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RESEARCH ARTICLE

Dissociation of functional categories in the syntax of Persian speaking deaf individuals

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Abstract

Background and Aim: An interesting area of research in deaf studies concerns the idea that various language components and particularly different functional categories such as tense, mood, and agreement are not impaired to the same extent. The present study aimed to explore the performance of Persian speaking deaf individuals on tests dealing with five functional categories, namely complementizer/Wh-words, tense, aspect, mood, and agreement.

Methods: This research was a cross-sectional study with two groups, first of which included 11 (4 boys and 7 girls) profoundly deaf students with hearing loss above 90 dB for both ears, aged between 14 and 22; and second group of 15 students with normal hearing with mean (SD) age of 14 (2) years. In addition to interviews, we also conducted sentence-completion and grammaticality judgment tasks to explore their performance in each category.

Results: The deaf group performed significantly worse than hearing group in all the tests. Our results also demonstrated a significant numerical gap between all five categories in the deaf group, beginning from the lowest least impaired category, which is in agreement, and ending up to the most impaired category, that is, complementizer.

Conclusion: We found a dissociation of functional categories in deaf individuals. Also, higher nodes are more vulnerable to impairments than lower nodes.

Keywords: Deaf; functional categories; dissociation; Persian

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Introduction

Chomsky (1981) defines the language faculty as a modular system or as one of the subsystems contained in the overall human cognitive system. It is assumed to be "an autonomous system that actually exists in the human brain interacting with other cognitive modules", just as the circulatory system and the respiratory system exist as physical organs in the body [1]. Furthermore, the actual state of one's language faculty is an interaction among many factors; however, only some of those are relevant to the inquiry into the nature of language [2]. Modularity in this sense is closely connected with dissociation of properties as "what we would expect on our modular assumptions" [3]. As Lightfoot notes, "We find submodular dissociations within the language organ suggesting that grammars have their own internal modules" [4]. A great number of studies have sought to explore the major claims of universal grammar (UG) in different fields of language disorder and obtained relevant evidence with which to assess the explanatory power of the theory. Dissociations of different linguistic categories and ways

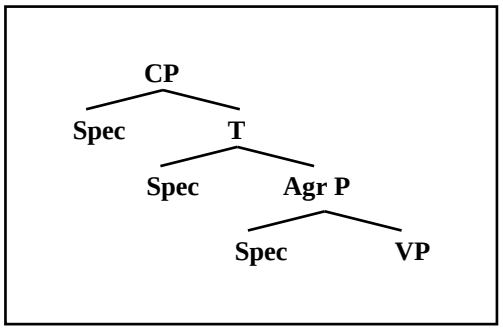

Fig. 1. Pollock's proposed tree structure for functional categories.

the linguistic categories affected by language impairments are among the issues pursued by such studies. One issue which has given rise to a great deal of controversy concerns Pollock's proposal (Fig. 1) for the split of verb inflection (Infl) node into functional categories of tense (T) and agreement (Agr) [5].

The split of tense and agreement and the order proposed by Pollock has encouraged a great number of studies, and a wealth of evidence has come from agrammatism, which can be defined as a language disorder associated with the "selective loss or impairment of grammatical words and inflectional morphemes." The speech of such patients is often telegraphic with the characteristic omission of functional words [6]. One of the earliest works to address the issue in a generative framework was carried out by Friedmann and Grodzinsky. They studied a Hebrew agrammatic patient with a dissociation of inflectional morphemes in production and observed that although tense inflection was severely impaired, agreement inflection was preserved. Leading to an argument in favor of the split of tense and agreement and the specific order proposed by Pollock, they came up with the claim proposed as tree pruning hypothesis (TPH) suggesting that higher nodes such as tense and complementizer nodes are more vulnerable to agrammatism effects. Hence, it is predicted that in some patients both tense phrase (TP) and complementizer phrase (CP) are impaired, and in others only CP is affected [7].

In deafness, the syntax and morphology, the so-called computational component of our linguistic knowledge are known to be the areas with more serious difficulty in the acquisition of language. As Albertini and Schley put it "for deaf language learners, the acquisition of morphology, syntax, and lexical knowledge often lag behind the acquisition of vocabulary, content knowledge, and rhetorical skills" [8]. Functional categories such as tense, aspect, mood, and agreement as well as prepositional phrases are often among the most seriously impaired parts. The poor performance of deaf individuals on syntax has been reported in many other studies like de Villiers et al. who based their study on the version of generative theory proposed by Radford, and who dealt with the functional categories of orally-educated profoundly deaf children with little exposure to formal Sign. They reported serious shortcomings with Wh-questions and their interpretation [9,10].

