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Research Paper: Lexical Access in Persian Speaking Children With and Without Specific Language Impairment

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ABSTRACT

Introduction: Word retrieval problems are among the limitations observed in children with specific language impairment during the initial schooling years. These restrictions are predictive of reading problems and poor performance at school. Additionally, studies on lexical access in Persian speaking children are scarce. Therefore, this study aimed to investigate and compare naming accuracy and latency in children with and without specific language impairment.

Methods: Twenty 7-9-year-old children with specific language impairment and 20 age-matched peers were recruited as the study participants. They were requested to name the 128 black and white line-drawing pictures from a Persian picture naming set for children, as rapidly as possible. We compared the effects of psycholinguistic variables on naming latency in the explored children with and without specific language impairment.

Results: Linear mixed-effects modeling presented an interaction between the research groups and the psycholinguistic variables. Significant main effects were found for name agreement (P≤0.00) and the age of acquisition (P=0.05) in children with typical language development; significant effects for name agreement (P≤0.00) and log frequency (P≤0.00) were revealed in children with specific language impairment.

Conclusion: The obtained models indicated that psycholinguistic factors could differently affect the naming latency in children with and without specific language impairment. Factors that may have accounted for the findings are discussed in this paper.

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Highlights

● The knowledge of word-finding abilities in children with specific language impairment could lead to choosing the best strategy for improving lexical access.

● The psycholinguistic variables should be controlled to achieve the best result for improving lexical access.

Plain Language Summary

Word finding difficulties are continuous problems in specific language impairment, which can affect literacy skills. The psycholinguistic variables could impact word-finding skills. Accordingly, therapists should be aware of psycholinguistic variables effective for the assessment and treatment of naming in children with specific language impairment. The obtained results suggested the significant impact of name agreement and word frequency on picture naming skills in the studied children. These results could help with the best planning of assessment and treatment of children with specific language impairment

1. Introduction

Specific Language Impairment (SLI) is a developmental disorder. In this condition, a child presents remarkable problems in language acquisition despite normal non-verbal intelligence and sensory ability (Leonard, 2014). This impairment is not homogenous and has a pattern, i.e. not observed in disorders with known causes, such as intellectual disability, autism, physical or neural impairments, and general learning disabilities. SLI includes a broad spectrum of deficits in various language aspects (Verhoeven & van Balkom, 2003). There exists a large body of literature on morphosyntactic, phonological, and pragmatic complications in children with SLI; however, there is a dearth of research on the mental lexicon, especially word retrieval problems (Van der Lely & Ullman, 2001; Bortolini & Leonard, 2000; McGregor & Appel, 2002).

When individuals learn new words, they store these words in their lexicon for later retrieval. Word retrieval significantly affects language processing and cognitive development (Messer & Dockrell, 2006). Additionally, 25% of children with language impairment encounter word-finding problems (Dockrell, Messer, & George, 2001). Such conditions are significant predictors of reading disorders and poor educational performance in school-aged children (Wolf & Segal, 1992). Numerous studies on children with SLI revealed that they name pictures more slowly and less accurately, compared to their counterparts with Typical Language Development (TLD) (Kambanaros & Grohmann, 2010; Lahey & Edwards, 1999; Leonard, Nippold, Kail, & Hale, 1983; Miller, Kail, Leonard, & Tomblin, 2001). Miller et al. (2001) found that children with SLI performed more slowly than those with TLD in all linguistic and non-linguistic tasks; however, the speed of performance was higher in them, than that of the children with other language impairments.

Psycholinguistic variables are an essential determinant of the naming latency and accuracy, such as name agreement, the Age of Acquisition (AoA), and so on (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997; D'Amico, Devescovi, & Bates, 2001; Masterson, Druks, & Gallienne, 2008; Newman & German, 2002). For instance, name agreement influences lemma selection (Alario et al., 2004; Bakhtiar, Nilipour, & Weekes, 2015; Cycowicz, et al., 1997). Furthermore, AoA and word frequency impact lexical selection (Alario, et al., 2004). Words with high-frequency of occurrence and those with early AoA are retrieved more quickly than the rest (German & Newman, 2004). Besides, numerous studies indicated that visual complexity influenced memory performance (Cycowicz, et al., 1997). More visually complex pictures require a longer time for retrieving the relevant concepts (Dimitropoulou, Dunabeitia, Blitsas, & Carreiras, 2009). However, familiarity has an opposite effect, compared to visual complexity, in this respect. Rated familiarity influences the stages of conceptual activation (Alario, et al., 2004). There are some variations in the effects of psycholinguistic features on naming skills in different cultures. For example, some common objects in the USA, including animals and vegetables, seem to be unrecognized in East Asia (Yoon et al., 2004). Therefore, due to the structural and cultural characteristics of different languages, we selected the Persian language for this study. In the Persian language, most studies on children with SLI have focused on the assessment of syntax, morphology, and cognition (Ahadi, Nilipour, Rovshan, Ashayeri, & Jalaie, 2014; Foroodi Nejad, 2011; Maleki

