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SEMANTIC AND PHONOLOGICAL VERBAL FLUENCY IN STUDENTS WITH DYSLEXIA[1]

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SUMMARY

Background: This article aims to assess the linguistic functioning in terms of phonological and semantic verbal fluency in people with dyslexia, when compared to those without dyslexia.

Material/ Methods: We examined, qualitatively and quantitatively, the preferred performance strategies, depending on specific learning difficulties and the criterion used, of 28 (53%) high school students with dyslexia and 25 (47%) without, who participated in our study.

Results: No intergroup differences in the phonological and semantic verbal fluency in the number of words produced were found; the semantic task turned out to be easier, and was performed faster, than the phonological task, for all participants, regardless of dyslexia. However, in the criterion group the performance in the phonological fluency task was affected by the selected sound. This result suggests that it is especially difficult for Polish students with dyslexia to differentiate between the representation of a sound and a letter. For the semantic fluency, we found that working memory was related to word production in the criterion group, but not in the control group. Since both working and long-term memory deficits have been reported in people with dyslexia, this suggests the inefficient verbal compensatory cognitive abilities used by this group. Word production turned out to be a relative strength of students with dyslexia, as they performed on a level with their non-dyslexic peers, while employing mostly similar strategies.

Conclusions: Subtle differences between the strategies employed by students with and without dyslexia in phonological and semantic verbal fluency seemed to be related to the phonological and memory deficits of the participants with dyslexia; yet these did not influence task performance efficiency.

Keywords: Word production, mental lexicon, short-term memory, sound/letter correspondence

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INTRODUCTION

Phonological awareness influences one's learning to read (Snowling & Hulme, 1994; Snowling & Nation, 1997), as reading fluency depends on the imprecision in the phonological representations of words (Swan & Goswami, 1997). Dyslexic symptoms manifest themselves, among others, in mental lexicon deficits, ones resulting from unstable and imprecise lexical representations (Krasowicz-Kupis, 2006). The subject literature suggests a reduction of verbal readiness in persons with specific learning difficulties, regardless of their age or education (Brosnan et al., 2002; Cohen, Morgan, Vaughn, Riccio, & Hall, 1999; Reiter, Tucha, & Lange, 2005). As their passive lexicon exceeds the active, they experience more problems when using phonetic clues, and make more errors in naming tasks (Krasowicz-Kupis, 2006), more often using explanations instead of single words (Frith, Lander, & Frith, 1995). Mental lexicon skills depend on the extraction of phonological codes from the long-term memory (Jones, Branigan, & Kelly, 2009). Their deficits may, in consequence, cause difficulties with remembering the right words, even amongst people with a rich vocabulary (Hatcher & Snowling, 2008).

Mental lexicon can be tested with the verbal fluency test (Auczywek & Fersten, 1992), which requires the production of the possibly largest number of words in response to a given criterion (semantic or phonological) within a specified time limit (Lezak, 1995); it positively correlated with the educational level (Kosmidis, Vlahou, Panagiotaki, & Kiosseoglou, 2004; Strauss, Sherman, & Spreen, 2006; Szepietowska & Gawda, 2013).

There is no consensus on the influence of the selected criterion on the performance of persons with dyslexia in the verbal (semantic or phonological) fluency tasks. Research has demonstrated an impaired performance in both types of fluency (Reiter et al., 2005; Snowling, Nation, Moxham, Gallagher, & Frith, 1997), and in the phonological alone (Frith et al., 1995; Lipowska, Bogdanowicz, & Buliński, 2008), or no deficit whatsoever (Reid, Szczerbinski, Iskierka-Kasperek, & Hansen, 2007). The authors of the latter study suggest that this apparent lack of differences may be due to the strategy used by the study participants, who employed semantic categories during the phonological fluency task.

Verbal short-term memory (due to limited storage capacity) affects a variety of language tasks, e.g. listening and/or reading comprehension, decoding. Its development is associated with a reduction in the verbal reaction time and the number of errors (Brady, 1986). Research has shown deficits in verbal short-term memory in dyslexia (Bogdanowicz, Lockiewicz, Bogdanowicz, & Pachalska, 2014; Krasowicz-Kupis, 2006; Pennington, Van Orden, Smith, Green, & Haith, 1990).

Effective organization of linguistic knowledge extraction from the long-term memory requires the involvement of short-term memory, auditory attention, action initiation and sustention, cognitive flexibility, coordination and monitoring the course of a performance and the speed of mental processes, access to the resources of lexical or semantic long-term memory (Piskunowicz, Bieliński, Zgliński, & Borkowska, 2013).