The fact that the deaf show problems in learning and using functional categories appears as a recurrent theme in many studies carried out in a generative framework. As de Villiers et al. note, "The proposal that deaf children have special difficulty with functional elements is by no mean novel with us" [9]. In a more recent study, Friedmann et al. reported the results of testing 14 school-age orally-trained deaf children showing a deficit in A-bar movement, manifested in an impaired comprehension of object relatives and topicalization structures [11]. To this, we should also add studies conducted among Persian deaf individuals. Gheitury et al. reported on the written performance of a 24-year-old Persian deaf woman, Maryam, who had rather serious problems with syntax and the inflectional morphology. Among the functional categories, tense and aspect were the most seriously impaired and agreement and mood were the categories with least number of errors [12]. In another study, with 13 Persian deaf students, significant dissociation between categories, most notably between verb inflection and derivational morphology was reported [13].

Before closing the introduction, to make the present study more comprehensible to English readers who are not familiar with Persian

Table 1. Persian aspectual distinctions

Perfective		**Imperfective**	
Simple past	*raft-am*	**Past continuous**	*mi- raft-am*
	‘went-I’		Cont.-was going-I
Present perfect	*raft-e-am*	**Present continuous**	*mi-rav- am*
	went-perf.-I		Cont.-go-I
Past perfect	*Raft-e bud-am*	**Present perfect continuous**	*mi-raft- e-am*
	‘went-perf.-was-I’		‘Cont.-went-perf.-I’

grammar and functional categories, we will briefly deal with these categories here. The temporal distinction of past and present in Persian is expressed in two distinct verbal stems, i.e. the past and the present, which serve as base for all verb forms. For instance, for the infinitive *di:d-æn* ‘to see’, there are two stems; *di:d* as past and *bi:n* as present. The other verbal categories are indicated via affixes referring to aspect, mood, and agreement. The distinction between perfective (Perf) and imperfective (Imperf) is expressed by the presence or absence of the prefix *mi:-* (imperfective marker) which is used with a variety of verb forms in past and present tense.

As examples indicate (Table 1), the aspectual system of Persian consists of simple past, present perfect, past perfect, past continuous, present continuous, and present perfect continuous. Unlike English, what is introduced above as the present perfect in Persian is considered as a type of past tense as it is created out of a past stem. A verb inflected for progressive (Prog) aspect (Asp) is frequently realized with an inflected form of *da:ʃtæn*, ‘having’ in present or past which acts very much like an auxiliary preceding the main verb to show emphasis on the continuity of the action of the main verb. It should be noted that the auxiliary is also inflected for all verbal categories.

1) *da:ʃt-æm dærs mi:-xa:nd-æm*
‘had-I lesson Prog.-read-I’
‘I was reading lessons.’

Similarly, mood (Mod) in Persian is recognized by the presence or absent of the prefix *be-/bo-* which is used to indicate the subjunctive (Subj) mood as opposed to indicative (Indic) verb forms. As we see in the following examples, the verb in subjunctive mood is often used in imperative, optative, and in some conditional sentences as well as in sentences indicating possibility.

2) *bo-xor (*imperative)
‘Subj. marker-eat!’
‘Eat.’

3) *xoda: be-het sæbr be-de!* (optative)
‘God to-you patience subj.-grant.’
‘May God grant you patience.’

4) *ægær dærs be-xa:n-i: movæfæq mi:-ʃæv-i:*.(conditional)
‘if lesson Subj.-read-you successful Ind.-be-you.’
‘if you study, you’ll succeed.’

As we noted, all verb forms refer to present or future events. Subjunctive mood in past tense is often indicated by the two words, *ba:jæd* ‘must’ and ʃɑ:jæd ‘perhaps’ and other words expressing necessity and probability that precede the main verb and the inflected forms of the verb *ba:ʃ‘be.*’

The Persian verb generally agrees with subject in person and number (singular (Sing.)/plural (Pl.)). Agreement markers appear as suffixes in different verb forms after all affixes are attached to the verb stem. In addition to categories discussed so far, a considerable space in recent research on Persian grammar is devoted to the

functional category CP (the so-called Complementizer Phrase). As a universal functional category, all languages, including Persian have a C as the head of maximal projection CP even though it may not realize phonologically. A glance at Persian data indicates the concept complementizer to be largely controversial. Among those arguing for complementizer; "*ke*" is the most cited candidate functioning as optional complementizer used much like that in English before a clause as a marker of subordination. For example, the use of *ke* in *fekr mi:-kon-æm (ke) færda: di:r-e*, 'I think that tomorrow is late' is optional. It is not, however, optional if it introduces a relative clause which modifies a preceding noun as in *mærd-i: ke di:d-i: æmu:-je mæn æst*, 'the man you saw is my uncle.' Generally speaking, question words, or in generative terms, what can be considered as complementizer in Persian comprise a set of interrogative pronouns such as *ki*: 'who or whom', *tʃi*: 'what', *kej 'when', kodʒa: 'where', tʃera: 'why', tʃænd* 'how much (price)', and the interrogative adjectives kodu:m 'which', *tʃænd, tʃænd-ta*: 'how many', *tʃeqædr* 'how much.' These forms can be used as subject or object [14]. In a generative framework, specifier (Spec) of CP is the landing site of Wh-words with overt or covert movement to this position. The overt movement is obligatory in English and optional in some languages such as Persian where the Wh-word remains in-situ (in their position) or may move optionally to the beginning of the sentence. Despite disagreement among Persian linguists over the landing site for the Wh-word, the fact that it is placed in a functional node higher than TP is not disputed. Although both sentences 5 and 6 are acceptable, the Wh-word *ki:* has moved to the beginning of the sentence in 6, to a position which is argued to be higher than the tense phrase [15].

