

## RESEARCH ARTICLE

# An analysis of the critical period effects on deaf individuals focusing on the acquisition of verb argument structure: a preliminary study

Amer Gheitury, Yassaman Choubsaz\*

English Department, Faculty of Literature and Humanities, Razi University of Kermanshah, Kermanshah, Iran

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### Abstract

**Background and Aims:** Considering the fact that different components of linguistic knowledge are not equally vulnerable, this study investigated the knowledge of argument structure of verbs in a group of deaf Persian speakers, as people who have been deprived of linguistic data during the early years of their childhood that is the critical period of language acquisition.

**Methods:** In this study, the knowledge of verb arguments was examined through two tasks, one written (for 10 verbs) and one pictorial (for 10 verbs), in the two groups of deaf and normal hearing individuals, each of which consisting of 12 participants (6 girls and 6 boys).

**Results:** The analysis of verb argument structure showed that the number of errors in pictorial tests and recognized verb arguments was not significantly different between the groups. However, the main challenge of the deaf participants was attributed to mapping the arguments of the verb onto syntactic level.

**Conclusion:** The results showed that linguistic levels are not equally dependent on the successful experience of the critical period. The syntax level was highly affected by the critical period, while concepts like verb arguments had the least

vulnerability.

**Keywords:** Argument structure; critical period hypothesis; deaf; language acquisition

### Introduction

The critical period hypothesis has always been controversial regarding the extent to which language acquisition is affected by age. According to this hypothesis, the time period to acquire a language is limited beyond which the acquisition is very hard and even becomes impossible. In other words, early years of life are considered as a sensitive period in which, one can acquire a first language easily and unconsciously, provided that s/he is exposed to sufficient language input. Otherwise, one can never master a language, especially the syntactic knowledge, thoroughly [1].

Arshavsky believes that exposure to a language is extremely important in the first years of life, and its impacts are not limited to the development of vocabulary and syntactic skills of the native language in children. He holds the view that the language input during the early years of life helps the activation of genetic programs that are very influential in linguistic functions. He also states that "in children deprived of a linguistic environment, the linguistic genes are deeply repressed, and such children cannot learn a language later in their life" [2].

Deaf children born to hearing parents are among

\* **Corresponding author:** English Department, Faculty of Literature and Humanities, Razi University of Kermanshah, Kermanshah, 6714967346, Iran. Tel: 009883-34283912, E-mail: y.choobsaz@yahoo.com

those who experience language deprivation. These people often face many difficulties in learning a language. Also, they normally do not learn a sign language until they attend special schools for deaf individuals. Hence, they miss a very important time period for learning a language and that is why they are often deprived of linguistic communication in their environment. As Schein and Delk [4] report, most deaf children who have hearing parents know no sign language because they are not exposed to sign language since they were born; therefore, it seems that they have missed the critical period for acquiring a language.

Extensive body of research in the field of language acquisition in deaf individuals over the past two decades shows that language deprivation during the early years of life affects some components of language more than others [5-8]. According to Jackendoff, in late language learning, language sub-components such as phonology, phrase structure rules and more specifically, inflectional system are severely impaired. However, it is claimed that some components of language are less prone to be impaired due to missing language acquisition in the critical period. Among these components, one can point to the domain of vocabulary and word order in sentences [9].

Eubank and Gregg [10] believe that the importance of the critical period is not the same for different areas of linguistic knowledge including phonology, syntax, lexicon and even their sub-components e.g. lexical items and inflection. Lee and Schachter [11] also believe that the principals of universal grammar (UG) such as binding are restricted to a particular time period which is age-dependent, as well. In recent years, linguists have studied all these theories under the label "multiple critical period hypothesis" and tried to discover which linguistic components, features, and interface levels are affected by the critical period, how and why.

