

# The Effects of Late Sign Language Acquisition on Emotion Recall and Expression in Deaf Children

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## Abstract

Children's emotional development is linked to language development for typically developing children and deaf children with native sign language exposure. However, approximately 90% of deaf children are born to hearing parents who are not familiar with sign language. These deaf children begin learning a sign language when they attend a school for the deaf. Late sign language exposure has negative consequences on several aspects of language development. We investigate whether acquiring sign language late affects children's emotion recall and channel of emotion expression. After watching a silent video depicting emotions, late- and native-signing deaf children retold the story in Turkish Sign Language. Results showed that late signers recalled fewer emotions and used fewer signs and facial expressions compared to native signers. Manual gestures (non-sign hand movements), head and body movements did not differ across groups. The findings suggest that late sign language acquisition negatively impacts deaf children's ability to recall and express emotions, highlighting the importance of early language exposure for the development of emotion recall.

**Keywords:** Late sign language acquisition, emotion recall, language development

## Introduction

Children's emotional development is closely linked to language development (e.g., Kalland et al., 2022). This relationship holds for both typically developing children and deaf children who have been exposed to a sign language from birth (Rieffe & Terwogt, 2006; Rieffe, 2012). However, 90% of deaf children are born to hearing parents, who often get exposed to sign language late (Mitchell & Karchmer, 2004). These deaf children typically begin learning a sign language only when they attend schools for the deaf (Lillo-Martin et al., 2023). Late sign language exposure is linked to delays in several aspects of language and cognition (Henner et al., 2016; Karadöller et al., 2017, 2024; Lillo-Martin & Henner, 2021; Mann et al., 2015; Mayberry et al., 2024; Miles et al., 2024; Schick et al., 2007). However, the link between late sign language exposure and the language abilities related to emotion recall has never been studied. In this study, we investigated whether acquiring language late, in the case of deaf children who are exposed to a sign language when they start school for the deaf, would relate to differences in emotional recall compared to deaf children with sign

language exposure from birth. Furthermore, we examined whether late sign language exposure relates to differences in channels of emotions expressed (i.e., sign, facial expressions, manual gestures, head and body movements).

Children's ability to recall emotions develops based on many factors, with language development being one of them. It's known that infants are born with an innate ability to learn language (Meier, 1991). However, not all children can get exposed to a fully-fledged language from birth, as in the case of deaf children with hearing parents (Mitchell & Karchmer, 2004). These children had difficulty accessing the surrounding spoken language at home, even with hearing aids or cochlear implants, as those devices do not always result in optimal hearing and speech outcomes (Hall et al., 2019). Consequently, these children had their first exposure to a conventional language later compared to typically developing hearing and/or deaf children with native exposure to language at home by their parents. Moreover, these children's first language exposure is less structured and restricted to the school setting after enrollment in the school for the deaf.

Late language acquisition in deaf children has been associated with delays in several aspects of cognitive and language development (Henner et al., 2016; Karadöller et al., 2017, 2024; Lillo-Martin & Henner, 2021; Mann et al., 2015; Mayberry et al., 2024; Miles et al., 2024; Schick et al., 2007). Limited access to language structures in the case of late learners hinders the recall of complex sentence structures (Mayberry et al., 2024), syntactical and analogical reasoning (Henner et al., 2016), basic word order (Miles et al., 2024), the use of complex morphological structures to express spatial relations (Karadöller et al., 2017, 2024), theory of mind (Schick et al., 2007), and cognitive and social-emotional abilities (Mann et al., 2015).

Studies comparing deaf children with late exposure to sign language and typically developing hearing children have identified several differences in their emotional development. For instance, late signer deaf children have been found to have more difficulty discriminating (Rieffe, 2012), expressing (Rieffe & Terwogt, 2006), and attributing (Gray et al., 2007) emotions compared to hearing controls. According to these findings, the emotional development of deaf children with late sign language exposure seems to

follow a unique pattern compared to hearing children. However, whether and how these differences come from deafness, language modality differences (sign vs speech), or late language exposure remains unclear. In order to decipher these possibilities, it is essential to compare deaf children exposed to sign language from birth with those who acquire it later in life.

