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Type of iconicity matters in the vocabulary development of signing children

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Abstract

Recent research on signed as well as spoken language shows that the iconic features of the target language might play a role in language development. Here we ask further whether different types of iconic depictions modulate children's preferences for certain types of sign-referent links during vocabulary development for objects in sign language. Results from a picture description task indicate that lexical signs with two possible variants are used in different proportions by deaf signers from different age groups. While pre-school and school-aged children favoured variants representing actions associated with their referent (e.g., a writing hand for the sign PEN), adults preferred variants representing the perceptual features of those objects (e.g., upwards index finger representing a thin, elongated object for the sign PEN). Deaf parents interacting with their children, however, used action and perceptual based variants in equal proportion and favoured action variants more than adults signing to other adults. We propose that when children are confronted with two variants for the same concept, they initially prefer action-based variants because they give them the opportunity to link a linguistic label to familiar schemas linked to their action/motor experiences. Our results echo findings showing a bias for action based depictions in the development of iconic co-speech gestures suggesting a modality bias for such representations during development.

Keywords: sign language; iconicity; vocabulary development; action; perception; child-directed communication

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Introduction

Regardless of whether they are expressed in the aural-oral (speech) or visual-manual channel (sign, gesture), languages can “mimic” the acoustic or visual properties of their referents (Dingemanse, Blasi, Lupyan, Christiansen, & Monaghan, 2015; Perniss, Thompson, & Vigliocco, 2010; Vigliocco, Perniss, & Vinson, 2014). That is, some linguistic forms, rather than having an arbitrary relationship with the referent, exhibit direct iconic mappings by means of perceptuomotor analogies between form and meaning. In spoken languages, words can have different motivated links with the sounds produced by their referent as in the case of onomatopoeia (e.g., *moo* for ‘cow’), ideophones (e.g., *gblogblogblo* in Siwu for ‘bubbling’), or in mimetic verbs (e.g., in Japanese the sounds /g/, /k/, and /r/ generate words associated to rotation) (Assaneo, Nichols, & Trevisan, 2011; Dingemanse, 2011; Oda, 2000). In addition to iconicity in speech, spoken languages are usually accompanied by the so-called iconic gestures which are manual depictions of the objects and events described in co-occurring speech (e.g., a curved handshape moving towards the mouth accompanying the verb *drink*) (McNeill, 1992). The sign languages of the deaf communities stand out for their prevalence of a large number of linguistic labels whose forms are motivated by the features of their referents (Cuxac, 1999; Emmorey, 2014; Klima & Bellugi, 1979; Padden, Hwang, Lopic, & Seegers, 2015; Perniss et al., 2010; Pietrandrea, 2002; Taub, 2001). Furthermore, a myriad of empirical studies employing linguistic, ethnographic, behavioural and neurological methods has produced strong evidence showing that iconicity is a common feature of spoken and signed languages (Dingemanse et al., 2015; Vigliocco et al., 2014).

Recent research on language development has found modulating effects of such iconic labels during spoken and signed language learning. Infants across different cultures are

sensitive to the iconic properties of words irrespectively of whether they are present in their own language or not (Revill, Namy, Defife, & Nygaard, 2014; Yoshida, 2012) and have been found to facilitate phonological and lexical development (Imai, Kita, Nagumo, & Okada, 2008; Imai & Kita, 2014; Kantartzis, Imai, & Kita, 2011; Laing, 2014). Iconicity also influences caregivers' communication in that it shapes the form of child-directed communication compared to adult-adult interactions (Akita, 2009; Yoshida, 2012). Regarding sign languages, traditional accounts concluded that iconicity does not play a role in sign acquisition (Meier, Mauk, Cheek, & Moreland, 2008; Newport & Meier, 1985; Orlansky & Bonvillian, 1984). However, more recent studies show that the first signs acquired by deaf children are iconic in nature (Thompson, Vinson, Woll, & Vigliocco, 2013). These findings provide converging evidence for the claim that linguistic forms that are more grounded in perceptual and motoric experience (i.e., iconic) are easier to learn, leading caregivers to modify their child-directed interactions accordingly (Imai & Kita, 2014; Perniss & Vigliocco, 2014).

This research, however, has not taken into account the different ways communicative signals might be linked to their referents, but has so far only compared iconic labels in general to arbitrary ones. Evidence from spoken and signed languages shows that iconicity is not a binary property, but rather that it comes in different forms and degrees, and exploits different possible types of perceptuomotor analogies (Dingemanse et al., 2015; Klima & Bellugi, 1979; Perniss, Zwitserlood, & Özyürek, 2015). Here we ask whether the different ways in which form and referent are linked in iconic signs might play a role in children's preferences in vocabulary development as well as in child-directed communication.

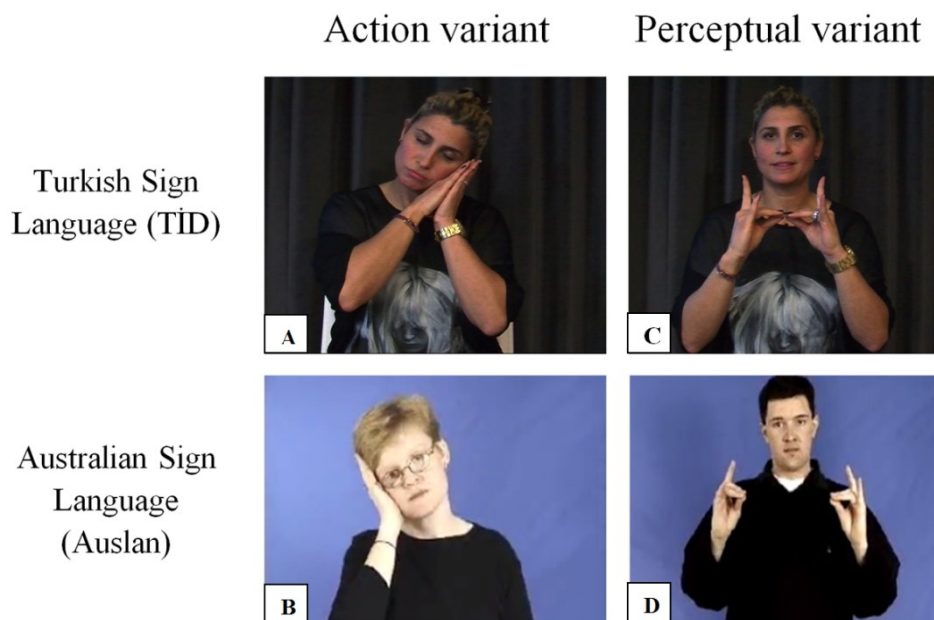
Iconicity and lexical variation in sign languages

Iconic signs may represent physical aspects of an object, manner and path of motion as well as spatial distribution and relationship between entities in a motivated way (Emmorey, 2001; Klima & Bellugi, 1979; Perniss, Zwitserlood, et al., 2015; Pietrandrea, 2002; Taub, 2001). The Analogue Building Model (Taub, 2001) proposes that iconic signs derive from our conceptual knowledge of an entity (e.g., an eagle flies, has wings and a curved beak), the selection of one its features (e.g., the wings) and its schematization into a manual phonology (e.g., the sign EAGLE in many sign languages consists of flapping the arms). Expanding on this model, Emmorey (2014) put forward the notion of "iconicity as structure mapping" which posits that a phonological representation of an iconic sign may overlap in varying degrees with a conceptual visual representation of a concept and this will influence linguistic development and processing. Iconic signs have been argued to make up two-thirds of a signed lexicon (Boyes-Braem, 1986) and the phonological structure of at least 50-60% of signs may be traced back to the visual features of a referent (Pietrandrea, 2002). As such, sign languages are unique in the large number of motivated structures within a conventionalised linguistics system.