5) *goft-i: ki: ka:r mi:-kon-e?*(Wh in-situ)
'said-you who work doing'
'you said who is working?'
6) *ki: goft-i: ka:r mi:-kon-e?* (moved Wh)
'who said-you work doing'
'who did you say is working?'

The present study aims to examine the performance of a group of Persian deaf individuals and a matched number of individuals with normal hearing, on tasks to do with tense, aspect, mood, agreement, and complementizer, and thereby to study the extent to which each category is impaired with respect to other four categories. In addition to spot the most problematic categories for Persian deaf people and possible implications for Persian syntax, we hope to come up with evidence with which to reconsider issues such as dissociation of functional categories.

Methods

This cross-sectional study was conducted within a period of 8 months, in Delfan, a town in Western part of Iran. According to statistics obtained from Rehabilitation Center of the town, most deaf individuals in the area were illiterate. Therefore, finding a considerable number of deaf individuals who could participate in written tests, as required by aims of this research, was very difficult. In the beginning, 30 deaf students with a hearing loss above 90 dB for both ears (the inclusion criteria to the experiment) were recruited for the study. All of them were high school students who studied Persian as the formal language in school. In order to form a homogeneous group, those students with problems other than deafness (weak eyesight, mental disorders, and physical handicaps) were excluded from the study.

A few others were also excluded as the parents did not give consent for their participation in the research. Finally, the study started with a group of 15 deaf individuals and a group of 15 individuals with normal hearing, for the sake of comparison. Unfortunately, four students stopped their cooperation with the researchers in the midstream with reasons having nothing to do with the research. Two of them left school, one moved to another city, and another broke his leg and left school for three months. Consequently, the researchers were left with a group of 4 boys and 7 girls profoundly deaf students, in the age range of 14-22 years that was well beyond the critical period claimed by Lenneberg's (1967) [16]. In other words, the entire group of deaf

Table 2. Details of deaf participants

Participants	Age	Sex	Pure-tone average in L-R ears (dB)	Onset of deafness	Age of diagnosis (month)	Deaf siblings
Case 1	14	M	98-102	Congenital	8	No
Case 2	14	M	120-110	Congenital	11	No
Case 3	16	F	100-100	Congenital	24	No
Case 4	16	F	113-114	Congenital	36	No
Case 5	17	F	109-92	3 month	3	No
Case 6	18	F	94-118	Congenital	11	No
Case 7	18	M	101-108	Congenital	At birth	A deaf sister
Case 8	18	M	120-116	Congenital	24	A deaf sister
Case 9	19	F	107-102	Congenital	18	No
Case 10	19	F	109-116	Congenital	6	No
Case 11	22	F	105-105	Congenital	11	No

M; male, F; female, L; left, R; right

individuals was at an age when the acquisition of language is considered to have been completed in a normal individual. The mean (SD) age of the deaf group was 17.36 (2.23) years. The history and relevant information about the way they communicated at school and at home, different communication skills acquired before and after going to school were collected during several interviews with parents, teachers, and their interpreters. In addition, medical reports indicating hearing rate of deaf participants were obtained from a Rehabilitation Center. Finally, detailed histories of the participants, including their behavioral and social pattern were obtained. The details of the deaf group are summarized in Table 2.

As seen in Table 2, with the exception of subjects 7 and 8 who had a newly born deaf sister, the rest of the participants were brought up in families having normal hearing individuals. All of them except subject 5, whose deafness, diagnosed in the third month, had been a consequence of kernicterus compounded with motor dysfunction and seizure, and were reported as congenital deaf. The age of diagnosis in all individuals in the group varied from 6 to 36 months. Most of them were diagnosed after the eleventh month. The hearing rate, considering both right and left ears, indicated that they can be referred to as profoundly deaf, and most of them, with the exception of subjects 2, 7, 8, and 11 used hearing aids. In addition, 5 out of 11, i.e. subjects 3, 5, 6, 9, and 11 had participated in speech therapy programs. Of all 11 participants, only subject 8 was not able to study at a primary school specialized for the deaf. However, living in Delfan, a very small town with no high school for the deaf, their education after elementary level was limited to ordinary high schools. Fortunately, at such schools, all participants have enjoyed the company and assistance of a deaf interpreter who closely assessed their performance and skills at different courses and activities such as history, geography, and theology and helped them be connected with teachers and their peers with normal hearing.