Verbal fluency test results can be assessed quantitatively and qualitatively (Troyer, Moscovitch, & Winocur, 1997). Quantitative evaluation includes: the total number of words, or the number and type of errors listed in certain time intervals (Szepietowska & Gawda, 2011). Qualitative evaluation includes combining words into clusters and switching between these subcategories (Troyer et al., 1997), and provides a deeper insight into the mechanisms of acquisition, development, and the usage of the mental lexicon (Pąchalska 2007; Jodzio, 2008). A semantic fluency test requires the use of vocabulary and the effective organization of semantic memory (Ardila, Ostrosky-Solís, & Bernal, 2006; Kavé, Kigel, & Kochva, 2008), and, to a lesser extent, involves executive functions (Sauzeon, Lestage, Raboutet, N'Kaoua, & Claverie, 2004). Participants differ in their approach to the task. The first strategy, based on the ready availability of the mental lexicon resources, is associated with the production of large clusters, and the relatively rare switching between them. The second strategy, based on the rapid screening of different types of lexical information, results in the production of multiple small clusters, and a frequent switching between them (Biechowska, 2012). A phonological fluency test, more difficult than the semantic one (Jodzio, 2008; Kosmidis et al., 2004) is influenced by the selected letter frequency in a given language (Borkowski, Benton, & Spreen, 1967); in Polish studies the most commonly used letters or sounds include: /k/, /m/, /p/, /s/, /w/ (Stolarska, Kroczka, Gergont, Steczkowska, & Kaciński, 2008). Moreover, as phonological fluency tasks depend on the ability to switch between categories to a greater extent than semantic ones do, they more accurately assess executive functions (Ardila et al., 2006). Szepietowska and Gawda (2011) note that switching, rather than clustering, affects the final outcome.

In the current literature, we found no information about qualitative differences (e.g. the preferred performance strategy for each criterion, the temporal aspect, the types of errors) in the verbal fluency test in persons with dyslexia, as compared with the persons without dyslexia.

This paper aims to assess the linguistic functioning in terms of phonological and semantic verbal fluency in people with dyslexia, as compared with people without dyslexia. We wanted to examine the preferred performance strategies, depending on the specific learning difficulties and the criterion used. The analysis included quantitative and qualitative aspect of participants' performance. In addition, we tested the impact of short-term memory on verbal fluency performance. We assumed that the participants with dyslexia will exhibit deficits in the phonological verbal fluency task (poorer word production, a higher number of errors, slower pace). Those deficits should be partly attributed to deficits in the long-term and short-term memory.

MATERIALS AND METHODS

Methods

1. *Wechsler Memory Scale III* — (Pąchalska & Lipowska, 2006). A Polish adaptation. One subtest was selected: Digit Span (forward and backward), which assesses verbal working memory.
2. *Verbal Fluency Test:* semantic and phonological criterion. We used the most common method: (Body & Muskett, 2013; Pąchalska 2007) naming words consistent with the criteria in one minute (Szepietowska & Gawda, 2011).
3. *Questionnaire* – a short survey developed by the authors for the study, to obtain basic demographic information about the student (e.g. age, gender, dyslexia report, ADHD report). A separate survey was completed by the participants and their parents.
4. *Test Matrices. Standard version* – (Raven, 1991), a Polish adaptation, to control the intelligence level.
5 Qualitative examination: The overall result, i.e., word production (WP) was calculated separately for each criterion: the number of words produced in the specified time limit, consistent with the criteria adopted in the task (Troyer et al., 1997). The semantic criterion were animals (the names of extinct animals were treated as correct); the phonological criteria were sounds: /p/, /w/, and /s/. The participants were instructed not to name first, last, and proper names. Colloquial words and borrowings were treated as correct and included in the overall score (Kavé et al., 2008; Strauss et al., 2006). The following responses were treated as errors: In the semantic fluency task: no points were awarded for a biological sub-category name (e.g., fish), if the respondents followed this with its representatives (e.g., a trout, a carp), and for the names of fictional fantasy animals (e.g., a unicorn, a dragon). In the phonological fluency task: perseverations (*P):* repetitions of words, including the repetition of the same word with other grammatical endings (as Polish is an inflected language), e.g., to win: *wygrywać*, a win: *wygrana*, a cheese: *ser*, a small cheese: *serek*, etc., intrusions (*I):* words that do not belong to the given category*,* neologisms (*N):* distorted and non-existent words (Szepietowska & Gawda, 2011), names depending on gender and age, e.g., a cat: *kot*, a small cat: k*ocię*, and synonyms (Troyer, 2000). Errors and repetitions were taken into account in the analysis of clusters and switches (Troyer et al., 1997).
6. Qualitative examination: The number of clusters of words, both consistent and inconsistent with the criterion, were calculated (Abwender, Swan, Bowerman, & Connolly, 2001). In the semantic fluency task: consecutive words belonging to the same semantic sub-categories (zoological categories, usage by humans, habitat, frequent co-occurrence in fairy tales, proverbs, and sayings) were treated as clusters in accordance with the criterion (task-consistent clusters, TC-CL) (Troyer et al., 1997), (Biechowska, 2012; Kosmidis et al., 2004). In the phonological fluency task: consecutive words that started with the same