At the lexical level, our main focus here, signs exploit a range of iconic depicting strategies to represent the same referent by showing actions associated with an object and how it is manipulated (i.e., handling), outlining its shape (i.e., tracing), or using a body part to represent its dimensions (i.e., instrument) (Padden et al., 2013, 2015).¹ The possibility to depict a referent in multiple ways results in the presence of more than one lexical variant for the same concept. In British Sign Language (BSL), for example, multiple lexical variants have been documented for a range of common concepts such as colours, countries and numbers (Stamp et al., 2014). Lexical variation for objects may involve, among others, two

¹ Note that similar ways of representing concepts have been also proposed for gestures accompanying speech (Müller, 2013), suggesting that these depictive strategies arise from basic affordances of the visual modality for representation (Masson-Carro et al., 2015; Perniss, Özyürek, & Morgan, 2015).

types: One representing a motor action associated with an object through manipulation or interaction with it (action-based signs) and the other representing its perceptual features (perceptual-based signs). In Turkish Sign Language (*Türk İşaret Dili*, TİD) and Australian Sign Language (Auslan), for example, the action-based variant BED represents someone lying on a pillow (Figure 1A-B), while the perceptual-based variant represents a mattress and bedhead (Figure 1C-D). These variants stand for the same concept and differ only in their iconic motivation² and have been explained further under the notion of iconicity as structure mapping (Emmorey, 2014). In this notion, even though the structure of both lexical variants is motivated by the same referent, they differ in the level of abstraction. In action variants, the sign articulators (i.e., body, head, and hands) represent the body parts executing an action associated with the referent in a one-to-one manner (e.g., body and hands are configured in a similar way as a person would when lying on a bed). This is not the case for perceptual signs because the hands do not represent the hands but rather the parts of an object (e.g., a bed's surface and its legs) and as such they require a higher level of abstraction.



² The high incidence of different sign variants for the same concept has become more evident with the advent of corpus-based databases of sign languages. Examples of action and perceptual variants in BSL are BUS, BANANA, SHOES (<http://bslsignbank.ucl.ac.uk/>); in Auslan, BED, GLASSES, DOG (<http://www.auslan.org.au/>); in Sign Language of the Netherlands (NGT) BANANA (<https://testsiteen.gebarencentrum.nl/>).

Figure 1. Action and perceptual-based variants BED in Turkish Sign Language (TİD) and Australian Sign Language (Auslan). The action variants (A and B) represent a person lying on a pillow while the perceptual variants (C and D) represent the bed head and mattress. The authors received signed consent from the person in images 1A and 1C to be published in this article. Copyright 2016 by Asli Özyürek. Images 1B and 1D adapted with permission from the Auslan SignBank (<http://www.auslan.org.au/>). Copyright 2016 by Auslan SignBank.

Iconic lexical variants are common in sign languages but it is unclear what factors drive lexical choice during signing. Experimental studies with adult signers have shown that sign languages do not use a single variant exclusively but merely a preference for one variant over others, and interestingly this preference varies across different sign languages. For example, adult users of American Sign Language (ASL) and Al-Sayyid Bedouin Sign Language (ABSL) have a clear preference for perceptual variants whereas users of New Zealand Sign Language (NZSL) are biased towards action-based signs (Padden et al., 2013). Based on the different patterns observed around the globe, researchers have proposed that sign languages can be classified into typological groups according to the referents they depict and the structural devices to represent them (Nyst, 2013; Padden et al., 2013). To date, however, lexical choice has only been studied in adult populations and in adult-adult interactions. As such, it remains an empirical question whether deaf signing children have the same preferences as adults and whether their caregivers align their choices accordingly interacting with them

Thus, in the present study we ask whether the use of different types of iconic signs varies across age groups, and whether certain variants (action or perceptual-based signs) are preferred by children versus adults as well as when the communication is targeted for children. We aim to further our understanding on this issue by investigating patterns of usage of specific types of iconic signs by five groups of deaf users of TİD: Two groups of children (pre-school and school-age), two groups of parents of the same children, and a separate group of adults.

The Role of Iconicity in the Acquisition of Signed and Spoken Languages

Over the last decade a large body of research supporting the facilitative role of iconicity in language development has emerged. The abundance of sound-symbolic words in the emerging vocabularies of speaking infants is more prevalent than previously attested; and seem to contribute significantly in lexical acquisition (Laing, 2014). Additional supporting evidence has convincingly demonstrated that children as young as 25 months of age are sensitive to mimetic (iconic) verbs and take advantage of the sound-symbolic links to learn new words (Imai et al., 2008). This effect is not only present in infants acquiring a language rich in sound-symbolism, like Japanese. Speakers of other languages are also sensitive to the iconic links between speech and referent and exploit them for vocabulary learning (Kantartzis et al., 2011; Revill et al., 2014). Compared to adults, toddlers use more sound-symbolic verbs over arbitrary ones despite both labels referring to the same motion event (Kita, Özyürek, Allen, & Ishizuka, 2010; Yoshida, 2012). The Bootstrapping Hypothesis suggests that iconic symbols “help infants and toddlers initially to associate speech sounds with their referents to establish a lexical representation” (Imai & Kita, 2014. p. 1).

Despite iconicity being much more pervasive in signed than in spoken languages, there has been some controversy on whether or how iconicity might play a role in sign language acquisition. The first studies investigating sign language acquisition do not report a facilitating effect of iconicity. Based on parental reports, Orlansky and Bonvillian (1984) followed the linguistic development of 11 deaf children acquiring ASL from birth (age range: 0;04-1;02) and found that they produced an equal proportion of iconic and arbitrary signs. Meier, Mauk, Cheek and Moreland (2008) investigated if four deaf children acquiring ASL (age range: 0;08-0;17) had access to sign iconicity by assessing whether they enhanced signs’ iconic features during spontaneous interactions with their caregivers. The authors did not find instances in which infants exaggerated any iconic properties of the sign (e.g., by licking their

hand for the sign ICE-CREAM) and thus concluded that maturational constraints rather than iconic sign-form mappings drive sign language acquisition. The negligible effect of iconicity during sign acquisition was attributed to children not having sufficient world knowledge to make associations between a linguistic symbol and its referent (Newport & Meier, 1985). The idea that iconicity takes time to learn was further corroborated in a study where hearing children (2;5 – 5;0) were asked to match an iconic sign with its referent (Tolar, Lederberg, Gokhale, & Tomasello, 2008). Children younger than 2;8 performed below chance but gradually improved in performance with age. At the earliest stages children cannot make associations between an iconic (manual) form and its referent because this capacity gradually emerges in the pre-school years (Namy, 2008).

Recent evidence, however, has shown that iconic signs are the first to be acquired by deaf children learning a sign language from their deaf parents (Thompson et al., 2013). Looking at parental reports of 31 deaf children learning BSL (age: 0;08–0;36), the authors found that the first signs to be comprehended and produced were iconic, even when phonological complexity, frequency, and imageability was controlled for.

In this and earlier studies, however, iconicity has been defined in a broad sense when a more fine-grained operationalization of iconicity could illuminate better its role during lexical development. Some evidence suggests that indeed when we look at different types of iconic links between a sign and its referent, one can see an effect of iconicity in sign comprehension. In the sign-picture matching task described above (Tolar et al., 2008), it was observed that signs depicting actions (e.g., the sign TOWEL represents a person pulling a towel side-to-side from behind) were the first and more accurately matched with their referent by children as young as 2;8. Thus, it is possible to expect that different types of iconicity may play a role at a developmental stage when the iconic links are available to

children (3 years of age onwards); and possibly that caregivers may align their lexical variant when interacting with children.

