

Research Article

Syntactic Comprehension in Persian-speaking 4–6 Grade Students with and without Hearing Impairment

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Short running title: Syntactic Comprehension in Persian-speaking...

Highlights:

- HI children performed significantly below TD peers on all syntactic structures
- Most difficult structures: passive voice, object relatives, noun phrase dependency
- No significant grade-related improvement in syntactic comprehension in either group

ABSTRACT

Background and Aim: Although early cochlear implantation give Hearing-Impaired (HI) children access to spoken language, they continue to show persistent difficulty with syntactically complex structures, while evidence on Persian-speaking HI children remains limited. This study aimed to investigate the comprehension of various Persian syntactic structures in HI children and compare it with that of their Typically Hearing (TH) peers.

Methods: After obtaining ethical approval, 17 Persian-speaking children with severe-to-profound hearing impairment in grades four to six (mean age: 12.7 ± 1.4 years; 12 boys, 5 girls) were recruited from Baghcheban schools in Tehran. All participants had been diagnosed and received cochlear implants before the age of two and had undergone all necessary rehabilitation programs. A matched control group of 17 typically hearing peers was also selected. The Persian Syntactic Comprehension Test (Mohammadi et al., 2019) was administered individually in a quiet room at each participant's school.

Results: HI children performed poorest on passive, object relative, and noun phrase dependency structures, while their best performance was on simple declarative and coordinate structures. TH children performed near ceiling across all structures. Significant differences were found between groups across all grades ($p < 0.05$). Within-group comparisons showed no significant grade-related differences in either group ($p > 0.05$), though a gradual non-significant improvement was observed in the TH group.

Conclusion: The primary difficulty for HI children lies in comprehending complex syntactic structures involving syntactic movement and long-distance dependencies, not merely longer sentences. Persistent difficulties in these structures highlight the need for targeted, structure-specific assessment and instruction in rehabilitation programs.

Keywords: Hearing loss; Persian-speaking children; comprehension; syntactic structures

Introduction

During speech production, the speaker conveys information to the listener. Several researchers maintain that comprehending any utterance necessitates both understanding word meanings and the precise grammatical rules governing their combination. In this view, comprehension depends partly on conceptual knowledge and partly on grammatical processing [1-4], a dual dependency evident in language development [5, 6]. This dual dependency makes syntax a critical component of language competence, particularly for populations with atypical language development.

Numerous studies have investigated the language development of Hearing-Impaired (HI) children. Research by Pressnell [7], Geers and Moog [8] in English, and Tur-Kaspa and Dromi [9] in Hebrew has shown that HI children exhibit a developmental pattern that differs from Typically Developing (TD) children. Some developmental milestones, such as babbling, follow a similar trajectory in both groups. Others, such as vocabulary acquisition, follow a similar developmental sequence but with a significant delay. For still other abilities—particularly morphosyntactic skills—the developmental pattern diverges fundamentally from TD children [10].

Vocabulary development in HI children has received considerable attention. A study by Lederberg and Spencer [11] on English-speaking HI children found that even when using Cochlear Implants (CIs), hearing aids, or high-quality intervention programs, HI children demonstrate a slower rate of vocabulary acquisition compared to their typically hearing peers. They learn new words at a slow pace, adding only a few words to their lexical repertoire each month [12]. However, Mayne et al. [13] found that early and consistent exposure to language input from infancy significantly facilitates vocabulary development in this population. Turning to grammatical development, research has consistently documented difficulties in morphosyntactic areas among HI children. In the Iranian context, several studies have examined general grammatical features using measures such as Mean Length of Utterance (MLU), number of utterances, and frequency of grammatical errors in connected speech samples [14-16]. While these measures provide valuable information about overall grammatical complexity and accuracy, they do not offer detailed insights into the comprehension of specific syntactic structures.

More recent Iranian studies have adopted more targeted approaches to investigate specific aspects of syntax and morphology in HI children. Teymouri et al. [17] examined perception development of complex syntactic constructions in Persian-speaking HI children, providing evidence that HI children show a delayed but qualitatively similar developmental pattern in perceiving complex structures compared to TD children. PahlavanNezhad and Niknezhad [18] compared speech syntactic features between HI and TD children, reporting significant differences in the use of grammatical morphemes and syntactic complexity. Pooresmaeil et al. [19] investigated the relationship between comprehension of syntax and reading comprehension in cochlear-implanted and TD children, finding a significant positive correlation between syntactic comprehension and reading abilities, highlighting the cascading effects of syntactic deficits on higher-order language skills.

