# EXPRESSION OF ARGUMENTS AND AGE OF ACQUISITION EFFECTS IN TURKISH SIGN LANGUAGE

SEMRA ÖZDEMİR

BOĞAZİÇİ UNIVERSITY

2021

# EXPRESSION OF ARGUMENTS AND AGE OF ACQUISITION EFFECTS IN TURKISH SIGN LANGUAGE

A thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Master of Arts

in

Linguistics

by

Semra Özdemir

Boğaziçi University

2021

# DECLARATION OF ORIGINALITY

I, Semra Özdemir, certify that

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ABSTRACT

Expression of Arguments and Age of Acquisition Effects in

Turkish Sign Language

This study explores how delayed exposure to Turkish Sign Language (TİD) affects the encoding of arguments on agreeing verbs, within an utterance, and in descriptions of multiple entities. The discussion on agreeing verbs hinges on the marking of referential loci that anchor arguments on person agreeing verbs (e.g. SHOW) and location agreeing verbs (e.g. FLY-TO). Location agreeing verbs are further examined to reveal patterns in the ordering of Figures (i.e. smaller, more mobile entities) and Grounds (i.e. larger, more immobile entities) within an utterance. Lastly, the expression of number information in noun phrases that introduce arguments during scene setting and verb phrases that describe events containing multiple entities are investigated. A series of elicitation tasks suggests the following: (i) late learners perform virtually on par with their native counterparts in terms of referent tracking, (ii) location agreement verbs elicit more faithful responses, in which referential loci are consistently cross-referenced on the verb, than person agreement verbs in both groups, (iii) native signers adhere more strictly to the Figure-Ground principle observed across sign languages, and (iv) late learners show a tendency to leave out number information on the verb when describing a single event with multiple entities. Taken together, these findings shed light on the critical period (Lenneberg, 1967) and offer insight into the components of language that are sensitive to the timing of language input.

# ÖZET

## Türk İşaret Dilinde Üyelerin İfade Edilmesi ve Dil Edinim Yaşının Etkileri

Bu çalışma Türk İşaret Diline (TİD) geç maruz kalmanın, uyum eylemlerinde, bir sözce içerisinde ve çoklu varlık betimlemelerinde üyelerin kodlanmasını nasıl etkilediğini araştırmaktadır. Uyum eylemleri üzerine olan tartışma, özne ve nesne gibi üyeleri demirleyen gönderimsel çıkakların kişi uyumlu eylemler (örn. GÖSTERMEK) ve konum uyumlu eylemler (örn. UÇMAK) üzerinde belirtilmesine dayanmaktadır. Bir sözce içerisindeki Figürler (yani daha küçük, daha hareketli varlıklar) ve Zeminler (yani daha büyük, daha hareketsiz varlıklar) sıralamasındaki eğilimleri ortaya çıkarmak amacıyla konum uyumlu eylemler ayrıca incelenmektedir. Son olarak sahne kurma esnasında üyeleri tanıtan isim öbeklerinde sayı bilgisinin ifade edilmesi ve birden çok varlık içeren olayları tanımlayan eylem öbekleri incelenmektedir. Bir dizi çıkartım görevi şu bulgulara işaret etmektedir: (i) geç öğrenenler, referans izleme açısından anadili TİD olan sağırlarla neredeyse aynı düzeyde performans sergilemekte, (ii) konum uyumlu eylemler her iki grupta kişi uyumla eylemlerden daha fazla gönderimsel çıkakların eylem üzerinde tutarlı bir şekilde çapraz referans verildiği sadık yanıtlar ortaya çıkarmakta, (iii) anadili TİD olan sağırlar işaret dillerinde gözlemlenen Figür-Zemin ilkesine daha sıkı bir şekilde bağlı kalmakta ve (iv) geç öğrenenler birden çok varlık içeren tek bir olayı tanımlarken eylem üzerinde sayı bilgisini dışarıda bırakma eğilimi göstermekte. Birlikte ele alındığında bu bulgular kritik döneme (Lenneberg, 1967) ışık tutmakta ve dil girdisinin zamanlamasına duyarlı olan dil bileşenleri hakkında fikir vermektedir.

# ACKNOWLEDGMENTS

Writing this thesis in the midst of a global pandemic was no easy feat. For this reason, I am forever indebted to each and every individual that offered me a word of encouragement throughout this challenging journey.

First and foremost, I would like to extend my deepest gratitude to my advisor Assist. Prof. Kadir Gökgöz. Had it not been for his course on the acquisition of syntax, I might have never stumbled into the world of sign language linguistics. I have come a long way under his guidance, and I am truly grateful for his encouragement and insightful discussions. His genuine care for the deaf community has been incredibly inspiring and has driven me to pursue further studies in this field.

Furthermore, I would also like to sincerely thank my committee members, Prof. Balkız Öztürk and Prof. Nihan Ketrez. They have drawn my attention to matters that complement and build onto my work through their generous feedback. Moreover, when I was applying to PhD programs, Prof. Balkız Öztürk kindly set aside time to assist me, for which I am truly grateful.

In addition, I also wish to thank Assist. Prof. Ena Hodzik for recruiting me as a research assistant in a project that combines simultaneous interpreting, a passion of mine, and research on psycholinguistics. She gave me the opportunity to gain further experience in empirical research and focus on my academic studies without having to search for an alternative source of income. It was a pleasure collaborating with her on such an intriguing project.

I must also thank Derya Nuhbalaoğlu and Serpil Karabüklü for organizing virtual meet-ups with sign language researchers. These meetings were eye-opening in that they

allowed me to gain a deeper understanding of the range of topics that can be explored in the realm of sign language linguistics.

Also, it goes without saying that I have been blessed with the best of friends. Thank you Hande and Demet for sharing the data you worked so hard to collect. You two are incredible friends, and I am beyond lucky that our paths have crossed. I also owe Furkan Atmaca a huge thank you. He patiently walked me through the data analysis stage and was always there for me whenever I needed someone to talk to. Furkan also brought the crew together through unannounced FaceTime calls, which kept our friendship strong. Thank you Aslı and Neslihan for your positive energy, Assem and Muhammed for your great company, and Noyan, Dilan, and Burcu for making the department a fun place to be. I owe Muhammed an additional thank you for pulling me back up when I was at my lowest and always putting a smile on my face. Also, thank you Furkan Dikmen for pushing me to work harder and sharing multiple laughs over SNL videos. I am also grateful for the other members of my cohort, Kadernur, Sercan, and Bergül; you all made the entire MA experience very enjoyable.

In addition, I wish to express my endless gratitude to my best friend Şeyma. She constantly reminds me of what I'm capable of achieving and keeps me in check. Her selfless acts of kindness warm my heart and inspire me to become a better person.

Lastly, I cannot begin to express how grateful I am for my family. My mom and dad have supported me in all my life endeavors, and I know I can always count on them. On a side note, sorry mom for getting so heated up when you kept asking about my progress. I know your only intention was to motivate me to keep going, and it worked. Also, I don't know how I got so lucky to have a sister like Selma. She has been there for me since day one, and she will forever be my partner in crime.

Overall, I am humbled by the tremendous amount of support I have received, and I hope this thesis has been successful in helping to lay the groundwork for future studies in this field.

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This thesis has been supported by the "Supporting Sign Language Development of Deaf Children with Hearing Parents through Linguistically Informed Preschool Stories" Boğaziçi University, Bilimsel Araştırma Projeleri (BAP), Start-up Project, #14458, PI Kadir Gökgöz.

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# ABBREVIATIONS

| | |
|---|---|
| 1 | 1st person |
| adj | adjective |
| ASL | American Sign Language |
| bi | bimanual |
| BSL | British Sign Language |
| CI | confidence interval |
| DGS | German Sign Language (*Deutsche Gebärdensprache*) |
| ent-CL | entity classifier |
| hand-CL | handling classifier |
| IX | index |
| GF | Ground-Figure |
| L1 | first language |
| lex-N | lexical noun |
| lex-V | lexical verb |
| LIS | Italian Sign Language (*Lingua dei Segni Italiana*) |
| LH | left hand |
| mono | monomanual |
| N | noun |
| N/A | not applicable |
| num | number |
| PL | plural |
| PST | past |

| | |
|---|---|
| RH | right hand |
| R-loci | referential loci |
| SE | standard error |
| SOV | subject object verb |
| TİD | Turkish Sign Language (*Türk İşaret Dili*) |

# CHAPTER 1

# INTRODUCTION

In several languages, specific features of nominal expressions are expressed on other constituents within the same utterance. These constituents may be nominal in nature (e.g. adjectives and demonstratives) or they may be verbal. This phenomenon is called agreement and occurs when "a grammatical element X matches a grammatical element Y in property Z within some grammatical configuration" (Barlow & Ferguson, 1988). The properties in question are typically called "phi features" and refer to person, number, and gender information. Moreover, the term "controller" is used for the nominal expression that bears the information which is copied onto the "target" (see Corbett, 2006). To exemplify, in the Turkish sentence in (1), the person and number features of the controller subject, namely first person and plural, are manifested on the target predicate in the form of the morpheme *-k*.

(1) Biz baklava ye-di-k.
1PL baklava eat-PST-1PL
'We ate baklava.'

Agreement is a property of natural language; thus, it appears both in the oral-aural modality (i.e. spoken languages) and the visual-gestural modality (i.e. sign languages). However, it behaves differently in each. To begin with, while spoken languages have established paradigms with unchanging morphemes that mark agreement, sign languages make use of referential loci (abbreviated as R-loci) in space to mark sentential arguments (Sandler & Lillo-Martin, 2006). In sign languages, after a

discourse referent is introduced by a lexical noun, it is assigned a spatial index through pointing with either the fingers, chin, head, lips or eyes (Sandler & Lillo-Martin, 2006). The verb then spatially agrees with the referents by starting at the locus of the subject and ending at the locus of the object. To illustrate, in (2), the signer first positions the subject, i.e. the boy, to the left, and proceeds to position the indirect object, i.e. the dad, to the right. Then, when articulating the predicate, the signer directs the action towards the indirect object starting from the referential locus of the subject.

(2)

| | | | | |
|---|---|---|---|---|
| RH: BOY | DAD | $IX_a$ | PAINTING | $_aSHOW_b$ |
| LH: $IX_a$ | $IX_b$ | $IX_a$ | PAINTING | $_aSHOW_b$ |

'The boy is here. The dad is here. The boy shows a painting to his father.'

Moreover, while agreement is uniform across verbs in spoken languages, meaning it appears across the board if present in a spoken language (Corbet, 2006), only a subset of verbs in sign languages show agreement. In this regard, Padden (1988) makes a distinction between three types of verb classes that occur in sign languages: plain, agreeing, and spatial. Plain verbs do not partake in agreement and are usually "body anchored" in that, during the articulation of a verb, physical contact is made with the body. Agreeing verbs, on the other hand, can agree with both the subject and object, as demonstrated in (2). Two-place agreeing verbs agree with their subject and direct object while three-place agreeing verbs agree with their subject and their indirect object. Lastly, spatial verbs also show agreement; however, they are unlike agreeing verbs in

that the referential loci with which they agree are typically motivated by the topographical relationship between arguments. In the case of agreeing verbs, on the other hand, referential loci are generally more abstract and do not necessarily mark the exact location of the referent, although a match is usually observed when the discourse referents are present at the time of speech. What's more, with both agreeing and spatial verbs, the permissible loci are not predetermined as they can be positioned anywhere within the signing space. Thus, sign languages do not employ a closed set of unique agreement markers (see Rathmann & Mathur, 2002), while spoken languages for which there is an agreement mechanism in place make use of a finite set of agreement markers that encode specific person/number/gender features.

Another difference between the two modalities lies in the phi-features that partake in agreement. While spoken languages mark person, number, and gender, sign languages only mark person and number (c.f. Rathmann & Mathur, 2002; Lillo-Martin & Meier, 2011)[1].

Despite their differences, both spoken and sign languages employ an agreement mechanism in their respective grammars. This allows for a comparison of the development and emergence of this phenomenon across modalities. In fact, sign languages offer an additional advantage in that they make possible the observation of late-exposure effects. Since a vast majority of deaf children are born to hearing parents—approximately 90% in the U.S. (Mitchell & Karchmer, 2004)—, such children generally do not receive linguistic input until school-age. This makes it possible for

[1] Zwitserlood & Gijn (2006) argue that Sign Language of the Netherlands has gender agreement that resembles that of Bantu languages; however, this has more to do with marking word classes on the verb with classifier morphemes, and not the canonical feminine vs. masculine divide.

researchers to investigate the components of grammar that are affected by delayed exposure, and thus offers invaluable insights into the critical period (Lenneberg, 1967). The present study aims to explore how late exposure to Turkish Sign Language (TİD) affects the way in which (i) arguments are encoded on the verb (through agreement markers, i.e. directionality and orientation), (ii) arguments are expressed within an utterance (through the ordering of Figures and Grounds), and (iii) number is marked on nominal and verbal expressions. The remainder of this thesis is structured as follows: Chapter 2 offers an overview of the basic concepts relating to agreeing verbs in addition to the acquisition literature on person and location agreement; Chapter 3 contains the main research questions regarding person and location agreement along with the methodology implemented to address these questions; and Chapter 4 presents the results of the first study together with a discussion; Chapter 5 introduces background information and acquisition literature on the expression of number; Chapter 6 contains the research question and method that guided the investigation into the expression of number; Chapter 7 offers a discussion of the results of the second study; and Chapter 8 concludes with a general overview of the findings and further remarks.

Lastly, it is important to note that throughout this thesis, all models are regression models that were run using the brms package in R (Bürkner, 2018). The contrasts used to compare the effect of predictors (i.e. the independent variables) were sum contrasts that added up to 0, such as -0.5 and +0.5. In plots that display the regression model results, the thin line shows the 95% confidence intervals (CI), the thicker line indicates the 50% CI, and the dot in the middle represents the median estimate.

# CHAPTER 2

# BACKGROUND: PERSON AND LOCATION AGREEMENT

## 2.1 Overview of person and location agreement

As mentioned in the previous chapter, sign languages have two types of verbs that display agreement: person-agreeing verbs and location-agreeing verbs. In the literature, these are often called "agreeing verbs" and "spatial verbs", respectively (Padden, 1988). To avoid confusion, this study will adopt the term "person-agreeing verb (PAV)" to refer to the former and the term "location-agreeing verb (LAV)" to refer to the latter.

PAVs align with the loci assigned to the subject and object, and they inflect for person and number, thus they are argued to exhibit syntactic agreement (Padden, 1988). Some examples from TİD include ASK, GIVE, and ANSWER. On the other hand, LAVs, such as MOVE and PUT in TİD, agree with loci associated with the beginning and end of an event, and they do not inflect for person and number; these types of verbs are claimed to show morphological agreement (Padden, 1988). In doing so, both types of verbs are argued to make use of the same mechanism: the morpheme PATH (Meir, 1998). The elements that fill the initial and final slots of this morpheme determine the direction of the agreement; in PAVs, the subject and object loci fill these slots, whereas in LAVs the starting and end point of moving objects fill these slots. From a semantic perspective, it has been argued that this behavior can be captured by positing that PATH is assigned the theta roles source and goal for both predicates (Fischer & Gough, 1978), although this would be interpreted as a more metaphorical source-goal in the case of

PAVs. For TİD in particular, a templatic model has been proposed to account for agreement patterns (Makaroğlu & İşsever, 2018)[2].