We also selected a group of 15 students with normal hearing, 7 boys and 8 girls, with a mean (SD) age of 14 (2) years. The age groups of the deaf and the hearing groups could not be matched since the students were selected on the basis of their syntactic knowledge, which the deaf students often lagged behind in as compared with their peers with normal hearing. For

instance, a hearing student at the age 20 could be a university student with a linguistic knowledge much superior and not comparable to deaf individuals of the same age. Nevertheless, we tried to select individuals with normal hearing and also the deaf having similar backgrounds in terms of family, social class, and even geographical situation of rural and urban areas.

It should be noted that this study can be considered as a starting point for future full-scale research projects, which can enhance the generality of the claimed hypothesis by involving a larger population and more ideal research conditions.

The linguistic tests included 5 sets of test specifically devised to assess the deaf group knowledge of functional categories of verb such as tense, agreement, mood, and aspect, and also complementizer as another functional category in the generative theory. These tests were prepared as three written tasks, that is, multiple choice, grammaticality-judgment, and short answer to questions. A pretest was conducted with another deaf and hearing group to enhance the validity and reliability of the experiment. As we did not find any standardized test for Persian in this area of study, we had to devise tests of our own.

For the sake of generalization, these tests should enjoy validity and reliability. To make these tests valid and precise, they were designed as multiple choice and grammaticality judgment based to minimize the biases of the researchers. The face validity of the tests, as well as the environment of conducting them, has been taken into account. The reliability of the tests has been measured. The Cronbach α for tests of five functional categories of agreement, tense, mood, aspect, and complementizer were 0.670, 0.902, 0.830, 0.865, and 0.920 respectively. As we can see from these results, the tests can be considered as reliable.

The activities of the participants in the classroom and break times were closely monitored so as to get well acquainted with their language skills and knowledge around words. This was a necessary step to devise the tests accordingly. We also asked the deaf group to write on topics they found interesting. Several writing samples were collected and analyzed, in which the verbal morphosyntax, as expected, demonstrated serious deficits. We reached a conclusion that complex sentences and abstract meanings could seriously worsen the performance of the deaf group on syntax tests; we based our tests on sentences which were easy to understand, thus avoiding abstract concepts and complicated structures.

A total of 90 tests were devised which were administered in three sessions on different days without a time limit for both groups to do the tests. However, the response time for each participant, deaf and hearing were recorded. As there were no schools specialized for the deaf where you can expect a group of deaf students in the same class and school, the tests were administered in different schools some of them in nearby villages. To assure that the tests only measure the wanted information, the participants were acquainted with the process of the experiment beforehand and participated in some similar experiment with some tests in the format of main test. Moreover, a deaf interpreter was present during the test period to solve the unexpected problems.

Agreement test

Twelve multiple-choice and 8 grammaticality-judgment tests were used to assess the participants' knowledge of subject-verb agreement in Persian. In multiple choice tests, the participants were provided with a sentence in which the verb was missing. They had to choose the correct form of the verb agreement with the subject out of three choices given. As we see in question 7, the choices are all the same except for agreement. In addition, since Persian is a pro-drop language where subjects are often omitted and easily recovered by verbs pronominal endings, subjects may easily be omitted.

7) *ma: hær ru:z sa:'æte 12 a:nha: ra: ……..*
We everyday at clock 12 them---------.
'we-------- them at 12 o'clock every day.'
*a) *mi:-bi:n-æm*
Cont. -see-1st Sing.-'I'
'I see.'

b) *mi:-bi:n-i:m*
Cont.-see-1st Pl.-'we'
'we are seeing.'
c) * *mi:-bi:n-ænd*
Cont.-see-3rd Pl. 'she/he'
'she/he is seeing.'
In grammaticality-judgment task, the participants were required to choose the correct form of a sentence which had the appropriate agreement between subject and verb.
8) a) *u: pedær væ ma:dæræʃra: du:st da:r-æd.*
'He loves her/his father and mother.'
'she/he her/his father and mother love have-3rd Sing. 'she/he''
b)* *u: pedær væ ma:dæræš ra: du:st da:r-æd.*
'she/he father and mother love have-3rd Pl. 'they''

Tense test
The morphological distinction between past and non-past was tested via an equal number of multiple-choice and grammaticality-judgment tests. In multiple choice tests the participants were provided with a sentence beginning or ending in a time clause with an empty slot for the verb to be filled in with an appropriate tense. To keep overlap of verbal categories to a minimum, all verbs in the choices carry identical morphosyntactic endings for agreement, mood, and aspect.
9) *færda: bætʃeha: ba: mo'ællem be ordu:…….*
'tomorrow children with teacher to camping ----------.'
a) *mi:-ræv-ænd*
Cont.-go-3rd Pl. 'they'
b)* *mi:-ræft-ænd*
Cont-went-3rd Pl. 'they'
In grammaticality-judgment task, participants were asked to choose the correct sentence with the appropriate tense.
10) a) *di:ru:z dær ba:za:r mi:ve ta:ze mi:-foru:xt-ænd.*
'yesterday in market fruit fresh Cont.-sold-3rd Pl. 'they''
'yesterday, in market they were selling fresh fruit.'
b) **di:ru:z dær ba:za:r mi:ve ta:ze mi:-foru:ʃ-ænd.*
'yesterday in market fruit fresh Cont.-sell-3rd Pl.'they' yesterday
'yesterday, in market they are selling fresh fruit.'

