Age of Acquisition Effects in Zero-Anaphora Comprehension in Turkish Sign Language

Hande Sevgi and Kadir Gökgöz

1. Introduction

Sign languages are natural languages, and we observe acquisition patterns similar to spoken languages when exposure to language begins at birth (Newport and Meier, 1985; Ramirez et al., 2013; among others). However, this is not the case for all deaf children. Studies show that 90-95% of deaf children are born to hearing families (Mitchell and Karchmer, 2004; Moores, 2001; among others). Unlike deaf children who are exposed to sign language from birth, which is the ideal situation for language development (Lillo-Martin & Henner, 2021), their exposure to conventional sign language is often delayed. This delay has important effects on the language skills of individuals (Emmorey, 2001; Lenneberg, 1967; among others). Moreover, it is not enough to be exposed to linguistic input after the critical period for some aspects of language to fully develop, no matter how long an individual receives relevant linguistic data (Mayberry and Kluender, 2018). Therefore, it is inevitable to observe differences in linguistic competencies across deaf adults (Mayberry and Eichen, 1991).

These differences are more pronounced in the syntax and morphology domains, particularly in complex structures (Boudreault and Mayberry, 2006). In their work on Hebrew and European Portuguese, Friedmann and Costa (2010) showed that coordinated structures show complexity depending on the presence or absence of crossing dependency, which they defined as 'the crossing of an argument over another' while resolving a zero anaphora in the second conjunct. Due to their complex nature, we focus on the coordinated structures in Turkish Sign Language (TİD)[1] in this study.

Several studies have investigated anaphora resolution in coordinated clauses in TİD. Sevinç (2006) examined word order and grammatical relations in TİD, particularly focusing on coordinated clauses where the second conjunct contained a zero anaphora. Based on their findings, they argued that TİD exhibited an ergative alignment, noting instances where a transitive sentence and an

* Hande Sevgi, Harvard University (handesevgi@g.harvard.edu), Kadir Gökgöz, Boğaziçi University (kadirgokgoz@boun.edu.tr). The data used in this project elicited thanks to the project 'Supporting Sign Language Development of Deaf Children with Hearing Parents through Linguistically Informed Preschool Stories' funded by Boğaziçi University Research Fund Grant Number 14458.

[1] Turkish Sign Language is one of the languages of the Deaf community in Türkiye.

 Proceedings of the 48th annual Boston University Conference on Language Development, ed. Hayat Abdullah Ali AlThagafi and Jupitara Ray, 481-493. Somerville, MA: Cascadilla Press.

intransitive sentence with a missing subject were coordinated, leading to only the ergative interpretation being viable. In other words, the missing subject of the intransitive verb could be coreferenced with the patient argument of the preceding transitive structure but not with its agent argument.

Nuhbaloğlu (2018), on the other hand, focused on the resolution of pronominal forms in TİD and German Sign Language (DGS) where there were two potential antecedents in the local discourse. Their findings showed that signers of both languages tended to interpret pronominal forms as referring to the second-mentioned argument in the structure. Moreover, they argued that the verb type, i.e., plain verbs or agreement verbs, played a significant role in the resolution of pronominal forms. They further noted that signers of the same language showed differences in their study. Nuhbaloğlu (2018) argued that this difference might be due to a potential age of acquisition-effect.

Based on these findings, we aim to reveal any effects of exposure age to a first sign language input in this domain. Therefore, we investigate potential differences among adult Deaf TİD signers who were exposed to a first sign language input at different ages, focusing on complex coordinated clause structures. We examine coordinated structures where the second conjunct lacks an argument to reveal any potential differences in the mechanisms utilized by adult Deaf signers to resolve zero anaphora, depending on their exposure age to a first sign language. With this purpose in mind, the paper is structured as follows: We introduce our research questions and the methods employed in this study in Section 2. We present the results in Section 3 and the discussion in Section 4. We conclude the paper in Section 5.

2. The current study

2.1. Objectives

Our study aims to determine any differences among different acquisition age groups regarding the strategies employed for zero anaphora resolution within coordinated structures. Following Nuhbaloğlu (2018), we argue that delayed exposure to a first linguistic input may result in variations in how signers interpret a zero anaphora within such structures. In this study, we aim to reveal what kind of differences we observe in their comprehension of zero anaphora and to seek explanations for such differences if there are any.

