Effects of Delayed Language Exposure on Spatial Language Acquisition by Signing Children and Adults

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Abstract

Deaf children born to hearing parents are exposed to language input quite late, which has long-lasting effects on language production. Previous studies with deaf individuals mostly focused on linguistic expressions of motion events, which have several event components. We do not know if similar effects emerge in simple events such as descriptions of spatial configurations of objects. Moreover, previous data mainly come from late adult signers. There is not much known about language development of late signing children soon after learning sign language. We compared simple event descriptions of late signers of Turkish Sign Language (adults, children) to age-matched native signers. Our results indicate that while late signers in both age groups are native-like in frequency of expressing a relational encoding, they lag behind native signers in using morphologically complex linguistic forms compared to other simple forms. Late signing children perform similar to adults and thus showed no development over time.

Keywords: sign language; late acquisition; spatial relations; left right

Introduction

The most frequently preferred way of spatial encoding in sign languages requires the use of morphologically complex linguistic forms and use of signing space analogue to how the entities are located with respect to each other in the real space (e.g., Emmorey, 2002). In these forms, called classifier predicates (CLs), signers use their hands to represent the location and motion of the entities, as shown in Figure 1a below. Morphological complexity of these forms comes from the need for choosing the correct handshape for the entities (e.g., index finger for long and thin entities) and simultaneous coordination of both hands in the signing space to express their locations (e.g., Supalla, 1982). The relative spatial location of these forms in signing space represents spatial relations among entities in an analogue way – unlike the categorical forms (i.e., ad positions or spatial nouns) in spoken languages.

Earlier studies on spatial language acquisition of native signing deaf children, mostly focused on motion events, have claimed such morphological complexity to be a hindering factor compared to hearing children (e.g. Engberg-Pedersen, 2003; Slobin, 2003). However, recent work has found that Turkish Sign Language (TİD) acquiring deaf children learn to encode static location of the objects placed on a lateral axis (e.g., pen left to paper, apple right to box) earlier than their hearing peers (Sümer, 2015; Sümer, Perniss, Zwitserlood, Özyürek, 2014). Even though these children mostly used classifier predicates, they also used specific lexical signs (i.e., relational lexemes) for left and right, which are body-anchored in TİD (see Figure 1b), as frequently as the native signing adults. Thus, classifier predicates and/or body anchored relational lexemes seem to facilitate the learning of static spatial relations for deaf children who have been exposed to sign language input since birth (native signers).

(a) RH: CL (paper)$_{locR}$ (b) RH: LEFT
LH: CL (pen)$_{locL}$ LH: LEFT

Figure 1: Descriptions from adult native signers of TİD for the spatial relation of the pen with respect to the paper using (a) classifier predicates and (b) body anchored relational lexeme for 'left' (Sümer et al., 2014).

It is not known however if similar patterns also emerge in language development of deaf children with delayed sign language exposure (late signers). A previous study with deaf children (ages 5-6 yrs.) who were never exposed to a sign language (i.e., home signers) found no evidence of relational encoding for spatial relation (Gentner, Özyürek, Gürcanli, Goldin-Meadow, 2013). Here, we investigate whether spatial encodings of a similar type studied by Sümer and her colleagues (2014) can also be learned within a short time by late signing children after brief exposure (2 years) to sign language (after the age of 6) or whether late exposure to sign language is a

drawback in mastering spatial language in general. Moreover, we investigate the effects of delayed language exposure on both late signing children as well as adults to see if any developmental pattern emerges in such delayed exposure to language and if yes how.

A body of evidence on the effects of late sign language acquisition by deaf individuals posits that adult late signers lag behind adult native signers in several domains such as general cognitive abilities (Bebko & McKinnon, 1990; Mayberry & Waters, 1991; Parasnis et al., 1996; Wilson, Bettger, Niculae, & Klima, 1997) and sign language comprehension (Emmorey, 1993; Emmorey & Corina, 1992; Mayberry & Eichen, 1991). Nevertheless, most of the studies were restricted only to sign language comprehension, and there are only a few studies on sign language production which focus only on adult patterns. Question of how late signing children perform in production compared to late adult signers and also to their age-matched native signing peers could be informative in understanding the impact of delayed language exposure for adult and child late signers, and to what extent development plays a role in delayed language acquisition.