Emotions are expressed via several channels. One common channel is to rely on words/signs (de Gelder & Vroomen, 2000; Ng et al., 2021; Reilly et al., 1992). One other very common channel is to use facial expressions (e.g., Jones et al. 2021). Another channel for expressing emotions is gestures, which are used by both speakers and signers (Guilbert et al., 2021; Levy & Kelly, 2020; Thakore et al., 2024; Wilcox, 2009). For instance, Guilbert et al. (2021) demonstrated that gestures helped hearing children recall emotion narratives. Other studies conducted with adults have shown that emotion expression through co-speech gestures enhances memory (Levy & Kelly, 2020) and recall (Thakore et al., 2024) of emotions.

Emotions are often expressed via multiple channels. For instance, when deaf children start to acquire emotion signs at around one and a half years of age, they also combine them with facial expressions, provided they are exposed to sign languages (Reilly et al., 1990). Moreover, adult signers also produce hand movements that express emotions, even when those movements are not part of specific emotional signs in their sign language (Reilly et al., 1992).

Overall, based on the previous work, it is unknown whether and how narrative recall of emotions, with respect to frequency and channel of expression, differs among deaf children with different language acquisition trajectories.

### The Present Study

The present study investigated whether acquiring sign language late affects children's emotion recall and their channel of emotion expression. We examined differences in their ability to recall emotional narratives, focusing on how frequently and through which channels—sign, facial expressions, manual gestures (non-sign hand movements), and head and body movements—they expressed emotions. To do so, we compared 8-year-old deaf children with two years of sign language exposure at schools for the deaf to their age-matched peers who acquired sign language from birth while recalling emotions present in a silent video demonstrating various emotions. We had the following predictions:

(a) Late signing children demonstrate a lower frequency of emotional recall compared to native signing children.

(b) Late signing children differ in the frequency of emotion expression channels (sign, facial expressions, manual gestures, head and body movements) compared to native signing children.

### Method

The methods reported in this study have been approved by the Ethics Review Board of Radboud University, Nijmegen, The Netherlands. Also, this study has been approved by the Survey and Research Commission of the Republic of Turkey and the Ministry of National Education, Turkey.

**Participants** The sample consists of profoundly deaf late-signing children ( $n = 30$ , Mean Age = 8.5) and native-signing children ( $n = 23$ , Mean Age = 8.5) of Turkish Sign Language (*Türk İşaret Dili*; TİD). Participation was voluntary. Participants were given a gender-neutral color pencil kit as gifts for attending the study.

**Materials** All participants watched a short, silent video titled *Spider Story* (Herman et al., 2004), which depicted various emotions (i.e., demand, refusal, annoyance, surprise, mischief, disgust). The story takes place between two children: a boy and a girl. The gist of the story is that the boy repeatedly demands different food and drink items from the girl, who initially complies. Eventually, she becomes annoyed and plays a trick on him by placing a spider in a sandwich and giving it to him. The story ends with the boy joyfully chasing the girl around the living room. This scenario was designed to elicit a range of lexical, morphological, grammatical, and pragmatic features. In addition to these, the spider story was chosen as a stimulus because the retelling of the story is not limited to the blunt depiction of actions of the characters but also includes various emotions expressed throughout the scenario (see also Denmark et al., 2019).

**Procedure** Study was administered in a quiet room at children's schools. Children sat in front of a computer and watched the Spider Story video and were asked to retell what happened in the video to a deaf adult native signer of TİD. Children were also asked to do a computerized version of the Corsi Block Tapping and Digit Span Tasks (Neurobehavioral Systems, 2017) to control their visual-spatial and serial recall abilities. The narrative recall task was video recorded for later annotation and coding.

**Coding** All emotions expressed were annotated and coded using ELAN (Version 6.8), a free annotation tool

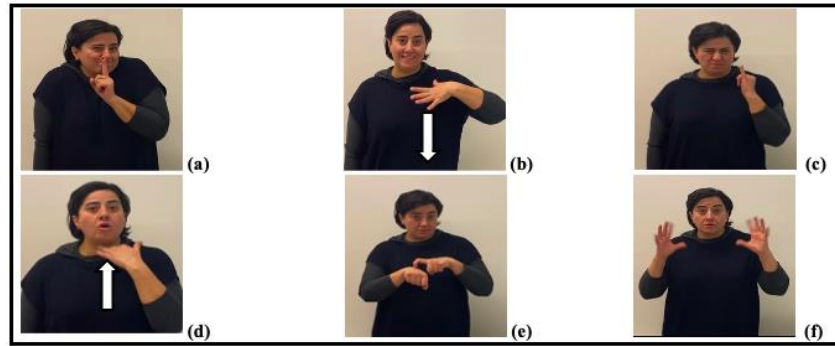


Figure 1: Examples from TİD native signer showing signs used to express following emotions (a) mischief; (b) demand; (c) disgust; (d) refusal; (e) annoyance; (f) surprise.