We further aim to explore how TİD signers interpret zero anaphora within coordinated structures in the absence of morphological cues such as eye gaze, directionality, or pointing, and assess whether syntactic cues play a similar role across these age of acquisition groups in this cognitive process. In other words, we aim to identify any heuristics employed by TİD signers and examine potential differences between the age of acquisition groups in their strategies. This study forms part of a broader project focused on revealing the impact of differing Turkish Sign Language exposure durations on the grammatical constructs developed by deaf individuals.

2.2. Methodology

To reveal any potential differences between different acquisition age groups, we conducted a self-paced forced-choice comprehension task in TİD.

2.2.1. Participants

We invited 16 native adult Deaf signers (M_{age} = 33) and 16 nonnative adult Deaf signers (M_{age} = 42), a total of 32 Turkish Sign Language signers to participate in our study at the Sign Lab at Boğaziçi University in Istanbul, Türkiye. In this study, native signers are those who were exposed to TİD from birth (via their parents, siblings, or close relatives) and nonnative signers are those who were exposed to TİD at a later age (via school), around 8 years old (Zorzi et al. 2022, among others). Prior to participation, we asked our participants to fill out a consent form and a questionnaire through which we confirmed their acquisition age group (henceforth, AoA in the graphs). Our participants indicated that they used TİD as their main way of communication in their daily lives. Although their birthplaces vary, all informants resided in İstanbul at the time of the study.

2.2.2. Stimuli

For this study, we constructed coordinated structures that consisted of two clauses. Based on previous studies (see Padden (1988) for American Sign Language (ASL) and Jantunen (2016) for Finnish Sign Language (FinSL) among others)[2] and our discussions with our two Deaf colleagues who are TİD signers, we indicated the coordination in our structures with a pause instead of the lexical conjunction 'and' in TİD, which is illustrated below, to have more natural structures.

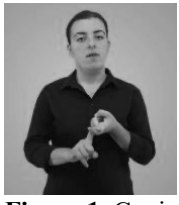


Figure 1. Conjunctive coordinator 'and' in TİD

We aimed not to include any kind of agreement such as directionality, nonmanual markers, or pointing in our stimuli since such agreement in sign language is a cue for the resolution of the referent of the dropped arguments (Lillo-Martin, 1986; Bahan et al., 2000; among others). With this purpose in mind, we

[2] Sign languages are argued to have lexical signs for conjunctions such as 'and' and 'but'; however, using these signs in coordinated structures is not mandatory.

chose plain verbs that do not show any kind of agreement with either the subject or the object to form the task sentences. We ensured the naturalness of our sentences through consultation with our Deaf colleagues.

Each item in our study included one clause with a transitive verb (TR), which has one subject and one object argument, and one clause with an intransitive verb (INT), which has a single subject argument. The first conjunct of the coordinated structure has its argument(s) as an overt noun phrase(s) while the second conjunct has one dropped argument, in other words, a zero anaphora. We manipulated the position of the transitive and intransitive verbs in the structures to reveal any differences in the resolution of a zero anaphora with respect to the presence of the potential competing antecedents in the discourse:

Table 1. The order of the clauses in the current task

NP_1 NP_2 TR	Ø INT
NP_1 INT	(Ø) NP_2 (Ø) TR

We argued that in cases where the transitive verb occurs in the first conjunct, the zero anaphora ultimately serves as the subject of the intransitive clause. On the other hand, there are two competing antecedents in the discourse. However, when the intransitive verb occurs in the first conjunct, the zero anaphora has only one possible antecedent. Nonetheless, the signers need to assign syntactic roles to these arguments. Our interest lay in determining whether the zero anaphora in these cases was interpreted as the subject or the object of the transitive clause.