Mood test
Different uses of subjunctive mood in imperative, optative, conditional sentences, and in verbs indicating possibility as opposed to indicative mood are examined via two types of test, 8 multiple-choice and 7 grammaticality-judgment. In the former, as we see in example 14, participants were provided with a sentence with an empty slot for verb which they had to fill in by choosing the verb bearing the right mood, indicative or subjunctive.
11) *ægær hæva: xu:b ba:ʃæd ʃa:jæd ……. gærdeʃ.*
'if weather good be perhaps ……..picnic.'
a) *be-ræv-i:m*
Subj.-go-1st Sing. 'I'
b)* *mi:-ræv-i:m*
Ind.-go-1st Sing. 'I'
In grammaticality-judgment tests, participants were asked to choose one of the two sentences which were in the correct mood.
12) a) *emʃæb ʃa:jæd dær xa:ne be-ma:n-æm.*
'tonight perhaps at home Subj.-stay-1st Sing. 'I''
b) **emʃæb ʃa:jæd dær xa:ne mi:-ma:n-æm.*
'tonight perhaps at home Ind.-stay- 1st Sing. 'I''

Aspect test
To assess the participants' knowledge of perfective and imperfective/progressive aspects, they were given 10 multiple-choice items and asked to fill in blanks with one of the two verbs which had the right aspect. In example 16, the verb kærd 'did' is used in perfective sense to describe an accident taken place before speech time.
13) *di:ru:z Reza: ba: ma:ʃi:n tæsa:dof ……. .*
'yesterday Reza with car accident ----------.'
a) *kærd*
'did'
b)* *mi:-kærd*
Prog.- did
In 17, the second example, the correct form of the verb to occupy the blank is in progressive aspect, *mi:-ræft-æm* which refers to an action in

progression simultaneously with another, di:d-æm, both of which took place in the past before the speech time.

14) *di:ru:z da:ʃt-æm be mædrese …… ke Ali ra: di:d-æm.*

'yesterday was-I to school ……. that Ali saw-'I''

a)* *ræft-æm*

went-I

b) *mi:-ræft-æm*

PRPG-went-I 'was going'

(In Persian "*da:ʃt-æn*" has the literal meaning 'have', but in this context it functions as an auxiliary emphasizing the continuity of the verb action)

In the grammaticality-judgment tests, the participants had to choose the sentence with a verb bearing the correct aspect.

15) a) *leba:sha: ra: ʃost væ ræft.*

'clothes washed and went-she/he.'

b)**leba:sha: ra: mi:-ʃost væ ræft.*

'clothes Prog.-washed and Perf.-went-she/he.'

Complementizer and Wh-words tests

The knowledge of the CP node can be assessed through the use of Wh-words and understanding of their movement to the specifier of CP. However, as Persian is an in-situ language with optional Wh-movement, testing the children's competence for CP was a bit more complex. Thus, we devised a test in which the participants were to read a short narrative made up of very simple and widely used words referring to certain things, time, place, and persons, and then answer 15 Wh-questions based on that information. As it was mentioned earlier, in Persian, Wh-words such as *ki:* 'who/whom', *kej* 'when', and *kodʒa:* 'where' can remain in place or optionally move to the beginning of the sentence. Ability to answer such questions could indicate that participants had the knowledge needed for understanding the correct use of Wh-word and its landing site in Spec of CP. A correct answer indicated that participants had knowledge of the possible places Wh-words could be used. Both types of Wh-questions, those remaining in place and those moved, were tested. As we see in examples, in 19 the Wh-word *kej* 'when' has moved whereas in 20 the Wh-word has remained in place.

16) *kej a:nha: be pa:rk ræft-ænd?…….*

'when they to park went-3rd Pl.?----------'

17) *pedær kej bæra:je Mærjæm bæstæni: xæri:d?.....*

'father when for Maryam ice-cream bought?----------.'

As the deaf group was not selected randomly, we used non-parametric tests to evaluate their performance. Spearman's correlation coefficient was used to measure the correlation of 5 language tests within the hearing and deaf groups separately. Friedman test with post hoc Wilcoxon with Bonferroni correction was applied to verify the difference of performance within the deaf and hearing groups in the five language tests too. To make a comparison, Mann-Whitney test was applied to compare different functional categories between the deaf and the hearing groups (a between-group-analysis) in each language test. The significant level was set at 0.05 in all tests.

