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**Lexical Access In Persian Speaking Children With And
Without Specific Language Impairment**

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Highlights

Knowledge of word finding abilities in children with specific language impairment could lead to choosing the best strategy for improving the lexical access. Moreover, the psycholinguistic variables should be controlled to achieve the best result.

Plain Language Summary

Word finding difficulties are the continuous problem in specific language impairment, which can affect literacy skills. The psycholinguistic variables can affect the word finding skills. Then, the therapist should be aware of psycholinguistic variables effect for assessment and treatment of naming in children with specific language impairment. The results showed a significant effect of name agreement and word frequency on picture naming skills in these children. Considering these results can lead to the best planning of assessment and treatment of children with specific language impairment.

Abstract

Introduction: Word retrieval problems are one of the limitations observed in children with specific language impairment during the

initial years of schooling. These limitations are predictive of reading problems and poor performance at school. In addition, there are a few studies on lexical access in Persian speaking children. Therefore, this study aimed to investigate and compare the naming accuracy and latency in children with specific language impairment.

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

Results: Linear mixed effects modeling showed an interaction between the groups and the psycholinguistic variables. Significant main effects were found for name agreement ($p \leq 0.00$) and age of acquisition ($p = 0.05$) in children with typical language development, while significant effects for name agreement ($p \leq 0.00$) and log frequency ($p \leq 0.00$) were revealed in children with specific language impairment.

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

Keywords: Child, Data accuracy, Reaction time, Specific language impairment, Word processing.

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Introduction

Specific Language Impairment (SLI) is a developmental disorder when a child has remarkable problems in language acquisition in spite of normal non-verbal intelligence and sensory ability (Leonard, 2014). This impairment is not homogenous and has a pattern which is not observed in disorders with known causes such as mental retardation, autism, physical or neural impairments, and general learning disabilities. SLI includes a broad spectrum of deficits in different language aspects (Verhoeven & van Balkom, 2003). There are many studies about morphosyntactic, phonological, and pragmatic problems in children with SLI, but there is a dearth of research on the mental lexicon, especially word retrieval problems (Van der Lely & Ullman, 2001; Bortolini & Leonard, 2000; Bishop & Norbury, 2002; McGregor & Appel, 2002).

When people learn new words, they store these words in their lexicon for later retrieval. Word retrieval plays a central role in language processing and cognitive development (Messer & Dockrell, 2006). In addition, 25% of children with language impairment suffer from word finding problems (Dockrell, Messer, & George, 2001) which are significant predictors of reading disorders and poor educational performance in school-aged children (Wolf & Segal, 1992). Numerous studies on children with SLI show

that they name pictures more slowly and less accurately in comparison with age-matched children 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 TLD children in all linguistic and non-linguistic tasks, but the speed of performance was higher than that of the children with other language impairments.

Psycholinguistic variables are an important determinant of the naming latency and accuracy such as name agreement, 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 has an effect on lemma selection (Alario et al., 2004; Bakhtiar, Nilipour, & Weekes, 2013; Cycowicz, et al., 1997). Also, AoA and word frequency have effects on lexical selection (Alario, et al., 2004). Words with high-frequency of occurrence and those with early AoA are retrieved more quickly (German & Newman, 2004). In addition, numerous studies indicate that visual complexity influence memory performance (Cycowicz, et al., 1997). More visually complex pictures need a longer time for the retrieval of the relevant concepts (Dimitropoulou, Dunabeitia, Blitsas, & Carreiras, 2009). However, familiarity have the opposite

effect compared to visual complexity. Rated familiarity influence the stages of conceptual activation (Alario, et al., 2004). There were some variations in the effects of psycholinguistic features on naming skills in different cultures. For example, some common objects in the U.S., such as animals and vegetables, seem to be unknown in East Asia (Yoon et al., 2004). Therefore, due to 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 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, SimaShirazi, and Rahgozar (2011) compared word (noun) definition skill between children with and without SLI and found significantly different scores in the content and structure aspects of the word definition skill between the two groups. In addition, Persian speaking children with and without SLI had a significant difference in word definition by labeling specific categories domain (Mohammadi, Nilipour, Sima Shirazi, & Rahgozar, 2014). Except for these few studies on lexical access domain, there are no other studies on lexical access, especially regarding the effect of

psycholinguistic variables on naming skills in Persian speaking children with SLI.

The present study had two aims: (1) to compare the picture naming accuracy and latency between children with and without SLI; (2) to determine the effect of psycholinguistic factors on naming latency by using Linear Mixed Effect (LME) modeling in school-aged children with and without SLI. This study is the first report of the effect of psycholinguistic factors on confrontation naming tasks on Persian speaking children with and without SLI.