This suggests that syntactic difficulties may cascade into broader academic challenges. Samiee et al. [20] analyzed the grammatical abilities in speech samples of Persian-speaking children with CIs using measures such as MLU and the number of grammatical errors, reporting that HI children exhibit persistent difficulties in the production of bound morphemes and function words. More recently, Salmani et al. [21] reported significant difficulties in producing complex structures (relative clauses, passives, complement clauses). Two Iranian studies have specifically investigated the comprehension and production of the passive voice [22, 23], but a systematic assessment of a broader range of syntactic structures remains lacking.

International research on the comprehension of syntactic structures in HI children has provided valuable insights. Duchesne et al. [24], examining syntax acquisition in 15 French-speaking cochlear-implanted children aged 5 to 8 years, showed that 35% scored within the normal range in syntactic comprehension and 42% scored within one standard deviation in morpheme comprehension, indicating considerable individual variation but also persistent difficulties in syntax for a substantial proportion of HI children. More specifically, Friedmann and Szterman [25] investigated the comprehension of sentences derived by syntactic movement in Hebrew-speaking HI children and found that HI children had significant difficulty comprehending object relative clauses and topicalized sentences with non-canonical word order. In comprehension tasks, they interpreted object relative clauses as movement-

free structures, suggesting a specific deficit in processing syntactic movement. This is relevant to Persian, as similar movement-based structures are examined here. In summary, the existing literature consistently demonstrates that HI children face substantial challenges in morphosyntactic development, with complex sentences and structures involving syntactic movement being particularly problematic. However, most previous studies—whether international or Iranian—have relied on global measures such as mean length of utterance, have analyzed grammatical errors in spontaneous speech samples, or have examined only a single structure. Notably, previous Iranian studies have predominantly focused on production rather than comprehension, and those that have examined comprehension have typically targeted only a single structure (e.g., passive voice) or have used general measures.

The importance of the present study lies in its systematic, structure-by-structure investigation of syntactic comprehension in Persian-speaking HI children, using a validated instrument that covers 24 distinct syntactic constructions. This approach allows for the identification of specific structures that are most vulnerable in this population, thereby providing evidence-based guidance for clinical assessment and targeted intervention. The aims of this study were: 1) to describe the syntactic comprehension profile of Persian-speaking HI children across a range of syntactic structures, 2) to compare their performance with that of age- and gender-matched TD peers, and 3) to examine whether syntactic comprehension improves with grade advancement within each group.

Methods

Research design and participants

The present study is a field study, descriptive-analytical and applied in nature. The target population comprised all HI children attending Baghcheban schools in Tehran during the academic year 2023–2024. The sample consisted of 17 Persian-speaking HI children in grades four to six from Baghcheban schools, selected through convenience sampling. Recruitment was administered as follows: after obtaining necessary administrative permissions, a list of special education schools was acquired from the Center for the Education of Exceptional Children. The researcher visited the schools and, in consultation with the center's counselor and speech-language pathologist, identified children who met the inclusion criteria. After identifying eligible participants, the researcher contacted parents, explained the study objectives, and obtained informed consent. Seventeen TD children, matched for gender, grade level, age, and socioeconomic status, were selected from regular schools geographically near the Baghcheban schools as the control group. Information regarding parental occupation and education level was collected through school records to confirm socioeconomic status matching. Regarding bilingualism, all participants were reported by their parents and teachers to be monolingual Persian speakers. Children with regular exposure to a second language (more than occasional use) were excluded. Additionally, children with deaf parents who used sign language at home were excluded from the study. All HI participants had severe-to-profound bilateral hearing loss and had received cochlear implants. All participants had been diagnosed and received intervention before the age of two and had undergone all necessary educational and rehabilitation programs. The control group consisted of 17 TD children matched for age (mean age: 12.5 ± 1.3 years), gender (5 girls, 12 boys), and grade level.