We further manipulated the thematic role of the single argument of intransitive verbs to see whether TİD signers utilize the syntactic properties of verbs in the resolution of zero anaphora as argued by Sevinç (2006). Therefore, we included three verb types in our study namely transitive, unergative, and unaccusative. The verbs used in this study are as follows:

Table 2. Verbs used in the current task

Transitive	FOLLOW, BITE, HIT
Unergative	RUN, ESCAPE, DANCE, LAUGH
Unaccusative	FALL, BE_SAD, DIE, GET_BORED

These manipulations resulted in a design with eight conditions (2 X 2 X 2): (i) the (no) overt argument in the second conjunct which targets the position of the clause with an intransitive verb, (ii) the thematic role of the argument of the intransitive verb, and (iii) the acquisition age group:

Table 3. Conditions of the current task

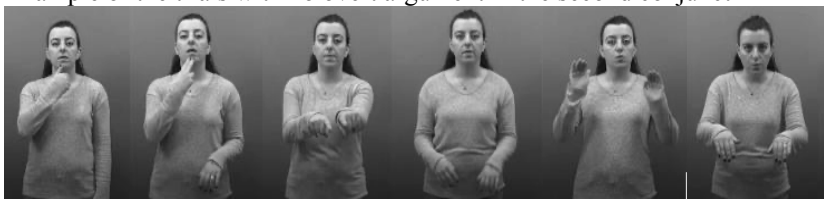
Native signers			Nonnative signers		
	Thematic role of argument of intransitive verb			Thematic role of argument of intransitive verb	
Overt argument in 2nd conjunct	Agent	Theme	Overt argument in 2nd conjunct	Agent	Theme
No overt argument in 2nd conjunct	Agent	Theme	No overt argument in 2nd conjunct	Agent	Theme

We did not manipulate the animacy degree of the arguments to avoid adding more conditions to the design, which would require more participants to obtain reliable results. Instead, we used human referents MAN and WOMAN which differ only in biological gender, and we balanced the thematic roles of the referents in the stimuli. In total, we formed twenty-four sentences.

2.2.3. Design and Procedure

As indicated before, we conducted a within-subjects self-paced forced-choice task in which our participants were asked to answer comprehension questions related to the twenty-four coordinated structures that include zero anaphora. To realize this, we recorded short videos of sentences in TİD with the help of a Deaf researcher who is an early-learner TİD signer. In our videos, we paid attention not to having any visual cues. As mentioned in the previous sections, instead of an overt linker, we used short pauses between the coordinated clauses following Padden (1988) and Jantunen (2016):

1) Example of the trials with no overt argument in the second conjunct



MAN WOMAN FOLLOW *pause* FALL

'The man follows the woman, ∅ falls down.'

Sevinç (2006) mentioned that animacy may result in an asymmetry in the word order of transitive clauses. To avoid any potential misinterpretation that could occur due to the reversibility of the sentences, we introduced a visual image describing the event in the first clause of the sentence in compliance with the SOV order, which is the basic word order in TİD (Sevinç, 2009; among others). By coercing this, we aimed to ensure a fixed reading for the transitive sentences across the board for TİD signers:

Figure 2. Example of the visual images used in this study

For each experimental sentence, we recorded a short video with our Deaf colleague. In these videos, we had questions that targeted the argument(s) of the verb in the second clause. Hence, we aimed to understand how TİD signers interpret the zero anaphora in the second clause and to investigate whether there are any differences between native and nonnative adult Deaf TİD signers in comprehending the coordinated clauses:

2) The example of question sentences following the coordinated structure

WHO FALL

'Who falls?'

The question sentence was followed by the presentation of the potential responses on the screen where our participants were expected to choose between two options that occurred in the discourse. Even though the forced-choice tasks are argued to give information only about the 'size of the difference between conditions in the form of the proportion of selections of the two […] in pair' (see Marty 2020 for a detailed discussion), we argued that this method was the optimal way of conducting our task since we aim to investigate the tendencies of the signers of two acquisition age groups:

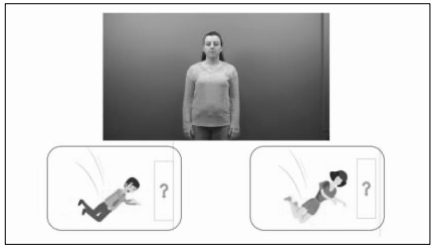


Figure 3. Example of the visual images for the responses

Throughout this task, we aimed to avoid any influence of spoken or written Turkish, the widely used spoken language of Türkiye. Therefore, we recorded an instruction video with our Deaf colleague, where the details of the task were explained in TİD. We prepared the comprehension task using PowerPoint.