Iconicity in child-directed communication

It is a well-established phenomenon that compared to adult-to-adult communication caregivers modify their behaviours during the interactions with their children. Child-directed speech, also called *motherese*, has features different from those present in the exchanges between adult conversational partners (Bornstein, Putnick, Cote, Haynes, & Suwalsky, 2015; Bornstein et al., 1992). Child-directed speech often exaggerates intonation contours to emphasise characteristics of certain words (Herold, Nygaard, & Namy, 2011), uses simplified vocabulary (Adi-Bensaid, Ben-David, & Tubul-Lavy, 2015), and higher pitch (Smith & Trainor, 2008). An interesting modification in child-directed speech has been observed when parents favour sound-symbolic words when an arbitrary label is also possible. Japanese parents speaking to their children tend to use words that reflect iconic aspects of the referent (mimetic verbs) instead of less iconic labels (Nagumo, Imai, Kita, Haryu, & Kajikawa, 2006; Yoshida, 2012). This trend diminishes substantially when parents interact with other adults.

Child-directed modifications are not exclusive to the spoken modality. There are reports that the iconic gestures produced by caregivers also serve as a communicative strategy through which children are capable of mapping new knowledge more easily. Campisi and Özyürek (2013) found that Italian adults use more iconic gestures when they were explaining how an instrument works to (an imagined) 12-year-old vs. to an adult addressee. It has also been observed that around 26 months English-speaking infants go through an iconic gesture spurt, which aligns with the time at which caregivers also increase the frequency and rate of their iconic gestures when communicating with their children (Ozçalışkan & Goldin-Meadow, 2011).

Another form of child-directed modification within the manual modality has been observed in sign languages. By means of repetition, avoidance of hand internal movements and displacement of locations, deaf parents alter their language to make signs more visually salient and facilitate acquisition (Holzrichter & Meier, 2000; Masataka, 2000). Deaf children are more attentive to child-directed signing than to communication designed for deaf adults (Masataka, 2000). It is not known, however, whether iconicity plays a role in child directed signing and more specifically whether caregivers modulate their choice of iconic lexical variant in their signing to deaf children.

The Present Study

Our study builds upon growing evidence on how iconic linguistic forms in both sign and speech may play a role in language development and in child-directed communication. It goes beyond previous studies in that it investigates whether different types of iconic depictions might be favoured by children and adults as well as by caregivers during development. Unlike previous studies that focused on 1-3 years we target an age period (range: 3;5 – 9;10) when iconicity is considered to be accessible to children (Namy, 2008). To do so, we specifically look at children and adults' preferences for lexical items where two iconic lexical variants exist for the same objects: one using representations akin to actions associated with the referent (action-based) and one with its perceptual features (perceptual-based). We specifically ask 1) Do signers of different age groups show a preference for one type of lexical variant when two variants are possible (action vs. perceptual)?; and 2) Do parents signing to their children choose a similar iconic depiction strategy as the one used by their children?

Based on studies showing that learning is easier when new forms overlap with previously known motor schemas (Yu, Smith, & Pereira, 2008), we expect young signers to prefer lexical variants that represent objects through the resemblance with the actions

associated with the referent (action-based variants). Emmorey's (2014) idea of "iconicity as structure mapping" would also support this prediction. In action-based variants, the hand represents the hand and thus there is a high degree of structural overlap between a linguistic form (i.e., the sign) and motor/action knowledge related to the referent. In contrast, perceptual-based signs, while still iconic, have a lower degree of structural overlap because the hand does not represent the hand but rather a part of the referent. Thus, the phonological form of perceptual-based variants has a more abstract relationship with the referent than action-based ones. This might lead to expectation that children will prefer the latter over the former.

Furthermore, based on studies showing alignment in frequency and rate of the iconic gestures used by children (e.g., Ozçalışkan & Goldin-Meadow, 2011), we expect parents' preferences to align with those of their children and differ from what is typical in adult-to-adult interactions. Finally, since there is no corpus-based data supporting the presence of lexical variants in TİD as in other sign languages (e.g., BSL, Auslan, Sign Language of the Netherlands), we also include a separate elicitation study by a different group of adult signers with the same target items to confirm that our iconic variants are lexical items of the TİD lexicon.

Method

The present data comes from a larger dataset investigating spatial descriptions by adult and child deaf signers of Turkish Sign Language (*Türk İşaret Dili*, TİD) (AUTHORS). In the task, participants described from a picture the spatial relationship (e.g., IN, ON, UNDER) between two objects to elicit a target sign. For the purpose of this study, we only focused on the lexical items for which two lexical variants are available (i.e., action and perceptual). See Procedure and Materials below.

Participants

Forty-eight deaf TİD signers living in Istanbul were recruited for this study and were categorised into five groups: Pre-school children (N = 10, mean age: 5;02, *SD* = 13 months, range: 3;5 – 6;10); school-age children (N = 10, mean age: 8;03, *SD* = 9 months, range: 7;02 – 9;10); the parents of the pre-school children (N = 9); the parents of the school-age children (N = 9); and a different group of adults unrelated to the other groups (N = 10). All children were native TİD signers and all adults were native or early signers (age of acquisition: 6 years or younger). All participants had lived in Istanbul all their lives and were users of the same TİD variant.

Materials and Procedure

Participants were instructed to describe the spatial relationship between two objects in a picture shown on a laptop. The computer screen was divided into four sections with each quadrant displaying a picture with two toys placed in different spatial arrangements. The four pictures included the same two toys (e.g., a toy plane and a toy bed) in different spatial relationships (e.g., the plane was on, under, next to, or in front of the bed). In a self-paced task, participants pressed a key to bring the four pictures to the screen with one of them being highlighted with a red frame (e.g., a plane under the bed). The red frame was indicative of the

picture participants had to describe to their interlocutor. Adults, pre-school children, and school-age children described the picture to a deaf research assistant. Parents of pre-school children and parents of school-age children described the pictures to their own children. They had not seen their children describing them to the deaf assistant. Interlocutors had a booklet with the same four pictures that the signer had for each description. After participants had described the highlighted picture, the interlocutor had to point at the correct picture on the booklet. The goal of the communicative exchange focused on the right type of spatial relation since the objects were the same in all four pictures.

From this dataset, we selected objects for which signers used two lexical variants: an action and a perceptual variant. Action-based signs represented objects through their resemblance to actions associated with the referent or the way an object is manipulated. Perception-based signs described the form of a referent by depicting its form with different hand configurations or by tracing its shape in space.³ The objects selected were: *toothbrush*, *cup*, *pen*, *bathtub* and *bed* and each were described two, four, four, three and three times, respectively, appearing in different spatial relations in the data set, making a total of 16 pictures. The objects used in the pictures were toys in a static position and did not show any agents performing an action on them.

Coding and data analysis

Each description was transcribed by a deaf assistant and later categorised into lexical signs labelling the objects in the picture and their corresponding classifier predicates. In the analysis we included lexical signs only.⁴ With the help of a deaf TID signer we verified that

³ Appendix 1 includes still images of the target lexical variants. Video clips of all signs are available in the Supplementary Materials.

⁴ In spatial descriptions most sign languages use manual structures called classifier predicates which follow lexicalised signs, and represent motion and location of referents. For instance, after introduction of lexical signs, an extended index finger on an open palm may represent a toothbrush or a man lying horizontally on a flat surface. All children and adults produced classifier predicates after the lexical signs and in similar frequency in the data from which the items for this study were selected (AUTHORS). Crucially, classifier predicates were not included in the analysis. In the current paper we followed a set of guidelines that have been previously used to distinguish lexical signs from classifier predicates in TID and

the signs coded were lexical variants for the same object. After the analysis was carried out, a second coder, who is also a TID user, independently classified 20% of the data (N = 169 descriptions out of 847) into action or perceptual variants to check for coding agreement. The interrater reliability for the two coders was found to be strong [$\kappa = 0.769$, $p < 0.001$, 95% CI (0.670, 0.868)].