Shahmahmood, Soleymani, & Faghihzade, 2011). In the lexical domain, Mohammadi, Nilipour, Sima Shirazi, & Rahgozar (2011) compared word (noun) definition skill between children with and without SLI. Accordingly, they detected significantly different scores in the content and structure aspects of the word definition skill between the study groups. Moreover, Persian speaking children with and without SLI presented a significant difference in word definition by labeling specific categories domain (Mohammadi, Nilipour, Sima Shirazi, & Rahgozar, 2014). Except for these few studies on the lexical access domain, there are no investigations on lexical access; especially regarding the effect of psycholinguistic variables on naming skills in Persian speaking children with SLI.

The present study aimed to compare the picture-naming accuracy and latency between children with and without SLI. Furthermore, we attempted to determine the effect of psycholinguistic factors on naming latency using Linear Mixed Effect (LME) modeling in school-aged children with and without SLI. This is the first report concerning the effect of psycholinguistic factors on confrontation naming tasks among Persian speaking children with and without SLI.

2. Materials and Methods

Twenty children with SLI aged 7-9 years (females=8, males=12; mean age= 8.1 y) and 20 children with TLD, aged 7-9 years (females=8, males=12; mean age= 8.3 y), as the control group, participated in this study. All research participants were monolingual Persian-speaking children. To select the TLD children, all children were assessed by a Speech-Language Pathologist (SLP) via an informal assessment. Raven's Colored Progressive Matrices Test (Karami, 2016) was performed among the study subjects. The investigated children's parents completed a questionnaire, containing demographic, medical, social, educational, and developmental history. We removed the children (from both study groups) with a serious vision problem.

The explored children with SLI were from the middle sociocultural class, studying in public schools. These children were selected from speech therapy clinics in Tehran City, Iran. The children were screened according to their SLP's opinions and parents' questionnaire data. There is a lack of a proper standardized test for school-aged children that could be considered a gold standard in Iran. Thus, we used clinical judgment as the reference standard to diagnose children with SLI (Kazemi & Saeednia, 2017). Two qualified SLPs (the first author of this paper and another SLP who had clinical experience with children) examined the children. They used clinical examinations and considered some di-

agnostic criteria, as follows: no history of communicative, phonological, and neurological problems; no motor speech disorders in informal oral assessments; no auditory problems revealed in the pure tone audiometry test; nonverbal Intelligence Quotient (IQ) to range within normal scope per Raven's Colored Progressive Matrices Test (Karami, 2016); and the presence of language problem diagnosis using the below scales:

Test of Language Development (TOLD-P:3): Its normalized information is available for children in Persian (Hasanzadeh & Minaii, 2002).

Persian Test of SLI: This test comprises three criteria for assessment; the determination of the percentage score of language disorder in children with SLI, compared to age-matched peers; the assessment of specific language features that have been impaired in children with SLI, and the determination of individual profile and severity of language impairment (Nilipour, 2002). This test's internal consistency was measured using Cronbach's alpha coefficient. Cronbach's alpha coefficient for this test was calculated as 0.90 for 60 children aged 5-10 years old (Nilipour, Karimi-Javan, & Ghoreishi, 2017). If the child was diagnosed with SLI by both SLPs, then he/she was included in this study. Eventually, 20 children were diagnosed with SLI. We received children's parents' permission for study participation by signing an informed consent form. The Ethics Committee code of this research was issued as IR.USWR.REC.1394.223.

The picture naming set consists of 128 simple black and white pictures. The picture naming set includes information on the frequency of name agreement, rated familiarity, visual complexity, AoA (for more information see Hassanati, Nilipour, Ghoreishi, Pourshahbaz & Momenian, 2017), and word frequency (i.e. obtained from a standardized Persian written corpus; then it was transformed into log-frequency value).Table 1 shows the normative data of picture naming set in the studied Persian-speaking children.

Each explored child was tested individually in several sessions. In the initial three sessions, the diagnostic assessments were performed by SLPs. In the case of meeting the diagnostic criteria of SLI, a picture-naming task was performed in the final session.