Before the actual study with our participants, we conducted a pilot study with another Deaf colleague who works as a researcher at Boğaziçi University. We recorded this pilot trial using two cameras. We placed one camera across from our colleague who faced the computer screen. We placed the other camera just behind our colleague to record their responses.

In the actual task, we asked our participants to watch the video that presented the experimental coordinated structures. By default, each video was played twice and followed by the visual that coerced the event in the first conjunct. We made sure that they watched the videos as many times as they wanted. They used the arrow keys of the laptop to move to the next trial at their self-paced. The reason for this choice was to avoid any frustration for Deaf participants that might be caused by the time limit.

We randomized the order of the trials for each participant to mitigate potential ordering effects. Following the completion of each question sentence, participants were presented with two potential antecedents in the form of visual images. Participants indicated their choice by pointing to the corresponding image, which appeared immediately after the question sentence concluded. Similarly, we randomized the positions of the options to prevent any bias related to their location. Each participant completed twenty-four sentences constructed for the comprehension task without having any problems related to the task procedure.

As a further step, we used the annotation tool ELAN to annotate the recorded videos. This process involved coding the independent variables and the responses of the participants to facilitate detailed analysis. To highlight the differences between conditions, we focused on the following criteria:

- Is the first clause intransitive?
- Is the subject of the intransitive verb an agent?

We annotated each item by assigning a value of ‘1’ if the clause with an intransitive verb was in the first conjunct, and ‘0’ if the clause with an intransitive verb was in the second conjunct. Furthermore, we annotated the stimuli with a value of ‘1’ if the argument of the intransitive clause was an agent and ‘0’ if the argument of the intransitive clause was non-agent.

To encode the responses of our participants, we created another tier in ELAN, serving as the dependent variable in our design. This tier aimed to address the question “Is the subject of the first clause the subject of the second clause?”. We annotated the response as ‘1’ if the subject of the first conjunct was also the subject of the second conjunct. If not, we annotated the response as ‘0’.

In the next section, we present the results of this task.

3. Results

In this comprehension study, we aimed to find out any variations between native and nonnative adult Deaf TİD signers with respect to zero anaphora resolution. Our overall results indicate that signers of Turkish Sign Language tend to choose the most recent argument in the discourse, NP_2, as the subject of the second conjunct in a coordinated structure regardless of their acquisition age group. This finding is in line with the previous studies that investigated only native TİD signers:

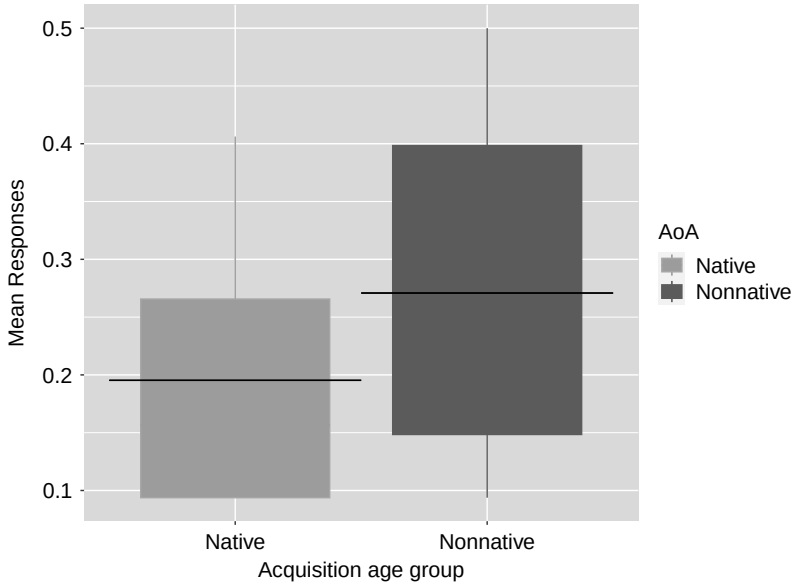


Figure 4. Overall results of the current task (0 on the y-axis indicates the choice of NP_2 as the subject of the second conjunct, 1 indicates the choice of NP_1 as the subject of the second conjunct)

When we conducted a logistic regression model on our data, we observed that the acquisition age had a significant effect on the responses of the participants ($p<0.05$, $p = 0.013$). Since our focus was to understand the differences between the strategies utilized by the age of acquisition groups to resolve a zero anaphora, we analyzed our data focusing on all independent variables as a next step.