(<http://tla.mpi.nl/tools/tla-tools/elan/>) for multimedia resources developed by the Max Planck Institute for Psycholinguistics, The Language Archive, Nijmegen, The Netherlands (Wittenburg et al., 2006). The data was initially annotated by a hearing late signer of TİD who had completed a beginner-level TİD course provided by the Ministry of Education in Turkey. Given the linguistic and non-linguistic complexity of emotion-related coding, the annotations were then fully reviewed by a hearing native signer of TİD who was specifically trained for the coding scheme used in this dataset. The native coder reviewed the existing annotations and marked instances where emotions were either missed or incorrectly identified. Therefore, we report the percentage agreement, which more accurately reflects the reliability in this context. The observed agreement was 90.27%, indicating a high level of consistency between coders.

The aim of the coding process is to identify expressive behaviors associated with the narrative across different emotional expression channels (e.g., sign, facial expressions, manual gestures, head and body movements). First, we identified the presence of an emotion(s) within the recall videos of participants. Next, we identified the channel of emotion(s) expressed in these renditions. The predefined emotions were demand, refusal, annoyance, surprise, mischief and disgust based on Denmark et al. (2019). See Figure 1 for examples of these emotions in TİD.

We conducted a post hoc sensitivity analysis using the G\*Power software (Faul et al., 2007). Given a sample size of 53, an alpha of .05, and a power of .95, the analysis indicated an effect size of 0.254 for simple linear regression. This suggests that our model is well-powered to detect moderately sized and meaningful relations among the predictors. Given the challenge of recruiting participants—particularly an underrepresented sample of atypically developing young children—this sample size is adequate and is comparable to effect sizes generally reported in the literature.

## Results

Native signers expressed emotions a total of 232 times, while late signers expressed emotions 178 times. See Table 1 for

more details. Data was analyzed using Jamovi (Version 2.3.28.0; Jamovi Project, 2022).

Table 1: Descriptive Statistics for Emotion and Gesture Variables by Sign Exposure Type

		Mean	SD	Sum
Emotion Total	Late	5.93	5.35	178
	Native	10.09	5.56	232
Sign	Late	0.4	0.68	12
	Native	1.65	1.8	38
Face	Late	3.17	3.09	95
	Native	4.91	3.13	113
Manual Gestures	Late	2.07	2.03	62
	Native	4.09	3.03	94
Head and Body	Late	0.7	1.32	21
	Native	1.09	1.35	25

## Control Measures

We controlled whether late and native signing children differ in their visual working memory and verbal working memory spans as a group. To do so, we conducted an independent samples t-tests on Corsi Block Tapping and Digit Span scores. Results showed similar visual working memory spans between late ( $M = 4.20$ ,  $SD = 1.40$ ) and native ( $M = 4.33$ ,  $SD = 1.01$ ) signers on Corsi Block Tapping Task scores ( $t(52) = -0.4$ ,  $p = 0.7$ ). Similarly, results showed similar verbal memory spans between late ( $M = 3.21$ ,  $SD = 1.24$ ) and native signers ( $M = 3.50$ ,  $SD = 0.93$ ) on Digit Span Task scores ( $t(51) = -0.96$ ,  $p = 0.34$ ).

## Data Analysis Plan

We ran 5 separate linear regressions to test whether late signing children demonstrate a lower frequency of emotional recall compared to native signing children, and whether late signing children differ in the frequency of emotion expression channels (sign, facial expressions, manual gestures, head and body movements) compared to native signing children. In each regression, language status is entered as an independent variable to predict (1) the total number of emotions recalled, (2) emotions recalled via signs, (3) facial expressions, (4) manual gestures, and (5) head and body movements, respectively.

## Emotion Recall

First, we compared the recall of total emotions across native and late signers. The results showed that native signers recalled significantly more emotions than late signers ( $\beta = 4.15$ ,  $SE = 1.51$ ,  $t = 2.75$ ,  $p = .008$ ) See Figure 2.

