., Qiu, J., & Cao, G. (2004). A review and hypothesis about the cognitive mechanism of insight. *Psychological Science, 27*, 1435–1437.