As pointed out earlier, the studies show that the components of language system are affected by the age of language acquisition in different ways. The current study was also conducted to evaluate this claim, aiming at investigating the

challenges the deaf individuals are faced with in argument structure or verb valency. In general, argument structure reflects the semantic relationships between verb, its dependents, and their proper syntactic positions [12]. As we know, a verb can have one or more dependents with regard to its meaning and type of activity it refers to. These dependents or arguments, as Haegeman indicates, are the least participants involved in the activity or state expressed by the verb [13]. For instance, the verb "xordan" (to eat) in Persian indicates an activity in which, two participants are required: one is the person or a creature that eats and the other is the thing that is eaten. The verbs that require two participants are called two-place verbs (predicates) or transitive verbs in the traditional sense. Those verbs that take only one argument are called one-place verbs corresponding to intransitive verbs, and those which require three arguments are referred to as three-place or di-transitive verbs [13].

In general, very few studies have been carried out on the issue of language deprivation during the early years of language acquisition and the way it affects the knowledge of verb valency. One of these studies has been conducted by Curiss [1] investigating Chelsea's knowledge of argument structure. Chelsea is a girl who was diagnosed as deaf at the age of 32. As Curtiss [1] observed, Chelsea exhibits deficits in the knowledge of verbs' argument structure and she often includes too many arguments or predicates.

As far as the authors are aware, linguistic studies have not yet focused on the issue of argument structure of Persian deaf individuals in Iranian context. The current study investigates the argument structure of verbs or verb valency in Persian deaf individuals. We also try to find an answer to the question that to what extent the knowledge of argument structure is affected in deaf individuals. In fact, the main purpose of this paper is to explore the knowledge of argument structure and to see whether language deprivation in the critical period affects all the language components equally or not. The research methodology and process are

explained in the following paragraphs.

### Methods

Two groups of deaf and normal hearing (NH) individuals (6 boys and 6 girls in each group) were examined. The inclusion criteria for the deaf group were as follows: being congenitally deaf, having passed the critical period of language acquisition (from birth to puberty) [1,10], having a normal intelligence, and being able to complete the written and pictorial tasks (not having motor disabilities). Data on age, cause of hearing loss, and age of hearing loss were collected by questionnaire. Besides the questionnaires, we interviewed, if necessary, the schools' counselor, doctor, or principal in order to seek more detailed information about the mean of hearing loss, its cause, and type of school in which the deaf students had studied before. The NH group included twelve ninth-grade students, 14 to 15 years of age (6 boys and 6 girls). The difference between the mean age of the deaf group (18 years of age) and the NH group (14.5 years of age) is due to the fact that the deaf students often start studying with delay in comparison with their peers, and sometimes they repeat each grade two or three times. Thus, it is expected that the mean age of individuals is higher in the deaf group than the NH group. It should also be noted that in order to observe ethical issues, the participants in both groups signed the informed consent form before the study.

In order to control the linguistic competence of the deaf group and to make sure that it is on a par with that of the NH group, we referred to similar studies. Most of these studies reported that on average, 17 to 18-year-old deaf students have written language on a par with hearing students who are 9-10 years old [17].

Considering all these circumstances, it was decided that the participants be selected from the ninth grade. Thus, the purposeful sampling method was employed. Written and pictorial tests were used for data collection. The researchers were in touch with the deaf community through the deaf institution, rehabilitation centers, and special schools for deaf individuals.

Our purpose was primarily to get familiar with the living conditions of deaf people and then, to get acquainted with the ways through which we could interact with deaf individuals.

Written tests in the form of sentence-completion tasks were developed and used to assess the knowledge of argument structure in the deaf group. Examining participants via written tests primarily was due to the fact that they were not in the same level of proficiency in understanding the sign language. However, they all were more or less equal in the proficiency of standard written language. That is because they use written language more often to communicate with hearing individuals.

As far as the authors are aware, tests to assess argument structure in particular have not been developed yet. Hence, the tests in the study were developed by the authors. In order to ensure that the tests are valid and reliable, the following steps were taken. Content validity, as a type of validity, means gathering all the information needed to carry out a research. To observe the content validity in the current study, we addressed the question of to what extent these tests can assess argument structure. To get the answer, we asked the opinions of the participants about the tests. This step was done along with the administration of the preliminary test, and it was found that the deaf participants have some problems with understanding the meanings of some verbs and making sentences. Thus, we replaced the challenging verbs with pictures in the main test stage. Another method for checking the content validity is to have the tests reviewed by a few experts in the field. This step was also taken by asking two linguists to verify the tests and applying their ideas.