The picture naming set was presented by DMDX software (Forster & Forster, 2003). Each child was seated in front of a laptop connected to a microphone. The child was instructed to name the pictures quickly, with one word, without using extra words or voices. To make sure the child was prepared for the test and the instructions were clear enough,

Hassanati, F., et al. (2020). Lexical Access in Persian Children. *BCN, 11*(5), 659-668.

661

3-5 experimental pictures were illustrated to the child. The responses were recorded by DMDX and written by the examiner. Each picture was presented to the child for 5000ms according to the pilot study and a previous study in children (D'Amico, et al., 2001). A time interval of 1000ms was considered between presenting the two pictures. The pictures were randomly provided in 4 blocks, with the breaks between the blocks. If the study participant could not respond in 5000ms, an error was recorded by DMDX. Furthermore, if the study participant answered incorrectly, these responses were excluded from reaction time.

In this study, the LME modeling method was used for investigating the effect of the model of psycholinguistic factors on naming latency (Bakhtiar & Weekes, 2015; Nilipour, Bakhtiar, Momenian, & Weekes, 2016; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009). LME modeling has several advantages over the classic statistical analyses. It includes the item and subject random effects, which leads to higher generalizability of the findings to larger populations and stimuli (Baayen, Davidson, & Bates, 2008; Jaeger, 2008; Quene & Van den Bergh, 2008). To our knowledge, this is the first study about the effect of psycholinguistic variables on naming latency in children with SLI in Persian using LME modeling. Furthermore, in this study, the lme4 package (https://cran.r-project.org/web/packages/lme4/) was applied in R software to analyze the data of children with and without SLI.

3. Results

Naming latency was only calculated for correct names. In the SLI group, 26.3% of the responses were incorrect and 8.12% were not recorded by the software, i.e. excluded from the analysis. We controlled the outliers in naming latency. Then, the normality of the obtained data was examined by the Shapiro–Wilk test. Table 2 presents the naming latency and accuracy in children with and without SLI. The correlation between the reaction time scores of the randomly selected sample (TLD group) and the normative data of picture naming was >0.75, i.e. a high correlation (P≤0.05).

We used LME modeling to analyze the relationship between picture-naming latency and psycholinguistic factors in the study subjects. We followed the backward analysis procedure (Baayen, Davidson, & Bates, 2008). Initially, we defined the full model, including all fixed variables along with the random variables of the subjects and items for all data. We found significant main effects for name agreement and AoA in the TLD; we also detected the same impacts for name agreement and log frequency in the SLI.

Next, we individually removed the variables, i.e. not significant in the full model. This measure aimed to determine whether their exclusion from the model reduced the model fit using the Likelihood Ration Test (LRT). The TLD data suggested that removing familiarity ($\chi^2_{(1)}$=0.17, P=0.67), complexity ($\chi^2_{(1)}$=0.02, P=0.88), and log frequency ($\chi^2_{(1)}$=0.005, P=0.93) would not reduce the model fit. Subsequently, we defined other models in which significant main effects from the full model were removed one by one.

Table 1. The normative data of picture naming set in the studied Persian-speaking children

Variables	Name Agreement (%)	Familiarity	Complexity	AoA (Month)	Log Frequency	RT (ms)
Mean±SD	86.09±17.10	3.67±1.23	2.32±0.91	27.22±5.85	1.83±0.55	1399.8±218.24
Max.	100	5	4.60	42	4.34	1941
Min.	31	1.20	1.00	11.60	1.00	10.56

Table 2. Mean(SD) scores of the naming latency of accurate responses in the picture naming set

Groups of Children	Mean±SD		T	Df
	TLD	**SLI**		
Naming Latency (ms)	1328.10±122.71	1567.41±117.43	-4.32 *	36
Correct Answers (%)	85.2	73.7	4.07 *	

* The significance level is 0.05; * Independent Samples t-test; df: Degree of Freedom

Hassanati, F., et al. (2020). Lexical Access in Persian Children. *BCN, 11*(5), 659-668.