Inclusion criteria for students in this study were: 1) enrollment in grades four to six at Baghcheban schools (experimental group) or regular schools (control group); 2) absence of co-occurring disorders, including sensory-motor or intellectual disabilities (confirmed by school records and psychologist report); 3) absence of any other co-occurring conditions (e.g., behavioral, emotional, or additional learning difficulties); 4) being monolingual Persian-speaking (no regular exposure to another language at home); 5) not having deaf parents (i.e., not using sign language at home); 6) parental informed consent; and 7) for the experimental group: severe-to-profound bilateral hearing loss with cochlear implants. The exclusion criterion was lack of cooperation during testing.

Procedure

The syntactic comprehension tests were administered individually in a quiet room at each participant's school. For HI children, the testing room was free from background noise. Instructions were presented both verbally and in written form to ensure full comprehension of task demands. For the control group, the same testing procedures were followed in a quiet room at their respective regular schools, with verbal instructions only. Each testing session lasted approximately 20–25 minutes for both groups.

Instrument

The syntactic comprehension test developed by Mohammadi et al. [26] was used to assess syntactic comprehension. This test comprises 24 standard Persian syntactic structures, including simple active sentences, passive sentences, relative clauses (subject and object), cleft sentences, topicalized structures, interrogatives, and complex sentences with embedded clauses. The test uses a picture-pointing paradigm in which the child hears a sentence and must select the corresponding picture from four options. The test has a content validity index of 0.81 and an internal consistency coefficient of 0.89, indicating acceptable reliability. The maximum possible score on the test is 24, with higher scores reflecting better syntactic comprehension.

The syntactic comprehension test consists of 24 syntactic structures, each containing 4 test items (sentences). For each item, a single page displays four pictures (one target and three distractors), and the child is required to select the picture that matches the spoken sentence. Each item is scored dichotomously, with a correct response receiving (1) point and an incorrect response receiving (0) points. A structure score is then calculated for each of the 24 syntactic structures: a score of (1) is awarded if the child correctly answers all four items of that structure, and a score of (0) is given if any of the four items are answered incorrectly. Thus, the structure score reflects the child's ability to comprehend all instances of a particular syntactic construction. The total score is computed as the sum of all item scores across the 96 items (24 structures×4 items), yielding a maximum possible total score of 96, with higher scores indicating better syntactic comprehension.

Data analysis

In this study, descriptive statistics (mean, standard deviation, minimum, and maximum) were calculated for both groups. The Kolmogorov–Smirnov test was used to assess the normality of data distribution. An independent-samples t-test was employed to compare syntactic comprehension scores between HI children and TD children. Additionally, a one-way ANOVA with Scheffé's post hoc test was conducted to examine differences in syntactic comprehension skills across grades (four, five, and six) within each group. The significance level was set at $\alpha=0.05$ for all analyses. All statistical analyses were performed using SPSS version 17.0.

Results

The present study examined syntactic comprehension in Persian-speaking HI children across 24 syntactic structures and compared their performance with that of TD peers. The findings revealed that HI children face significant and persistent difficulties in comprehending complex syntactic structures, particularly those involving syntactic movement (passive voice, object relative clauses) and long-distance dependencies (noun phrase dependency). These structures were the most challenging for HI children, with accuracy rates below 50%, while TD children performed near ceiling across all structures. This pattern indicates that the deficit in HI children is not merely a function of sentence length or general complexity, but specifically related to the processing of syntactic movement and non-local dependencies—a finding consistent with previous research on Hebrew-speaking HI children [25]. Importantly, no significant grade-related improvement was observed within the HI group, suggesting that these syntactic difficulties are persistent and do not resolve spontaneously with age or grade advancement, despite early diagnosis and intervention (all participants had received cochlear implants before age two and undergone rehabilitation programs). This persistence highlights that current intervention approaches may not adequately address the specific syntactic comprehension deficits in this population. The findings have important clinical and educational implications. First, assessment protocols for HI children should include systematic, structure-specific evaluation of syntactic comprehension rather than relying solely on global measures such as mean length of utterance or general language tests. Second, intervention programs should incorporate targeted instruction on complex syntactic structures, particularly those involving movement and non-local dependencies, using explicit teaching strategies and structured practice. Third, the strong correlation between syntactic comprehension and reading abilities reported in previous research [19] suggests that addressing these syntactic deficits may have cascading benefits for higher-order language skills and academic achievement. The present study contributes to the growing body of literature on syntactic development in HI children by providing a comprehensive, structure-by-structure analysis in Persian, a language with rich morphology and relatively flexible word order. However, several limitations should be acknowledged. The sample size was relatively small (17 HI children), which may limit the generalizability of the findings. Additionally, the cross-sectional design does not allow for tracking individual developmental trajectories. Future research should employ longitudinal designs with larger samples to examine the developmental course of syntactic comprehension in HI children and evaluate the effectiveness of targeted interventions. Despite these limitations, the present study