Another type of validity is face validity. To check the face validity, we considered fatigue in the participants during responding to the tests. Therefore, the harder questions were posed in the first section of the tests and easier ones were left for the last sections. In addition, we ensured that the font size and the distance between the lines are appropriate for those who might suffer from visual impairment or concentration difficulties.



**Fig. 1.** A sample picture for the argument structure test for the verb "xabidan (to sleep)".

There are also several methods to evaluate the reliability of data gathering tools. One of them is the test-retest method. In the present study, we administrated a preliminary test before running the main test and entered the data to SPSS 20. After administrating the main test, the correlation between the two test results (i.e. preliminary test and main test) was calculated using the test-retest and reliability coefficient of 0.75 was obtained. Therefore, the researcher ensured that the data collection tools are reliable.

In the section of written tests, we embedded 10 questions for each of which, the respondents were asked to make a sentence with the given verbs. Four of these verbs were one-place and six of them were two-place predicates. In order to choose these verbs, it was tried to use tangible verbs with which the deaf participants are familiar in daily life. Sentence making with three-place predicates was left for the section of pictorial tests. The following examples are from the section of written tests:

- 1).....poxt. (.....cooked.....)
- 2).....mi-puš-am (I put on.....)
- 3).....komak mi-kon-am (I help.....)
- 4).....otu mi-zan-am (I iron.....)

While we were administrating the written tests, we noticed that verbs like "gozaštan" (to put), "dadan" (to give), "gaštan" (to go around), and "avardan" (to bring) were challenging for the deaf respondents. That is why we replaced these verbs with pictures in the main test. In other words, we tried to show them the meaning of the verbs with pictures and asked them what the person in the picture is doing. For instance, in the case of the verb "xabidan" (to sleep), we

provided them with a picture of a boy who was sleeping (Fig. 1). We wrote a name for the boy on top of the page and asked the respondents "What is Mohammad doing?" In fact, this was an attempt to elicit the correct structure from the respondents using pictorial stimuli as well as relevant questions. Research to assess and measure language ability in deaf individuals has shown that picture processing is much easier for deaf individuals than words and written sentences [14]. Ormel et al. [15] also confirm that using only written words to assess the language abilities of deaf individuals may underestimate their knowledge. For these reasons, visual tests were developed and administrated for those words which were difficult for deaf participants to understand.

As for rating the responses, one point was considered for each question in the written and pictorial sections. If a respondent provides just one argument for a two-place verb which needs two obligatory participants (arguments), he/she will get half a point. In case the respondent leaves the question unanswered or writes an irrelevant answer, he/she will get no point. Thus, each of the written and pictorial sections received the total score of 10. Mann-Whitney test in SPSS 20 was used for statistical analysis. The reason for using Mann-Whitney test in this study was non-normal distribution of data; therefore, it was necessary to use a non-parametric test.

## Results

The demographic characteristics of the deaf group are provided in Table 1. The results of the

**Table 1. Descriptive characteristics of the deaf participants**

Number	Gender	Age	Pure tone average the right/left ears	Hearing device	Other information
1	Female	16	55/53	Hearing aid since 7 years old	Hard of Hearing
2	Female	17	90/90	None	Congenital deaf
3	Female	18	86/86	None	Congenita deaf
4	Female	19	115/115	None	Congenital deaf and a deaf sister
5	Female	19	115/115	None	Congenital deaf
6	Female	22	96/90	None	Congenital deaf
7	Male	16	80/80	Hearing aid since 7 years old	Congenital deaf
8	Male	17	95/95	Hearing aid since 4 years old	Congenital deaf
9	Male	17	75/75	Hearing aid since 7 years old	Congenital deaf
10	Male	18	90/90	Cochlear implants since 2 years old	Congenital deaf
11	Male	19	90/90	None	Congenital deaf with two deaf siblings
12	Male	19	80/80	None	Congenital deaf