Moreover, several diagnostics have been proposed to tease the two verb types apart. For example, Padden (1988) offers three tests which show the following: i) the starting point of LAVs cannot be associated with a person argument, ii) exhaustive marking can only appear on PAVs, and iii) reciprocal marking is only possible with PAVs. Furthermore, Rathmann & Mathur (2004) also provide a test which demonstrates that PAVs do not allow for the modification of path whereas LAVs do; for instance, the movement can stop halfway when producing BRING, an LAV, (to indicate an object was brought halfway) but not GIVE, a PAV. Nonetheless, some scholars have argued that the boundary between the two is fuzzy and have grouped them together as simply non-plain verbs (Quadros & Quer, 2008), albeit still acknowledging their individual differences. We will not delve into this debate and will adopt the view that LAVs and PAVs are two separate classes of verbs.

Another distinction to be made involves the two different types of LAVs. The first type consists of predicates that express static location, such as BE-AT in TİD, and the second type involves predicates that describe motion in space, such as MOVE and PLACE in TİD (Levinson, 2003). This study deals only with the latter.

Lastly, the agreement markers used with LAVs and PAVs have been argued to have different interpretations. They are claimed to convey semantic features (i.e. location) in LAVs, whereas they are said to represent purely formal features (i.e. subject

[2] Makaroğlu & İşsever (2018) argue that sign languages in general, and TİD in particular, contain underspecified roots that must combine with a verbal template specifying the handshape and locus in order to be pronounced. The authors propose that the locus feature of the verb determines whether it will exhibit agreement, as opposed to semantic and/or syntactic constraints.

and object) in PAVs (see Berk, 2003). Furthermore, in their review of language acquisition and language emergence literature, Kwok et al. (2020) conclude that while person agreement involves the feature [person], locative agreement does not; they further posit that locative agreement emerges earlier since the use of space in such agreement represents concrete space, as opposed to the use of space in person agreement, which represents abstract formal features in such agreement.

## 2.2 Figures and Grounds in spatial expressions

The terms "Figure" and "Ground" originate from Gestalt psychology, which argues that the human mind, when perceiving a scene, brings one component with distinct boundaries to the fore (the Figure) and perceives the rest of the scene as the background (the Ground) (Schacter et al., 2011). In the context of sign language linguistics, this terminology has been widely adopted in studies on locative expressions, particularly studies on TİD (Özyürek et al., 2010; Sümer et al., 2013), to explain the ordering of locative referents. The general observation has been that Grounds (i.e. larger, more immobile objects) precede Figures (i.e. smaller, more mobile objects) in spatial expressions (Napoli & Sutton-Spence, 2014; Happ & Verköper, 2006).

What is peculiar is that the reverse often occurs in spoken languages, as demonstrated by Talmy (1983) who provides the English examples in (3). In (3a), the more natural utterance, the figure (i.e. the bike) precedes the ground (i.e. the house). Nevertheless, unlike in sign languages, there is no uniform pattern that is observed across spoken languages.

(3) a. The bike is next to the house
b. ?The house is next to the bike. Talmy (1983, p. 231)

Many studies suggest that the tendency for Grounds to precede Figures in sign languages is driven by a modality constraint (e.g. Emmorey, 2002; Perniss, 2007). These studies argue that since larger objects are perceptually more salient, they precede smaller ones in the visual modality (Volterra et al., 1984). This proposal is corroborated by a study on gesture ordering which reports that non-deaf participants frequently produced larger, more immobile objects before smaller, more mobile ones (Gershkoff-Stowe & Goldin-Meadow, 2002).

With respect to Figure-Ground ordering in TİD, Özyürek et al. (2010) and Sümer et al. (2013) report that native adult signers of TİD comply with the general observation and mostly introduce Grounds first when describing static locative relations. However, despite the parallelism, Özyürek et al. (2010) do note that TİD differs from other languages of the same modality in the use of simultaneous classifiers to describe spatial relations; they argue that while many sign languages generally introduce a Figure with a simultaneously represented Ground, these simultaneous constructions are uncommon in TİD and they are used only to express "a specific, non-default spatial relation between Figure and Ground" (p. 1135).

To recap, Figures and Grounds occur exclusively with LAVs. The Figure generally corresponds to the agent in intransitive events, such as a bird which flies to a tree, and the theme in ditransitive events, such as a plant put on a shelf by a woman. The Grounds in these examples are the tree and the shelf, i.e. the target, or indirect object, of the event. An example of Ground-before-Figure ordering in TİD is presented in (4). To describe an event involving a bird perching on a tree, the signer first produces TREE

(the Ground, indicated in blue) and then BIRD (the Figure, indicated in red). First the Ground (i.e. the target) is expressed, then the Figure (i.e. the agent), followed by a verb that agrees with both by beginning from the location of the Figure and ending at the location of the Ground. Therefore, the resulting ordering of arguments within the utterance is object-then-subject, whereas the order in which the verb agrees with these arguments is subject-then-object.

(4)

TREE$_a$ IX$_b$ BIRD $_b$PERCH$_a$
'The tree is here. Here is the bird. The bird perches on the tree.'

## 2.3 Faithfulness

As mentioned in the previous chapter, spatial indices (or referential loci, abbreviated as R-loci) are assigned to arguments in the signing space and are referred back to via the direction/orientation of the verb. In the literature, this phenomenon has been accepted to be an inherent part of agreement and thus lacks a proper label; some have elaborated and called it "the structure sharing of an index value" (Cormier et al., 1999) or "shared reference" (Senghas & Coppola, 2001), but these do not capture the potential inconsistencies that may arise in indexing (see below).

This study adopts the term "faithfulness"[3] to describe the consistency between the assignment of a specific locus when referentially anchoring an argument in the signing space and the cross-referencing of the same locus on the verb via direction/orientation. An instance of "faithful" agreement, which was provided in the introduction, is repeated in (5). In this example, the signer describes a scene in which a boy shows a painting to his father by first positioning the boy on the left and the father on the right, and then proceeding to articulate the verb SHOW with a rightwards orientation. Thus, the verb complies with the with the referential loci of the subject (locus a) and object (locus b) by bearing an a-to-b orientation. The decision to coin a term and explore this phenomenon was motivated by the fact that we observed instances in which signers assigned specific R-loci to arguments but did not adhere to these R-loci when articulating verb agreement. To illustrate, in example (6), a response to the same stimulus described above, the signer first positioned the dad (i.e. the object) on the right and the boy (i.e. the subject) on the left. However, when signing the verb SHOW, the participant flipped the positions of the boy and dad (by signing from right to left) and did not stick to their initial R-loci, yielding an "unfaithful" utterance. Had it not been for the stimulus, this would normally be interpreted as a dad showing a painting to a boy given the orientation of the verb[4].

[3] This term is not to be confused with the notion of "faithfulness" used in Optimality Theory (Prince & Smolensky, 1993).
[4] We do acknowledge that the upwards head tilt seems to depict that the agent is addressing a taller person, i.e. the dad. However, the issue at hand is the orientation of the verb.

(5) Faithful response

RH: BOY DAD $IX_a$ PAINTING $_aSHOW_b$
LH: $IX_a$ $IX_b$ $IX_a$ PAINTING $_aSHOW_b$
'The boy is here. The dad is here. The boy shows a painting to his dad.'

(6) Unfaithful response

$DAD_a$ $BOY_b$ PAINTING $_aSHOW_b$
'The dad is here. The boy is here.' Intended: 'The boy shows a painting to his dad.'

Previous research deals with these inconsistencies in the context of acquisition and deems them as "errors" (Meier, 1982; Berk, 2003). However, we have observed that such mismatches in referential indexing also appear in the utterances of adult native signers. Thus, we believe they are not errors but rather naturally occurring mismatches.

## 2.4 Age of acquisition and the critical period

Research that explores the effects of age of acquisition on language processing and production provides insight into which aspects of language are (un)affected as a result of delayed exposure. One of the earliest studies in this field was conducted by Lenneberg (1967) who reports on deaf children's acquisition of English and proposes that there is a critical period during which an individual's ability to acquire language is at its peak due

to greater brain plasticity. Many acquisition studies on both spoken and signed languages later emerged and reported the components of grammar that were (un)affected by delayed exposure, one of the most famous being on Genie (Curtiss, 1977).

Although a plethora of studies have looked into age of acquisition effects in sign languages (e.g. Newport, 1990; Mayberry, 1995; Emmorey et al., 1995), not all of them explicitly draw a connection between their findings and their implications for the sensitive period. Berk (2003), however, neatly ties her observations back to what they suggest for the critical period. This study will attempt to do the same.

To better understand whether there is a critical period for verb agreement in sign languages, and if so, which specific aspects of agreement are affected by delayed input, one first needs to understand how verb agreement regularly develops in sign languages.

## 2.5 The acquisition of verb agreement in sign languages

There is no consensus in the literature on the exact onset and mastery of verb agreement in sign languages; however, it appears that proper usage is generally achieved around the age of 3. In the case of ASL, Meier (1982) studied three deaf children and found that they were able to correctly use agreement morphology at 3 years of age, although they continued to make omission errors afterwards. Casey (2003), on the other hand, observed 6 deaf children and first identified signs of agreement in ASL at the age of 1;6 and proper usage at 2;6. With regards to BSL, Morgan et al. (2006) found that one deaf child with deaf parents began to consistently produce agreement between 2;11 and 3;0. The authors state that before these ages, deaf children use word order to indicate who did what to whom without inflecting for agreement, producing sequences like $\text{POINT}_2$

ASK $POINT_3$ (“you ask him”) instead of $_2ASK_3$. Unfortunately, no studies have reported the age at which verb agreement is mastered in TİD.

To reveal the effects of delayed exposure to linguistic input, many researchers have employed various tasks to assess late-learners’ knowledge of syntax and morphology. Newport & Supalla (1990), for instance, report that the later deaf adults were exposed to ASL, the worse they performed on tests of ASL verbs of motion. Furthermore, Emmorey et al. (1995) recruited adult native, early and late ASL signers for one offline and one online task that tested participants’ sensitivity to errors in aspect and agreement; they found that while all groups were able to successfully identify grammatical errors in both aspect and agreement in an offline task, the early and late learners were not sensitive to agreement errors in an online task although they did recognize aspect errors. The authors argue that early and late signers may be able to better identify errors in aspect since it involves the semantics of the verb while agreement is purely syntactic as it marks arguments. Another grammaticality judgement task was conducted by Boudreault & Mayberry (2006) who tested syntactic structures of varying complexity (including simple and agreeing-verb constructions) and reported that performance declined as age of exposure to ASL increased.

With respect to the comprehension and production of basic word order, it seems that it is mostly unaffected by late exposure. This was observed in two separate picture matching tasks consisting of ASL sentences (Newport, 1990; Mayberry & Lock, 2003). In fact, consistent word order was even observed in homesign (Goldin-Meadow, 2003), a gestural system created by deaf children who receive virtually no linguistic input to communicate with family members, indicating that word order is a resilient property of language that is unaffected by language exposure.

Furthermore, one study also compares how late learners acquire LAVs and PAVs. Berk (2003) collected linguistic data from two deaf children, MEI and CAL, who were first exposed to ASL around the age of 6. She found that these two children frequently made errors with PAVs; some errors included agreement with the wrong referent or failure to set up and/or use space. Their native counterparts, on the other hand, made practically no errors with such verbs, demonstrating that late exposure had an effect. This is comparable to the findings of Quadros & Lillo-Martin (2007) who reported virtually no errors in agreement upon observing one native deaf child acquiring ASL and one native deaf child acquiring Brazilian Sign Language (LSB). Contrary to PAVs, LAVs did not pose a challenge for MEI and CAL; in fact, they performed nearly on par with their native counterparts. Regarding word order, MEI and CAL made heavy use of the canonical SVO order and barely attempted derived word orders that are permissible in ASL, similar to what has been observed with deaf adult late signers (Newport 1984). Based on these results, Berk (2003) argues that sensitive period effects are selective and exist only for purely formal features (which involve PAVs that agree with syntactic arguments) and not for semantic features (which are at play in LAVS that mark spatial locations). Moreover, she posits that late signers may not be aware of the mechanisms that underlie word order changes.

With respect to Figures and Grounds, many studies have found that children tend to omit the latter. For instance, Supalla (1982) reported that although children aged 5 and above used the correct classifier for Figures roughly 90% of the time, they often left out the Ground handshape. Similarly, Engberg-Pedersen (2003) and Tang et al. (2007) observed that even at 6 and 7, deaf children acquiring Danish Sign Language (DSL) and Hong Kong Sign Language (HKSL) had a tendency to omit the Ground handshape.

Morgan et al. (2008) found that the same holds for BSL at much younger ages as well; the authors analyzed a corpus and found very limited Ground descriptions up until the age of 2;6. Several studies have attributed this frequent omission to the fact that Figures and Grounds are almost always produced simultaneously in sign languages, which creates a challenge for young children (Supalla, 1982; Newport & Meier, 1985). Moreover, this may also have to do with the fact that children are more attuned to Figures than Grounds, as demonstrated by Göksun et al. (2009) who report that infants begin to recognize changes in Figure stimuli earlier than changes in Ground stimuli.

Regarding the acquisition of Ground-Figure ordering in TİD, Sümer et al. (2013) observed that while deaf preschoolers did not rely heavily on any specific ordering, deaf school-age children and adults had a tendency to produce Grounds before Figures. The same finding was reported for another set of TİD-speaking deaf adults in Özyürek et al. (2010). Sümer et al. (2013) argue that deaf preschool-age children may use both Ground-Figure and Figure-Ground order because they "find it hard to suppress Figure objects which can be more salient than Ground objects" (p. 23).

# CHAPTER 3

# RESEARCH QUESTIONS AND METHODOLOGY: PERSON AND LOCATION AGREEMENT

## 3.1 Research questions

This study aims to address the following research questions:

1) Is verb agreement sensitive to age of acquisition in TİD? If so, which specific constructions are affected by late exposure?
2) Does delayed exposure to linguistic input have an impact on the order in which Figures and Grounds are expressed in TİD?

To tackle the first question, two production tasks that elicited LAVs and PAVs were conducted and data were analyzed for faithfulness and any other potential differences/similarities between the groups. To explore the second question, the data obtained for LAVs were separately analyzed for Figure-Ground ordering.

We hypothesized that if verb agreement is an age sensitive phenomenon, then late signers should perform unlike native signers, possibly by exhibiting difficulties with faithfulness as it requires referent tracking. Furthermore, we predicted that agreement type (i.e. person vs. location) may also give rise to differences in performance, considering that the two categories have been observed to behave differently (e.g. Kwok et al., 2020). On the other hand, for Figure-Ground ordering, we predicted that late learners would demonstrate native-like performance, especially if the Figure-Ground principle is perceptually driven, as argued in the literature (e.g. Volterra et al., 1984; Napoli & Sutton-Spence, 2014).

## 3.2 Methodology

Two production tasks were carried out. A total of 32 signers (20 females and 12 males) between the ages of 18 and 51 (mean 34) were recruited for the first task. The number of native and late signers was evenly distributed, with 16 native signers and 16 late signers. The group of native signers consisted of deaf adults who were first exposed to TİD from birth by virtue of their deaf parents. The late signers, on the other hand, started receiving TİD input between the ages of 5 and 17, with a majority of participants reporting school age (5-7) as the onset.

Prior to the task, informed consent was obtained by the help of a deaf assistant who translated the written document into TİD. Participants were shown 7 stimuli consisting of 5 scenes targeted to elicit agreement person agreement (PAVs) (see Figure 1 for an example) and 2 scenes targeted to elicit location agreement (LAVs) (see Figure 2 for an example). While 4 of the stimuli were animated images, i.e. gifs, the remaining 3 were still images. The stimuli were created in Adobe Illustrator 2019. Participants were instructed to describe the event in the image/gif to a native signer who sat across them. Their responses were recorded using a camcorder.