underscores the necessity of structure-specific assessment and instruction in rehabilitation programs for HI children.

Discussion

The present study was designed to provide a fine-grained, structure-by-structure profile of receptive syntactic abilities in Persian-speaking HI children, assessing 24 distinct syntactic constructions using a validated picture-pointing task. This approach allows for the identification of specific structures that are most vulnerable and those that are relatively preserved, offering evidence-based guidance for targeted assessment and intervention.

The finding that HI children performed significantly below TD children across all syntactic structures is consistent with previous research documenting syntactic deficits in this population [7-9, 17, 18, 20]. However, the present study extends these findings by demonstrating that the deficit is not uniform across structures but is selectively concentrated on those involving syntactic movement and long-distance dependencies. This selective vulnerability aligns with the results of Friedmann and Szterman [25], who found that Hebrew-speaking HI children had significant difficulty comprehending object relative clauses and topicalized sentences, interpreting them as movement-free structures. Similarly, Duchesne et al. [24] reported that a substantial proportion of French-speaking cochlear-implanted children scored below the normal range in syntactic comprehension, with considerable individual variation mirroring the wide range observed in our HI group (8.33% to 87.50% for structures). The present study thus corroborates these international findings while providing the first comprehensive mapping of this selective vulnerability in Persian.

A notable point of comparison concerns the grade-related performance. While Teymouri et al. [17] reported a delayed but qualitatively similar developmental pattern in Persian-speaking HI children compared to TD children, the present study found no significant grade-related improvement within the HI group. This discrepancy may be attributed to differences in the age range and grade levels examined: They included a wider age range (6–12 years) and focused on perception development, whereas the present study targeted a narrower grade range (fourth to sixth grade) with a specific comprehension task. Furthermore, the cross-sectional design of the present study may not capture the subtle developmental changes that longitudinal designs might reveal. It is also possible that the syntactic structures assessed in the present study—particularly those involving movement and long-distance dependencies—are more complex than those examined by Teymouri et al., and thus may require more prolonged and targeted intervention to show measurable improvement.

The finding that fifth graders in the HI group unexpectedly outperformed sixth graders is another point of divergence from the developmental pattern observed in TD children, where sixth graders performed best. This pattern was not reported in previous Iranian studies, as most have focused on younger children or have used global measures rather than structure-specific assessment. One possible explanation for this unexpected finding is the wide individual variation within the HI group: scores ranged from 8.33% to 87.50% for structures, indicating that individual differences in early intervention quality, family involvement, and rehabilitation history may play a more significant role than grade advancement alone. This interpretation is consistent with the conclusions of Duchesne et al. [24], who reported that even among cochlear-implanted children with similar ages of implantation, considerable individual variation in syntactic outcomes persisted, highlighting the role of non-auditory factors in language development. Additionally, the relatively small sample size in each grade ($n=4-7$) may have contributed to the lack of a clear developmental trend.

Another important comparison concerns the pattern of difficulty across specific structures. The finding that noun phrase dependency was the most difficult structure for HI children (mean score: 1.52 out of 4) aligns with the results of Salmani et al. [21], who reported that Persian-speaking HI children had significant difficulties in producing complex structures involving non-local dependencies. Similarly, the difficulty observed with passive voice (mean score: 1.88) and object relative clauses (mean score: 1.82) is consistent with the findings of Ghaemi et al. [22] and Afaghi et al. [23], who reported comprehension difficulties with passive voice in Persian-speaking HI children. However, the present study extends these findings by providing a direct comparison of difficulty across multiple structures within a single framework, revealing a clear hierarchy of difficulty that was not previously available.