In series of studies, Newport (1988; 1990) investigated language production of adult late signers through descriptions of motion events. She found that they described motion events by using fewer classifier predicates (CLs) than native signers, but rather preferred simple forms such as lexical verbs. Given that the motion events consist of several components, such as Figure, Ground, Path, Manner (Talmy, 1985), it raises the question of whether similar patterns emerge for late signing children and adults in describing static events which has fewer components, such as only Figure and Ground. In addition, a previous study (Sümer, 2015) revealed that adult-like descriptions of static spatial relations are acquired earlier for static locations than for motion event descriptions in TİD by native signing deaf children. We do not know if these patterns also apply to late signing children and adults of TİD and if there are any developmental patterns in late signers.

The Present Study

To answer above questions, this study investigates the effects of late sign language exposure on the ability to encode static spatial events for left-right spatial relations by late signers of TİD and compares them to those of native TİD signers, which were already reported by Sümer et al. (2014) and Sümer (2015). We also compare the descriptions of late signing children and adults to those of native children and adults obtained earlier by Sümer (2015) to see if there is any developmental pattern in late signers.

Participants

Seven adult late signers (30;0 - 49;0, M = 39.14 years), 7 child late signers (7;3 - 10;9, M = 7;8), 10 native adult signers (18;5 - 45;10, M = 31;4), and 10 native child signers (7;2 - 9;10, M = 8;3)[1] participated in the study. All late signers had learned TİD after age 6 when they started a school for the deaf. Late signers did not have any prior exposure to sign language because according to the Turkish Education System, age 6 is the earliest age for starting school in Turkey. Before starting school, these signers mainly stayed at home with their non-signing parents. As a result, late signing children participated in this study, had exposure of 2 years of sign language at the time of testing. Before starting to school, both children groups got two hours of speech therapy every week. At the end of the study, adult participants received a small monetary compensation; child participants received a gender neutral color pencil kit.

Stimuli and Procedure

Stimuli included a set of 36 displays. In each display, there were 4 pictures[2] consisted of two entities placed in various spatial configurations (Left, Right, In, On, Under, Front and Behind) to each other. Within each display (four-picture set), only one picture was considered to be the target, which was marked with a red outer frame. The experimental displays we focused on in this study consisted of 6 displays, in which the target picture depicted either Right or Left configurations (Figure 2).

Figure 2: Example of a display. The target picture (apple to the right of the box) to be described is framed in red.

Participants were seated across a confederate deaf addressee who was a native signer of TİD. Stimuli were presented through a 15" MacBook Pro computer. Computer screen was only visible to the participants. Participants were asked to describe the target pictures to the addressee and were not instructed to use any specific strategy. In order to create an interactive nature, addressee was given a booklet containing the same displays and was asked to point at the picture that the participant described. At the end of the experiment, participants filled out demographics and language background surveys.

[1] Data of native signers were collected as part of a bigger project conducted between 2010 and 2015 (Sümer, 2015).

[2] Pictures used in the study were originally developed by Dr Jennie Pyers and were adapted further for the purposes of this present study.

Coding

Descriptions for the target items were coded for the presence of spatial encoding and choice of linguistic strategies used to describe spatial relationship between two entities by using ELAN, a free annotation tool (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). We categorized three main linguistic strategies used to encode, specifically, Figure object's relation to Ground object: Classifier predicates CLs (Figure 1a), Relational Lexemes like LEFT and RIGHT (Figure 1b), and other alternative linguistic forms. Other forms included showing the location of objects through pointing (59% of the cases; Figure 3), placing the objects in the signing space through virtually drawing by hand (SASS), using a lexical verb to infer objects (e.g. using sign for "to sit" to represent location of a boy).

Annotation of data from the native signers were done by hearing research assistants and a native TİD signer and coded by the second author of this study. Annotation of data from the late signers were done by hearing research assistant and coded by the first author of this study. Later, all annotation and coding was checked by the second author of this study. All annotators and coders had knowledge of TİD.

(a) RH: Point (cat)$_{locR}$
LH: CL (boat)$_{locL}$

(b) RH: CL(house)$_{locR}$
LH: Point (horse)$_{locL}$

Figure 3: Descriptions from late signers of TİD for two objects located on the lateral axis by using pointing by (a) an adult TİD signer (middle finger point) and (b) a child TİD signer (index finger point).