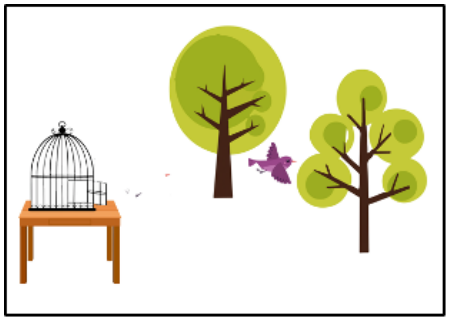


Figure 1. PAV-eliciting stimulus

Figure 2. LAV-eliciting stimulus

The second task had a similar design. A total of 27 signers (14 native signers and 13 late signers), all of whom had also been recruited for task 1, took part in this task. All of the 4 stimuli they were shown elicited location agreement, amounting to a total of 6 LAV stimuli and 5 PAV stimuli when combined with the first task. The stimuli in this task consisted only of still images. A complete list of the stimuli employed in both tasks is presented in Table 1. Unlike the first task, this task required participants to describe the event directly to the camera as if they were signing to a Deaf friend.

Table 1. Complete List of Stimuli for Agreement Elicitation Task

| Person Agreeing Verbs | Location Agreeing Verbs |
|---|---|
| 1. Woman (left) shouts at girl (right)<br>2. Man (right) calls firefighter (left)<br>3. Boy (left) shows painting to dad (right)<br>4. Boy (left) looks up at helicopter (right)<br>5. Woman (left) gives money to bank teller (right) | 1. Woman (left) puts a plant on a shelf (right)<br>2. Bird (left) lands on a tree (right)<br>3. Man with wings (right) flies to a tree (left)<br>4. Woman (left) picks up a pot from a table (right)<br>5. Dog with wings (left) flies to a tree (right)<br>6. Waiter (left) puts a cup on a table (right) |

It is worth noting that the stimuli were selected from a pool of data that were collected as part of a larger research project. Due to the exploratory nature of this project, in addition to the limited knowledge on TİD that existed when the project was first conceived, many aspects of the stimuli were not controlled for. One such aspect is the telicity of verbs. For instance, while in one static stimulus, a winged dog is oriented towards a tree, in another dynamic stimulus, the bird flies to and lands on the tree, thus completing the action. The criteria used to select these verbs included the transparency of agreement and a tendency to set up the signing space in the responses of signers. Moreover, events with more than one interpretation (e.g. GIVE GIFT being ambiguous between the action of giving a gift and taking/receiving a gift) were also avoided as it is

difficult to determine whether the signers perceive the arguments as undergoers or agents, i.e. the thematic roles they ascribe to arguments.

Similarly, the alignment of TİD has not been widely attested, therefore no distinction was made between unergative and unaccusative verbs in the creation of stimuli. However, a recent study has found that TİD appears to exhibit active alignment (Sevgi, 2019). Therefore, one might expect that since object agreement is mandatory in sign languages (Meier, 1982), the subject of unnaccusative verbs (which also start from underlying object position in a syntactic configuration) may also result in greater levels of agreement, as compared to the subject of unergative verbs.

In addition, the animacy of arguments was also not controlled for. Cross-linguistically, the inanimate indirect objects of ditransitive verbs like "give" surface as prepositional phrases, whereas animate indirect objects pattern with applicatives (see Marantz, 1993). Therefore, it is worth comparing how animacy interacts with agreement in indirect object position. We leave this to further research.

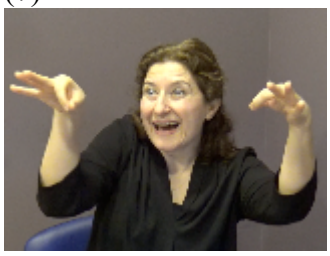
Overall, since both production tasks were virtually identical and had overlapping participants, with the only difference being the addressee of the signing (a native signer in Task 1 and a camera in Task 2), we decided to collapse the data and treat both as one.

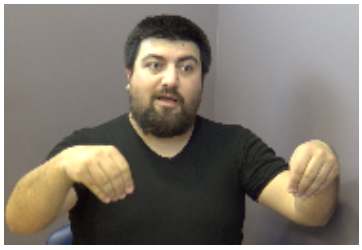
### 3.3 Analysis: LAVs vs. PAVs and Figure-Ground ordering

The data were coded in ELAN, an open-source software that allows for the annotation of video files (Sloetjes & Wittenburg, 2008). We introduced three tiers: predicate handshape, referent establishment, and faithfulness. In the first tier, we marked the particular form of the verb that was used. For instance, when the stimulus involved the

event of showing, 5 different forms of the verb ‘to show’ were used, 3 of which are provided in (7).

(7)


(a) SHOW_1


(b) SHOW_2


(c) SHOW_4

In the referent establishment tier, we marked the loci in which signers introduced the object of the verb. We segmented the signing space into three areas: “right (R)”, “left (L)” and “middle (M)”. There were also instances in which signers did not introduce the object (but produced only the verb); we labeled these “N/A”.

In the faithfulness tier, we marked the consistency between the loci in which objects were introduced and the loci with which the verb agreed, either via direction or orientation (see section 2.1.3). If there was a mismatch between the two, i.e. if an object was introduced on the right but the verb agreed with an object locus on the left, then we marked this as “false”. When there was no mismatch, we labeled this as “correct”. Since subject agreement has been observed to be optional (Meier, 1982; Padden, 1988), we opted not to include it in our analysis.

In our analysis of Figures and Grounds, we recorded the order in which they were produced for each stimulus in an Excel sheet, which was either “FG” (Figure-Ground) or “GF” (Ground-Figure).

# CHAPTER 4

# RESULTS AND DISCUSSION: PERSON AND LOCATION AGREEMENT

## 4.1 Results for faithfulness

For faithfulness, we recorded a total of 332 data points, 16 of which were excluded due to lack of argument indexing in the signing space. We found no appreciable difference between native and late learners across agreement types. In fact, as shown in Figure 3, both groups behaved quite similarly in that they were more faithful to the referential loci in location agreement as compared to person agreement. Both native and late signers demonstrated a stronger tendency to produce faithful responses when presented with LAV-eliciting stimuli as compared to PAV-eliciting stimuli. This demonstrates that age of acquisition does not affect faithfulness rates while agreement type does.

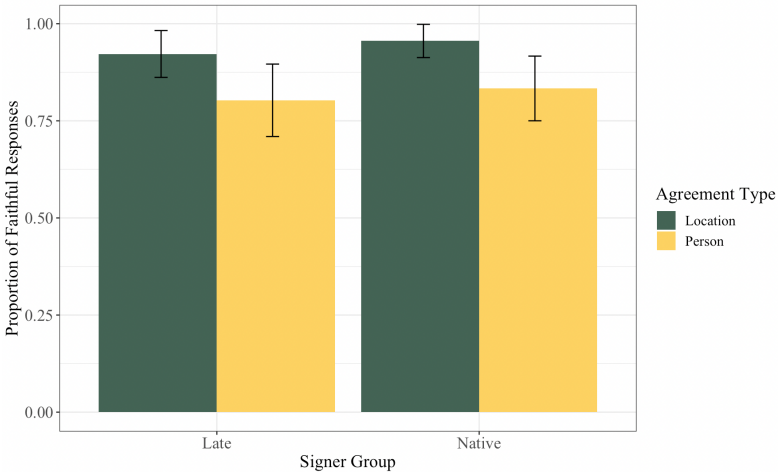



Figure 3. Proportion of faithful responses by agreement type and signer group

We fit the data to a regression model[5] with the following predictors: (i) agreement type (contrast: +0.5 location, -0.5 person) and (ii) signer group (contrast: +0.5 native, -0.5 late). The results are provided in Figure 4.

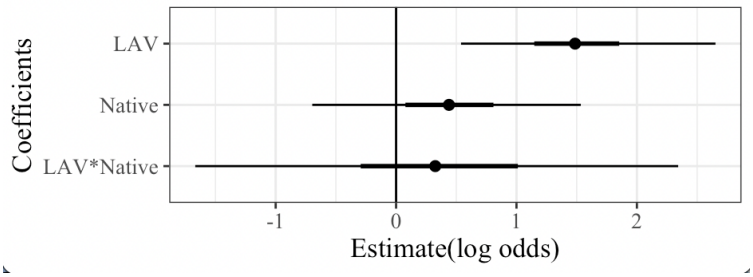



Figure 4. Model results fit to faithfulness with the predictors agreement type (LAV, PAV) and signer group (native, late)

Here, the estimate for LAV suggests that location agreeing verbs increased the likelihood of faithfulness as compared to person agreeing verbs. This can be inferred from the fact that the probability distribution of LAV lies entirely on the positive end of the scale. Moreover, the estimate for the coefficient native runs through zero, suggesting that signer group did not have an appreciable effect on faithfulness. For a more fine-grained analysis of the effect of signer group, we ran a hypothesis function[6] (provided by the brms package in R), which yielded the results provided in Table 2. In the posterior probability column, a value that is very close to 1.0 is required to infer that there is a strong effect. However, we found that this value to be 0.78, which is at most an indicator of a slight tendency. Thus, it is safe to conclude that signer group had only a weak effect

[5] The model description was as follows: brm(ResponseFaithful ~ AgreementType*SignerGroup + (AgreementType*SignerGroup|Participant). We were interested in how faithfulness interacted with agreement type and signer group. Moreover, in order to control for the variation that may be exhibited by each participant with respect to both variables, random effects were incorporated into the model through the portion of the code that reads (VerbType*SignerGroup|Participant).

[6] This hypothesis function returns an estimate of the predictor native being higher than 0.

on faithfulness. The final estimate (LAV*Native) shows the effect of nativeness and LAV combined. We may infer that the two combined do not have a noteworthy effect, given that the distribution falls on both the positive and negative ends of the scale.

Table 2. Results of the Hypothesis Function Native > 0 for Faithfulness

| Hypothesis | Lower Confidence Interval | Upper Confidence Interval | Posterior Probability |
|---|---|---|---|
| Native > 0 | -0.49 | 1.34 | 0.78 |

4.2 Results for Figure-Ground ordering

For Figure-Ground ordering, we recorded 172 data points and excluded 2 due to incomprehensibility. We observed that in contrast to faithfulness, the two groups differed in their ordering of Figures and Grounds, as shown in Figure 5. While native signers introduced the Ground first in 81% (SE: 0.04) of the trials, thus adhering more strictly to the Figure-Ground principle observed across sign languages, late learners only did so in 58% (SE: 0.06) of the trials. Thus, there was an effect of age of acquisition on the ordering of Figures and Grounds. Moreover, a broad survey of the results revealed that a majority of native signers (11/16) produced GF ordering in at least 5 of the 6 LAV stimuli, whereas this was not the case with late signers (4/16). Further research is needed to determine why all native signers do not produce GF ordering in 100% of their responses; however, one speculation may be that they are influenced by the ordering employed by the plentitude of late signers they interact with, considering that late signers make up a majority of the deaf population.

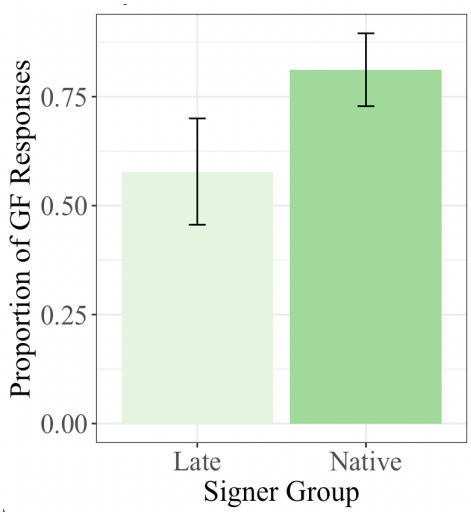


Figure 5. Proportion of Ground-Figure responses by signer group

For further inference, we ran a regression model[7] for the predictor signer group. As there is only one predictor, we opted to provide only the results of the hypothesis function, which returns CI values along with the posterior probability. The results suggest that being a native signer strongly increased the probability of eliciting a Ground-Figure response. As shown in Table 3, the hypothesis function revealed a strong effect of the predictor native since the posterior probability is 0.97, which is fairly close to 1.0. Thus, this confirms that nativeness (i.e. age of acquisition) had an appreciable effect on GF ordering, such that belonging in the group of native signers greatly increased the likelihood of producing GF responses.

Table 3. Results of the Hypothesis Function Native > 0 for Ground-Figure

| Hypothesis | Lower Confidence Interval | Upper Confidence Interval | Posterior Probability |
|---|---|---|---|
| Native > 0 | 0.13 | 2.33 | 0.97 |

[7] The code read as follows: brm(ResonseGroundFigure ~ SignerGroup + (SignerGroup|Participant). Thus, the interaction between signer group and GF ordering was calculated, and the variation that may appear within participants was controlled for.

## 4.3 Discussion

We had two main research questions, which are reiterated below:

1) Is verb agreement sensitive to age of acquisition in TİD? If so, which specific constructions are affected by late exposure?
2) Does delayed exposure to linguistic input have an impact on the order in which Figures and Grounds are expressed in TİD?

In response to our first research question, we found that verb agreement, more specifically the co-referencing by referential loci in the signing space and on the verb, is not sensitive to age of acquisition in TİD. Late signers exhibited similar levels of faithfulness to R-loci as native signers. In addition, the performance of both groups was affected by agreement type, with greater levels of faithfulness being exhibited for LAVs as compared to PAVs. This suggests that faithfulness, and thus referent tracking, is a resilient property of verb agreement in TİD and remains intact regardless of delayed input. Thus, it appears that there is no critical period for the faithfulness aspect of verb agreement in TİD.

This finding is noteworthy in that although the literature reports that agreement is generally mastered by the age of 3 in sign languages (Meier, 1982), most of the late signers in our study received initial TİD input at school age (roughly 5-7 years of age), yet they still performed on par with their native counterparts. In other words, the late signers in our study were able to compensate for the language (and more specifically, verb agreement) input they were deprived of during the ages when cognitive immaturity is heightened and allows for more successful language learning (see Newport, 1990 for her “less is more” hypothesis).

Furthermore, contrary to studies that have attempted to conflate person agreeing verbs and location agreeing verbs into a single category (Quadros & Quer, 2008; Laurenço & Wilbur, 2018), our findings corroborate the work of Berk (2003) and Kwok et al. (2020) and suggest that a distinction needs to be drawn between these categories. Our study has revealed differing levels of faithfulness to R-loci for the two verb types. When producing LAVs, they demonstrated greater levels of faithfulness, which supports the idea that these indexes are easier to track as they represent concrete space (Kwok et al., 2020) and mark semantic features (Berk, 2003), thus making them potentially easier to retain during discourse. On the other hand, we observed lower levels of faithfulness for PAVs, supporting the argument that the R-loci used in person agreement involve abstract grammatical features (Berk, 2003; Kwok et al., 2020). Based on this, we infer that the R-loci involved in PAVs are more fragile and create a greater challenge for referent tracking, regardless of age of acquisition. This is contra Berk (2003), who posited that sensitive period effects are selective and apply only to PAVs upon observing that the late learners in her study experienced virtually no difficulty with LAVs while they made several errors with PAVs. However, since native signers and late learners alike produced nearly identical levels of unfaithful responses in our study, we conclude that age of acquisition effects do not exist for the referent tracking aspect of verb agreement in TİD.