first two sounds, words beginning and ending with the same sounds and being different in a single vowel, rhyming words, and homonyms, if the participant, while naming, indicated different meanings of the given words (e.g., *sałata* as lettuce or a salad) were treated as clusters in accordance with the criterion (task-consistent clusters, TC-CL). In both tasks, we also examined the presence of task-discrepant clusters, TD-CL, i.e., the occurrence ofological fluency task, and of phonological clusters in the semantic fluency task (Abwender et al., 2001). The cluster size was calculated starting from the second word. If two clusters partially overlapped, shared words were calculated for each cluster separately. If a smaller cluster appeared within the larger one, only the larger was calculated. For each task, we calculated the average size of clusters (Troyer et al., 1997). Moreover, we distinguished two types of switches between clusters - indirect and direct ones. Direct switches (cluster switches, CS) represent the transition between the adjacent or partially overlapping clusters. Indirect switches (hard switches, HS) included, in addition, transitions between the clusters and words not belonging to any cluster, and between neighbouring non-cluster words (Abwender et al., 2001). The pace of participants' work was calculated as the number of words given by each participant during the first fifteen seconds of the task (correct and incorrect words were taken into account). For the phonological fluency, we calculated separate scores for each sound: /p/, /s/, and /w/, as well as a composite score: the sum of three scores divided by 3 for each examined aspect.

Participants

28 (53%) high school (1st and 2nd year) students with dyslexia and 25 (47%) without dyslexia participated in our study. They were matched by gender, age (M_{age} = 17 years, SD_{age} = 0.7, range: 16 to 18 years), and IQ (see Table 1). No student reported ADHD or neurological disorders. The participants were native speakers of Polish. All of the students and their parents gave their consent to participate after having been informed about the aims of the study and its procedure. The students in the criterion group all had an independent report issued by state psychological and educational counselling centres, stating the diagnosis of dyslexia.

Table 1. Descriptive characteristics of the compared groups

	students with dyslexia		students without dyslexia		
	female	male	female	male	
gender [b]	12 (23)	16 (30)	11 (21)	14 (26)	$\chi^2(1) = 0$, $p = .933$
age in months [a]	208 (7.03)		209 (7.11)		$t(50) = 0.45$, $p = .652$
nonverbal IQ [a]	52 (3.43)		53 (4.09)		$t(50) = 1.45$, $p = .153$

Note: [a] = mean figures given (*SD* in parenthesis), [b] = actual figures given (% in parenthesis)

Procedure

The study was conducted in selected high schools in Gdansk and Kartuzy, Poland. The test was carried out in two stages: for the IQ assessment and the questionnaire, the participants were assessed in groups by two researchers; for the assessment of verbal fluency, all participants were assessed individually by one researcher, in a separate room in the school, to limit possible distractions. Each of the participants performed the tasks in the same order. The responses were written down and recorded at the same time, with the consent of the participants, for later verification.

RESULTS

An ANOVA with repeated measures, followed by a post hoc Tukey test, demonstrated (Fig. 1) that in both groups the semantic verbal fluency task (M = 23.14, SD = 5.96 for the criterion group, M = 25.76, SD = 6.49 for the control group) was easier than the phonological tasks for all three sounds: /p/ (M = 12.64, SD = 4.26, $p \leq .001$ for the criterion group, M = 12.72, SD = 3.68 for the control group, $p \leq .001$), /w/ (M = 12.11, SD = 4.56, $p \leq .001$ for the criterion group, M = 10.52, SD = 4.26, $p \leq .001$ for the control group), and /s/ (M = 9.32, SD = 3.41, $p \leq .001$ for the criterion group, M = 10.36, SD = 3.43, $p \leq .001$ for the control group).