Results

Mean proportions of linguistic strategies were calculated for each participant. Arcsine transformation was applied to all data to ensure normality. The mean proportions and standard errors (SEs) in the table and the graphs are reported from the untransformed data.

First we investigated the frequency of encoding a spatial relation of entities by different groups in each language status. Results of the 2 (Age: Adults, Children) X 2 (Status: Native, Late) Between Subjects ANOVA on mean proportions of encoding a spatial relation revealed no main effect of age, F (1,30) = 2.918, p = .098, η^2 = .089, MSE = .381, no main effect of status, F (1,30) = .373, p = .546, η^2 = .012, MSE = .049 and no interaction, F (1,30) = 768, p = .388, η^2 = .023, MSE = .100. These results indicate that all groups of participants generated equal amount of relational encodings (Table 1).

Table 1: Mean Proportions and SEs of frequency of encoding a spatial relation as a function of Age and Status.

Participants	Native Signers	Late Signers
Adults	0.97 (.02)	0.98 (.03)
Children	0.92 (.05)	0.81 (.11)

As the next step, we investigated what types of linguistic strategies were preferred by each age group and status. The results of a 2 (Between Subject, Age: Adults, Children) X 2 (Between Subject, Status: Native, Late) X 3 (Within Subject, Linguistic Strategy: CLs, RLs, Other) Mixed ANOVA yielded a main effect of Linguistic Strategy, F (1.32,12.42) = 37.114, p < .001, η^2 = .533, MSE = .314, no main effect of age, F (1,30) = .347, p = .560, η^2 = .011, MSE = .008, no main effect of Status, F (1,30) = 1.385, p = .249, η^2 = .044, MSE = .008. Due to a marginal interaction between Linguistic Strategy and Status, F (1.32,12.42) = 3.628, p = .053, η^2 = .108, MSE = .314, separate analyses were conducted for each Status.

Linguistic Strategies used by Native Signers

The results of 2 (Between Subjects, Age: Adult, Child) X 3 (Within Subjects, Linguistic Strategy: CLs, RLs, Other) mixed ANOVA showed no main effect of age, F (1,18) = 1.214, p = .285, η^2 = .063, MSE = .028 but a main effect of Linguistic Strategy, F (1.25,22.53) = 60.186, p < .001, η^2 = .770, MSE = .183, without an interaction between them, F (1.25,2.53) = .251, p = .674, η^2 = .315, MSE = .183. Tests of within subject comparisons showed that classifier predicates were preferred more frequently than relational lexemes (p < .001) and other linguistic forms (p < .001). The frequency of using relational lexemes and other forms found to be similar to each other (p > .05). The lack of main effect for age indicated that deaf children used the linguistic forms in three different categories as frequently as deaf adults. See Figure 4 below.

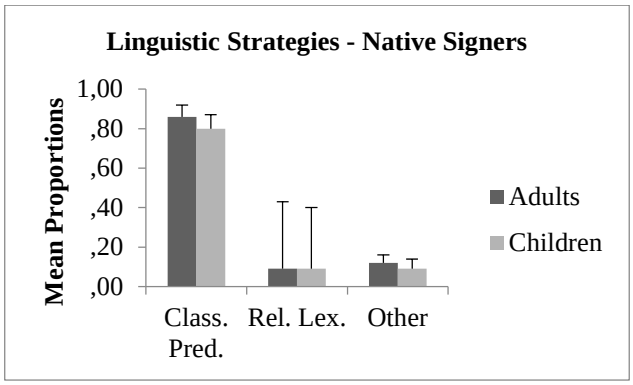

Figure 4: Mean proportions and SEs of linguistic descriptions of native signers as a function of age.

Linguistic Strategies used by Late Signers

The results of 2 (Between Subjects, Age: Adults, Children) X 3 (Within Subjects, Linguistic Strategy: CLs, RLs, Other) mixed ANOVA showed no main effect of age, F (1,12) = .097, p = .761, η^2 = .008, MSE = .015 but a main effect of Linguistic Strategy, F (1.18,14.10) = 6.771, p = .017, η^2 = .036, MSE = .588, without an interaction between them, F (1.18,14.10) = .450, p = .544, η^2 = .036, MSE = .588. Tests of within subject comparisons showed that relational lexemes were used less frequently than classifier predicates (p < .01) and other forms (p < .05). The frequency of using classifier predicates and other forms are found to be similar to each other (p = 573). The results indicate that late signers -unlike native signers- use other forms as frequently as classifier predicates. See Figure 5 below.