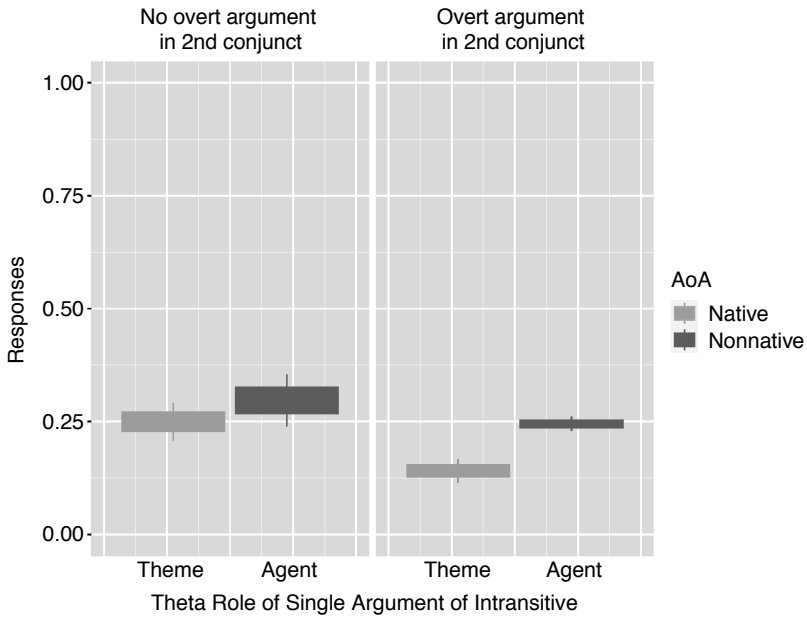


Figure 5. Results including all independent variables (Native signers on the left side of each column, nonnative signers on the left side of each column)

We conducted another logistic regression model where we focused on the potential interactions of the dependent variables:

3) glm(Response ~ AoA * Thematic role of intransitive verb's subject * Presence of overt argument in the second conjunct, data = data, family = binomial)

The results showed that the acquisition age ($p<0.01$, 0.008) and the presence of an overt argument in the second conjunct ($p<0.01$, 0.006) have significant effects on the choice of the referent of a zero anaphora while the thematic role of the intransitive verb's subject does not have any significant effect. We observe a very marginal interaction only between the presence of an overt argument in the second conjunct and the thematic role of the intransitive verb's subject ($p<0.1$):

Table 4. Results of the logistic regression model where I stands for the independent variable 'the age of acquisition groups', II stands for 'the presence of the overt argument in the second conjunct, and III stands for 'the thematic role of the intransitive verb's subject'

Parameters	Estimate	z value	Pr(>|z|)
I	0.46	2.618	0.008
II	0. 48	2.715	0.006
III	0.18	-1.033	0.3
I:II	-0.46	-1.3	0.19
I:III	0.35	-0.99	0.3
II:III	0.63	-1.78	0.07
I:II:III	-0.49	0.69	0.48

In the next section, we discuss the obtained results.

4. Discussion

The results of this study indicate that TİD signers of both acquisition age groups tend to choose the most recent argument in the discourse, NP_2, as the subject of the second conjunct in a coordinated structure when there are no morphological cues such as pointing, eye gaze, directionality as well as in the absence of any syntactic agreement encoded in the signing space. However, when we conducted a logistic regression model on our data, we observed that the age of acquisition had a significant effect on the responses of the signers. Being a nonnative signer significantly increases the ratio of choosing NP_1 as the subject of the second clause in a coordinated clause.