Moreover, the participants with dyslexia scored lower in the /s/ criterion task, than in the /p/ criterion task, p = .017. A Mann-Whitney test for independent samples showed that in the semantic fluency task participants with dyslexia, as compared with participants without dyslexia, produced fewer task consistent clusters ($Mdn_{dyslexic}$ = 6, $Mdn_{nondyslexic}$ = 8, U = 210.5, Z = 2.52, p = .012, r = 0.35), and cluster switches ($Mdn_{dyslexic}$ = 5, $Mdn_{nondyslexic}$ = 7, U = 195.5, Z = 2.74, p = .005, r = 0.38). No other qualitative differences were observed for the semantic and phonological

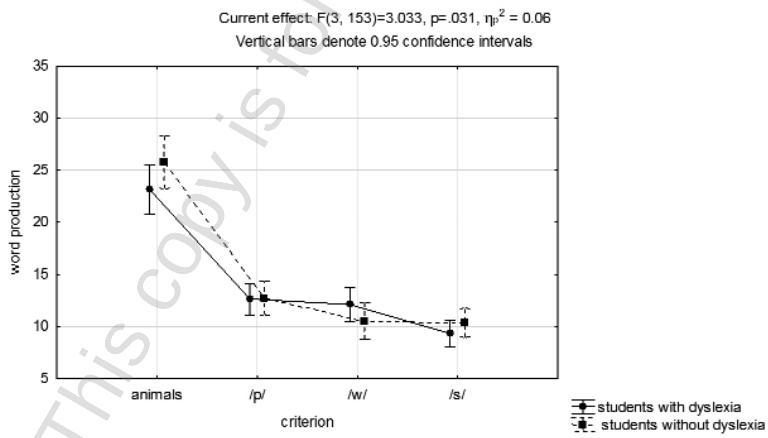

Figure 1. Semantic (animals) and phonological (sounds: /p/, /w/, /s/) fluency in the compared groups

fluency task in the number of task discrepant clusters, cluster sizes, cluster switches, hard switches, perseverations, intrusions, and neologisms.

An ANOVA with repeated measures, followed by a post hoc Tukey test, demonstrated (Fig. 2) that in both groups the semantic verbal fluency task (M = 11.21, SD = 2.75 for the criterion group, M = 12.88, SD = 3.03 for the control group) was performed faster than the phonological task for all three sounds: /p/ (M = 6.04, SD = 2.33, $p \leq .001$ for the criterion group, M = 5.56, SD = 1.73, for the control group, $p \leq .001$), /w/ (M = 4.86, SD = 1.78, $p \leq .001$ for the criterion group, M = 4.88, SD = 1.86, $p \leq .001$ for the control group), and /s/ (M = 5.00, SD = 1.68, $p \leq .001$ for the criterion group, M = 5.28, SD = 1.88, $p \leq .001$ for the control group). Differences between the criterion and the control group in the speed of verbal fluency tasks failed to reach any level of significance.

Wilcoxon signed ranks test indicated that in the semantic fluency task, the participants produced more task consistent (TC-CL) than task discrepant (TD-CL) clusters: (TC-CL: M = 6.32, SD = 2.06, TD-CL: M = 0.36, SD = 0.56, T = 0, Z = 4.62, $p \leq .001$ for the criterion group, TC-CL: M = 7.6, SD = 1.96, TD-CL: M = 0.40, SD = 0.50, T = 0, Z = 4.37, $p \leq .001$ for the control group). Similarly, in the phonological fluency task, the participants produced more task consistent than task discrepant clusters: (TC-CL: M = 2.25, SD = 1.02, TD-CL: M = 1.06, SD = 0.71, T = 16.5, Z = 4.14, $p \leq .001$ for the criterion group, TC-CL: M = 2.03, SD = 0.94, TD-CL: M = 0.91, SD = 0.56, T = 4, Z = 3.98, $p \leq .001$ for the control group). The average cluster was longer in the semantic than in the phonological task in the criterion group (semantic: M = 1.94, SD = 0.51, phonological: M = 1.64,