The finding that TD children demonstrated near-ceiling performance across all structures (mean scores above 3.9 out of 4) confirms that syntactic comprehension in typically developing Persian-speaking children is largely established by fourth grade. This is consistent with the findings of Zarifian et al. [15], who reported that Persian-speaking TD children achieve adult-like syntactic performance by school age. However, the present study

provides more detailed normative data by reporting performance on 24 specific structures, which may serve as a useful clinical benchmark.

One finding that warrants further discussion is the relative ease of coordinate sentences for HI children (mean score: 3.8 out of 4), despite their length. This contrasts with the difficulty observed for passive voice and object relative clauses, which are not necessarily longer but involve syntactic movement. This pattern is consistent with the findings of Friedmann and Szterman [25], who reported that Hebrew-speaking HI children performed relatively well on subject relatives but poorly on object relatives, suggesting that the critical factor is not length but the presence of syntactic movement. This pattern also aligns with the processing capacity account proposed by Pooremaeil et al. [19], who reported a significant correlation between syntactic comprehension and reading comprehension in cochlear-implanted children. The present study thus provides further support for the view that syntactic comprehension deficits in HI are rooted in limitations in processing capacity—particularly in working memory and phonological processing—which disproportionately affect structures that cannot be processed via simple linear heuristics.

The clinical implications of these findings are clear. The evidence-based hierarchy of syntactic difficulty provided by this study can guide speech-language pathologists in prioritizing assessment and intervention targets. The most vulnerable structures—passive voice, object relative clauses, and noun phrase dependency—should be explicitly taught using strategies that address the underlying processing demands, such as thematic role assignment and sentence-reconstruction activities. The finding that grade advancement alone does not lead to improvement underscores the need for targeted, structure-specific intervention rather than reliance on maturation or general language exposure.

Future research should investigate the effectiveness of such targeted interventions through longitudinal and intervention studies. Additionally, studies should explore the relationship between syntactic comprehension deficits and other cognitive factors such as working memory and phonological awareness, and examine whether similar patterns of difficulty are observed in other age groups or in children with different types and degrees of hearing loss.

Several limitations should be acknowledged. The sample size was relatively small (17 participants per group), limiting generalizability. The cross-sectional design does not allow for tracking individual developmental trajectories. The researchers could not control for factors such as quality of early intervention, family involvement, or home language environment, which may have contributed to the wide variation within the HI group. The study only included children with CIs and severe-to-profound hearing loss, so findings may not generalize to other types or degrees of hearing loss. The study focused solely on comprehension and did not examine production. Finally, the study was conducted in Tehran and may not represent Persian-speaking HI children in other regions of Iran.

Conclusion

This study provides the first comprehensive, structure-specific profile of syntactic comprehension in Persian-speaking Hearing Impaired (HI) children using a validated instrument covering 24 syntactic structures. The findings identify passive voice, object relative clauses, and noun phrase dependency as the most vulnerable structures, while simple declaratives, coordinate structures, and basic modification are relatively spared. Furthermore, the persistence of syntactic comprehension deficits across grades, despite early diagnosis and cochlear implantation before age two, indicates that these challenges are not merely developmental delays but require targeted intervention. The unexpected finding that fifth graders outperformed sixth graders in the HI group—a pattern not observed in typically developing children—suggests that individual differences in early intervention quality, family involvement, and rehabilitation history may play a more significant role than grade advancement alone. The wide individual variation (scores ranging from 8.33% to 87.50% for structures) further underscores the need for personalized assessment and intervention planning rather than grade-based expectations.

Ethical Considerations

Compliance with ethical guidelines

All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments. The study was approved by the Ethics Committee of [Institute for Humanities and Cultural Studies] (Ethics Code: [IR.IHCS.1404.002]).

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Authors' contributions

FG: Study design, interpretation of the results, and drafting the manuscript; HA: Acquisition of data, statistical analysis, and drafting the manuscript.

Conflict of interest

No conflicts of interest are declared.