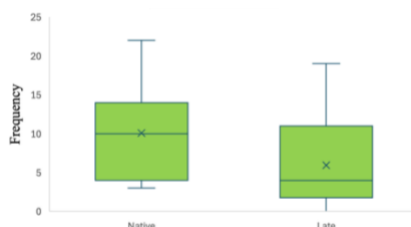


Figure 2: Frequency of Total Emotions expressed across native and late signers.

Next, we explored whether native and late signing children differ in the preferred channels (sign, facial expression, manual gestures, head and body movements) that expressed these emotions. See Figure 3.

To do so, we first compared the frequency of emotions expressed in sign across native and late signers. The results showed that native signers recalled emotions using signs significantly more frequently than late signers ( $\beta = 1.25$ ,  $SE = 0.36$ ,  $t = 3.51$ ,  $p < .001$ ).

Second, we compared the frequency of emotions expressed in facial expressions across native and late signers. The results showed that native signers recall emotions using facial expressions significantly more frequently than late signers ( $\beta = 1.75$ ,  $SE = 0.86$ ,  $t = 2.03$ ,  $p < .05$ ).

Third, we compared the frequency of emotions expressed in manual gestures across native and late signers. The results showed no significant difference in the frequency of emotions recalled using facial expressions across the groups ( $\beta = 0.77$ ,  $SE = 0.50$ ,  $t = 1.53$ ,  $p = .133$ ).

Lastly, we compared the frequency of emotion expressed in head and body movements. The results showed no significant difference in the frequency of emotions recalled using head or body movements across the groups ( $\beta = 0.39$ ,  $SE = 0.37$ ,  $t = 1.05$ ,  $p = 0.30$ ).

## Discussion

In this study, we investigated whether acquiring language late leads to differences in children's emotion recall and whether the channel of emotion expression varies based on the timing of sign language acquisition. The results indicate that deaf children with hearing parents—who often acquire sign language later in life—show differences in emotional recall compared to their peers exposed to sign language from birth. These children lag behind their native signing counterparts not only in recalling emotions in general but also when expressing them via signs and facial expressions, which are the most common channels of expressing emotions (e.g., Reilly et al., 1992). However, there was no relationship between the late acquisition of sign language and the frequency of manual gestures and head and body movements.

First of all, the findings of this research contribute to the evidence showing a close link between language and emotional development in children (Kalland et al., 2022) and expand on the relationship between sign language acquisition and emotional development within the same age group with differing levels of sign language exposure (Gray et al., 2007). We built on the previous work by providing evidence on how the timing of sign language acquisition relates to differences in emotion recall development. To our knowledge, our study is the first to question the link between being exposed to sign language late or early on children's emotional recall abilities. Previously, deaf children without autism spectrum disorder were found to channel more emotions via facial expressions than deaf children with this disorder (Denmark et al., 2019). Here, we extend this finding to the effect of the timing of language acquisition on expressing emotions by using not only facial expressions but also signs and/or gestures.

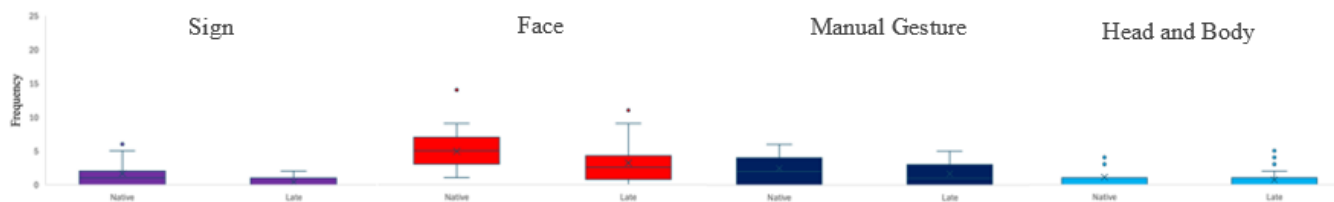


Figure 3: Frequency of emotions expressed in Sign, Facial Expression, Manual Gesture, and Head and Body Movement across native and late signers.