In order to ensure that these variants were indeed part of the TID lexicon (i.e., not gestures or idiosyncratic sign productions), a separate *post hoc* elicitation and comprehension study with a different group of TID signers was carried out (N = 17, five of them native signers and the rest were exposed to TID after 6 years of age). In the sign elicitation task, participants were shown pictures of the five objects used in the original study but without the spatial relation as well as five filler pictures. The stimulus materials were generated from the pictures used in the picture description task, and using Photoshop the non-target items were removed, so that they were presented in isolation. Participants were told that the aim of the task was to create a TID dictionary and that it was necessary to document all possible variants for each concept. Pictures were presented one at a time by an adult deaf research assistant and participants' responses were video recorded. We also included a sign comprehension task in which the same research assistant produced all the sign variants observed in the picture description task, one at a time, while participants were presented with two pictures of individual objects. One of the pictures referred to the sign produced by the research assistant. Participants were asked to select the picture of the sign observed but were explicitly told that it was also possible not to choose any picture if they thought the sign did not correspond to any of them. The sequence of the tasks was counterbalanced across participants.

German Sign Language based on very similar data (Özyürek, Zwitserlood, & Perniss, 2010; Perniss, Zwitserlood, & Özyürek, in press) and Sign Language of the Netherlands (Zwitserlood, 2003).

Results

We calculated the proportions of action and perceptual-based signs produced by counting the number of signs for each iconicity type divided by the total number of lexicalised signs produced for all the descriptions for each subject (see Supplementary Materials for examples). On the arcsine-transformed proportions of the action variants, we carried out linear mixed-effects models with crossed random effects using restricted maximum likelihood estimation. Age Group was the fixed factor (Adults, pre-school children, school-age children, parents of pre-school children and parents of school-age children) and random effects were participants, items and age of acquisition (native vs. acquisition after 6 years of age). The partial effect of Age Group was significant. Pre-school children (mean: 0.81, $SD=0.21$) produced significantly more action variants than adults (mean: 0.25, $SD=0.14$) [$\beta = 0.1110$, confidence interval (CI) = 0.073, 0.148, $p < 0.001$]. School-age children (mean: 0.72, $SD=0.12$) also produced more action variants than adults [$\beta = 0.0932$, CI = 0.056, 0.130, $p < 0.001$]. Similarly, compared to adults, pre-school parents (mean: 0.58, $SD=0.28$) [$\beta = 0.0582$, CI = 0.013, 0.103, $p = 0.013$] and school-age parents (mean: 0.56, $SD=0.19$) [$\beta = 0.0614$, CI = 0.021, 0.101, $p = 0.003$] produced significantly more action signs. Pairwise comparisons after Bonferroni corrections revealed there was no significant difference in the proportion of action signs produced by both groups of children [$t(9) = 1.029$, $p = 0.330$]. There was no difference in the proportion of action signs produced by pre-school children and pre-school parents [$t(8) = 1.543$, $p = 0.161$]. Similarly, school-age children did not differ from school-age parents [$t(8) = 1.606$, $p = 0.147$]. Both groups of parents produced the same proportion of action signs [$t(8) = 0.095$, $p = 0.927$]. Partial effects of participant, item, age of acquisition and interactions did not reach significance ($ps > 0.3$). See Figure 2.

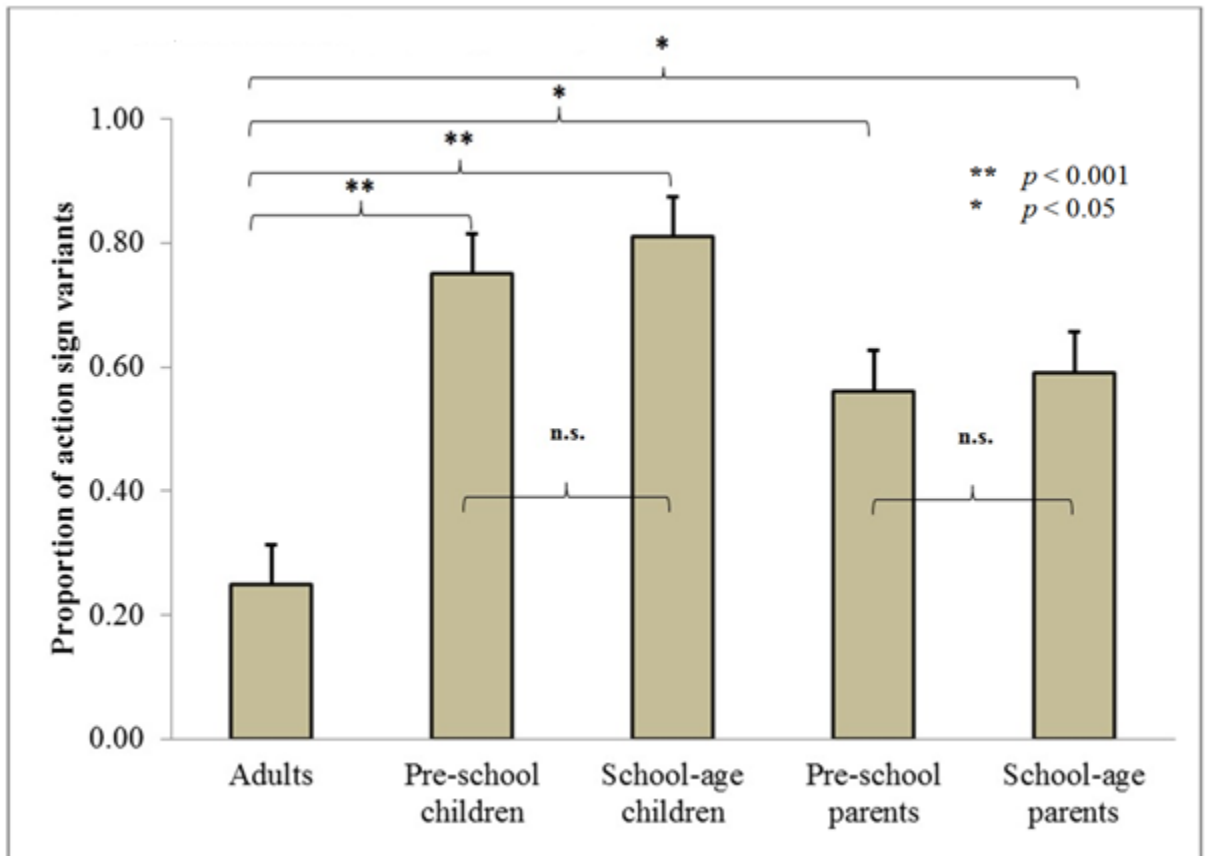


Figure 2. Proportion of action variants out of all signs across age groups. Bars represent standard error.

Figure 3 shows the proportion of action signs produced per item in each group. As the statistical analysis on the random factors show, despite some variation the same preferences hold for all the items: Adults produced few action signs when interacting with a deaf adult but both groups of children and their parents favoured the action variants more than adults.

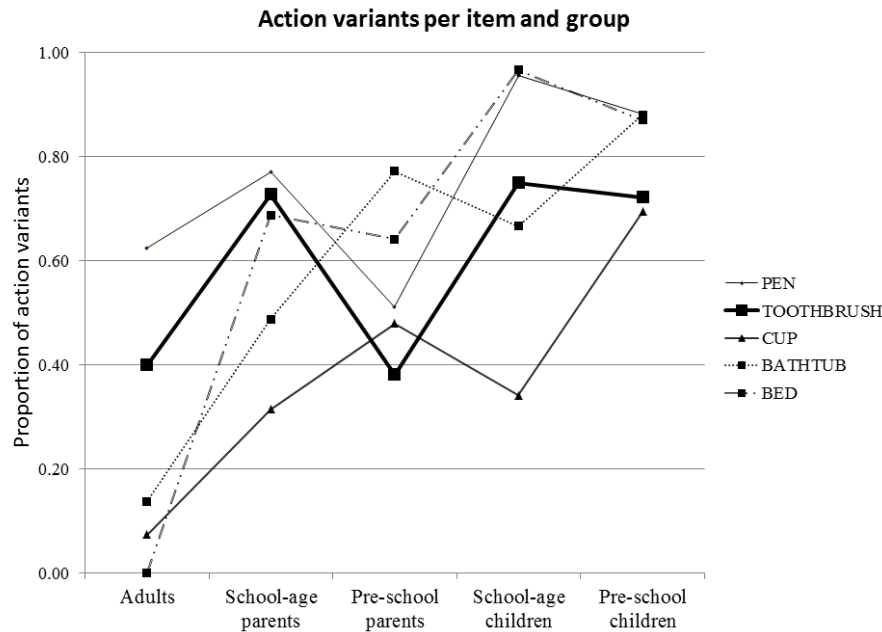


Figure 3. Proportion of action variants out of all signs per item for all age groups.