Table 3. A summary of LME models of RTs in the TLD group

Fixed Effects	Estimate	Std. Error	t	P
Intercept	1813.93	180.26	10.06	0.001
name agreement	-8.36	1.54	-5.43	0.001
AoA	8.41	3.32	2.52	0.05
Random effects	Variance	Correlation		
Random effects	Variance	Correlation		
Items (Intercept)	18627.64			
Subj (Intercept)	197187.63			
Subj (name agreement slope)	22.28	-0.90		
Subj (AoA slope)	61.15	-0.01	-0.38	
Residual	147052.70			

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Table 4. The summary of LME models of RTs in the SLI group

Fixed Effects	Estimate	Std. Error	t	P
Intercept	2806.50	169.40	16.56	0.001
name agreement	-10.87	1.78	-6.10	0.001
Log frequency	-152.13	43.05	-3.53	0.001
Random effects	Variance			
Random effects	Variance			
Items (Intercept)	40747			
Subj (Intercept)	35601			
Residual	245025			

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The related results revealed that excluding AoA ($\chi^2_{(1)}$=7.33, P<0.01) and name agreement ($\chi^2_{(1)}$=41.98, P<0.001) from the general model significantly reduced the model fit. The same procedure was followed with the SLI. First, we removed those predictor variables, i.e. not significant in the full model. The relevant results indicated that removing complexity ($\chi^2_{(1)}$=0.99, P=0.31), familiarity ($\chi^2_{(1)}$=1.49, P=0.22), and AoA ($\chi^2_{(1)}$=1.96, P=0.160) did not reduce the model fit at all. However, the one-by-one exclusion of name agreement ($\chi^2_{(1)}$=23.87, P<0.001) and log frequency ($\chi^2_{(1)}$=6.22, P<0.05), significantly impacted the model fit.

Then, we tested whether excluding by-subject and by-item random intercepts from the models influenced their fitness to model. The step-by-step removal of by-subject intercept ($\chi^2_{(1)}$=97.67, P<0.001) and by-item intercept ($\chi^2_{(1)}$=66.91, P<0.001) significantly affected the model fit in the TLD data. We witnessed the same effect in the SLI data. After removing the by-subject intercept and comparing the new model with the full model, these data were statistically significant ($\chi^2_{(1)}$=97.67, P<0.001). Excluding the by-item intercept from the model revealed the same result ($\chi^2_{(1)}$=75.39, P<0.001).

The optimal available model for the TLD data was RT ~ name agreement + AoA + (1| subjects) + (1| items). Next, we tested whether adding by-subject random slopes for significant effects could improve the model fit. Adding name

Hassanati, F., et al. (2020). Lexical Access in Persian Children. *BCN, 11*(5), 659-668.

663

agreement ($\chi^2_{(2)}$=42.41, P<0.001) and AoA ($\chi^2_{(2)}$=29.24, P<0.001) as by subject's random slopes significantly improved the model fit for the TLD data. The forwarding step-by-step analysis findings for the SLI data revealed the following model as the best one: RT ~ name agreement + log frequency + (1| subjects) + (1| item). We added by-subject random slopes for significant effects in the next stage. Including name agreement ($\chi^2_{(1)}$=1, P=1) and log frequency ($\chi^2_{(1)}$=0.50, P=0.47) failed to improve the model fit.

Based on the mentioned comparisons of the results, we proposed the following model for the TLD data (Table 3): RT ~ name agreement + AoA + (1 + name agreement + AoA | subjects) + (1 | items), and the following one for the SLI data (Table 4): RT ~ name agreement + log frequency + (1 | subjects) + (1 | items).

4. Discussion

The present study aimed to determine the picture-naming accuracy and latency as well as the effect of psycholinguistic factors on naming latency in 7-9-year-old children with and without SLI. The obtained data indicated that children with SLI had less accurate and slower naming speed, compared to their age-matched peers. This finding was consistent with those of the previous studies (Lahey & Edwards, 1996; Montgomery, 2002; Windsor & Hwang, 1999; Hassanati, Nilipour, Ghoreishi, Pourshahbaz & Momenian, 2018). Leonard et al. (1983) concluded that children with SLI performed more quickly than younger language-matched peers and more slowly than age-matched counterparts. An explanation of such findings could be a different language development and deficit in the semantic representation of words in children with SLI (Leonard, et al., 1983). Some scholars believed that the size of expressive vocabulary could determine the level of word retrieval success (Leonard, et al., 1983; Sheng, 2010). Additionally, the reason for the slower naming times of the language-impaired children could be a limitation in word retrieval or storage limitation) Messer, & Dockrell, 2006).

LME modeling method was used for exploring the model of psycholinguistic factors' effect on naming latency. The models obtained in children with and without SLI indicated that name agreement significantly impacted naming latency. This effect may be due to the competition between the target name and incorrect responses, as well as that between the target name and its alternative names. Selecting the target name among numerous alternative names in the mental lexicon requires a longer time (Alario et al., 2004; Cycowicz, et al., 1997).