With respect to our second research question, we found that delayed exposure does indeed impact the ordering of Figures and Grounds. While native signers produced Grounds first in roughly 80% of the locative agreement trials, late signers only did so about 58% of the time. Thus, the native signers adhered more strictly to the Figure-Ground principle. We propose two possible explanations to account for this data: either

(i) Figure-Ground ordering is more linguistically, rather than perceptually, driven than previously believed, or (ii) late signers overgeneralize the canonical SOV word order of TİD, and also possibly more susceptible to get influenced by the Turkish ordering of Figures before Grounds.

The first possibility would suggest a counterargument to the idea that Figure-Ground ordering stems from a perceptual constraint and thus is a result of the visual modality (e.g. Volterra et al., 1984; Napoli & Spence, 2014). This is an unlikely explanation, given that it would be unexpected for native and non-native signers to follow different development paths in terms of perception. Rather, it may be that the deprivation of early linguistic input causes such differences in argument ordering. Support for this argument comes from Supalla (1982) who found that ASL acquiring children aged 5 and above used correct Figure classifiers almost all the time, while they often left out Ground shapes. Similar tendencies to omit Grounds were also reported for children aged 6-7 who were acquiring Danish Sign Language (DSL) (Engberg-Pedersen 2003) and Hong Kong Sign Language (HKSL) (Tang et al., 2007). In fact, greater attention to Figures was also observed at much younger ages for infants (Göksun et al., 2009). Thus, in their natural course of linguistic development, these children were not more attuned to Grounds, as would be necessitated by a perceptual constraint that posits larger objects are more salient and therefore precede smaller ones (i.e. Figures). It seems that the suppression of Figures is learned so that the Grounds can be expressed first, possibly through exposure to linguistic tools such as topicalization, and this may be the aspect of Figure-Ground ordering that is sensitive to age of acquisition.

The omission of Grounds by young deaf children and their placement in secondary position by late deaf adult signers of TİD may also be related to the

development of narrative skills and scene setting. Based on evidence from English and Hebrew, Berman (2001) suggests that story beginnings are heavily dependent on cognitive development and generally do not contain scene-setting elements in early stages since children have not yet developed a "representation of the listener" (Berman & Slobin, 1994). This neatly accounts for the absence of Grounds, which are part of the scene, in the speech of young children. With respect to the performance of the late signers, it has been shown that late L1 acquisition has adverse effects on overall development and causes cognitive delays (Hall, 2017). Such delays may be responsible for inhibiting the development of narrative skills in late learners. It is possible that late learners place more emphasis on the character rather than the background when describing an event due to incomplete narrative competence.

Another explanation as to why late signers produce the Figure before the Ground more often than native signers could be that the former overgeneralize the canonical SOV word order of TİD. In a Figure-Ground-Verb sequence (such as BIRD TREE PERCH), the subject comes first, followed by the oblique object and then the verb. A heavy preference for canonical word order among late learners is also reported in Berk (2003); the author found that late learners MEI and CAL were reluctant to use derived word order and posited that they may not have knowledge of the operations that allow for changes in word order. Alternatively, the late learners in the present study may also be influenced by the SOV word order of Turkish where the Figure Subject precedes the Ground Object.

To sum up, our findings suggest that age of acquisition effects exist for Figure-Ground ordering, i.e. the expression of arguments within an utterance, but not for the encoding of arguments on the verb.

# CHAPTER 5

# BACKGROUND: EXPRESSION OF NUMBER

Virtually all languages, regardless of modality, employ a mechanism to encode number, i.e. the presence of multiple entities and/or events; this plurality may be expressed on constituents such as the verb, noun, and adjective via morphological processes such as affixation, reduplication, and stem modification (Corbett, 2000). However, uniformity in the pluralization strategy that is adopted is not always observed within and across languages (Pfau & Steinbach, 2005). For example, a subset of nouns in a particular language may mark plurality through suffixation (e.g. *cat-s* in English), while other plural nouns in the same language may bear zero-marking (e.g. *deer* in English). Furthermore, the morpheme reserved for marking plurality may appear in different forms, i.e. it may exhibit allomorphy, depending on the phonological properties of the stem to which it attaches; for example, in Turkish the plural suffix *-lAr* surfaces with either a front vowel (-ler) or back vowel (-lar) depending on the final vowel in the stem to which it attaches. In addition, some languages, such as TİD, may mark the number of the human entities directly on the noun through number incorporation (Kubuş, 2008).

This chapter will explore how sign languages in general, and Turkish Sign Language in particular, mark the plurality of both nouns and events. In other words, it will investigate how number is expressed in both noun phrases (NPs) and verb phrases (VPs). Moreover, this chapter will offer comparisons of the pluralization strategies used in spoken languages and sign languages in both the nominal and verbal domain. Lastly, this chapter will present the results of a number elicitation experiment that recruits both

native signers and late signers of TİD. A discussion of the findings will serve not only to document such strategies, but also to compare the effects of delayed linguistic exposure on number marking in TİD, thus providing further insight into the critical period and aspects of number marking that are sensitive to age of acquisition.

## 5.1 The expression of number in the nominal domain

Languages make use of a plethora of strategies to express plurality in the nominal domain. Some frequent strategies adopted in spoken languages to mark plurality directly on the noun include affixation (e.g. *dog-s*), stem modification (e.g. *teeth* as the plural of *tooth*), and zero marking (e.g. *moose* to mean multiple moose). Another attested yet more scarcely encountered strategy is reduplication; this is observed in Warlpiri, which doubles the stem of a noun, such as *wati* meaning 'man', to express plurality, resulting in *wati-wati* meaning 'men' (Nash, 1980).

Similarly, sign languages have also been shown to mark plurality directly on the noun. The two main strategies that have been reported in the literature are complete reduplication and zero marking (see Pfau & Steinbach, 2006), both of which are observed in spoken languages, as demonstrated above. Reduplication as a means of expressing multiple entities has been documented for DGS (Pfau & Steinbach, 2006), ASL (Wilbur, 1987), BSL (Sutton-Spence & Woll, 1999), and LIS (Pizzuto & Corazza, 1996). However, as indicated in these studies, reduplication is subject to various constraints in each respective language, and thus is not entirely productive, like it is in spoken languages. In DGS, for example, only non-body-anchored nouns (i.e. signs that

do not make contact with the body) that are signed laterally or on the midsagittal plane[8] can undergo reduplication, whereas nouns involving complex movement[9] and body-anchored nouns bear zero marking in the plural (Pfau & Steinbach, 2006). In a similar fashion, LIS nouns can only be reduplicated when they are signed in neutral space[10] and lack complex movement, and body-anchored nouns can only be pluralized through zero marking (Pizzuto & Corazza, 1996). Thus, like in English and Turkish, phonological constraints determine the form of the plural marker in sign languages (see Pfau & Steinbach, 2006 for an in-depth discussion). In the case of TİD, there are conflicting views as to whether reduplication is a well-established pluralization strategy. While Kubuş (2008) observed instances of (sideward and in situ[11]) reduplication in his dataset, thus claiming it to be an attested pluralization strategy in TİD, Zwitserlood et al. (2013) argue that these are rare occurrences and seem to be severely constrained.

A number of pluralization strategies are available exclusively to sign languages, i.e. languages in the visual-gestural modality. One such strategy is the pluralization of single-handed classifiers/nouns through the use of two hands. Kubuş (2008) provides examples of such constructions in TİD; he explains that the single-handed classifier[12] for both CAR and APPLE can be expressed with two hands to indicate the presence of two objects. The double-handed articulation of single-handed signs to mark plurality has also been observed in British Sign Language (Kyle & Woll, 1985, as cited in Zwitserlood et

[8] This refers to the vertical plane that symmetrically divides the body in two.
[9] Complex movement involves the inherent specification for non-simple movements, such as circulating, as in the circular movement used to sign BICYCLE in DGS (Pfau & Steinbach, 2006).
[10] Neutral space describes the space in front of the chest, which is considered the default location (Padden 1990).
[11] In sideward reduplication, the sign is repeated along a horizontal plane. In situ reduplication, on the other hand, requires repetition in a single location.
[12] This means that the classifier is typically signed with one hand and does not require two hands.

al., 2013), Flemish Sign Language (Heyerick & Vermeerbergen, 2011, as cited in Zwitserlood et al., 2013), and Estonian Sign Language (Miljan, 2003). Similarly, in Austrian Sign Language (ÖGS), a two-handed sign, such as HIGH-BUILDING, can be made plural by introducing a repeated alternating movement[13] (Skant et al., 2002, as cited in Pfau & Steinbach, 2006). In addition, localization is also widely used to indicate plural referents. In this strategy, nouns/classifiers are mapped onto the signing space to demonstrate their spatial configuration. For instance, Zwitserlood et al. (2013) observed multiple occurrences of localization in their TİD dataset, and they found that the precise number of referents was replicated for a smaller set of nouns; they analyze such structures as "instances of a basic predicative root that is articulated simultaneously with a referential device" (p. 286). To put it differently, they ascribe a predicative property to such forms. The idea that spatial localization bears a predicative meaning has also been posited by Herbert (2016) based on a subset of the DGS examples in Pfau & Steinbach (2005). This claim has also been made by Kubuş (2008) for localized classifiers in TİD; he observed that there were instances when signers first signed the number of entities, e.g. ÜÇ ARABA ('three car'), then reiterated the presence of multiple entities with a two-handed classifier, e.g. ARABA.CL-2H ('CAR.CL-2H'), and completed the utterance with VAR ('there are'). Based on this observation, Kubuş (2008) ascribes a predicative feature to classifiers, as opposed to attributive. Moreover, since these classifiers do not always come after a quantifier-noun pair, he argues they are optional in attributive adjective phrases, which he argues is an indicator that "plurality in TİD can be distributed within a clause and that (optional) agreement relations between the

[13] Alternating movement refers to instances when the hands move one after another.

pluralized noun (...) and the classifier predicate (...) can hold" (p. 129). Furthermore, Pfau and Steinbach (2006) argue that although such localized classifiers do act as a means of marking plurality, they differ from other strategies, such as reduplication, in that their semantic interpretation also encompasses the spatial location of referents; thus, they conclude such constructions are verbal agreement markers. All in all, a number of unique pluralization strategies are employed by languages in the visual-gestural modality, and these include the addition of a second hand for single-handed signs, the incorporation of alternating movement for two-handed signs, and the spatial localization of multiple entities.

Along with inflections on the base noun, languages also indicate plurality through the use of modifiers, such as numerals and quantifiers, in conjunction with the base noun to form a phrase (e.g. *five cat-s)*. In addition, they also show variation with respect to NP-internal number agreement, i.e. the plural inflection of both the modifier and the noun within the NP. One language that does allow plurality to be expressed more than once within the NP is English. To exemplify, in the phrase *two cat-s*, both the modifier *two* and the base noun *cat* bear plural features; the former is inherently expressed whereas the latter is explicitly expressed through the plural suffix *-s*. Turkish, on the other hand, only allows for plurality to be expressed once within the NP. To demonstrate, in the phrase *iki kedi* (meaning 'two cats'), only the numeral *iki* ('two') bears plural features, whereas the base noun *kedi* ('cat') is without plural marking. A phrase such as **iki kedi-ler*, in which a numeral is present and the noun it modifies bears the plural suffix -lAr, would be deemed infelicitous. A similar kind of variation is observed across sign languages. For instance, while DGS does not allow for the base noun to bear plural marking when its modifier expresses plurality, that is the

reduplication of the base noun is blocked when modified by a quantifier (Pfau & Steinbach, 2006), ÖGS (Skant et al., 2002) and LIS (Pizzuto & Corazza, 1996) do appear to mark plurality on both the modifier and noun. To illustrate, Pfau & Steinbach (2006) provide the example in (8), in which the reduplication of a base noun to mark plurality is ungrammatical when it is accompanied by a numeral modifier. In LIS, on the other hand, nominal reduplication can optionally occur when accompanied by a quantifier, as demonstrated in (9), an example borrowed from Pizzuto & Corazza (2006).

(8) a. *FIVE BOOK++
b. FIVE BOOK DGS, Pfau & Stainbach (2006, p. 170)

(9) a. TOWN MANY
b. TOWN+++ MANY LIS, Pizzuto & Corazza (1996, p. 176)

In addition, there are several types of modifiers that can appear next to the base noun in sign languages to indicate plural referents. To narrow the scope of this discussion, this section will concentrate solely on TİD, as it is the main focus of the present study. Two studies that document the modifiers used for plural marking in TİD are Kubuş (2008) and Zwitserlood et al. (2013). In an elicitation task that measures how native signers describe static images containing various arrangements of multiple objects, Kubuş (2008) found that quantors, or numerals such as İKİ (‘two’) and ÜÇ (‘three), were frequently used, particularly to describe smaller, more countable groups of objects. Moreover, he recorded that when describing greater quantities of objects, signers frequently made use of adjectives bearing plural meaning, such as ÇOK (‘many’), SIRA (‘lined up’), KALABALIK (‘crowded’), and KARIŞIK (‘mixed’). In addition, he observed that the different features of multiple objects in a group can be

listed to indicate plurality; the example he provides is the utterance YILDIZ MAVİ SARI MOR (STAR BLUE YELLOW PURPLE) used to indicate the presence of three stars. In a similar elicitation task and an independent analysis of spontaneous data, Zwitserlood et al. (2013) found that numerals and quantifiers were also often used, and they observed that while numerals appeared both to the right and to the left of the noun, quantifiers rarely preceded the noun.

Another morphological process employed by TİD to mark the plurality of nouns is numeral incorporation, i.e. the simultaneous articulation of a number and noun. This strategy was reported in both Kubuş (2008) and Zwitserlood et al. (2013); the former study found that entity classifiers used for human beings could also bear number information for groups of up to 4 individuals, and the latter found that this strategy was usually used for nouns that denote time measurements, such as WEEK, along with the sign for GRADE. An example is provided in (10), in which the signer articulates all features of the sign WEEK but modifies the handshape of the dominant hand to include the numeral TWO. Moreover, Zwitserlood et al. (2013) argue that, in TİD, numeral incorporation involves "the simultaneous combination of phonologically underspecified lexemes" (p. 281). Thus, they suggest that it does not apply to all nouns but is available only to a limited set

(10)

TWO^WEEK
'Two weeks' Gökgöz (2020, p. 298)

Overall, numerous strategies are utilized to mark plurality in the nominal domain, and not all strategies are employed by both the spoken and signed modalities. In the visual-gestural modality in particular, number can be marked directly on the noun. This can be achieved through the reduplication of a noun, the two-handed articulation of single-handed signs, or the introduction of alternating movement in two-handed signs. Furthermore, nouns and classifiers can be localized, i.e. signed in multiple locations, to indicate their plurality in addition to their spatial arrangement. Additionally, numerals and quantifiers can also be used to modify the base noun, and in such quantifying phrases, there may or may not be number agreement between both constituents, depending on the language. Lastly, number can simultaneously be articulated with a noun or classifier through number incorporation to express the exact cardinality of referents in a given event.

## 5.2 The expression of number in the verbal domain

As mentioned in previous chapters, agreeing verbs also inflect for number. The literature proposes the following values for number in sign languages: singular, dual, exhaustive, and multiple (Klima & Bellugi, 1979, as cited in Rathmann & Mathur, 2003; Padden, 1983). Singular involves the presence of a single entity (i.e. a singular indirect object in "He gave a gift to one person"), dual involves two entities (e.g. "He gave a gift to two people"), exhaustive expresses the distribution of events over persons (e.g. "He gave a gift to each person"), and multiple refers to larger crowds of individuals (e.g. "He gave a gift to all attendees."). In ASL, dual agreement is encoded with the signing of the verb towards two locations, exhaustive agreement is indicated by directing the verb at

multiple locations along an arc, and multiple agreement is marked with a sweeping movement (Klima & Bellugi, 1979). It is important to note that when discussing number agreement, the sign language literature has generally referred to agreement with multiple indirect objects, hence the examples provided above, as opposed to subject and direct object agreement. This is likely due to the fact that while (indirect) object agreement has been observed to be mandatory, subject agreement has commonly been deemed optional (Meier, 1982). In fact, when both a plural subject and object are present, the verb takes on plural object agreement, and the subject is expressed by alternative means, such as a noun phrase and overt pronouns (Sandler & Lillo-Martin, 2006).