We further looked at the markedness in the handshapes produced by participants to attest whether avoidance of phonologically complex signs explained the preference for action-based variants. In sign phonology, seven unmarked handshapes, $\text{2 } \text{1 } \text{] } \text{>}$ $\text{F} < \text{A}$, have been described as the basic hand configurations from which more complex ones stem (Battison, 1978). These handshapes are the first to emerge in signing toddlers (Boyes-Braem, 1990), are present in all studied sign languages, and constitute a large proportion of signs in many lexicons (Johnston & Schembri, 2007). We found a homogenous distribution of marked and unmarked handshapes across action and perceptual signs for all lexical variants (see Appendix 2).

We also investigated whether deaf parents exhibited another feature of child-directed signing, namely repetition (Holzrichter & Meier, 2000). More importantly, we looked at how they used this strategy with the different lexical variants. To that end, we calculated the

instances in which adults (parents and adults) produced more than one sign for the same description. Out of 159 signs produced, there were only two instances (1.2% of the adult signs) in which an adult repeated a sign in a description in signing to another adult. In contrast, there were 33 instances in pre-school parents (17.6% of a total of 188 signs) and 37 instances for school-age parents (18% of 195 signs). We then calculated the sequence of signs for each repetition, that is, the sequence of iconic variants for each description (see Table 1).

When deaf parents produced a sign more than once, in the majority of cases they repeated the same sign. This was consistent in both pre-school and school-age parents (both approximately 60%). To a lesser extent, both groups switched the lexical variant. In the case of pre-school parents, it was more common that they started with a perceptual-based sign and then produced an action-based sign (30% of instances). In school-age parents, there was a more balanced split with both transitions being almost as frequent. Statistical analysis on switches to a different variant (i.e., perceptual to action, and action to perceptual) revealed that only pre-school parents had a significant inclination to produce an action-based variant after they had produced a perceptual-based one ($\chi^2 = 18.10$, $df = 1$, $p < 0.001$).

Transition type	Proportion of transitions	
	Pre-school parents (N = 33 signs)	School-age parents (N = 37 signs)
Perceptual-Action	0.30	0.19
Action-Perceptual	0.10	0.22
Same	0.60	0.59
TOTAL	1.00	1.00

Table 1. Proportion of instances when parents repeated a sign for a single concept. These included transitions from one type of lexical variant to another (perceptual to action or action to perceptual) or instance when parents repeated the same variant they produced initially.

Finally, we report the data from the *post hoc* sign elicitation and comprehension task that would establish whether the variants used by the different groups were indeed part of the TĪD lexicon. In the sign elicitation task, we found that 80% or more of participants produced both lexical variants for BATHTUB, CUP and PEN. The action and the perceptual variants for BED were produced by 50% and 80% of the participants, respectively. The action and perceptual variants for TOOTHBRUSH were produced by 90% and 60% of participants, respectively. In the comprehension task, all participants chose the target picture 100% of the times for all the items. These data show that all variants coded in the picture description task for all groups of signers are permissible signs of the TĪD lexicon (i.e., not gestures or idiosyncratic manual elaborations).⁵

Discussion

An interesting feature of sign languages is that signs for objects may have two iconic lexical variants: one representing an action associated with the referent, and the other one representing its perceptual features. Previous research has shown that these variants co-exist in the signed lexicon with adult signers showing preference of one variant over the other (Padden et al., 2013). In this study we investigated, first, whether the two types of iconic depictions influence preference for a specific type of variant in deaf signing children from different age-groups when compared to deaf adults; and second, whether deaf parents' lexical choice during child-directed signing aligned to their children's.

⁵ The fact that some signs may look like some of the gestures used by the speaking community does not mean they are not part of a signed lexicon. Whereas some signs may have a gestural origin (Janzen & Schaffer, 2002), the structural similarities between some iconic signs and iconic gestures should be attributed to the affordances of objects and the devices to depict them in the visual modality (Kendon, 2014; Masson-Carro et al., 2015; Padden et al., 2013, 2015; Perniss, Özyürek, et al., 2015). The results of the *post hoc* tasks confirm that these are possible lexical TĪD variants regardless of their similarities with the gestures used by the surrounding speaking community. We do not, however, rule out the possibility that the sign forms that are initially preferred in sign language acquisition might be the ones that have similarities with gestural representations.

We corroborated earlier findings in adult-adult interactions from other sign languages in that TID signers prefer one variant over the other (Padden et al., 2013, 2015). Adult TID users favour mainly perceptual-based variants at least for the five items we studied. This preference may be motivated by the typological properties of each individual sign language (e.g., NZSL uses action whereas ASL, ABSL as well as TID use perceptual variants). Interestingly, however, we found that action-based variants are preferred by both groups of children interacting with an adult. Caregivers interacting with their children also favoured action-based variants, which is remarkable considering that the perceptual variant is the preferred form in adult-adult communication. Individual variation, age of sign exposure (nativeness) in caregivers, or specific items is unlikely to explain this effect because the partial effects of these factors accounted for a negligible proportion of the variance (less than 3%).

The finding that deaf children have a preference for action-based lexical variants fits well with the notion of iconicity as structure mapping (Emmorey, 2014). This idea posits that the more overlap between a phonological and a conceptual representation, the more iconicity will facilitate language processing and acquisition. In our study, action-based signs have a more direct structural mapping with the concept they represent because the hand represents the hand (e.g., the handshape \perp in the action variant TOOTHBRUSH represents a hand holding a toothbrush). In contrast, perceptual signs, while still iconic, do not have such direct structural mapping because the hand does not represent the hand (e.g., the handshape H does not represent a finger but rather the thin elongated form of a toothbrush). Perceptual signs have a higher level of abstraction and children may require more cognitive maturity to

make the relevant association. The distinction between action and perceptual signs reminds us that iconicity is not a categorical property of language but rather lies within a continuum with some signs being more transparent than others (Klima & Bellugi, 1979; Pizzuto & Volterra, 2000). Here we argue that type of iconicity matters because action-based signs lie well within the transparent end of the continuum and as such are more directly (one-to-one) mapped to their referent which explains children's preference during vocabulary development.

Deaf children's preference for action-based variants also goes in line with research in the development of children's co-speech gestures. When children (2-5 years) are prompted to produce the word for an object, they tend to accompany their spoken response with an iconic gesture that depicts the objects by the actions associated with it – like pretending to hold an umbrella while uttering the word *umbrella* (Stefanini, Bello, Caselli, Iverson, & Volterra, 2009). This trend is not language-specific because a similar pattern was observed in Japanese and Italian toddlers performing the same task (Pettenati, Sekine, Congestri, & Volterra, 2012). Children's (40-60 months) fast-mapping of action gestures to object referents has been interpreted as actions being an easier type of gesture to process (Marentette & Nicoladis, 2011). Tolar et al., (2008) also found that hearing children's ability to match iconic signs with their referent improved with age (2;6-5;0 years) and importantly, the first and most accurately recognised were signs for objects that referred to actions associated with them. These studies suggest that children acquiring a spoken language are biased towards manual forms representing body actions because they create a bridge between a linguistic label and children's action/motor experiences (Pettenati et al., 2012; Stefanini et al., 2009).