To understand the factors that might cause this difference, we conducted another regression model including all independent variables that we manipulated throughout this task. The results of this model point out a more prominent significant effect of age of acquisition groups in the responses as well as the significant effect of the presence of overt argument in the second conjunct, in other words, the position of the clause with the intransitive verb:

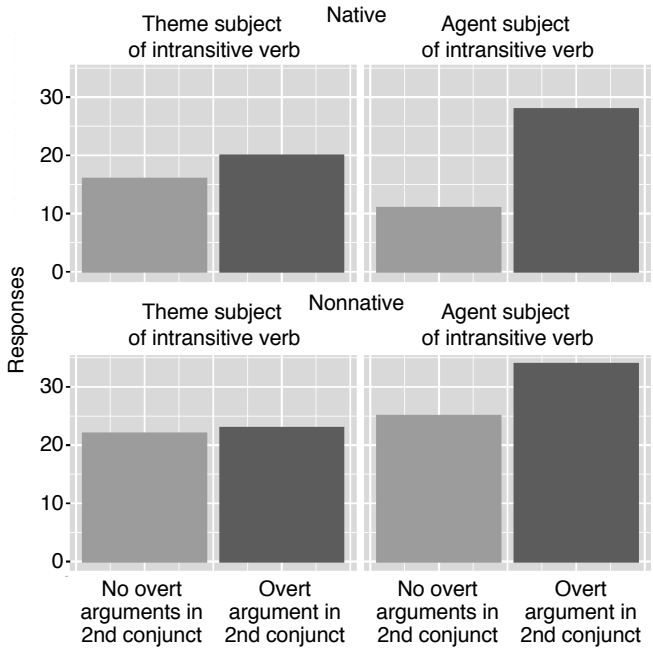


Figure 6. A closer look at the results (Native signers on the top, nonnative signers on the bottom)

Our initial prediction was that the signers would use the syntactic cues such as the thematic roles of the subject argument of the intransitive verbs to resolve a zero anaphora in coordinated structures in the absence of any other morphological cues. However, our results show that this independent variable has no significant effect at all.

We argue that despite the overall tendency to choose NP_2 as the subject of the second conjunct, these results indicate the potential cues utilized by signers while resolving a zero anaphora: The presence of an overt argument in the second conjunct affects the choice of native signers while nonnative signers do not rely on this information as much as the former group. We argue that this might be the impact of the delayed first language acquisition on the strategies employed by signers based on their language acquisition age.

At this point, we want to point out the marginal interaction effect that we observe between the presence of an overt argument in the second conjunct and the thematic role of the intransitive verb's subject. We observe that signers tend to choose NP_1 as the subject of the second conjunct when there is an overt argument in the second conjunct and the subject of the intransitive verb is an agent. A closer look at the cases where the subject of the intransitive verb is an agent in Figure 6 below shows us a subtle difference between the age of acquisition groups. This leads us to consider the possibility that nonnative signers might not be able to use the thematic roles as a syntactic cue at a discourse level similar to native signers

while they are capable of doing this at the morphosyntactic level (Sevgi & Gökgöz, 2023). However, a more detailed study is necessary to understand the system behind this difference.

5. Conclusion and Further Studies

This study highlights the potential differences observed in the comprehension of TİD signers while resolving zero anaphora in coordinated structures. However, more research in this domain is required to get a better understanding of the mechanism that the signers utilize in this process. As a further step, we are going to analyze the response times of native and nonnative signers to detect similarities and differences in their response time in different conditions. We argue that a difference in the same condition across the age of acquisition groups might be informative about the strategies the signers utilize.

We argue that acquiring such information is necessary to identify further age-sensitive structures in the grammar of Turkish Sign Language. This knowledge is crucial for developing diagnostic materials and intervention strategies aimed at ensuring the timely provision of sensitive primary linguistic input for Deaf children at risk of language deprivation.

Further research in this domain promises to reveal nuanced patterns and complexities, deepening our understanding of the cognitive processes guiding language choices among Deaf TİD adult signers based on their language acquisition age.

References

Bahan, Benjamin, Judy Shepard-Kegl, Robert Lee, Dawn MacLaughlin, Carol Neidle. 2000. The Licensing of Null Arguments in American Sign Language. *Linguistic Inquiry*, 31(1), 1-27.

Boudreault, Patrick and Rachel Mayberry. 2006. Grammatical processing in American Sign Language: Age of first-language acquisition effects in relation to syntactic structure. *Language and Cognitive Processes*, 21, 608-635.