Nevertheless, number agreement with the subject does readily occur, as subjects can be marked for dual (e.g. "The two of them ask me") and exhaustive plurality in ASL (Sandler & Lillo-Martin, 2006). Moreover, although not ascribed as a form of number agreement, the verb can express the exact cardinality of agents through number incorporation, or the inclusion of a numeral in a sign (Liddell, 1996). The notion of number incorporation has often been treated as a word formation process by which signs for units of measurement (e.g. WEEK, MONTH, AGE, DOLLAR) take on numeral marking, resulting in the simultaneous expression of numerical value and the base sign (e.g. TWO-WEEK). One form of number incorporation that is seldom discussed is the inclusion of numerals within the sign PERSON, which has been reported for Russian Sign Language (Semushina & Mayberry, 2019), ASL (Jones, 2013), Japanese Sign Language (Ktejik, 2013), Taiwan Sign Language (Fischer et al., 2011), and Estonian Sign Language (Miljan, 2003). In these studies, PERSON is listed among other nominal categories that permit numeral incorporation. Moreover, even though the combination of the sign for PERSON and a number sign can function as a predicate, it is not treated as a

device for marking subject number. Fischer et al. (2011), for example, show that the incorporation of FIVE and PERSON (five extended fingers) can mark the number of agents doing the action (e.g. "Five persons get onto an airplane") in Taiwan Sign Language[14]. Similarly, Miljan (2003) mentions that the sign for WANDER is articulated with a downward V-handshape (i.e. with the index and middle finger pointing downward) in citation form, but it is produced with an upward V-handshape when indicating that two people are performing the event of wandering. As the numeral incorporated into the sign PERSON[15] expresses the exact cardinality of the doers of the action, this phenomenon will be treated as an instance of number agreement with the subject in this study.

Furthermore, the plurality of events can also be expressed on the verb, which is generally considered a form of verbal aspect but can also be treated separately as "verbal number" (Corbett, 2000). Leaving this discussion aside, it is interesting to compare the strategies adopted by spoken and sign languages to mark event number. Spoken languages that do encode event number directly on the predicate generally do so through modifications to the verbal stem, as in the example from Hausa provided in (11) (Eulenberg, 1971, as cited in Corbett 2000).

(11) a. naa aikee su
I send them
b. naa a''aikee su
I send.PL them Hausa, Eleunberg (1971, as cited in Corbett, 2000, p. 246)

[14] Fischer et al. (2011) do not consider numerals in predicates as incorporated forms that express both cardinality and the base form of the sign. Instead, they posit that they are merely numerals that replace the lexical sign they modify.

[15] We do not exclude the possibility that the numeral may in fact be incorporating with the predicate, and not the sign for PERSON, per se. However, what is crucial is that the numeral on the predicate indicates the exact number of agents performing the action, and thus exhibits agreement-like properties.

The subject is singular and the object is plural in both, yet they have different interpretations. While (11a) can only mean the sending was done at the same time to the same place, (11b) can mean the sending was done at different times to different places, thus indicating a multitude of events. In sign languages, the typology of event plurality has not been extensively discussed. However, in a study on French Sign Language, Kuhn & Aristodemo (2017) explain that event plurality can be marked through the exact repetition of a verb (12a) and the alternating repetition of a verb (12b).

(12) a. JEAN CAMERA BRING FORGET-rep.
'John repeatedly forgot to bring a camera.'

b. FRIEND POSS-1 IX-arc CAMERA BRING FORGET-alt.
'My friends each forgot to bring a camera.'

LSF, Kuhn & Aristodemo (2017, p. 2)

Here, exact repetition expresses the distribution of sub-events over time while alternating repetition indicates that sub-events are distributed across participants. This phenomenon may be unique to French Sign Language, and further research in this field will reveal whether event plurality (or pluractionality) is manifested in different forms in other sign languages.

One strategy to mark event number that is seldom mentioned in the sign language literature, as it may seem relatively straightforward, is the one-to-one correspondence between the number of events and the iterations of verb movement (e.g. Coppola et al., 2013; Pfau & Steinbach, 2006). To exemplify, if one event (e.g. JUMP) is performed by three different people one after another, resulting in three separate events, this can be expressed by articulating the complete trajectory of the verb once for each doer of the action (e.g. producing JUMP three times, beginning from the starting point of the action and stopping at the end point). This differs from the pluractionality

described above as it involves the exact number of times an event is performed, as opposed to its continuous occurrence over time.

Overall, verbs in sign languages can encode the number of objects (e.g. Sandler & Lillo-Martin, 2006), the number of subjects (e.g. Miljan, 2003), the reoccurrence of events over time (e.g. Kuhn & Aristodemo, 2017), and the exact iterations of events (e.g. Coppola et al., 2013). This study is concerned primarily with the expression of subject number, object number, and event number, and more specifically, dual and trial plurality, in both the nominal and verbal domain.

### 5.3 The acquisition of number expressions

In order to express plurality, children must first understand the concept of numbers and the lexical items that represent them. One dominant view posits that in order to properly use number words, young children first need to learn the fundamental principles of counting (Gelman & Gallistel, 1978, as cited in Musolino, 2004). This is further facilitated when languages employ grammatical number that marks a distinction between singular and plural, such as English (e.g. *cat* vs. *cat-s*) and Russian (Sarnecka et al., 2007). In a Give-N task, Sarnecka et al. (2007) found that a greater number of English and Russian learners understood the meanings of numerals as compared to children acquiring Japanese, a language which does not distinguish between the singular and plural. In fact, when an even more fine-grained number distinction is made in the grammar, such as the the singular-plural-dual divide in Slovenian and Saudi Arabic, children are better at understanding number words, such as *two* (Almoammer et al.,

2013). Taken together, these studies demonstrate that the grammar shapes knowledge of numerical concepts.

Sign languages are seemingly advantageous in terms of number acquisition as they feature "number-to-number iconicity" (Taub, 2001), whereby the number of extended fingers directly corresponds to the number of modified entities. This iconicity holds for at least the numbers ONE to FIVE in many sign languages, as reported in a survey of 92 sign languages (Semushina & Fairchild, 2019). However, findings regarding the role of iconicity in the acquisition of sign language are conflicting. While one study has found that children as young as 2-3 can detect iconicity in number signs (Wiese 2003), another has suggested that iconicity does not seem to play any role in the acquisition of number representations based on a comparison of English learners' and ASL learner's knowledge of the numbers 1-5 (Carrigan et al., 2018). Thus, iconicity may in fact not be a facilitator for the acquisition of numerals.

After mastering number concepts, children need to incorporate that knowledge into their production of agreeing verbs that mark number. This is no easy feat, given the fact that such predicates require the appropriate use of directionality, movement, and handshape. In fact, deaf children do not fully acquire the first component, i.e. directionality, until the age of 3;0 (Kantor, 1982, as cited in Hou, 2013; Morgan et al., 2006). Movement also poses a challenge for young children, particularly when used with classifier signs (Kantor, 1980). With regards to handshape, relatively fewer errors are made by young children, again when classifiers are not involved (Kantor, 1980). For example, while 3-year-old ASL learners can correctly produce the V-handshape in signs like SEE and TWO, they have difficulty using the same handshape as a by-legs classifier (Kantor 1980). The same study found that these children were also able to articulate the

sign THREE, but were unable to use the same handshape as an entity classifier cross-referencing certain vehicles. Given these complexities, Newport & Meier (1985) have argued that deaf children need to be exposed to abundant input in order to master the subparts of verbs of motion and location. It seems that it is not until age 5 that ASL learners are able to correctly articulate agreeing verbs (Supalla, 1982, as cited in Conlin-Luippold & Hoffmeister, 2013).

Although there is a substantial body of literature devoted to the acquisition of agreeing verbs, as described above, research on the acquisition of plural marking in such verbs is rare. One study by Hou (2013) recruited deaf children aged 3;4 to 5;11 to test their production of multiple, exhaustive, and dual plurality and compared these results to the performance of adults. Hou found that children in all age groups often omitted plurality, which is attributed to its conceptual complexity and the possibility that children may conceive plural referents as one collective group. Thus, it appears that plural marking in directional verbs is mastered well beyond the age of 5. Interestingly, the same study reports that adults also omitted plurality when producing directional verbs, suggesting that it is optional in the grammar. This further complicates the acquisition of verb agreement since children are already faced with the challenge of learning that subject agreement is optional whereas object agreement is obligatory (Hou 2013). In addition, one study has also suggested that the plural forms of agreeing verbs may be uncommon in language directed towards children (Mathur & Rathmann, 2010, as cited in Hou, 2013). Thus, the protracted development of plurality in agreeing verbs is most probably a consequence of a number of factors.

Some studies have also investigated age of acquisition effects in the description of plural entities. Conlin-Luippold & Hoffmesiter (2013), for instance, found that native

deaf signers scored higher than late signers on a Plurals and Arrangement Test (63% vs. 55%, respectively) that required the use of classifiers to describe various spatial arrangements of objects. However, the same study reports that as their age progressed, late signers demonstrated an increased understanding of agreeing verbs and plural classifier constructions, suggesting that "[deaf children of hearing parents] were able to readjust their internal grammars in accord with the rules of ASL" (p. 11).

The effects of delayed linguistic exposure have also been investigated in the production of classifiers. Newport (1988), for instance, found that adult late signers of ASL used classifiers less frequently than their native counterparts and opted for less complex forms, like lexical verbs. Similarly, Karadöller et al. (2017) reported that late signers of TİD did not demonstrate a strong tendency to use classifiers, as compared to native signers, and preferred more simple forms. Furthermore, in descriptions of multiple objects with various spatial arrangements, Semushina et al. (2020) observed that late signers used classifiers with less frequency than native signers and often did not use plural marking at all. Interestingly, however, the authors report that the forms preferred by native signers also included classifiers that did not feature plural marking.

Moreover, the timing of language exposure has been shown to be crucial for the production of ASL verbs of motion. Newport (1988) reports that only deaf children who receive language input from birth can perform morphological analysis by incrementally building onto the morphology of verbs of motion. The same study posits that early signers (exposed to ASL between 4 to 6 years of age) and late signers (exposed to ASL after the age of 12), on the other hand, treat verbs of motion as unanalyzable lexical items. This is evidenced by adult late signers' frequent use of frozen forms in inappropriate contexts. An example of a frozen form that is provided is the verb FALL

(a downward V shape produced with an arm movement and pivot path), which has the features of a human classifier but can also be used for inanimate objects. Thus, very early language exposure is necessary to analyze the subparts of verbs of motion and produce increasingly complex forms (Newport, 1988).

# CHAPTER 6

# RESEARCH QUESTIONS AND METHODOLOGY: EXPRESSION OF NUMBER

## 6.1 Research questions

In previous chapters, we explored whether verb agreement, and more specifically faithfulness to R-loci, were sensitive to age of acquisition. If that was the case, we wanted to tease apart the specific constructions that were affected by delayed exposure, leading to a comparison of PAVs and LAVs. Our results demonstrated that person information, or rather the expression of loci carrying person information, was not affected by delayed input. In this chapter, we explore whether another phi feature, namely number information, is sensitive to age of acquisition. In other words, our research questions are as follows:

1) Does delayed exposure to linguistic input have an impact on the expression of number in TİD?
2) Do native signers and late signers differ in their production of number in the nominal and verbal domain?

In pursuit of the answer to these questions, we carried out an elicitation task and compared the responses of native signers and late signers of TİD.

## 6.2 Methodology

We conducted an elicitation task with 31 signers of TİD. While 15 participants were native signers, 16 were late signers. Moreover, 16 signers were male while 15 were female, and their mean age was 35 (range: 24-51). All of these participants were also recruited for the verb agreement task described in previous chapters. To reiterate, in this study, native signers are defined as deaf individuals who were born to deaf parents and started receiving TİD exposure from birth, whereas late signers are defined as deaf individuals who have hearing parents and first received TİD input when they started school (age 5-7).

Participants were shown various stimuli consisting of animated gifs in randomized order, and they were instructed to describe the stimuli to a deaf addressee sitting opposite them. This study analyzed responses for 8 of the stimuli. Half of the stimuli contained plural objects while the other half contained plural subjects. Furthermore, the number of plural entities was either two or three, and the events were either performed sequentially or simultaneously. The stimuli are listed in Table 2. The intransitive verb JUMP was used in all four plural subject stimuli. Meanwhile, in all plural object stimuli, the ditransitive verb PUT was used, and only the number of the direct object was manipulated, with the subject and goal remaining singular.

Before the experiment was administered, informed consent was obtained through a native signer who translated the written document requesting consent into TİD. Throughout the task, all responses were recorded using a video camera.

Table 4. Stimuli for Number Elicitation Task

| | | |
|---|---|---|
| Plural Subject | | |
| Dual number | Simultaneous events | Two kids jump from one trampoline to another at the same time. |
| | Sequential events | Two kids jump from one trampoline to another one by one. |
| Trial number | Simultaneous events | Three kids jump from one trampoline to another at the same time. |
| | Sequential events | Three kids jump from one trampoline to another one by one. |
| Plural Object | | |
| Dual number | Simultaneous events | A man picks up two cups and puts them on a shelf at the same time. |
| | Sequential events | (For two times and two different cups) A man picks up one cup and puts it on a shelf. |
| Trial number | Simultaneous events | A man picks up three apples and puts them on a shelf at the same time. |
| | Sequential events | (For three times and three different apples) A man picks up one apple and puts it on a shelf. |

## 6.3 Analysis

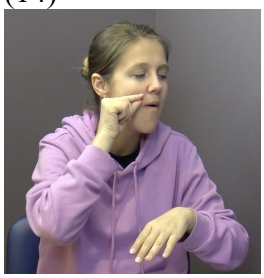
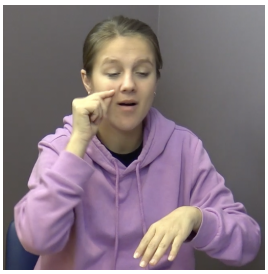
In our analysis, we examined how number is expressed both in the nominal domain and in the verbal domain. To tackle the nominal domain, we first looked at whether number was expressed at all within the NP used to introduce plural entities during scene setting. If it was, we recorded the form that was used. To exemplify, if the stimuli contained two boys jumping, we checked for the expression of this duality in the NP used to introduce the entities in a scene. The most common strategy for marking this duality is the production of a numeral followed by a noun (e.g. TWO CHILD), as shown in (13).

(13)


TWO CHILD
‘Two children’

However, as mentioned above, TİD employs a number of strategies to express multiple entities (Zwitserlood et al., 2013; Kubuş 2008); thus, any alternative method to mark the multitude of entities was accepted as number marking, even if a numeral was not explicitly articulated. This is illustrated in (14). To indicate the presence of two people, the signer makes contact with her cheek twice when producing PERSON while simultaneously shifting her gaze to look in two different directions. Therefore, she is marking duality with an alternative method that does not contain the numeral TWO, but does indeed specify the presence of two entities.