Furthermore, the obtained model in children with TLD indicated that AoA affects the naming latency in them. This result was consistent with those of the previous studies (Cycowicz, et al., 1997; D'Amico, et al., 2001; Newman & German, 2002). Newman and German (2005) concluded that the words acquired at the lower ages are more easily retrieved than those acquired later (Newman & German, 2005). When the words were acquired earlier, there were more connections between the semantic and phonological components of the words; thus, they have retrieved more accurately (Gershkoff-Stowe & Smith, 1997). According to the growing network model, the words acquired earlier have higher connections and present a central position in the semantic network (Steyvers & Tenenbaum, 2005).

The present model obtained for children with SLI indicated that word frequency influenced the latency of picture naming. This model indicated that children with SLI were significantly better at naming high-frequency words, than naming low-frequency words. Multiple studies indicated that the children with and without various language disorders encounter further problems in naming the words with lower frequency (Cycowicz, et al., 1997; D'Amico, et al., 2001; Kambanaros & Grohmann, 2010; Mainela-Arnold & Evans, 2005; Newman & German, 2002). Leonard et al. (1983) concluded that high-frequency words have more connections. Besides, they have a stronger representation in the mental lexicon that requires less time to access (Leonard, et al., 1983). Moreover, the frequency might affect the connections between various representations, especially lemma and lexeme (Alario, et al., 2004; Barry, Hirsh, Johnston, & Williams, 2001; Barry, Morrison, & Ellis, 1997). Words with high-frequency occurrences have a lower activation threshold of a word, thereby facilitating word retrieval (Dewhurst, Hitch, & Barry, 1998; Sheng, 2007).

AoA seems to have a universal significant effect on timed picture naming across languages in impaired and unimpaired adult speakers (Alario, et al., 2004; Bakhtiar, Nilipour, & Weekes, 2013; Bates et al., 2003; Nilipour, Bakhtiar, Momenian, & Weekes, 2016); as well as in children with TLD and word-finding difficulties (Cycowicz, et al., 1997; D'Amico, et al., 2001; German & Newman, 2004; Newman & German, 2002). However, we observed no effect of AoA in children with SLI. It is necessary to note that most studies on naming skills have been conducted on adults or children with TLD. This result could be explained by some reasons. One of the possible reasons for not observing the effect of AoA in children with SLI could be the general delay in vocabulary acquisition and the inefficiency of lexical access in children with SLI (Dockrell & Messer, 2004). Children with SLI acquire the words later in a limited time (usually with practice) (Sheng, 2010); accord-

ingly, the effect of AoA may not be observed in them, like children with TLD. Furthermore, lexical items are poorly differentiated in their semantic-lexical representations and these representations may not be well organized. However, it is necessary to examine the effect of AoA on naming skills in different languages by various methods to reach a definite result.

5. Conclusion

Generally, this study could help to better understand this important aspect of children's language use. The present study was the first to apply LME modeling of the effect of psycholinguistic factors on naming latency in children with and without SLI. The obtained models indicated that such factors could differently impact the naming latency in children with and without SLI. Such differences may be due to the delay in language acquisition such as lexical access in children with SLI. These results could be useful for adequate assessment and intervention in language-impaired children. Future studies may focus on the effect of other psycholinguistic factors, such as neighborhood density in the naming skill of children. However, further studies are required on more subjects in different languages by highly-accurate statistical approaches, like LME modeling.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Science (IR.USWR.REC.1394.223). Written informed consent was obtained from the parents of study participants.

Authors' contributions

Conceptualization: Fatemeh Hassanati, Reza Nilipour, Zahra Sadat Ghoreishi, Mohammad Momenian; Methodology: Fatemeh Hassanati, Reza Nilipour, Zahra Sadat Ghoreishi, Mohammad Momenian; Writing-original draft, investigation: All author; Writing – review & editing: Fatemeh Hassanati, Reza Nilipour, Zahra Sadat Ghoreishi; Funding acquisition: Fatemeh Hassanati, Reza Nilipour, Zahra Sadat Ghoreishi; Resources: Fatemeh Hassanati, Reza Nilipour, Zahra Sadat Ghoreishi, Mohammad Momenian; Analysis Fatemeh Hassanati, Mohammad Momenian; Supervision: Reza Nilipour, Zahra Sadat Ghoreishi.

Conflict of interest

The authors declared no conflicts of interest.

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Hassanati, F., et al. (2020). Lexical Access in Persian Children. *BCN, 11*(5), 659-668.

665

Basic and Clinical
NEUR◉SCIENCE

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667

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