Emmorey, Karen. 2001. *Language, cognition, and the brain: Insights from sign language research*. Lawrence Erlbaum Associates.

ELAN (Version 6.7). 2023. Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. https://archive.mpi.nl/tla/elan.

Friedmann, Naama and João Costa. 2010. The child heard a coordinated sentence and wondered: On children's difficulty in understanding coordination and relative clauses with crossing dependencies. *Lingua*, 120(6), 1502-1515.

Jantunen, Tommi. 2016. Clausal coordination in Finnish Sign Language. *Studies in Language*, 40(1), 204-234.

Lenneberg, Eric. 1967. The biological foundations of language. Hospital Practice 2(12), 59–67.

Lillo-Martin, Diane & Jonathan Henner. 2021. Acquisition of Sign Languages. *Annual Review of Linguistics*, 7(1), 395–419.

Lillo-Martin, Diane. 1986. Two kinds of null arguments in American Sign Language. *Natural Language and Linguist Theory*, 4(1), 204-234.

Marty, Paul, Emmanuel Chemla, John Sprouse. 2020. The effect of three basic task features on the sensitivity of acceptability judgment tasks. *Glossa: A Journal of General Linguistics*. 5(1), 72.

Mayberry, Rachel I. & Robert Kluender. 2018. Rethinking the critical period for language: New insights into an old question from American Sign Language. *Bilingualism: Language and Cognition*. 21(5), 938–944.

Mayberry, Rachel I. & Ellen B. Eichen. 1991. The long-lasting advantage of learning sign language in childhood: Another look at the critical period for language acquisition. *Journal of Memory and Language*, 30(4), 486–512.

Mitchell, Rose and Michael Karchmer. 2004. Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies*, 4, 138–168.

Moores, Donald. 2001. *Educating the Deaf: Psychology, Principles, and Practices*. Boston, MA: Houghton Mifflin Company.

Newport, Elissa, and Richard P. Meier. 1985. The acquisition of American Sign Language. In Dan I. Slobin (ed.), *The cross-linguistic study of language acquisition*, 881–938. Hillsdale, NJ: Lawrence Erlbaum Associates

Nuhbaloğlu, Derya. 2018. *Comprehension and production of referential expressions in German Sign Language and Turkish Sign Language: An empirical approach*. Doctoral dissertation, Georg-August Universität, Göttingen, Germany.

Padden, Carol. 1988. *Interaction of morphology and syntax in American Sign Language*. New York: Garland.

R Core Team. 2022. R: A language and environment for statistical computing. R Foundation for Statistical Computing Vienna, Austria. https://www.R-project.org/.

Ramírez Naja, Amy Lieberman, Rachel Mayberry. 2013. The initial stages of first-language acquisition begun in adolescence: when late looks early. Journal of Child Language, 40(2), 391-414.

Santos, Stacee, Hiram Brownell, Marie Coppola, Anna Shusterman, Sara Cordes. 2023. Language experience matters for the emergence of early numerical concepts. NPJ Science of Learning. 8(1), 57.

Sevgi, Hande & Kadir Gökgöz. 2023. Classifiers, Argument Expression, and Age of Acquisition Effects in Turkish Sign Language. *Sign Language and Linguistics*, 26(1). John Benjamin Publishing Company.

Sevinç, Ayça M. 2006. *Grammatical relations and word order in Turkish Sign Language (TİD)*. Unpublished master's thesis. Middle East Technical University, Ankara, Turkey.

Zorzi Giorgia, Beatrice Giustolisi, Valentina Aristodemo, Carlo Cecchetto, Charlotte Hauser, Josep Quer, Jordina Sánchez Amat, Caterina Donati. 2022. On the Reliability of the Notion of Native Signer and Its Risks. *Frontiers in Psychology*, 13, 716554.

Proceedings of the 48th annual Boston University Conference on Language Development

edited by Hayat Abdullah Ali AlThagafi and Jupitara Ray

Cascadilla Press Somerville, MA 2024

ISSN 1080-692X
ISBN 978-1-57473-097-5 (2 volume set, paperback)

Ordering information

To order a copy of the proceedings or to place a standing order, contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA
phone: 1-617-776-2370, sales@cascadilla.com, www.cascadilla.com