(14)

$\text{PERSON}_a$ $\text{PERSON}_b$
‘Two people’

An additional strategy that encodes number is the use of a noun-adjective sequence to mark each of the entities in a scene. This type of plural device was previously reported for TİD in Kubuş (2008). To exemplify, when presented with

stimuli containing two cups, one red and one green, the signer in (15) first produced CUP and RED, followed by CUP and GREEN. Each noun-adjective pair modifies one entity, and therefore this is considered a complete response which marks dual number.

(15)

CUP RED CUP GREEN
'One red cup, one green cup'

In addition, there were also instances in which a noun was followed by a sequence of adjectives that modified each of the existing entities, such as CUP RED GREEN in (16). For now, we leave a detailed semantic and syntactic analysis of such constructions to further research.

(16)

CUP RED GREEN
'One red one green cup'

A final strategy that expresses number is the articulation of a single-handed sign with two hands. This is illustrated in (17). The signer produces CUP with both hands to indicate the presence of two cups. This type of plural marking device was only observed once in the data.

(17)

RH: CUP
LH: CUP
‘Two cups’

If any of the above-mentioned strategies were employed, the response was considered to contain number information. Furthermore, we also marked the absence of number marking. If only a bare noun was produced during scene setting, e.g. CHILD in neutral space, we marked this response as lacking number features. We analyzed responses to plural-object stimuli in a similar fashion. That is, we checked whether any strategies were employed to mark the presence of multiple objects. We created the following tiers in ELAN (Sloetjes & Wittenburg, 2008) to record the presence of number features along with their form: num-on-subject, subject-form, num-on-object, object-form. If the response contained number features, we marked them as “yes” in the num-on-subject and num-on-object tiers; if not, we marked them as “no”. Moreover, we specified the exact form used to describe the entities in the subject-form and object-form tiers. For example, the response in (13) was marked as “num+N” to indicate a numeral was produced followed by a noun. Meanwhile, (14) was marked as “N+doublegaze”.

To explore number agreement in the verbal domain, we examined how, and if, number was expressed on the verb. To this end, we recorded the verb type, hand number, and number of repetitions used by each signer in response to each stimulus. The first heading, verb type, was divided into five categories: entity classifier, handling

classifier, number classifier, lexical verb, and lexical noun. This study will not delve into the complexities of classifiers, as the main focus is to describe and offer a comparison of how native signers and late learners produce number agreement. The reader is referred to Supalla (1982) for an in-depth discussion on classifiers. However, we will briefly discuss the meaning of each of the classifiers marked in the annotation.

Entity classifiers are used to represent the whole of an object. For example, the downwards V-handshape and the V-hooked handshape in TİD were used quite often to describe the event of jumping. The index and middle finger represent the legs of a person and their downward orientation shows that the entity is upright. Handling classifiers, on the other hand, represent how the hand manipulates an object. To exemplify, signers used the hooked flat extended shape, in which all fingers are bent as if to grasp a round object, to represent the carrying of an apple from one place to another. Lastly, what we have deemed number classifiers are incorporated forms consisting of the combination of an entity classifier (an upright index finger) and a numeral. To illustrate, the V-handshape pointing upwards was used to represent two individuals jumping at the same time. Each upward finger represents a separate individual and the entire form simultaneously expresses the number two, as in (18). When a number classifier was used, we recorded the exact number in parentheses.

(18)

RH: TWO

Another verb type is lexical verb. These predicates do not bear any classifier-like properties as they do not represent the size or shape of the entity that is involved in the event. They are the citation form of a verb that one would find in a dictionary. An example of a lexical verb is provided in (19). The signer is producing PUT with her right hand to describe the event of putting an apple on the bottom-most shelf. This handshape is lexical since it can be used to express the placement of objects with different shapes and sizes, and the configuration of the fingers are not modified according to the physical properties of the object being carried. In other words, the fingers are not curled inwards to represent the roundness of the apple that is being moved, as is the case with classifier predicates that depict the physical properties of the object.

(19)

RH: PUT

The remaining verb type is lexical noun. With these types of verbs, the lexical noun that is affected by the action, i.e. the theme, is used to express the event. For example, in (20), the signer produces CUP with both hands in a sideways trajectory to indicate two cups are being carried.

(20)

RH: CUP
LH: CUP

In addition to verb type, we also took note of the number of hands used to produce a verb. We marked this as either “bi” if two hands were used and “mono” if a single hand was used.

Lastly, we coded the number of repetitions used in the articulation of a predicate. These repetitions refer to the number of times a signer articulated a complete trajectory, starting from the beginning point of an event and stopping at the end point. To exemplify, in her description of a stimulus containing two boys jumping one after another, the signer in (21) first starts the jumping movement from the left of the signing space and ends it on the right. She then repeats the same movement for the second participant in the event. Thus, the number of repetitions in this response is two. The exact number of repetitions was indicated in parentheses. If the verb was only produced a single time, this was marked as “once”.

(21)

Two complete iterations of the verb JUMP (indicated with an entity classifier)

To sum up, when annotating the verb form produced by signers, we recorded the verb type, hand number, and repetition number. The template we used is provided in Figure 6. To illustrate, the verb form in (20) was annotated as "ent-CL_mono_repeated(2)", meaning an entity classifier was used with a single hand to produce the verb, and this was repeated twice.

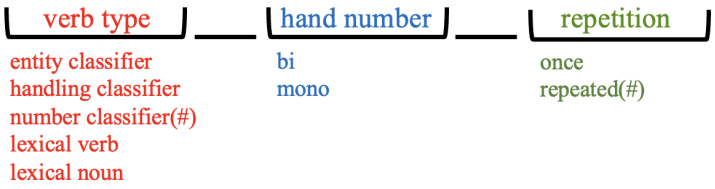



Figure 6. Template for annotation of verb form

Furthermore, we also coded the completeness of the responses. By completeness, we mean the full expression of all plural entities and events. To mark this, we created a rubric listing the combinations of verb types, hand numbers, and repetition numbers necessary to convey all the plural entities and events in a given stimulus. In the plural-subject stimuli, there were either two subjects or three subjects, and these subjects either performed one event altogether at the same time (simultaneous event), or they performed one event one by one (sequential events). In order to be considered complete, a response to a dual-subject/simultaneous event stimulus (i.e. two boys jumping from one trampoline to another at the same time), for example, would need to contain either a single-handed number classifier representing two entities or a double handed entity classifier; the number of movements would need to be one. This is summarized in Figure 7. Another complete response for this stimulus would be the use of a double-handed

number classifier incorporating the number one on each hand; however, there was only one occurrence of this verb form in the data.

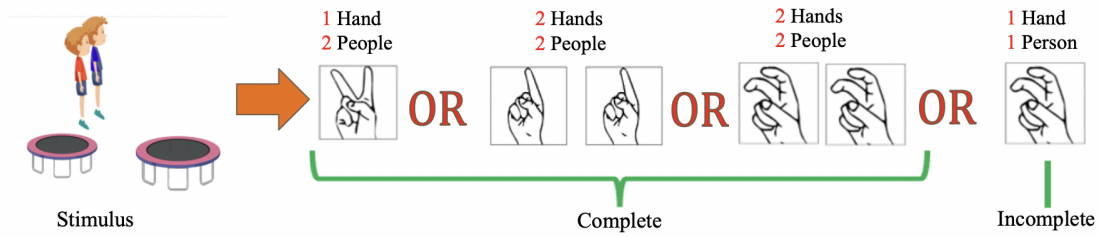
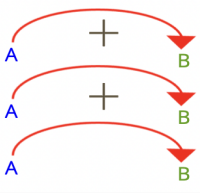
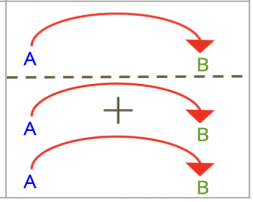



Figure 7. Types of complete and incomplete responses for a dual-subject/simultaneous event stimulus[16]

When analyzing responses to sequential event stimuli, i.e. stimuli containing more than one event, we counted the number of full movements, which went from the starting point of the event (A) to the end point (B) . For stimuli containing two events, we marked responses with two full movements as "complete" and one movement as "incomplete". On the other hand, for stimuli containing three events, we coded three movements as "complete", and we marked one movement and two movements as "incomplete". This is summarized in Table 5 below.

Table 5. Movement Criteria for Sequential Event Stimuli[17]

| Number of Events | Complete Response | Incomplete Response |
|---|---|---|
| *Two*<br>e.g. Two kids jump from one trampoline to another one by one. |  |  |
| *Three*<br>e.g. Three kids jump from one trampoline to another one by one. |  |  |

[16] The handshapes are taken from Kubuş (2008).

[17] The dotted line indicates that either of the two responses were considered incomplete.

Moreover, when analyzing agreement with object number, we checked primarily for hand number. For example, if two objects were present, we marked responses in which bimanual handling classifiers or lexical signs were used as "complete" and those with mono-manual handling classifiers or lexical signs as "incomplete". To illustrate, in response to a stimulus in which a man picks up two cups from a table and puts them on a shelf, the signer in (22) produces the lexical sign CUP with two hands to indicate the duality. Thus, he provides a complete response by representing the exact number of plural entities. In (23), on the other hand, the signer produces a single-handed lexical sign in response to the same stimuli containing two cups. Therefore, her response is incomplete as it does not represent two entities but rather one.

(22)

RH/LH: $CUP_a$ $CUP_b$
'[A man] moves two cups from point a to b.'

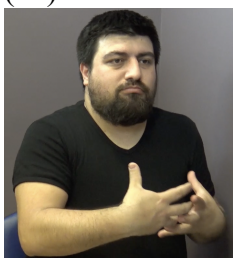
(23)

RH: $CUP_a$ $CUP_b$
Intended: '[A man] moves two cups from point a to b.'

Furthermore, when three objects were present in the stimuli, hand number was yet again an indicator of a complete response. However, since it is not physically

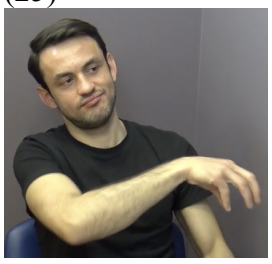
possible to sign with three hands, the use of two hands to represent a group of entities was deemed “complete”. For example, when shown a stimulus containing a man carrying three apples from a table to shelf, the signer in (24) produced a bi-manual handling classifier with interlocked fingers to indicate multiple objects were being carried from one location to another. In addition, he also puffs his cheeks to represent the heaviness of the load. An incomplete response, on the other hand, would be one which employs a mono-manual classifier or lexical sign, as in (25). Only one out of the three apples is represented by the single handed classifier.

(24)




RH/LH: hand-$CL_a$ hand-$CL_b$

(25)



RH: hand-CL

Lastly, we compared the data elicited from native TİD signers to those elicited from late TİD signers to determine whether number agreement is sensitive to age of acquisition. To this end, we first checked for number agreement in the nominal domain by calculating the percentage of responses in which number features were present on the NP introducing the plural entity. Then, we tallied the specific forms used by both groups

to express number within the NP (e.g. “num+N”, “num”). This was followed by an analysis of number marking in the verbal domain. We calculated the percentage of complete responses in addition to the frequency of verb forms produced by both groups.

# CHAPTER 7

# RESULTS AND DISCUSSION: EXPRESSION OF NUMBER

## 7.1 Results

We collected a total of 248 data points (31 signers x 8 stimuli), one of which was excluded due to a technical problem in the recording. We analyzed these data for age of acquisition effects in number expressions within the nominal domain and the verbal domain.

To explore the expression of number information in the nominal domain, we checked for the presence of number features in the noun phrase used to introduce the plural entities in a scene. As mentioned above, number features could be manifested in the form of a numeral followed by a noun (e.g. TWO CUP), or an alternative method that expresses the multitude of entities, such as multiple gaze accompanied by the repeated production of a noun (see example 14). The absence of number features refers to the use of a noun without plural marking (e.g. CUP). We found that both groups performed similarly when no distinction was made between plural subject and plural object, i.e. when all the data were taken into account. As shown in Figure 8, both non-native and native signers expressed number features within the NP at similar rates (83% native signers, SE: 0.04; 87% late signers, SE: 0.03).

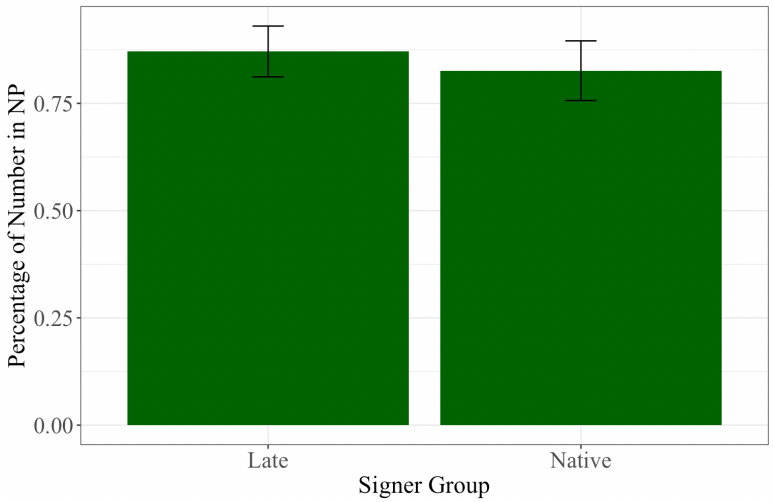



Figure 8. Percentage of responses with number in the NP by signer group

However, when we categorized responses according to the grammatical function of the plural entity (subject vs. object), we observed an effect only for native signers, as shown in Figure 9. Native signers were more likely to produce a noun phrase containing number features when the plural entity was a subject, as opposed to an object. There was no such effect for late signers.

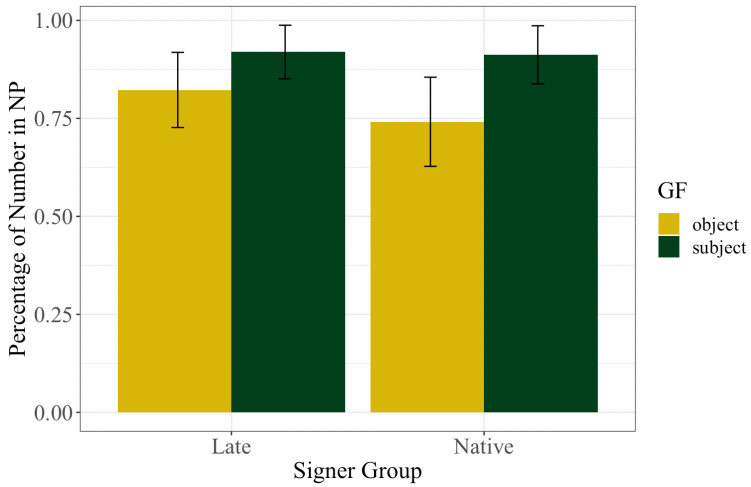



Figure 9. Percentage of responses with number in the NP by signer group and grammatical function (GF)

To draw further inferences from the data, we fitted the data using a regression model with the following predictors: plural argument (+0.5 object, -0.5 subject), cardinality (+0.5 trial, -0.5 dual), event type (+0.5 simultaneous, -0.5 sequential), and signer group (+0.5 native, -0.5 late). The results are provided in Figure 10.