Results

This study was conducted with the participation of two groups, a group of 4 male and 7 female deaf students aged from 14 to 22 years and mean (SD) age of 17.36 (2.23) years, and the second group of 15 students with normal hearing with the mean (SD) age of 14 (2) years. A self-made test on functional categories of agreement, tense, mood, aspect, and complementizer in three forms of grammaticality judgment, multiple choice, and short response was conducted. The mean (SD) scores of correct responses for the hearing group were 98.65 (0.45), 99.06 (0.35), 98.3 (0.61), 98 (0.73), and 97.73 (0.48) for Agr P, Mod P, Asp P, TP, and CP, respectively. The mean (SD) scores for the deaf participants were 90.9 (1.72), 75.13 (2.83), 73.6 (3.60), 67.7 (4.50), and 55.73 (4.22), respectively, for Agr P, Mod P, Asp P, TP, and CP. The detailed correctness scores of two groups on all five tests are given in percentages in Tables 3 and 4. A between-group analysis showed that the deaf group performed significantly worse than hearing group in all tests

Table 3. Correctness scores of the deaf group in percentage

Participants	Agr P	Mod P	Asp P	TP	CP
Case 1	90	60	60	55	40
Case 2	90	67	65	45	13
Case 3	90	67	65	60	53
Case 4	90	73	70	65	53
Case 5	100	100	95	95	87
Case 6	85	60	60	55	47
Case 7	100	87	85	85	80
Case 8	70	40	40	25	7
Case 9	90	80	80	75	67
Case 10	95	93	90	90	73
Case 11	100	100	100	95	93
Mean (SD)	91 (1.72)	75 (2.83)	73 (3.61)	68 (4.5)	56 (4.22)

Agr P; agreement phrase, Mod P; mood phrase, Asp P; aspect phrase, TP; tense phrase, CP; complementizer phrase

(Mann-Whitney test: Z=-2.96, p=0.003 for Agr P; Z=-3.72, p<0.001 for Mod P; Z=-3.83, p<0.001 for Asp P; Z=-4.09, p<0.001 for TP; Z=-4.3, p<0.001 for CP).

Spearman's correlation coefficient indicated a significant dependence among all five functional categories in the deaf group (r_s=0.885, p<0.001 for agreement-tense; r_s=0.916, p<0.001 for agreement-mood; r_s=0.914, p<0.001 for agreement-aspect; r_s=0.888, p<0.001 for agreement-complementizers; r_s=0.961, p<0.001 for tense-mood; r_s=0.959, p<0.001 for tense-aspect; r_s=0.984, p<0.001 for tense-complementizers; r_s=0.998, p<0.001 for mood-aspect; r_s=0.943, p<0.001 for mood-complementizers; and r_s= 0.945, p<0.001 for aspect-complementizers). However, this was not the case for the hearing group and such a dependence was not observed (r_s=-0.067, p=0.811 for agreement-tense; r_s= -0.237, p=0.396 for agreement-mood; r_s=-0.360, p=0.187 for agreement-aspect; r_s=-0.107, p= 0.705 for agreement-complementizers; r_s=0.263, p=0.344 for tense-mood; r_s=0.721, p=0.082 for tense-aspect; r_s=0.843, p=0.088 for tense-complementizers; r_s=0.293, p=0.289 for mood-aspect; r_s=0.139, p=0.622 for mood-complementizers; r_s=0.549, p=0.084 for aspect-complementizers) which indicated no significant correlation among 5 functional categories in hearing individuals.

As the hearing group performed almost perfectly in all five language tests with the median scores of 20, 20, 15, 20, 15 for 20 agreement tests, 20 tense tests, 15 mood tests, 20 aspect tests, and 15 complementizer tests, respectively; we compared the performance of deaf individuals on these language tests. Based on Friedman test results, there was a significant difference in the performance of deaf individuals in five functional category tests (χ^2=41.76, p=0.000). Post hoc analysis with Wilcoxon signed-rank tests was conducted with Bonferroni correction applied, resulting in a significance level set at p<0.001. This within-group analysis of scores for the deaf group on each functional category as compared to others indicated a significant difference between all categories when each category was compared to the

Table 4. Correctness scores of the hearing group in percentage

Participants	Age	Agr P	Mod P	Asp P	TP	CP
Case 1	13	95	100	100	100	100
Case 2	13	95	100	100	100	100
Case 3	14	95	100	100	95	93
Case 4	14	95	100	100	100	100
Case 5	14	100	100	95	95	93
Case 6	14	100	100	95	100	100
Case 7	14	100	100	100	100	100
Case 8	14	100	100	100	100	100
Case 9	14	100	100	100	100	100
Case 10	14	100	100	100	100	100
Case 11	14	100	100	100	100	100
Case 12	14	100	100	95	90	93
Case 13	14	100	93	90	90	93
Case 14	15	100	93	100	100	100
Case 15	15	100	100	100	100	93
Mean (SD)	14 (2)	99 (0.46)	99 (0.35)	98 (0.62)	98 (0.74)	98 (0.49)

Agr P; agreement phrase, Mod P; mood phrase, Asp P; aspect phrase, TP; tense phrase, CP; complementizer phrase

other 4 categories (Wilcoxon test: TP-Agr P Z= -2.94, p=0.003; Mod P-Asp P Z=-2.96, p=0.007; Asp P-Agr P Z=-2.81, p=0.005; CP-Agr P Z= -2.94, p=0.003; Mod P-TP Z=-2.69, p=0.007; Asp P-TP Z=-2.81, p=0.008, CP-TP Z=-2.97, p=0.003; Asp P-Mod P Z=-2.98, p=0.003; CP-Mod P Z=-2.96, p=0.003; CP-Asp P Z=-2.98, p=0.003).