Results showed that native and late signers show different production patterns in their descriptions of the location of the objects when they are placed to left or right to each other. Namely, native signers show a significant preference over using the morphologically complex CLs in describing, however, late signers employ other simpler forms as frequently as CLs. Moreover, this tendency is significant for all age groups.

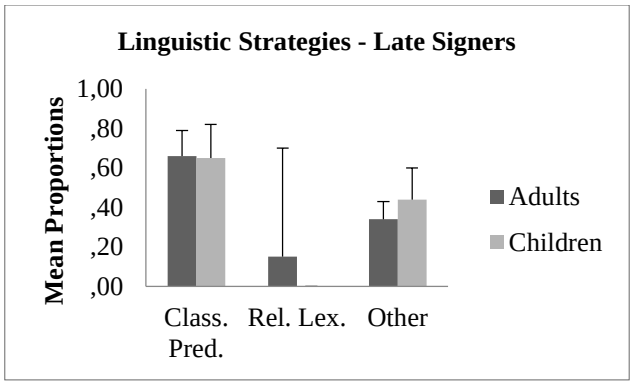

Figure 5: Mean proportions and SEs of linguistic descriptions of late signers as a function of age.

Discussion and Conclusion

Our study has two key findings. First, late signing adults and children differ from native signing adults and children in their linguistic descriptions. Namely, late signers do not show a preference for CLs. Rather they employ simpler other forms as frequently as CLs compared to native signers. These findings clearly indicate that late exposure to sign language by deaf individuals has long-term effects on their production patterns. Second, late signing children perform similar to late signing adults in their static spatial event descriptions and show no further developmental trajectory in their preferred linguistic devices.

Results of this study complement the previous literature – yet in another sign language – showing a tendency towards decreased preference for CLs and increased preference for other simpler forms not only for complex event descriptions, as found in ASL (Newport, 1988; 1990), but also for simple static events (Sümer et al., 2014; Sümer, 2015). In the case of native signers of TİD, both adults and children prefer CLs more than RLs and other forms while the nature of this distribution is different for late signers of TİD, who use CLs and simpler other forms such as pointing in similar amounts while they prefer RLs for left and right less frequently. The body-anchored relational lexemes in TİD were very rarely used by late signing adults and not at all by the late signing children. Thus, the use of CLs and RLs did not seem to ease acquisition for these children as they did for native children. However, we should be cautious in generalizing the effects of these comparisons due to relatively few number of participants we could investigate especially from late signing group.

Considering the high proportion of relational encodings shown on Table 1, 2-year exposure to sign language after age 6 seems to be enough to initiate spatial language production in late signing children to become adult like. This is a rather striking finding since Gentner and her colleagues (2013) found that home signing children (deaf children never exposed to a sign language) in similar age range do not produce gestures in a way that would encode spatial relations, which indicates the necessity of sign language input for relational encoding to emerge at all. This pattern also shows that while relational encoding might emerge as the earliest feature of encoding a spatial event, and as less sensitive to delayed exposure, morphologically complex forms or body anchored relational lexemes such as LEFT and RIGHT might be more resistant to the timing of the input to develop.

The difference in the preference for linguistic forms to encode spatial relations between native signers and late signers provides evidence for the role of maturational constrains in language acquisition. Moreover, previous studies have been mostly on comprehension of sign language (e.g., Mayberry & Eichen, 1991), our results indicate that these effects are not only restricted to comprehension, but also observed in production, as also shown by Newport (1988; 1990). Furthermore, it shows that these results on motion event expressions can be extended to those of static events.

Our study also uniquely displays these patterns for late signing children for the first time in the literature. Although, late signing adults of TİD have lengthier language experience compared to late signing children, who have only a 2-year of sign language exposure, we still observed similar preferences in how frequently they prefer CLs and other forms. It seems that the hindering

effects of delayed language exposure persist in language production despite many years of language use. This finding is also in line with other studies that show the significance of age of acquisition, rather than the length of exposure, in both sign and spoken language development (Mayberry, 2010).

Finally, late signing children were not only exposed to sign language late but also the kind of language they were exposed to, that is the language used by their late signing peers in the primary school, was also non-native. Thus, future research should also investigate the effect of type of language input (i.e., non-native input) in addition to age of acquisition in late signing children and adults on late signers' language production.

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