The parallels between sign and gesture development are not surprising due to the overlaps in types of representations between both forms of manual communication. Whereas sign languages differ from each other in the preferred type of depictions they use for objects

(e.g., ASL and ABSL: perceptual-based signs; NZSL: action-based signs) (Padden et al., 2013), hearing people from different cultures have a clear tendency to produce action-based gestures when depicting objects that have affordances for manipulation (Masson-Carro, Goudbeek, & Krahmer, 2015; Padden et al., 2015; van Nispen, van de Sandt-Koenderman, Mol, & Krahmer, 2014). Thus, it is possible that during sign vocabulary development signing children initially prefer sign variants that resemble the type of representations also preferred in gestures (i.e., action-based depictions).

The prevalence of gestures with action-based representations in speaking children has been explained by the link they create between a linguistic label and children's action/motor experiences (Pettenati et al., 2012; Stefanini et al., 2009). The literature on gesture and embodied cognition propose that gestural representations are mainly grounded in action/motor representations and are direct consequences of action simulations (Cook & Tanenhaus, 2009; Hostetter & Alibali, 2008). Within the realm of sign languages, the fact that the handshape of action-based signs represents the hand creates direct structural mappings between a linguistic form and a conceptual representation thus facilitating sign-referent associations (Emmorey, 2014). In other words, children might prefer action-based variants during vocabulary development because they provide a congruent link between a linguistic form and their action/motor experiences. This interpretation goes in line with studies demonstrating that language development is tightly linked to motor schemas (Yu et al., 2008; Yu & Smith, 2012). This link may be particularly relevant to vocabulary development in sign-acquiring children who face the cognitive challenge of developing multiple lexical variants for the same concept.

We now move to sign productions by deaf parents. We found, first, that deaf parents use repetitions of the lexical items more often than in adult-to-adult interactions, a feature reported in child-directed communication (Holzrichter & Meier, 2000). This shows that

during interactions with children as old as 9-10 years deaf caregivers might still employ features of child-directed signing. Interestingly, parents also showed a preference for action-based signs during communication with children than in adult-to-adult interactions. There are possible explanations for this effect. One is that parents might be aligning their variant or are primed by their children. Several studies have shown that parents modulate their own language based on their children's developing communicative skills. When children reach a linguistic milestone and start producing certain structures their caregivers modify their own responses to align with them. In that sense, infants prompt their parents about their readiness to produce certain communicative structures and as a result caregivers modify their language accordingly. This has been attested in vocalizations (Bornstein et al., 2015), pointing (Butterworth, 2003), object manipulations (Fukuyama et al., 2014), and iconic gestures (Ozçalışkan & Goldin-Meadow, 2011). We deem likely that parents' inclination for action-based signs during child-directed signing can be attributed to their accommodating to the lexical variants used by their children. It is also possible that caregivers use iconicity as a communicative strategy and initially chose forms that ground representations to their children's action/motoric experience (Perniss & Vigliocco, 2014). That is, parents may regard action-based signs more easily accessible to children.

Is it the case then that children's action-based preferences can be explained by the parental input rather than their bias for representations that map directly to their action/motoric experiences? Even though the design of our study does not allow us to refute completely the direct effects of input on children's preference, we argue that this does not seem to be the case. First of all, even though not significant, children seem to have a greater bias for action-based signs than parents (see Figure 2). Furthermore, a post hoc analysis between action-based renditions in child-parent pairs revealed no significant correlation (Kendall Tau: 0.205, $p = 0.091$). Even though not conclusive, this evidence is in line with the

claim that deaf parents, rather than children, accommodate to their addressees. Paradigms in psycholinguistics investigating accommodation (e.g., priming in a communicative context between deaf parents and children) could be implemented in future research to investigate the source of this effect.

Conclusion

Our results go beyond recent claims about the effect of iconicity in sign and spoken language acquisition by showing for the first time that type of iconicity matters in sign learning and in child-directed signing. We suggest that children's preference for action-based variants reflect a general modality bias for communicative symbols relying on action/motor representations in communicating about objects, as also found in the development of co-speech gestures. This might be due to the close link between such representations in the manual/visual and action/motor experience (Cook & Tanenhaus, 2009; Hostetter & Alibali, 2008). These findings open new avenues for further research in language and vocabulary development. Investigating different types and degrees of iconicity, exploiting different perceptuomotor analogies may reveal important effects of iconicity in vocabulary learning in both signed and spoken languages.

References

- Adi-Bensaid, L., Ben-David, a., & Tubul-Lavy, G. (2015). Content words in Hebrew child-directed speech. *Infant Behavior and Development*, 40, 231–241. doi:10.1016/j.infbeh.2015.06.012
- Akita, K. (2009). *A grammar of sound-symbolic words in Japanese: Theoretical approaches to iconic and lexical properties of mimetics*. Kobe University.
- Assaneo, M. F., Nichols, J. I., & Trevisan, M. A. (2011). The anatomy of onomatopoeia. *PLoS*

One, 6(12), 1–27.

Battison, R. (1978). *Lexical borrowing in American Sign Language*. Silver Spring, MD: Linstok Press.

Bornstein, M. H., Putnick, D. L., Cote, L. R., Haynes, O. M., & Suwalsky, J. T. D. (2015). Mother-Infant Contingent Vocalizations in 11 Countries. *Psychological Science*, 26(8), 1272–1284. doi:10.1177/0956797615586796

Bornstein, M., Tamis-LeMonda, C. S., Tal, J., Ludemann, P., Toda, S., Rahn, C. W., ... Vardi, D. (1992). Maternal responsiveness to infants in three societies: the United States, France, and Japan. *Child Development*, 63(4), 808–821. doi:10.1111/j.1467-8624.1992.tb01663.x

Boyes-Braem, P. (1986). Two aspects of psycholinguistic research: iconicity and temporal structure. In *Signs of Life: Proceedings of the Second European Congress on Sign Language Research*. Amsterdam: University of Amsterdam.

Boyes-Braem, P. (1990). Acquisition of the handshape in American Sign Language: A preliminary analysis. In V. Volterra & C. J. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 107–127). Washington, D. C.: Gallaudet University Press.

Butterworth, G. (2003). Pointing is the royal road to language for babies. In *Pointing: Where Language, Culture, and Cognition Meet* (pp. 9–29). New York: Psychology Press.

Campisi, E., & Özyürek, A. (2013). Iconicity as a communicative strategy: Recipient design in multimodal demonstrations for adults and children. *Journal of Pragmatics*, 47(1), 14–27. doi:10.1016/j.pragma.2012.12.007

Cook, S. W., & Tanenhaus, M. K. (2009). Embodied communication: speakers' gestures affect listeners' actions. *Cognition*, 113(1), 98–104. doi:10.1016/j.cognition.2009.06.006