Discussion

The present study was conducted to explore dissociation of functional categories in Persian acquired by 11 deaf individuals. The test material comprised three types of tasks; sentence-completion, grammaticality-judgment, and short answers to questions, through which we examined their knowledge of 5 functional categories of CP, TP, Asp P, Mod P, and Agr P.

Correctness scores demonstrated that the hearing group performed almost perfectly in all tests, while this is not the case for the deaf group. As we see in Table 3, the deaf group had the best performance on Agr P test (Mean=91, SD=1.72) and the worst on CP test (Mean=56, SD=4.22). The results can be arranged in a hierarchy starting from best performance on agreement and ending up through mood, aspect, tense, to complementizer. The dissociation of scores achieved by the deaf group in each language test as compared to rest of the four tests was significant, in a way that the worst performance was observed for CP, followed by tense, aspect, mood, and agreement in a descending order. The highest scores which placed the performance of deaf individuals very close to normal hearing speakers belonged to agreement. As

Table 4 shows, no such significance is indicated for hearing group's performance in the tests. Comparing the performance of the two groups on all five tests, we can infer that, while there is a significant difference between all five categories in the deaf group, a bigger gap between Agr P and other 4 categories is indicated.

Although the results of the present study confirm the predictions of TPH for aggrammatic patients, we should be cautious since we are dealing with two different phenomena, aphasia often is caused by a stroke which keeps linguistically vital regions of the brain from functioning and deafness-related deficits caused by auditory deprivation in early years. As far as knowledge of language is concerned, deaf individuals born to hearing families receive little language input (oral or signed) and often lag behind their hearing peers. This is often explained by an appeal to the critical age of language acquisition which they missed, even though the effects of missing a critical period do not appear to be identical for all components of language. Syntax, phonology, and inflectional morphology seem to be areas most vulnerable to effects of missing a critical period. Significantly, semantics and lexical knowledge are parts, which can be learned beyond the critical age.

As one instance which merely indicates different influences on language components, we may point to the controversy over the exact nature of verb argument structure as being semantic or syntactic [17,18]. Evidence from deaf studies is in favor of verb argument structure being of a semantic nature. As Choubsaz and Gheitury reported, deaf participants demonstrate a close to normal performance on knowledge of argument structure when tasks are accompanied by pictures. A possible explanation for good performance on verb argument structure as opposed to other grammatical categories might be sought in the fact that auditory deprivation does not necessarily mean closing all cognitive outlets. Despite lack of auditory input the deaf can continue learning through other means such as visual signs. The acquisition of knowledge of argument structure of a verb like give which needs a giver, something to give, and someone to give, seems to depend at least partly on perception of outside experiences [19].

As for dissociation of functional categories, apart from theoretical differences, there are other explanations according to which some functional categories, on our understanding, are easier to acquire. The explanation by Bybee seems to focus on different nature of mood and agreement as opposed to tense and aspect. Mood distinctions express what the speaker wants to do with the proposition in the particular discourse, assertion, command, and attitude toward the truth of propositions. Since it expresses the speaker's attitude, it lacks a direct effect on the situation described by the verb. Both of these properties make mood less relevant to the verb than either tense or aspect. Thus, we might expect mood to occur less frequently as an inflectional category than aspect and tense. Agreement categories in verbal inflection do not refer to the situation described by the verb, but rather to the participants in the situation. These are only some issues that may influence application of theoretical predictions [20].

Obviously, the present study has no evidence with which to challenge TPH, any more than opening up the predictions of TPH to a new and probably more extensive domain, deafness, and first language acquisition. Given all criticism as well as evidence available from other languages, the need for a reformulation of the main idea is felt more than any time.

As we place the studied functional categories on a tree diagram (Fig. 2) from the most impaired

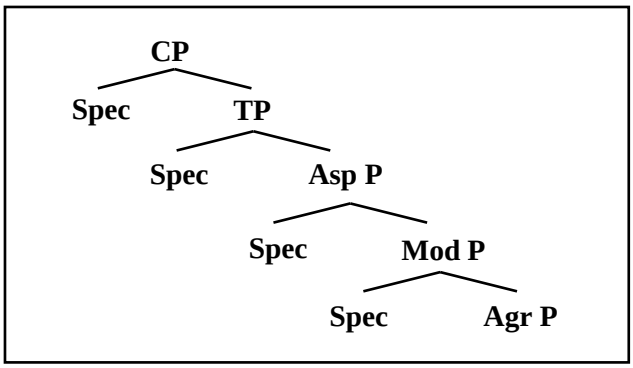

Fig. 2. Tree structure for Persian functional categories.