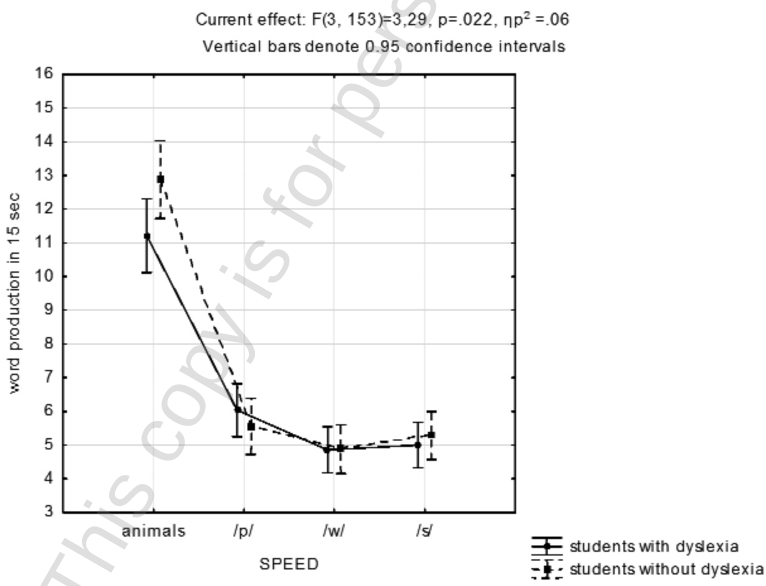

Figure 2. Speed of semantic and phonological fluency in the compared groups

Table 2. Word production, working memory and aspects of semantic fluency – correlations in the compared groups

	WM - forward	WM - backward	Task consistent clusters	Cluster size	Hard switches	Cluster switches
participants with dyslexia						
Word production	0.61	0.41	0.83	0.48	0.44	0.80
participants without dyslexia						
	ns	ns	0.72	n.s.		0.76

$p \leq .05$
Note: ns = not significant

SD = 0.89, *T* = 58.5, *Z* = 3.29, $p \leq .001$); an opposite relationship was observed in the control group (semantic: *M* = 1.96, *SD* = 0.46, phonological: *M* = 2.08, *SD* = 1.08, *T* = 78, *Z* = 2.27, *p* = .023). However, all clusters were rather short, as they consisted on average of only 2 words.

In addition, Wilcoxon signed ranks test indicated that in the semantic fluency task, hard switches were more frequent than cluster switches: (HS: *M* = 7.05, *SD* = 2.34, CS: *M* = 1.64, *SD* = 0.89, *T* = 0, *Z* = 4.62, $p \leq .001$ for the criterion group, HS: *M* = 12.2, *SD* = 3.50, CS: *M* = 6.96, *SD* = 2.03, *T* = 0, *Z* = 4.37, $p \leq .001$ for the control group). Similarly, in the phonological fluency task, hard switches were more frequent than cluster switches: (HS: *M* = 7.05, *SD* = 2.34, CS: *M* = 1.64, *SD* = 0.89, *T* = 0, *Z* = 4.62, $p \leq .001$ for the criterion group, HS: *M* = 7.23, *SD* = 2.28, CS: *M* = 2.08, *SD* = 1.08, *T* = 0, *Z* = 4.37, $p \leq .001$ for the control group). Intrusions were more frequent in the phonological than in the semantic task (semantic: *M* = 0.07, *SD* = 2.26, phonological: *M* = 0.81, *SD* = 0.67, *T* = 12, *Z* = 3.72, $p \leq .001$ in the criterion group; semantic: *M* = 0.52, *SD* = 0.71, phonological: *M* = 0.81, *SD* = 0.67, *T* = 36.5, *Z* = 2.75, *p* = .006 in the control group).

In order to investigate the relationship between word production, verbal working memory, and aspects of semantic fluency (task consistent clusters, task discrepant clusters, cluster size, hard switches, cluster switches), we calculated the Spearman Rank Order Correlations (Table 2).

In the dyslexia group, there were positive correlations between word production (Table 2) and: task consistent clusters, cluster switches (a very strong link), working memory (forward) (a strong link), cluster size, hard switches, working memory (backward) (a moderate link); In the control group, there were positive

Table 3. Word production, working memory and aspects of phonological fluency – correlations in the compared groups

	Task consistent clusters	Task discrepant clusters
participants with dyslexia		
Word production	0.80	0.42
participants without dyslexia		
	0.71	n.s.