- Cuxac, C. (1999). French sign language: proposition of a structural explanation by iconicity. *Gesture-Based Communication in Human-Computer*, 1739(1), 165–184.
- Dingemanse, M. (2011). *The Meaning and Use of Ideophones in Siwu*. Max Planck Institute for Psycholinguistics.
- Dingemanse, M., Blasi, D. E., Lupyan, G., Christiansen, M. H., & Monaghan, P. (2015). Arbitrariness, iconicity and systematicity in language. *Trends in Cognitive Sciences*, 19(10), 603–615. doi:10.1016/j.tics.2015.07.013
- Emmorey, K. (2001). *Language, Cognition, and the Brain: Insights from Sign Language Research*. Mahwah, N. J.: Lawrence Erlbaum Associates.
- Emmorey, K. (2014). Iconicity as structure mapping. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369(20130301). doi:dx.doi.org/10.1098/rstb.2013.0301
- Fukuyama, H., Qin, S., Kanakogi, Y., Nagai, Y., Asada, M., & Myowa-Yamakoshi, M. (2014). Infant's action skill dynamically modulates parental action demonstration in the dyadic interaction. *Developmental Science*, 1–8. doi:10.1111/desc.12270
- Herold, D. S., Nygaard, L. C., & Namy, L. L. (2011). Say It Like You Mean It: Mothers' Use of Prosody to Convey Word Meaning. *Language and Speech*, 55(3), 423–436. doi:10.1177/0023830911422212
- Holzrichter, A., & Meier, R. P. (2000). Child-directed signing in American Sign Language. In *Language Acquisition by Eye* (pp. 25–40). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Hostetter, A. B., & Alibali, M. W. (2008). Visible embodiment: Gestures as simulated action. *Psychonomic Bulletin & Review*, 15(3), 495–514. doi:10.3758/PBR.15.3.495
- Imai, M., & Kita, S. (2014). The sound symbolism bootstrapping hypothesis for language

- acquisition and language evolution. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369(20130298). doi:dx.doi.org/10.1098/rstb.2013.0298
- Imai, M., Kita, S., Nagumo, M., & Okada, H. (2008). Sound symbolism facilitates early verb learning. *Cognition*, 109(1), 54–65.
- Janzen, T., & Schaffer, B. (2002). Gesture as the substrate in the process of ASL grammaticization. In R. Meier, D. Quinto-Pozos, & K. Cormier (Eds.), *Modality and Structure in Signed and Spoken Languages* (pp. 199–223). Cambridge: Cambridge University Press.
- Johnston, T., & Schembri, D. A. (2007). *Australian Sign Language (Auslan): An introduction to sign language linguistics*. Cambridge: Cambridge University Press.
- Kantartzis, K., Imai, M., & Kita, S. (2011). Japanese Sound-Symbolism Facilitates Word Learning in English-Speaking Children. *Cognitive Science*, 35(3), 575–586. doi:10.1111/j.1551-6709.2010.01169.x
- Kendon, A. (2014). Semiotic diversity in utterance production and the concept of “language.” *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369, 20130293. doi:dx.doi.org/10.1098/rstb.2013.0293
- Kita, S., Özyürek, A., Allen, S., & Ishizuka, T. (2010). Early links between iconic gestures and sound symbolic words: Evidence for multimodal protolanguage. In A. D. Smith & M. B. Schouwstra (Eds.), *Proceedings of the 8th International conference on the Evolution of Language (EVOLANG 8)* (pp. 429–430). Singapore: World Scientific.
- Klima, E., & Bellugi, U. (1979). *The Signs of Language*. Harvard: Harvard University Press.
- Laing, C. E. (2014). A phonological analysis of onomatopoeia in early word production. *First Language*, 34(5), 387–405. doi:10.1177/0142723714550110

- Marentette, P., & Nicoladis, E. (2011). Preschoolers' interpretations of gesture: label or action associate? *Cognition*, *121*(3), 386–399. doi:10.1016/j.cognition.2011.08.012
- Masataka, N. (2000). The role of modality input in the earliest stages of language acquisition: Studies of Japanese Sign Language. In C. Chamberlain, J. P. Morford, & R. I. Mayberry (Eds.), *Language acquisition by eye* (pp. 3–24). Mahwah, N. J.
- Masson-Carro, I., Goudbeek, M., & Kraemer, E. (2015). Can you handle this? The impact of object affordances on how co-speech gestures are produced. *Language, Cognition and Neuroscience*, 1–11. doi:10.1080/23273798.2015.1108448
- McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. Chicago: University of Chicago Press.
- Meier, R., Mauk, C. E., Cheek, A., & Moreland, C. J. (2008). The form of children's early signs: Iconic or motoric determinants? *Language Learning and Development*, *4*(1), 63–98. doi:dx.doi.org/10.1080/15475440701377618
- Müller, C. (2013). Gestural modes of representation as techniques of depiction. In C. Müller, A. Cienki, S. Ladewig, D. McNeill, & J. Bressemer (Eds.), *Body - Language - Communication: An International Handbook on Multimodality in Human Interaction* (pp. 1687–1701). Berlin: De Gruyter Mouton.
- Nagumo, N., Imai, M., Kita, S., Haryu, E., & Kajikawa, S. (2006). Sound iconicity bootstraps verb meaning acquisition. *Paper Presented at the XVth International Conference of Infant Studies*.
- Namy, L. (2008). Recognition of iconicity doesn't come for free. *Developmental Science*, *11*(6), 841–846.
- Newport, E. L., & Meier, R. P. (1985). The acquisition of American Sign Language. In D. Slobin (Ed.), *The Cross-Linguistic Study of Language Acquisition, Volume 1* (pp. 881–

- 938). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Nyst, V. (2013). Gesture as a blue print for sign language structure. *Paper Presented at the Minerva Symposium on Emergent Languages and Cultural Evolution.*
- Oda, H. (2000). *An embodied semantic mechanism for mimetic words in Japanese.* Indiana University.
- Orlansky, M. D., & Bonvillian, J. D. (1984). The role of iconicity in early sign language acquisition. *The Journal of Speech and Hearing Disorders, 49*(3), 287–92.
- Ozçalışkan, S., & Goldin-Meadow, S. (2011). Is there an iconic gesture spurt at 26 months? In G. Stam & M. Ishino (Eds.), *Integrating gestures: the interdisciplinary nature of gesture* (pp. 163–174). Amsterdam: John Benjamins.
- Özyürek, A., Zwitserlood, I., & Perniss, P. (2010). Locative expressions in signed languages: a view from Turkish Sign Language (TID). *Linguistics, 48*(5), 1111–1145.
- Padden, C., Hwang, S.-O., Lepic, R., & Seegers, S. (2015). Tools for Language: Patterned Iconicity in Sign Language Nouns and Verbs. *Topics in Cognitive Science, 7*(1), 81–94. doi:10.1111/tops.12121
- Padden, C., Meir, I., Hwang, S.-O., Lepic, R., Seegers, S., & Sampson, T. (2013). Patterned iconicity in sign language lexicons. *Gesture, 13*(3), 287–305.
- Perniss, P., Özyürek, A., & Morgan, G. (2015). The influence of the visual modality on language structure and conventionalization: Insights from sign language and gesture. *Topics in Cognitive Science, 7*(Special Issue), 2–11.
- Perniss, P., Thompson, R. L., & Vigliocco, G. (2010). Iconicity as a general property of language: evidence from spoken and signed languages. *Frontiers in Psychology, 1*(227), 1664–1678. doi:dx.doi.org/10.3389/fpsyg.2010.00227