Findings of our research also provide insight into the relationship between the timing of sign language exposure and language development in deaf children regarding the recall of emotions via frequent channels. Specifically, we found that late signing children recalled emotions through signs and facial expressions less frequently compared to native signing children. With this finding, we contribute to the literature on the role of late sign language acquisition and how late signing children lag behind their native signing peers on several aspects of language and cognitive development such as the recall of complex sentence structures (Mayberry et al., 2024), syntactical and analogical reasoning (Henner et al., 2016), basic word order (Miles et al., 2024), the use of complex morphological structures to express spatial relations (Karadöller et al., 2017, 2024), theory of mind (Schick et al., 2007), and cognitive and social-emotional abilities (Mann et al., 2015). Our findings further suggest that late language acquisition is also related to total emotion recall and the channels in which emotions are expressed.

Moreover, our findings add to the previous findings on emotional development across deaf and hearing children (Rieffe & Terwogt, 2006; Rieffe, 2012) by showing that the emotional recall abilities of deaf children also differ based on the timing of language acquisition. This suggests that language acquisition trajectories of children may play a vital role in our understanding of emotional language development of deaf children. Hence, before comparing the emotion recall abilities of deaf children to hearing children, it is important to consider the timing of language acquisition. Possibly, deaf children with early access to a sign language might perform similarly to their hearing counterparts, while those who have late access to a sign language potentially lag behind their hearing peers. Yet, our study was not set to disentangle these possibilities, and further research is needed to uncover such differences.

Our findings also contribute empirical evidence to the literature on how emotions are expressed via multiple channels and add new evidence to it by showing how these different channels are employed as a function of the timing of sign language exposure. First of all, our findings add to the literature suggesting that emotions are expressed through multiple modalities, not only through hand gestures but also

through facial expressions, which are one of the most common channels for expressing emotions (Kelly et al., 2025). Furthermore, our findings are in line with previous research showing differences in expressing emotions via facial expressions between hearing and deaf children (Jones et al., 2021) to expression differences between deaf groups varying in the timing of sign language exposure. These results are also in accordance with the finding that deaf people not only use facial expressions but also manual signs to express emotions (Reilly et al., 1992). However, as a novel finding, it seems that when it comes to expressing emotions through manual gestures and/or head and body movements timing of language acquisition does not make a difference. Overall, results corroborate evidence for the role of language development in emotion expression (Cole et al., 2010) and underline the importance of early language exposure for the development of emotion recall and expression.

One limitation of the present study is the relatively small sample size, consisting of 24 native-signing and 30 late-signing deaf children. This makes it difficult to generalize the findings to the broader population. However, it is important to consider that working with special populations such as deaf children presents unique recruitment challenges. In particular, finding children who are native signers is especially difficult, as they make up only 10% of the deaf population (Mitchell & Karchmer, 2004).

It is also hard to decipher whether differences in emotional narrative recall are a function of the timing of sign language acquisition or if they result from less robust conceptual representations of emotions or limited emotional scaffolding between deaf children and hearing parents (see Calderon, 2000). Although we controlled for groups' visual-spatial and verbal working memory capacities, they were entered indirectly into our models. Thus, it is still hard to define whether differences reported derive from potential differences in cognitive capacities (see Özer & Göksun, 2020).

These findings have important practical implications for educational and clinical settings. Understanding that late sign language exposure may hinder emotion recall and expression highlights the need for early language intervention programs. Promoting early access to sign language—especially for deaf children of hearing parents—could support not only linguistic development but also emotional and social

competence. This insight can guide the design of targeted support programs in both school and therapeutic contexts to foster better emotional communication and well-being in deaf children.

In summary, this is the first study exploring the effect of late sign language exposure on emotion recall and modality of emotion expression which offers a novel perspective on the relationship between language and socio-cognitive development. These findings demonstrate that delayed exposure to sign language may hinder the development of emotion recall abilities in deaf children of hearing parents. These children lag behind their native counterparts not only in recalling emotions but also in expressing them as signs and facial expressions, which are the most common channels of emotion expression (Reilly et al., 1992). However, there was no relationship between the late acquisition of sign language and the frequency of manual gestures and head and body movements. These findings add to the literature suggesting that emotions are expressed through multiple modalities, including facial expressions as one of the most dominant channels (Kelly et al., 2025). Moreover, results corroborate evidence for the role of language development in emotion recall (Cole et al., 2010) and underline the importance of early language exposure for its development.

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