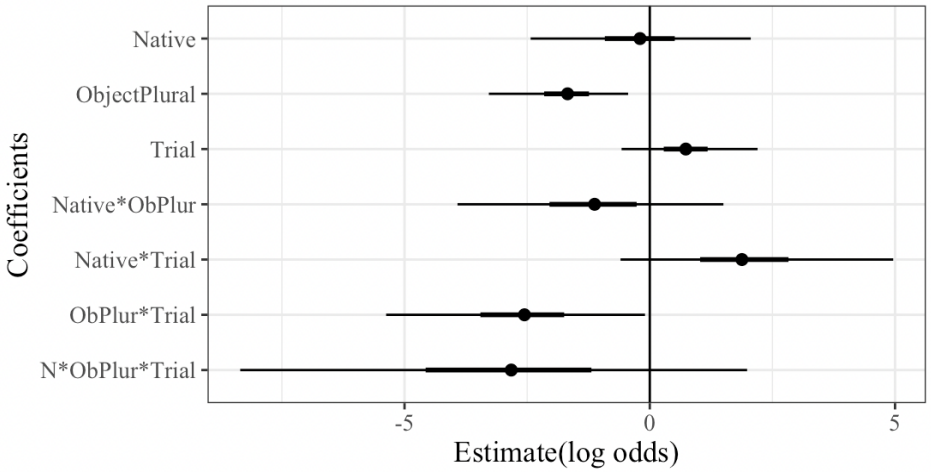



Figure 10. Model results fit to number within NP with the predictors signer group (native, late), plural argument (object, subject), and cardinality (trial, dual)

The estimate for the coefficient native crosses through the baseline 0, suggesting that signer group did not exhibit any effect. The coefficient for object plural, on the other hand, did show a main effect. When the plural argument was an object, as opposed to a subject, this increased the likelihood for the production of number information within the NP. Moreover, when the cardinality of the plural argument was trial (and not dual), this also slightly increased the probability for number to be encoded in the NP. A hypothesis function (Trial > 0) revealed that the posterior probability for trial number increasing number encoding within the NP was 0.87 (lower CI: -0.36, upper CI: 1.92); from this, we can infer that there was a slight effect of trial number. The combined effect of the coefficients native and plural object was slightly skewed toward the negative side,

meaning native signers were somewhat less likely to mark number information when the plural argument was an object. The hypothesis function we used to measure the posterior probability of the combined effect of native and plural object (Native:Trial < 0) revealed that this value was 0.87, which can be interpreted as a slight tendency towards decreasing number encoding in the NP. Moreover, the combined effect of the coefficients native and trial also resulted in a strong tendency to increase number expression, as confirmed by the hypothesis function (Native:Trial > 0) yielding a posterior probability of 0.93 (lower CI: -0.21, upper CI: 4.35). Interestingly, the combined effect of plural object and trial number appears to decrease the overall tendency to produce number information in the nominal domain, since this estimate falls entirely within the negative area. Lastly, the three-way interaction between all the predictors does not seem to exhibit an appreciable effect.

Moreover, we also compared the specific NP forms employed by native signers and late learners used to introduce plural entities in a scene. To reiterate, the possible forms were as follows: a bare noun (N), a noun in juxtaposition to an adjective (N+adj), only a numeral (num), a numeral accompanied by a noun (num+N), and alternative forms (such as multiple gaze) that were marked as “other”. With respect to the data elicited from native signers, which is shown in Figure 11, the most frequently used form was num+N, which accounted for 69% of responses (37% plural subject, 32% plural object). This was followed by N, a form that does not bear number features, at 17% (4% plural subject, 13 % plural object). The usage of the remaining alternatives was limited, with num at 7%, N+adj at 4%, and other at 2%. However, it is interesting to note that N+adj was only used with plural objects and num was only used with plural subjects.

A similar distribution was observed for late signers of TİD, as shown in Figure 12. The most frequent form they used was also num+N, which made up 75% of responses (38% plural subject, 37% plural object). The forms that followed were N (a total of 11%, with 2% plural subject and 9% plural object), num (9%), N+adj (3%), and other (2%). Once again, N+adj was only used for plural objects and num was only used for plural subjects.

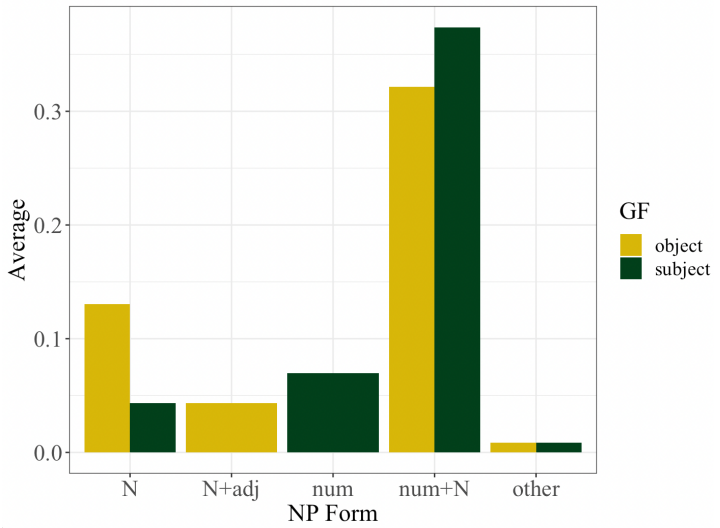



Figure 11. Distribution of NP forms in responses of native signers by grammatical function (GF)

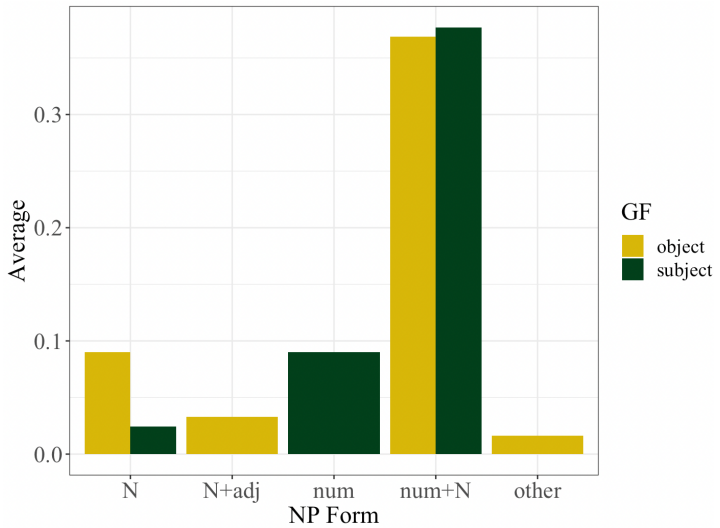



Figure 12. Distribution of NP forms in responses of late signers by grammatical function (GF)

Regarding number agreement in the verbal domain, we checked for (i) the complete expression of plural entities/events and (ii) the verb type used to describe the event. The former refers to the articulation of the exact number of entities through hand number and number classifiers (see Figure 7), in addition to the precise number of events through iterations of movement (see Table 5). Verb type, on the other hand, involves the specific form of the predicate (e.g. entity classifier, handling classifier, number classifier, lexical verb, lexical noun, and other).

With respect to completeness, when all the data were taken into account, we found that both groups produced similar levels of complete responses; the exact percentage was 85% (SE: 0.04) for native signers and 80% (SE: 0.03) for non-native signers. This is shown in Figure 13.

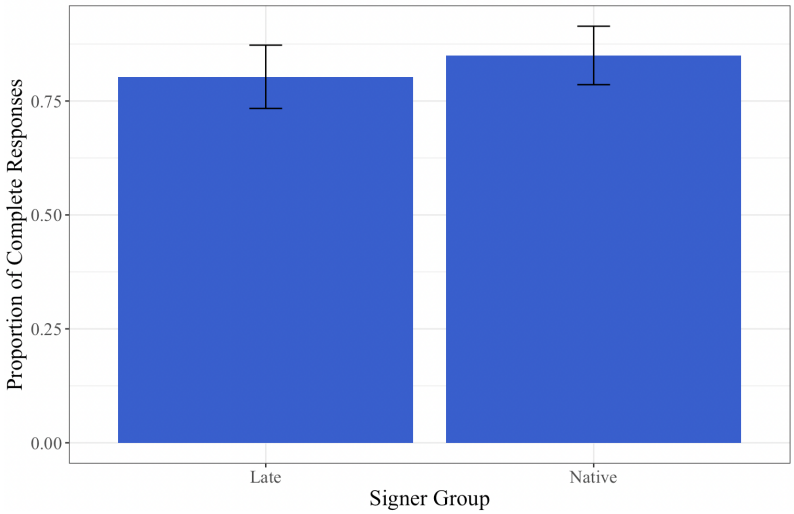



Figure 13. Proportion of complete responses by signer group

However, when event plurality (simultaneous vs. sequential events) was taken into consideration, we observed an effect for late signers only (Figure 14). When the

event was simultaneously performed (i.e. it contained multiple entities acting or being acted upon at the same time), late signers were far less likely to produce a complete response as compared to sequential events (94%, SE: 0.03 and 67%, SE:0.06, respectively). That is, they did not always produce the exact number of plural subjects or plural objects (via hand number or number classifier) when expressing a single event with more than one agent/theme. This is in contrast to sequential events in which there is either only one agent (e.g. one boy) or one agent and theme (e.g. one boy and one cup) per event. Native signers, on the other hand, did not show such an effect as they produced similar levels of complete responses for sequential events and simultaneous events, i.e. when multiple events were performed one by one and at the same time.

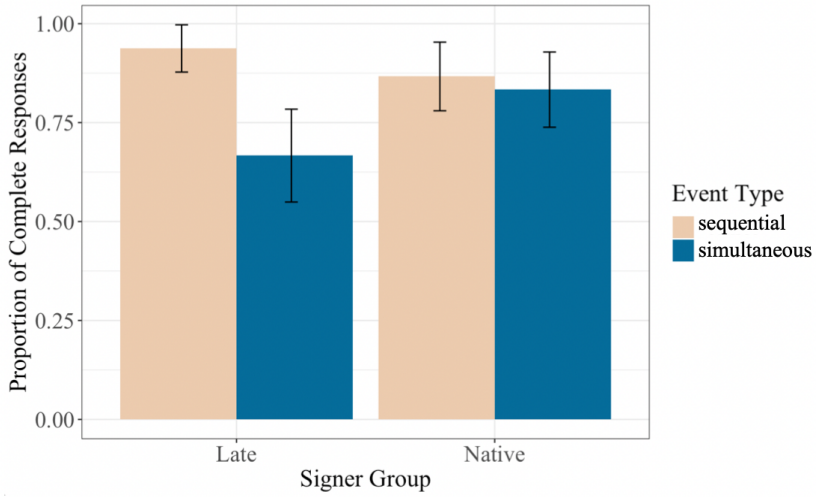



Figure 14. Proportion of complete responses by signer group and event type

We ran a regression model to investigate the magnitude of the above effects with the predictors signer group (contrast: +0.5 native, -0.5 late) and event type (contrast: +0.5 simultaneous, -0.5 sequential). The results are presented in Figure 15.

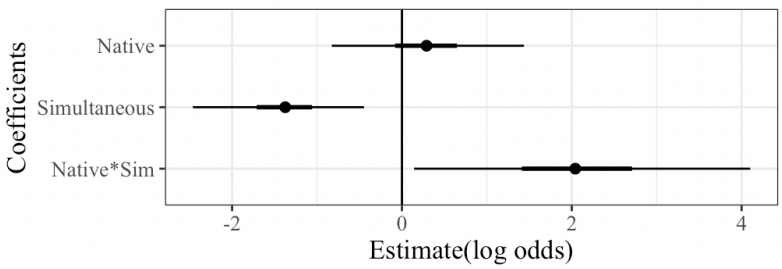



Figure 15. Model results fit to complete number within VP with the predictors signer group (native, late) and event type (simultaneous, sequential)

The estimate for the coefficient native indicates no effect of signer group, as it runs through zero. On the other hand, the estimate for event type shows a strong effect, with simultaneous events lowering the probability of producing complete verbs. This can be inferred from the fact that the estimate lies entirely within the negative end of the scale; the effect size is corroborated by the hypothesis function (Simultaneous < 0) that turns out the value 1.0 for the posterior probability (lower CI: -2.27, upper CI: -0.58). Thus, simultaneous events greatly reduced completeness in responses. However, it appears that late signers are responsible for this tendency, given that the combined effect of the coefficients native and simultaneous (the bottom-most estimate in Figure 15) actually exhibits a positive effect. In other words, although simultaneous events generally resulted in lower completeness, the late signers' responses mostly caused this effect. The hypothesis function (Native:Simultaneous > 0) reveals a posterior probability of 0.98 (lower CI: 0.49, upper CI: 3.74) for the combined effect of the coefficients native and simultaneous, which is an indicator of a reliable effect.

In addition, we also examined the distribution of the verb types used by native signers and late learners to describe events with plural subjects and plural objects. The possible verb types were entity classifier (ent-CL), handling classifier (hand-CL), lexical noun (lex-N), lexical verb (lex-V), number classifier (num-CL), and other (i.e.

combinations of various verb types). The findings for native signers are provided in Figure 16, and the findings for late signers are shown in Figure 17. Native signers most frequently used number classifiers, which accounted for 31% of responses. Late signers, however, used number classifiers only 23% of the time. Moreover, while native signers produced entity classifiers in only 14% of responses, late signers had a greater tendency to use them, as they accounted for 24% of responses. In addition, lexical forms (i.e. lex-N and lex-V) were used almost equally often by native signers (33%) and late signers (32%). Furthermore, number classifiers were almost exclusively used for plural subject stimuli. As expected, entity classifiers were produced only for plural subject stimuli, as they express human agents. Likewise, handling classifiers appeared only with plural object stimuli, since they indicate how an object is manipulated with the hands. Lastly, lexical forms appeared only in response to plural object stimuli.