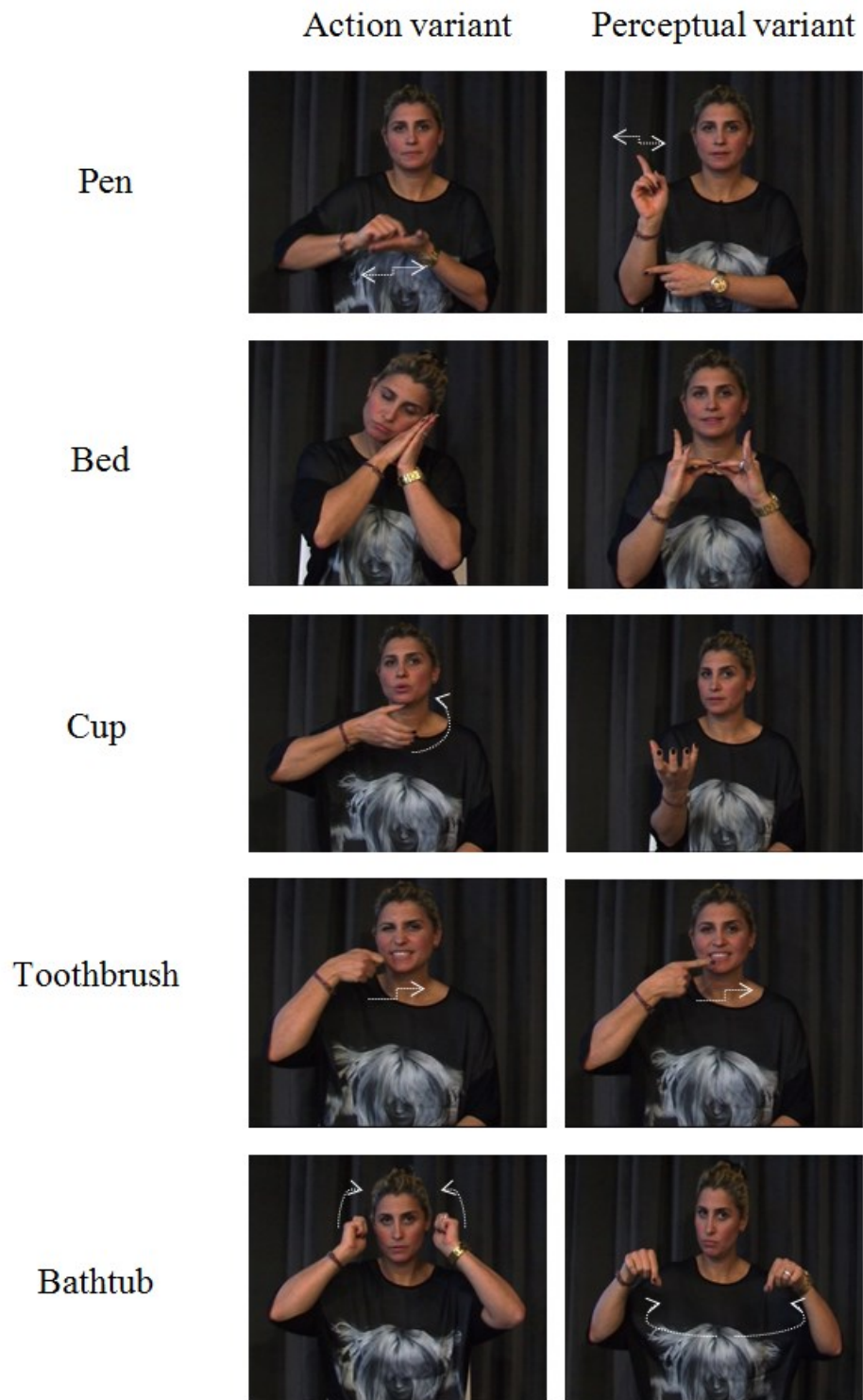
- Perniss, P., & Vigliocco, G. (2014). The bridge of iconicity : from a world of experience to the experience of language The bridge of iconicity : from a world of experience to the experience of language. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369(20130300). doi:dx.doi.org/10.1098/rstb.2013.0300
- Perniss, P., Zwitserlood, I., & Özyürek, A. (2015). Does space structure spatial language? A comparison of spatial expression across sign languages. *Language*, 91(3), 611–641.
- Pettenati, P., Sekine, K., Congestrì, E., & Volterra, V. (2012). A Comparative Study on Representational Gestures in Italian and Japanese Children. *Journal of Nonverbal Behavior*, 36(2), 149–164. doi:10.1007/s10919-011-0127-0
- Pietrandrea, P. (2002). Iconicity and arbitrariness in Italian Sign Language. *Sign Language Studies*, 2(3), 296–321. doi:dx.doi.org/10.1353/sls.2002.0012
- Pizzuto, E., & Volterra, V. (2000). Iconicity and transparency in Sign Languages: A cross-linguistic cross-cultural view. In K. Emmorey & H. L. Lane (Eds.), *The signs of language revisited: An anthology to Honor Ursula Bellugi and Edward Klima* (pp. 229–250). Mahwah, N. J.: Lawrence Erlbaum Associates.
- Revill, K. P., Namy, L. L., Defife, L. C., & Nygaard, L. C. (2014). Cross-linguistic sound symbolism and crossmodal correspondence: Evidence from fMRI and DTI. *Brain and Language*, 128(1), 18–24. doi:10.1016/j.bandl.2013.11.002
- Smith, N., & Trainor, L. J. (2008). Infant-directed speech is modulated by infant feedback. *Infancy*, 13(4), 410–420. doi:10.1080/15250000802188719
- Stamp, R., Schembri, A., Fenlon, J., Rentelis, R., Woll, B., & Cormier, K. (2014). Lexical variation and change in British Sign Language. *PloS One*, 9(4), e94053. doi:10.1371/journal.pone.0094053
- Stefanini, S., Bello, A., Caselli, M. C., Iverson, J. M., & Volterra, V. (2009). Co-speech

- gestures in a naming task: Developmental data. *Language and Cognitive Processes*, 24(2), 168–189. doi:10.1080/01690960802187755
- Taub, S. (2001). *Language from the body: Iconicity and metaphor in American Sign Language*. Cambridge: Cambridge University Press.
- Thompson, R. L., Vinson, D. P., Woll, B., & Vigliocco, G. (2013). The road to language learning is iconic: Evidence from British Sign Language. *Psychological Science*, 23(12), 1443–1448.
- Tolar, T. D., Lederberg, A. R., Gokhale, S., & Tomasello, M. (2008). The development of the ability to recognize the meaning of iconic signs. *Journal of Deaf Studies and Deaf Education*, 13(2), 225–240. doi:dx.doi.org/10.1093/deafed/enm045
- van Nispen, K., van de Sandt-Koenderman, M., Mol, L., & Krahmer, E. (2014). Pantomime Strategies: On Regularities in How People Translate Mental Representations into the Gesture Modality. In *Proceedings of the 36th Annual Conference of the Cognitive Science Society (CogSci 2014)* (pp. 3020–3026). Austin, TX: Cognitive Science Society, Inc.
- Vigliocco, G., Perniss, P., & Vinson, D. (2014). Language as a multimodal phenomenon: implications for language learning, processing and evolution. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 369(20130292). doi:dx.doi.org/10.1098/rstb.2013.0292
- Yoshida, H. (2012). A cross-linguistic study of sound-symbolism in children's verb learning. *Journal of Cognition and Development*, 13(2), 232–265. doi:10.1080/15248372.2011.573515
- Yu, C., & Smith, L. B. (2012). Embodied attention and word learning by toddlers. *Cognition*, 125(2), 244–62. doi:10.1016/j.cognition.2012.06.016

- Yu, C., Smith, L. B., & Pereira, A. (2008). Grounding word learning in multimodal sensorimotor interaction. In B. C. Love, K. McRae, & V. M. Sloutsky (Eds.), *Proceeding of the 30th Annual Conference of the Cognitive Science Society* (pp. 1017–1022). Austin, TX.: Cognitive Science Society.
- Zwitserslood, I. (2003). *Classifying Hand Configurations in Nederlandse Gebarentaal (Sign Language of the Netherlands)*. University of Utrecht.










Appendix A

Figure A1. Action and perceptual lexical variants for the variants *pen*, *bed*, *cup*, *toothbrush* and *bathtub*. Copyright 2016 by Asli Özyürek. The authors received signed consent from the person in the images to be published in this article.



Appendix B

Figure A2. Distribution of marked and unmarked handshapes (Battison, 1978) for action and perceptual based variants.

Sign gloss	Action variants		Perceptual variants	
	Marked handshapes	Unmarked handshapes	Marked handshapes	Unmarked handshapes
PEN				
TOOTHBRUSH				
CUP				
BATHTUB				
BED		