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Table 1. Demographic characteristics of students with and without hearing impairment

Grade	Group	Gender	Total N	Mean Age
Fourth	TD	1 girl, 3 boys	4	11 years, 1 month
Fourth	HI	1 girl, 3 boys	4	11 years, 3 months
Fifth	TD	2 girls, 5 boys	7	12 years, 5 months
Fifth	HI	2 girls, 5 boys	7	12 years, 6 months
Sixth	TD	2 girls, 4 boys	6	14 years, 1 month
Sixth	HI	2 girls, 4 boys	6	14 years, 2 months
Total	TD	5 girls, 12 boys	17	12.5 ± 1.3 years
Total	HI	5 girls, 12 boys	17	12.7 ± 1.4 years

HI: hearing impaired children, TD: typically developing children

Table 2. Descriptive statistics for overall syntactic comprehension test scores in hearing impaired children and typically developing children

Grade	Group Variable	Typically Developing children				Hearing impaired children			
		Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum
Fourth	Correct syntactic items	97.00%	1.41%	96.00%	98.00%	66.40%	20.94%	37.50%	87.50%
	Correct syntactic structures	21.50%	0.70%	21.00%	22.00%	35.42%	15.40%	16.67%	50.00%
Fifth	Correct syntactic items	96.66%	0.57%	96.00%	97.00%	79.61%	11.08%	61.46%	98.96%
	Correct syntactic structures	21.00%	0.00%	21.00%	21.00%	56.54%	17.48%	41.67%	87.50%
Sixth	Correct syntactic items	97.80%	1.09%	96.00%	99.00%	75.34%	19.20%	46.88%	97.92%
	Correct syntactic structures	21.80%	1.09%	20.00%	23.00%	47.22%	29.18%	8.33%	83.33%
Overall	Correct syntactic items	97.30%	1.05%	96.00%	99.00%	75.00%	16.47%	37.50%	98.96%
	Correct syntactic structures	21.50%	0.84%	20.00%	23.00%	48.28%	22.29%	8.33%	87.50%

Table 3. Mean of correct responses to different structures, from simple to difficult

Structure type	Typically developing children		Hearing impaired children	
	Correct responses %	Mean (out of 4)	Correct responses %	Mean (out of 4)
Two-element sentences	100.00	4.00	97.5	3.9
Irreversible three-element sentences	100.00	4.00	97.5	3.9
Sentences with coordinate phrases	98.75	3.95	95	3.8
Coordination with compound conjunction	100.00	4.00	95	3.8
Superlative adjective	100.00	4.00	92.5	3.7
Negative sentences	100.00	4.00	90	3.6
Structure "A not B"	100.00	4.00	87.5	3.5
Noun phrase with prepositions "on" and "in"	100.00	4.00	85	3.4
Comparative adjective	100.00	4.00	82.25	3.29
Reversible three-element sentences	100.00	4.00	80.75	3.23
Verb aspect	86.25	3.45	77.75	3.11
Noun phrase with prepositions "down" and "up"	100.00	4.00	70.00	3.00
Object drop	95.25	3.81	67.5	2.70
Four-element sentences	89.75	3.59	66.00	2.64
Sentences with subject and object pronouns	88.50	3.54	66.00	2.64
Pronoun reference resolution	98.75	3.95	64.5	2.58
Plural/singular inflection	93.00	3.72	61.75	2.47
Enclitic pronoun as object	100.00	4.00	60.25	2.41
Subject relative clause	94.25	3.77	60.25	2.41
Compound conjunction "neither...nor"	98.75	3.95	58.75	2.35
Subject drop	97.50	3.90	52.75	2.11
Passive voice	100.00	4.00	47.00	1.88
Object relative clause	93.00	3.72	45.5	1.82
Noun phrase dependency	96.5	3.86	39.5	1.52

Table 4. Comparison of syntactic comprehension (based on number of correct items) between hearing impaired children and typically developing children

	Mean difference	95% CI for mean difference		p
		Lower	Upper	
Fourth	-33.530	-65.523	-1.536	0.045
Fifth	-20.851	-30.695	-11.007	0.002
Sixth	-24.946	-44.293	-5.599	0.021

Table 5. Comparison of syntactic comprehension (based on number of correct structures) between hearing impaired children and typically developing children

	Mean Difference	95% CI for Mean Difference		p
		Lower	Upper	
Fourth	-12.630	-18.512	-6.747	0.006
Fifth	-7.558	-11.440	-3.676	0.003
Sixth	-9.796	-17.147	-2.445	0.019