$p \leq .05$
Note: ns = not significant

correlations between word production and: task consistent clusters,cluster switches (a very strong link), and hard switches (a strong link).

In order to investigate the relationship between word production, verbal working memory and aspects of phonological fluency (task consistent clusters, task discrepant clusters, cluster size, hard switches, cluster switches), we calculated the Spearman Rank Order Correlations (Table 3). In the dyslexia group, there were positive correlations between word production and: task consistent (a very strong link) and task discrepant clusters (a moderate link). In the control group word production correlated positively with task consistent clusters (a very strong link). These findings were confirmed by a multiple regression, which demonstrated specific relationships between the adopted strategy of fluency performance and its results. We entered as independent variables all variables correlated with the word production score in the semantic and phonological fluency tasks in both groups. In the control group: the number of task consistent clusters (entered as an independent variable) predicted word production in the phonological fluency task (entered as a dependent variable), $F(1, 23) = 22.147$, $p \leq .001$, $R^2 = .497$, $R^2_{Adjusted} = .475$; $B = 2.204$, $\beta = 0.705$. In the dyslexia group: the number of task consistent and task discrepant clusters (entered as independent variables) predicted word production in the phonological fluency task (entered as a dependent variable), $F(2, 25) = 33.773$, $p \leq .001$, $R^2 = .730$, $R^2_{Adjusted} = .708$; task consistent clusters accounted for 55% of variance, $B = 2.572$, $\beta = 0.752$, task discrepant clusters accounted for 8% of variance, $B = 1.470$, $\beta = 0.300$, and the number of task consistent clusters, average cluster size, and hard switches (entered as independent variables) predicted word production in the semantic fluency task (entered as a dependent variable), $F(6, 21) = 58.388$, $p \leq .001$, $R^2 = .943$, $R^2_{Adjusted} = .927$; task consistent clusters accounted for 1% of variance, $B = 1.325$, $\beta = 0.457$, average cluster size accounted for 20% of variance, $B = 5.410$, $\beta = 0.466$, hard switches accounted for 8% of variance, $B = 0.601$, $\beta = 0.312$. A multiple regression did not show a predictive function of strategies in the semantic fluency task in the control group.

DISCUSSION

We found no intergroup differences in the phonological and semantic verbal fluency in the number of words produced. This result is consistent with Reid et al., (2007) who also examined native speakers of Polish. However, other studies have indicated deficits in phonological fluency in persons with dyslexia (Frith et al., 1995; Lipowska et al., 2008; Plaza, Cohen, & Chevrie-Muller, 2002; Wilson & Lesaux, 2001). Reid et al., (2007) suggest that this apparent lack of differences is due to the diversity of symptoms depending on the type of dyslexia. Cohen et al. (1999) showed that verbal fluency deficits occur in the phonological, but not visual subtype of dyslexia. We found that the semantic task turned out to be easier, and was performed faster, than the phonological task, for all participants, regardless of dyslexia. This result has been previously demonstrated in various groups of participants (Jodzio, 2008; Kosmidis et al., 2004); and our study confirms its occurrence in both a group of normal readers and a group with specific reading and writing difficulties. We observed the lowest result of all participants in the /s/ sound task, though with no significant differences. These results cannot be explained by the fact that the ease of word production increases with the availability of vocabulary satisfying the adopted phonological criterion (Borkowski et al., 1967; Ruff, Light, Parker, & Levin, 1997), as the /s/ sound has a relatively large frequency in Polish. However, the respondents produced words that did not belong to the right category, often listing words starting with sound [š]: e. g. *szafa*, or [ś] / [s']: e.g., *siatka*. Frith et al. (1995) suggest that such errors may be due to the fact that the recall of words based on a phonological cue is facilitated by the ability to read and write, and associated with a simultaneous recall of the sound in the form of the representation of a letter. Consequently, both phonological and orthographic representations are recalled. The authors indicated a lower tendency of people with dyslexia to commit such errors, as compared with people without specific learning difficulties, explained by a weaker link between their orthographic and phonological representations. We did not observe a similar relationship.