Materials and Methods

Participants

Twenty children with SLI aged 7-9 years (F=8, M=12; mean age= 8.1) and 20 children with TLD aged 7-9 years (F=8, M=12; mean age= 8.3) as a control group participated in this study. All 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 and the parents filled out a questionnaire which contained personal, medical, social, educational and developmental information history. Its note that we removed the children (in the both groups) who have a serious vision problem.

Children with SLI were from middle sociocultural class, studying in public schools. These children were selected from speech therapy clinics in Tehran. The children were screened according to their SLP's opinions and parent questionnaire. Due to the lack of any proper standardized test for school-aged children that could be considered a gold standard in Iran, 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 diagnostic criteria:

1. Lack of a history of communicative, phonological and neurological problems;
2. Lack of motor speech disorders in informal oral assessments;
3. Lack of auditory problems in the pure tone audiometry test;
4. Nonverbal intelligence quotient within normal range by Raven's Colored Progressive Matrices Test (Karami, 2016);
5. Presence of language problem diagnosis by using:
 - 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; determination of the percentage

score of language disorder in children with SLI compared to age-matched peers, assessment specific language features that have been impaired in children with SLI, and determination of individual profile and severity of language impairment (Nilipour, 2002). Internal consistency was measured using Cronbach's alpha. The Cronbach's alpha for this test was 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.

Finally, 20 children were diagnosed with SLI.

We received children's parents' permission by signing a consent form. The Ethics Committee Code of this research was IR.USWR.REC.1394.223.

Stimuli

The picture naming set consists of 128 simple black and white pictures. The picture naming set includes information on the percentage of name agreement, rated familiarity, visual complexity, AoA (for more information see Hassanati, Nilipour, Ghoreishi, Pourshahbaz & Momenian, 2017), and word frequency² (which was

² Although these frequency accounts are based on an adult corpus, like some previous studies (German & Newman, 2004; Kambanaros & Grohmann, 2010;

taken from a standardized Persian written corpus, (Hassani, 2005) and then transformed into log-frequency value).

[Table1 is here]

Procedure

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

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, not using extra words or voices. In order to make sure the child was prepared for the test and the instructions are clear enough, three to five experimental pictures were shown 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 previous study in children (D'Amico, et al., 2001). A time interval of 1000ms was considered between the two pictures. The pictures were provided randomly in four blocks, with the breaks between the blocks. If the

Newman & German, 2002; Sheng, 2007), they contain data for many words that are available in a database of core elementary school vocabulary of Persian children (Nematzadeh, Dadras, & DastjerdiKazemi, 2011) and are probably age-independent.

participant could not respond in 5000ms, an error was recorded by DMDX. Also, if the participant didn't answer correctly, these responses didn't account for reaction time.

Data Analysis

In this study, LME modeling method was used for investigation of the model of psycholinguistic factors effect 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 takes the item and subject random effects into account, which leads to higher generalizability of the findings to the larger population and stimuli (Baayen, Davidson, & Bates, 2008; Jaeger, 2008; Quene & Van den Bergh, 2008). To the best of 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.

Also, in this study, lme4 package (<https://cran.r-project.org/web/packages/lme4/>) was used in R software in order to analyze the data in both children with and without SLI.

Results

Naming latency was calculated only for correct names. In the SLI group, 26.3% of the responses were incorrect and 8.12% were not recorded by the software, which were excluded from the analysis. We controlled the outliers in naming latency and then normality of the data was examined by the Shapiro–Wilk Test. Table 2 shows the naming latency and accuracy in children with and without SLI. It is noteworthy that the correlation between the reaction time scores of the randomly selected sample (TLD group) and the normative data of picture naming was higher than 0.75 that is a high correlation ($p \leq 0.05$).

[Table2 is here]

We used the LME modeling in order to analyze the relationship between picture naming latency and psycholinguistic factors in both children with and without SLI. We followed the backward analysis procedure (Baayen, Davidson, & Bates, 2008). First, we defined the full model including all fixed variables along with the random variables of subjects and items in both with and without SLI data. We found significant main effects for name agreement and AoA in the TLD as well as for name agreement and log frequency in the SLI.

Next, we removed the variables which were not significant in the full model one by one to determine whether their exclusion

from the model reduced the model fit using Likelihood Ratio Test (LRT). The results of the TLD data showed 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. In the next step, we defined other models in which significant main effects from the full model were removed one by one. The 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. At first, we removed those predictor variables which were not significant in the full model. The results showed that the removal of 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.