written and pictorial tests in both groups are shown in Table 2. It should be noted that the latter table represents the exact (correct) answers of each respondent. As can be inferred from Table 2, among the deaf girls, respondent 1 scored the best (with the least number of errors) in both written and pictorial tests. The respondent 1 was the only "hard of hearing" subject among the ninth-grade students (with the hearing loss of 53 dB in her left ear and 55 dB in her right ear). She had studied her elementary grades in a public school. But, due to her impaired hearing, she had problems with comprehending others' speech in noisy environment of public classes and schools. That is why she decided on a special school for deaf individuals at her secondary-school years. She did a good job at hearing provided that the words were loudly and articulately uttered. Because of this, she had fewer errors compared to her classmates.

Among the deaf boys, respondent 9 had the least errors and obtained the highest score. He was a congenital deaf with hearing loss of 75 dB in both ears. He has been using hearing aids since

he was 7 years old. His literature teacher described him an active and attentive student in the class.

As Table 2 indicates, the mean score of the deaf participants in the written tests of argument structure was 8.20 out of 10. The mean score of the NH group in the same tests was 9.20 out of 10. The comparison of the mean scores between the two groups using Mann-Whitney test indicated a significant between-group difference in this study ( $p=0.001$ ) (with the power of 80%).

The Cohen D test was also run in order to calculate the effect size. The effect size was obtained as 0.78, implying a relatively large effect.

The comparison of the scores of deaf and NH participants in the pictorial tests (Table 2) using Mann-Whitney test showed that both groups were the same in terms of the mean of the performance ( $p=0.054$ ) (with the power of 80%). This result suggests that there is no significant difference between the two groups in terms of performance [19]. (The Cohen D test was also run for the pictorial tests and the effect size was calculated as 0.86, indicating a relatively large effect).

**Table 2. The correct answers of the deaf and normal hearing groups in the written and pictorial tests of verb argument structure**

Participants	Written test score		Pictorial test score	
	Deaf group	NH group	Deaf group	NH group
1	10	10	10	10
2	7.5	10	9.5	10
3	8	10	9	10
4	8.5	10	10	10
5	3.5	10	10	9.5
6	8	10	10	10
7	9.5	8	10	9
8	7.5	10	6	10
9	9	10	10	10
10	10	9.5	6.5	10
11	9	10	8.5	10
12	8	10	8	10

If we hold the belief that picture processing is much easier than word and sentence processing for deaf individuals, based on the results of the pictorial tests, we will come up with the following conclusion. The qualitative analysis of deaf respondents' sentences shows that they generally do not make mistakes in recognizing the argument structure of verbs as well as the number of the participants involved in a particular event. However, they face challenges in using prepositions, case markers, and formal aspects of language. Therefore, most of the errors are of syntactic type.

### Discussion

An extensive body of research have focused on the significance of the critical period for language acquisition and relevant issues such as effectiveness of language acquisition in childhood as well as the relationship between language acquisition and age [2,3,9,20]. As Birdsong points out, according to advocates of the critical period hypothesis, there is a limited

period of time during which learning and mastering a language is possible; whether that language is the first or the second language. This claim is generally accepted among the language acquisition researchers [11,22,23] and a lot of evidence has been presented to support it. We also investigated the issue that to what extent the knowledge of argument structure is affected in people who missed the critical period. The origin of this argument goes back to the claim made by Jackendoff [9] and Eubank and Gregg [10] indicating that different components of language are affected by missing the critical period in different ways; and basically, some of these components (such as acquisition of vocabulary) are possibly acquired after the critical period. The analysis of data in this study shows that as far as the meanings of verbs are concerned, this area of semantic knowledge can be embedded in those who were not exposed to a language in the critical period. This is in line with the claim of Jackendoff [9] and Choubsaz and Gheitury [5]. A concept that manifests sem-