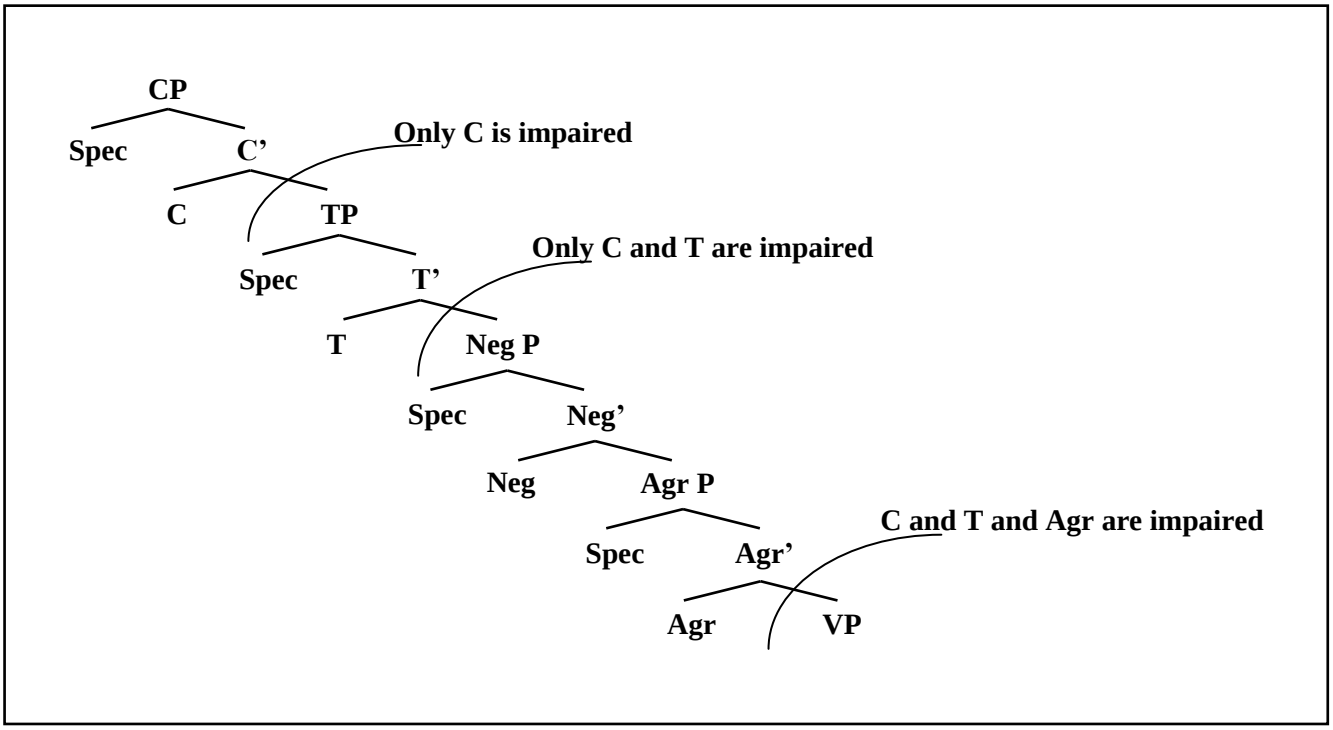

Fig. 3. Hierarchy of impairment of functional categories as predicted by tree pruning hypothesis.

category (complementizer) to the least impaired (agreement), we come up with a diagram for Persian functional categories proposed by Taleghani that is obtained from pure syntactic argumentations [21].

Our findings on the one hand provide some experimental evidence to support the order of functional categories proposed by syntacticians and, on the other, provide predictions on categories most vulnerable to impairment in deaf individuals. As we can see in the tree diagram in Fig.3 (obtained from Friedmann and Grodzinsky) a lower syntactic node such as agreement (Agr P) is less impaired than a higher node such as TP and vice versa [7]. However, as Druks concludes, Friedmann's TPH does not seem to have dealt convincingly with evidence of variability, of conflicting evidence from languages with different organization of the syntactic tree, or evidence that overrides the interdependency of IP and CP layers. It seems that the story of TPH should be radically rewritten to be able to account for preserved comprehension, partial and inconsistent deficits in either a representational or processing framework [22].

Conclusion

The findings of this study support the dissociation of 5 functional categories in the syntactic competence of Persian speaking deaf participants. As was indicated, the severity of impairment of a category depends on its position on tree diagram, that is, higher nodes are more vulnerable to impairment than lower nodes. As this study was conducted with 11 Persian participants, the results cannot be generalized to all contexts where deaf individuals are taught. It should rather be considered as a starting point for further research on deaf individuals from other cultures and languages where a larger number of deaf participants can be involved.

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Conflict of interest

The authors declared no conflicts of interest.

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