We found that in the criterion group the performance in the phonological fluency task was affected by the selected sound; the participants scored higher in the /p/ than in /s/ task. This result suggests that it is especially difficult for Polish students with dyslexia to differentiate between the representation of a sound and a letter. Moreover, this result shows that the choice of a sound and/or a letter for a verbal fluency task should not be based only on its frequency, but also on the sound/letter correspondence related to it, as certain combinations might affect the performance of participants with specific learning difficulties. We found that in the semantic fluency task the participants with dyslexia, as compared with the participants without dyslexia, form fewer clusters consistent with the criterion, and less often switch from one cluster to another. There is no clear attribution of this result to the two strategies suggested by Biechowska et al. (2012). No other differences in the semantic and phonological fluency, including the number of errors (of any type) or cluster sizes were observed. Comparing the performance in the semantic and phonological (an average score calculated on the three separate scores) tasks independently within the two groups, we found that the participants produced more task consistent than task discrepant clusters in both criteria. For the semantic task, this strategy may be due to the semantic organization of the mental lexicon, which renders the search based on an alphabetic or phonetic clue more difficult (Strauss et al., 2006). It is surprising, then, that the participants did not transfer this strategy to the phonological task, but followed the general phonetic instruction received. This might have contributed to their lower score in the latter, more difficult task – where they also produced more intrusions. Moreover, the average cluster was longer in the semantic than in the phonological task in the criterion group; an opposite relationship was observed in the control group, though on average each cluster was only 2-word long. In both tasks, hard switches were more frequent than cluster switches, so the participants did not switch from one cluster to another, but introduced single, unrelated words between them.

For the semantic fluency, we found that working memory was related to word production in the criterion, but not in the control group. In the participants with dyslexia, word production correlated positively with task consistent clusters, cluster size, and hard switches (which predicted the score in word production), cluster switches, and working memory. The results confirm links between memory functioning and word production reports (Ruff et al., 1997; Strauss et al., 2006). Moreover, since both working (Bogdanowicz et al., 2014; Hatcher, Snowling, & Griffiths, 2002; Swanson & Sáez, 2003) and long-term (Lockiewicz, Bogdanowicz, Bogdanowicz, Karasiewicz, & Pąchalska, 2012; Shessel & Reiff, 1999) memory deficits have been reported in people with dyslexia, it suggests inefficient verbal compensatory cognitive abilities being used by this group. In the participants without dyslexia, semantic word production correlated positively with task consistent clusters, cluster and hard switches, none of which predicted the final score. Therefore, it seems that for the participants with dyslexia the usage of particular strategies: longer clusters consistent with the criterion and hard switches is more important for the correct performance of the task. For the phonological fluency, we found that in the participants with dyslexia, task consistent and discrepant clusters predicted the score in word production; in the participants without dyslexia, only task consistent clusters predicted it. It would be recommended to include active and passive vocabulary measures in subsequent studies, as these might be moderators in verbal fluency performance.

CONCLUSIONS

We found no intergroup differences between the high school students with and without dyslexia in the phonological and semantic verbal fluency in word production. The semantic task turned out to be easier, and performed faster, than the phonological, for all participants, regardless of dyslexia. Our study demonstrated that in the criterion group the performance in the phonological fluency task was affected by the selected sound; this result suggests that it is especially difficult for Polish students with dyslexia to differentiate between the representation of a sound and a letter. Moreover, this result shows that certain sounds and/or letters, even though frequent in a language, might pose problems for participants with specific learning difficulties, due to their lower sound/letter correspondence.

The differences between the strategies applied by the compared groups that we found were few. In the semantic fluency task the participants with dyslexia, as compared with the participants without dyslexia, formed fewer clusters consistent with the criterion, and less often switched from one cluster to another. This difference, however, did not influence the performance efficiency. Participants with dyslexia, but not participants without this disorder, employed working memory to perform this task, which suggests reliance on additional inefficient verbal compensatory cognitive abilities. However, our study also demonstrated that for the participants with dyslexia the usage of particular strategies: longer clusters consistent with the criterion and hard switches is more important for the correct performance of the task.

We found that all participants produced more task consistent than task discrepant clusters in both criteria, not transferring the strategy of searching semantically-organised resources of mental lexicon to the phonological task, but followed the general phonetic instruction received. This might have contributed to their lower score in the latter, more difficult task – where they also produced more intrusions. In both tasks, hard switches were more frequent than cluster switches in both groups.

A detailed examination of the qualitative and quantitative characteristics of phonological and semantic verbal fluency reveals subtle differences between the strategies employed by students with and without dyslexia. The observed differences seemed to be related to the phonological and memory deficits of the participants with dyslexia; yet they did not influence task performance efficiency. In general, word production turned out to be a relative strength of students with dyslexia, as they performed on a level with their non-dyslexic peers, while employing mostly similar strategies.

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