antic knowledge is the argument structure of verbs. Native speakers must know the meaning of the verbs in order to figure out how many arguments a verb needs. It seems that the deaf participants in this study did not have any problem in recognizing that a verb like "to wash" requires someone to do the washing (the agent) and something to be washed (the patient). As far as data of pictorial tests are concerned, this claim, i.e. insusceptibility and recoverability of semantic knowledge, is confirmed. However, the analysis of data of written tests (as can be seen in Table 2) requires more reflection. The respondents' challenges begin where they need to use the arguments in the syntactic level properly. One of their problems is that they do not use the correct form of verbs. To clarify, the respondents used a word that belonged to the category of nouns rather than using a certain verb. For instance, they used "xande (laughter)" where they were supposed to write "xandidan (to laugh)". It seems that the deaf respondents had more problems in the use of predicates (verbs) rather than arguments. They also seem to have troubles in adding prefixes (tense, person, and number) to the verbs.

In one view, if we take participants involved in an event as verb valency and consider their syntactic type dependent on the semantics and semantic features of the event, we can say that deaf individuals who were deprived of critical period data are not significantly different from hearing individuals. Thus, it can be argued that the semantic component and the argument structure of the verb in particular are affected less than the syntactic component when someone fails to pass the critical period successfully (this argument is based on the approach that defines argument structure as information about the number of participants in an event). Furthermore, it is suggested that if someone is deprived of linguistic data in this period, the semantic component of language will be learned in future. This is while the formalistic and syntactic issues of language, such as proper use of case markers and inflectional suffixes as well as prepositions are not possible to be acquired later in life if someone is deprived of language input

during the critical period. This deficiency will not even be recovered with literacy and subsequent efforts.

In the present study, although the performance of the two groups was not significantly different in the pictorial tests, the small number of participants should be noted as a limitation of this study. This limitation raises the question that "if the number of participants was larger, could we achieve the same result?" In this regard, studies with larger sample sizes have been conducted for example by Ormel et al. [15] (on 59 deaf participants), indicating that deaf individuals generally outperform in picture cognition tasks rather than word cognition tasks. This can be due to the fact that despite their auditory deprivation, deaf individuals do not suffer from cognitive deprivation. Other limitations of the study are the heterogeneity of the participants with respect to age and severity of their hearing loss. However, no one can deny that how difficult it is to identify congenitally deaf individuals who have passed the critical period and are heterogeneous in linguistic competence and willing to cooperate with a researcher.

One of the studies focusing on the issue of verb argument structure has been conducted by Thordardottir and Weismer [24] in which, 50 students with specific language impairment (SLI) have been compared with 50 normal students in terms of conversation patterns. In this study, the children were asked to describe a book, a movie, school activities, or their vacation. In the meantime, their language data was recorded and transcribed. The results indicated that although the number of errors in argument structure was not significant between the two groups, those participants who had specific language disorders preferred to use less complicated argument structures. Furthermore, they were less flexible in using verb alternations (i.e. using a verb in one or more argument structures). Although the present research employed a different methodology compared to the study of Thordardottir and Weismer [24], it seems that the results of both studies are in the same line. As pointed out earlier in the methodology section, the participants of the present

study had also problems in making sentences with three-place verbs (which were more complicated structures according to [24]) such as "gozaštan" (to put), "dadan" (to give), "gaštan" (to go around), and "avardan" (to bring). That is why we replaced these verbs with images in the pictorial tests.

### Conclusion

The results highlight the importance of the critical period as a stage in childhood in which a window of opportunity to acquire a language is opened to humans. The results also showed that linguistic production of deaf participants in this study is deficient compared to natural language. Another interesting topic explored in this research was the vulnerability of different language components in case of language data deprivation in the critical period. The data analysis indicated that different language components are not equally affected by having a successful critical period. The participants of this study, whose common characteristics were deprivation of language data during the critical period, performed almost similarly to the hearing ones in recognizing and using the correct arguments (participants) in an event, even though most of them had problems in formal issues of language which were basically dependent on the syntactic level.

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