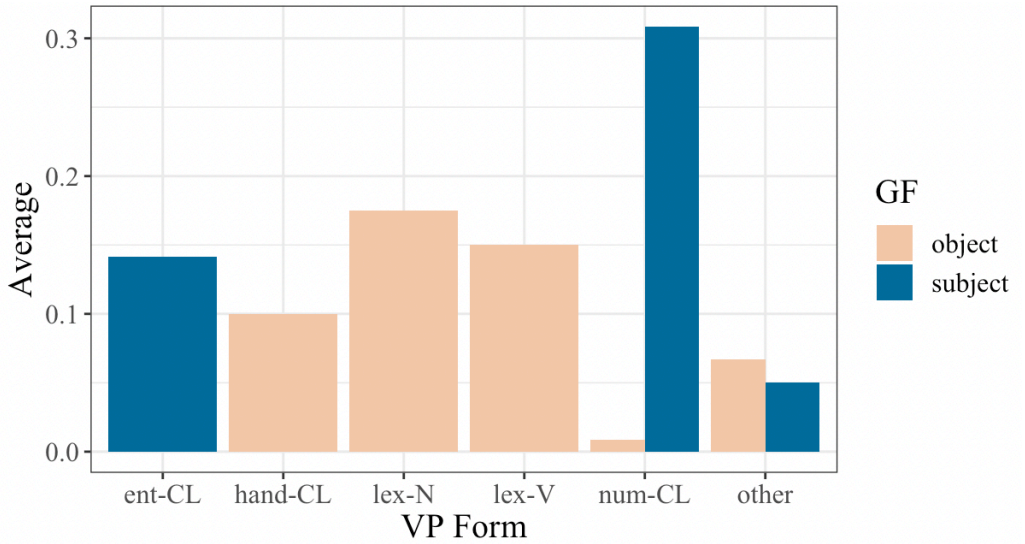



Figure 16. Distribution of verb types in responses of native signers by grammatical function (GF)

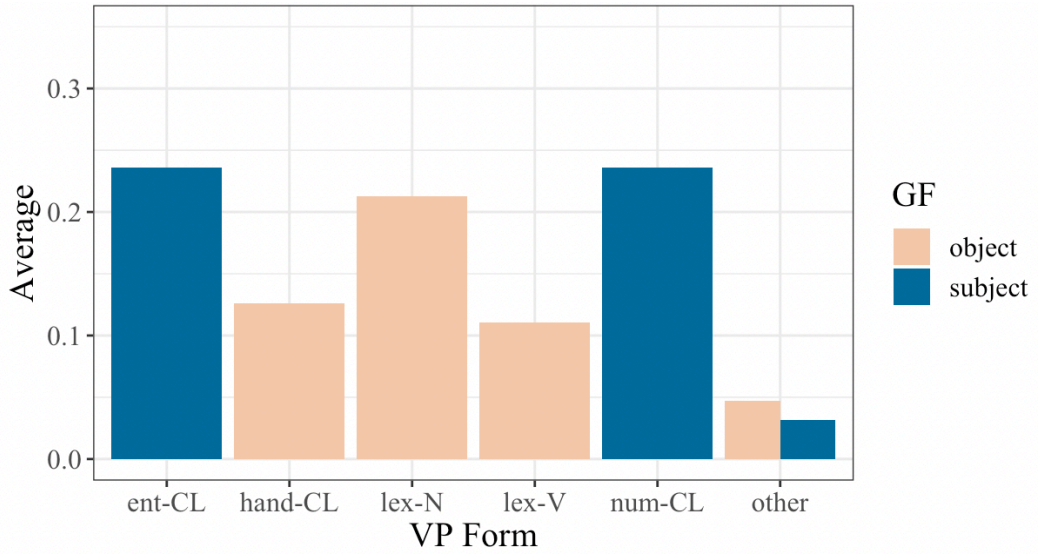



Figure 17. Distribution of verb types in responses of late signers by grammatical function (GF)

Lastly, we analyzed the frequency by which number information appeared both within the NP and the VP. We found that in a majority of responses, 1 and the verbal domain, with the rates amounting to 71% (Figure 18) and 72% (Figure 19), respectively. Moreover, native signers were slightly more likely to produce responses with number only within the VP (noNP-yesVP, 17%) as compared to responses in which number only appeared in the NP (yesNP-noVP, 11%). The opposite occurred with late signers, who were marginally more likely to produce number only within the NP (yesNP-noVP, 15%) as compared to only within the VP (noNP-yesVP, 9%).

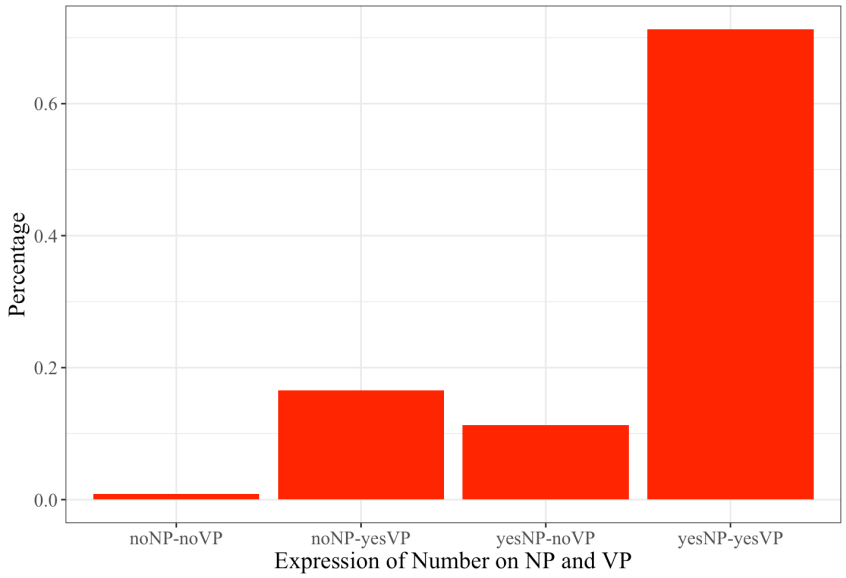



Figure 18. Distribution of number expression within NP and VP in data of native signers

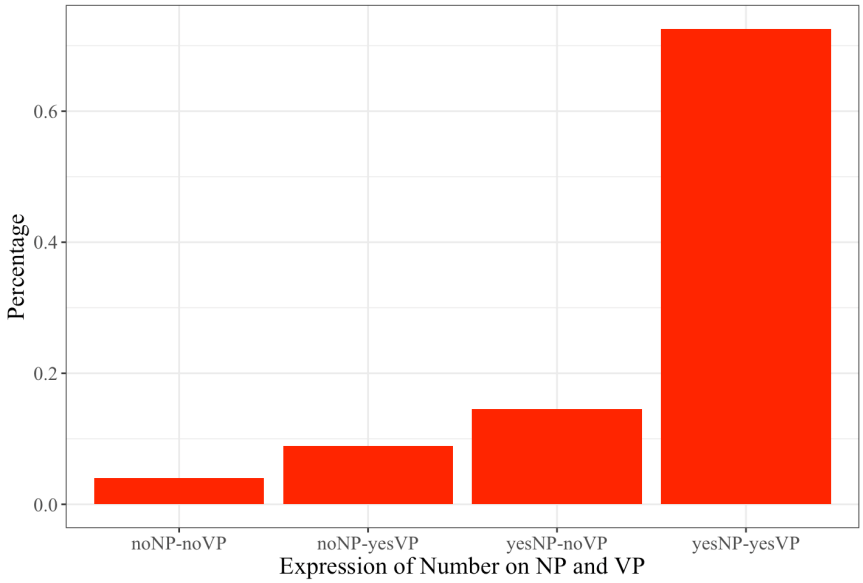



Figure 19. Distribution of number expression within NP and VP in data of late signers

## 7.2 Discussion

In this section of our study, we were interested in exploring the effects of delayed language exposure on the expression of number in both the nominal and verbal domain.

More specifically, we explored if and how native signers and non-native signers of TİD encode dual and trial plurality both when introducing multiple entities by means of a noun phrase and describing an event through the articulation of a verb. We found that both groups expressed number information in the noun phrase at similar rates when all data were taken into account (native signers: 83%, SE: 0.04, late signers: 87%, SE: 0.03). Thus, the frequency by which number information is produced when setting a scene does not appear to be affected by age of acquisition. However, when responses were categorized according to the grammatical function of the plural entity, namely object and subject, we found an effect only for native signers. When native signers did express number within the NP, they were more likely to do so for plural subjects as compared to plural objects. This may result from the fact that object agreement is obligatory in sign languages, whereas subject agreement is not (Meier 1982), thus making it possible to recover object number information from the verb. In fact, it may even be the case that the number information of the object is more unmarked; support for this comes from the fact that ASL morphologically encodes only object number when both subject and object are plural, and uses alternative strategies, such as overt pronouns, to mark subject plurality in such cases (Sandler & Lillo-Martin 2006). If this is true for TİD as well, then only native signers of TİD are sensitive to the unmarked nature of object plurality whereas non-native signers are not.

Moreover, despite the plethora of ways to express nominal plurality in TİD (Kubuş 2008; Zwitserlood et al., 2013), both groups most frequently used a numeral with a noun (num+N). This aligns with Kubuş's (2008) observations that numerals are often used to describe small groups consisting of two or three entities in TİD. Interestingly, this was followed by N, a form that bears no number information, in both

groups (17% native signers, 11% late signers). Moreover, most of these bare N forms were produced in response to plural object stimuli. The use of forms that do not bear plural marking in describing multiple entities is not unique to TİD, as both native signers and late signers of ASL have been shown to prefer classifier forms unaccompanied by plural marking when describing scenes with a multitude of objects (Semushina et al., 2020). This suggests that number marking is not obligatory in the nominal domain.

Furthermore, both groups used the NP form "num" (e.g TWO) when introducing plural subjects only. It appears that only plural subjects permit ellipsis in the noun phrase (i.e. TWO [BOY]), whereas plural objects do not.

With respect to the verbal domain, we analyzed the predicates articulated by signers to describe scenes in which either the agent or theme was plural. To reiterate, the plural entities were dual or trial in number, and the events were either performed simultaneously (e.g. three kids jumping at the same time) or sequentially (e.g. three kids jumping one after another) (see Table 2 for a complete list). We conducted an analysis of completeness and checked for the full expression of (i) entity number through the use of the appropriate number of hands or number classifier and (ii) event number through the use of the appropriate number of movements. When all data were taken into account, we found that native signers and late signers produced similar levels of complete responses (85%, SE: 0.04 and 80%, SE: 0.03, respectively). This suggests that the indication of entity and event number is a resilient property of language that is unaffected by the timing of language exposure, despite the morphosyntactic complexities involved in verbs of motion (Hou, 2013).

Even though overall completeness rates were similar, there was an appreciable effect of event number in the production of complete responses for late signers only.

Participants exposed to TİD at a later age were far less likely to produce complete responses when presented with simultaneous-event stimuli, as compared to sequential-event stimuli. To reiterate, completeness for simultaneous event stimuli required the use of either two hands or the number classifier TWO when dual plurality was involved, or the number classifier THREE when trial plurality was involved, in addition to a single movement of the verb. It seems that the source of the complexity stems from the articulation of a number classifier in predicate position, as late signers readily produce number signs in the nominal domain. In the verbal domain, the number classifier is accompanied by movement to indicate the trajectory of the event, which may in fact heighten the complexity. Therefore, a morpho-syntactic factor appears to be at play. A relevant finding was reported for young children acquiring ASL; although three-year-olds were fully capable of articulating the sign THREE, they were unable to use the same handshape as a vehicle classifier (Kantor, 1980). Therefore, the handshape of number signs does not pose a challenge, but their morpho-syntactic function in an utterance does. In addition, late signers may also be treating certain verbs as frozen forms, i.e. a form that generically represents an event, such as a downwards V-handshape moving along an arcing trajectory to indicate any event of jumping. This would normally be used to indicate that one person is jumping, but it may be conceived as a device to mark any jumping event, which would thus lack number information. In fact, Newport (1988) found that adult late signers of ASL often used frozen forms, such as the verb FALL produced with a human-entity classifier for any object that falls. However, further research is needed to ascertain whether frozen forms do exist in TİD and are indeed employed by late learners.

Regarding verb type, we observed that native signers were more likely to use number classifiers (31% vs. 23%), whereas late signers demonstrated a greater tendency to produce entity classifiers (24% vs. 10%). This is noteworthy in that entity classifiers are morphologically less complex and represent only one entity. Number classifiers, on the other hand, incorporate both number information and entity information. Therefore, native signers show a greater tendency to use more morphologically complex forms. This observation aligns with the findings of Karadöller et al. (2017), who found that adult late signers were more reluctant to use complex classifiers as compared to their native counterparts.

Furthermore, lexical forms (i.e. lexical nouns and lexical verbs) were used virtually equally often by both groups, as they made up about a third of responses in both groups (33% native signers, 32% late signers). These forms only appeared in response to plural object stimuli, which is most likely a consequence of the nature of the stimuli. The event of jumping in plural subject stimuli was only expressed with number classifiers and entity classifiers; no lexical alternatives were observed. Lexical forms are also the least complex among the verb types. This is because lexical verbs do not convey any information about the object being manipulated and only describe the event (e.g. PUT in example 19), and lexical nouns are the citation form of the object undergoing an action and also do not demonstrate how the object is manipulated, as classifiers would. Overall, both groups produce lexical forms at similar rates, suggesting that they are not sensitive to age of acquisition.

Lastly, both groups showed a similar tendency to express number both in the nominal and verbal domain (71% native signers, 72% for late signers). That is, they often marked number information both in the NP that introduced plural entities and the

verb that expressed an event with multiple entities acting or being acted upon. Therefore, number information was likely to carry across a single response in both groups.

# CHAPTER 8

# CONCLUSION

This study investigated the effects of delayed exposure on the expression of arguments in TİD. To this end, a series of elicitation tasks were administered to both native signers born to deaf parents and late signers who first received TİD input at school age. These targeted the production of person/location agreement, Figure-Ground ordering in spatial expressions, and number in both the nominal and verbal domain. The findings of the first task that measured faithfulness to R-loci, i.e. commitment to spatial indices that anchor referents in the signing space, demonstrate that late learners perform on par with their native counterparts, suggesting that referent tracking through grammatical space is a resilient property of language unaffected by the timing of linguistic input. There was, however, an effect of verb type for both groups in that while location-agreeing verbs (LAVs) were articulated with greater levels of faithfulness, person-agreeing verbs (PAVs) proved to be more fragile and elicited less faithful responses. This provides further evidence that a distinction does indeed need to be drawn between PAVs and LAVs, as suggested by Berk (2003) and Kwok et al. (2020), and that they should not be conflated into a single category of agreeing verbs, as advocated by Quadros & Quer (2008) and Laurenço & Wilbur (2018).

In addition, an analysis of Figure-Ground ordering revealed that native signers adhered more strictly to the sign language modality specific cross-linguistic tendency to produce Grounds before Figures. Two possible explanations are as follows: (i) Figure-Ground ordering is shaped by linguistic constraints that emerge during the critical

period, rather than perceptual constraints, or (ii) non-native signers produce Figure-Ground-verb sequences (which corresponds to subject-object-verb ordering) that align with the canonical SOV order of TİD, and possibly Turkish.

A comparison was made between the expression of the number in the nominal and verbal domain. With respect to the former, findings show that both groups indicated number information within the NP in a majority of responses. In doing so, both groups most frequently opted to use a numeral accompanied by a noun (e.g. TWO APPLE), thus confirming the observation that numerals are often used with small groups of entities in TİD (Kubuş, 2008)[18]. However, it is interesting to note that an effect of grammatical function (subject vs. object) was observed only for the group of native signers, who were more likely to indicate number information within the NP when the plural entity was a subject. This may result from the obligatory marking of object agreement (Meier, 1982), which allows for the number information of the object to be recovered from the verb. If this is the case, then only native signers are sensitive to this feature of object agreement.

In terms of number expression in the verbal domain, one primary finding was that late signers differed from their native signers in their responses to simultaneous-event stimuli. Late signers indicated number information far less frequently when describing events containing multiple entities acting or being acted upon at the same time. In other words, they did not use number classifiers as often as native signers to mark the exact cardinality of agents and instead opted for less complex entity classifiers.

[18] Kubuş (2008) also investigates larger groups of entities and indicates that adjectives which bear a plural meaning, such as ÇOK (MANY), are often used with such quantities. Further research is necessary to determine whether the strategies adopted for describing larger quantities are influenced by the timing of language exposure.

Similarly, they did not use two hands to express multiple themes as often as native signers. Based on these observations, it appears that late signers experience difficulty in articulating number classifiers in predicate position, which also requires the addition of movement, considering that they freely use them in noun phrases (e.g. THREE CUP). Aside from this, both groups used lexical forms at similar rates and simultaneously expressed number information in both the NP and VP almost equally often.

Overall, these findings suggest that expressing number in the verbal domain is more challenging than marking person and location agreement for late learners of TİD. This complexity may derive from the fact that number introduces new information into the predicate; not only is the signer required to mark the spatial indices of referents, thus performing referent tracking, they also have to encode the quantity of individuals. This necessitates the modification of handshape to mark extra information on the predicate.

In further studies, it would be interesting to explore how animacy interacts with such phenomena and what happens when larger groups of entities are presented in the stimuli. Moreover, an analysis of all persons (first, second, third) in all sentence positions (subject, direct object, indirect object) would provide a more complete picture of verb and number agreement. Lastly, a more controlled selection of verbs categorized according to telicity and the thematic role of the subject may also provide greater insight into the phenomena examined here.

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