In the next stage, we also tested whether exclusion of by-subject and by-item random intercepts from the models influenced their fit. The step-by-step removal of by-subject intercept ($\chi^2(1) = 97.67$, $p < 0.001$) and by-item intercept ($\chi^2(1) = 66.91$, $p < 0.001$) had a significant effect on the model fit in the TLD data. We witnessed the same effect in the SLI data. When we removed the by-subject

intercept and compared the new model with the full model, the result was significant ($\chi^2(1) = 97.67, p < 0.001$). The exclusion of the by-item intercept from the model revealed the same result ($\chi^2(1) = 75.39, p < 0.001$).

So far, the best model for the TLD data is $RT \sim \text{name agreement} + \text{AoA} + (1 | \text{subjects}) + (1 | \text{items})$. In the next step, we tested whether adding by-subject random slopes for significant effects could improve the model fit. Adding name 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 results of forwarding step-by-step analysis for the SLI data revealed the following model as the best one: $RT \sim \text{name agreement} + \log \text{ frequency} + (1 | \text{subjects}) + (1 | \text{items})$. We added by-subject random slopes for significant effects in the next stage. The inclusion of name agreement ($\chi^2(1) = 1, p = 1$) and log frequency ($\chi^2(1) = 0.50, p = 0.47$) did not improve the model fit. Based on the mentioned comparisons of the results, we proposed the following model for the TLD data (see Table 3): $RT \sim \text{name agreement} + \text{AoA} + (1 + \text{name agreement} + \text{AoA} | \text{subjects}) + (1 | \text{items})$, and the following one for the SLI data (see Table 4): $RT \sim \text{name agreement} + \log \text{ frequency} + (1 | \text{subjects}) + (1 | \text{items})$.

[Table3 is here]

[Table4 is here]

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 present study indicated that children with SLI had less accurate and slower naming speed than their age-matched peers consistent with 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 peers. Some explanation of such phenomena could be a different language development and deficit in the semantic representation of words in children with SLI (Leonard, et al., 1983). Some authors believe that the size of expressive vocabulary determines the level of word retrieval success (Leonard, et al., 1983; Sheng, 2007). Also, the reason of 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 investigation of the model of psycholinguistic factors effect on naming latency. The models obtained in children with and without SLI indicated that

name agreement had a significant effect on the 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. The selection of the target name among the many alternative names in the mental lexicon requires a longer time (Alario et al., 2004; Cychowicz, et al., 1997).

Furthermore, the obtained model in children with TLD indicated that AoA affects the naming latency **in these children**, which was consistent with the results of the previous studies (Cychowicz, et al., 1997; D'Amico, et al., 2001; Newman & German, 2002). Newman & 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, and thus were retrieved more accurately (Gershkoff-Stowe & Smith, 1997). According to growing network model, the words acquired earlier have more connections and have 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.

Many studies indicated that the children with and without various language disorders have more 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 the high-frequency words have more connections and stronger representation in the mental lexicon that needs fewer time to access (Leonard, et al., 1983). Some authors believe that the frequency affects 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 lower the 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) and in children with TLD and word finding difficulties (Cycowicz, et al., 1997; D'Amico, et al., 2001; German & Newman, 2004; Newman & German, 2002), but we did not observe the effect of AoA in children with SLI. Of course, it is necessary to note that most studies on naming skill have been conducted on adults or TLD

children. There are some reasons for this result. One of the possible reasons for not observing the effect of AoA in children with SLI can 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, 2007), so the effect of AoA may not be observed like TLD children. Also, 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 skill in different languages with different methods to find the definite result.

Generally this study could help to better understand this important aspect of children's language use. Review of different studies revealed that the present study was the first research that applied 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 affect the naming latency in children with and without SLI differently. The differences may be due to the delay in language acquisition such as lexical access in children with SLI. This results could be useful for adequate assessment and intervention in the 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, more studies are needed on more subjects in different languages by using highly accurate statistical methods, such as LME modeling.

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Disclosure Statement

The authors declare no conflicts of interest.

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Tables

Table1. The normative data of picture naming set in Persian-speaking children

variables	Agreement (%)	Name	Familiarity	Complexity	AoA (month)	Log Frequency	RT (ms)
Mean	86.09	3.67	2.32	27.22	1.83	1399.8	
SD	17.10	1.23	0.91	5.85	0.55	218.24	
Maximum	100	5	4.60	42	4.34	1941	
Minimum	31	1.20	1.00	11.60	1.00	10.56	

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

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

*The significance level is 0.05. * independent t test

df, degree of freedom.

Table 3. Summary of **LME** models of RTs in the TLD group

Fixed effects	Estimate	Std. error	T value	P value
(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			

Table 4. Summary of **LME** models of RTs in the SLI group

Fixed effects	Estimate	Std. error	T value	P value
(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			