Does space structure spatial language?: A comparison of spatial expression across sign languages

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Language, Volume 91, Number 3, September 2015, pp. 611-641 (Article)

Published by Linguistic Society of America
DOI: 10.1353/lan.2015.0041

DOES SPACE STRUCTURE SPATIAL LANGUAGE? A COMPARISON OF SPATIAL EXPRESSION ACROSS SIGN LANGUAGES

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The spatial affordances of the visual modality give rise to a high degree of similarity between sign languages in the spatial domain. This stands in contrast to the vast structural and semantic diversity in linguistic encoding of space found in spoken languages. However, the possibility and nature of linguistic diversity in spatial encoding in sign languages has not been rigorously investigated by systematic crosslinguistic comparison. Here, we compare locative expression in two unrelated sign languages, Turkish Sign Language (*Türk İşaret Dili*, TİD) and German Sign Language (*Deutsche Gebärdensprache*, DGS), focusing on the expression of FIGURE-GROUND (e.g. cup on table) and FIGURE-FIGURE (e.g. cup next to cup) relationships in a discourse context. In addition to similarities, we report qualitative and quantitative differences between the sign languages in the formal devices used (i.e. unimanual vs. bimanual; simultaneous vs. sequential) and in the degree of iconicity of the spatial devices. Our results suggest that sign languages may display more diversity in the spatial domain than has been previously assumed, and in a way more comparable with the diversity found in spoken languages. The study contributes to a more comprehensive understanding of how space gets encoded in language.*

Keywords: spatial language, linguistic diversity, sign language, German Sign Language (DGS), Turkish Sign Language (TİD), semantic specificity, crossmodal diversity

1. INTRODUCTION. How does our perceptual experience of space get encoded in language? Spoken languages of the world exhibit a vast diversity of semantic, lexical, and grammatical means of encoding space, focusing on different aspects of spatial relations and using fundamentally different systems of spatial reference (Ameka 1995, Ameka & Levinson 2007, Berman & Slobin 1994, Bowerman 1996, Bowerman & Levinson 2001, Brown 1994, Grinevald 2007, Kopecka 2006, Levinson & Meira 2003, Levinson & Wilkins 2006, Majid et al. 2004, Pederson et al. 1998, Slobin 1996, Strömqvist & Verhoeven 2004, Talmy 1983, 1985).

For sign languages—the natural languages of the deaf, produced in the visual-spatial modality—however, the possibility and nature of such diversity in spatial language has not been rigorously investigated. Unlike in spoken languages, the visual-spatial modality of sign languages allows iconic representations of space through a direct mapping of entities and the spatial relations between them onto the hands and the space in front of the body (Emmorey 1996, 2002, Talmy 2003). Thus, it has been suggested that the spatial domain, due to the affordance of iconic spatial representation, exhibits a high degree of modality-driven similarity across sign languages, in contrast to the typological diversity of spoken languages (Aronoff et al. 2003, Meier 2002). However, recent typological in-

* This research was funded by a Dutch Science Foundation (NWO) VIDI grant (no. 276-70-009) and a European Research Council (ERC) Starting Grant (no. 23000174) awarded to the last author and supporting the first and second authors as postdoctoral researchers. The work was further supported by the Max Planck Institute for Psycholinguistics. We thank Marloes van der Goot, Menno Jonker, and Nick Wood for technical assistance and for data archiving. We thank Uwe Zelle for collection and transcription of the DGS data, and thank all of the DGS signers who participated in the study. We thank the İzmir Deaf Association (*İzmir Sağırları Koruma ve Kalkındırma Derneği*) and its members for their help in collecting the TİD data, and Hasan Huseyin Yılmaz for transcription of the TİD data. We are grateful to Beyza Sümer for helpful discussions and thank two anonymous referees for valuable comments on previous versions of the manuscript.

vestigations (e.g. Perniss et al. 2007, Zeshan 2004, 2006, Zeshan & Perniss 2008) have shown that sign languages exhibit differences in linguistic structure across different domains of expression, suggesting that there may be differences across sign languages in the spatial domain as well, notwithstanding the affordances of the modality.

Claims about the homogeneity of spatial expression in sign languages have been based mainly on studies of individual sign languages, as contrasted with what is already known about the diverse and different nature of spoken languages, and not on studies directly comparing different sign languages with each other using similar spatial-language elicitation tasks. A within-modality comparative investigation is crucial for understanding to what extent modality vs. language-specific linguistic structure shapes expression of space, even where iconic mapping of meaning to form is possible. If modality drives spatial encoding in sign languages, we would expect to see similarities between sign languages in terms of the type and nature of devices used in locative expression. If language-specific linguistic structures influence spatial language beyond, and in addition to, the effects of the modality, however, then we would expect to see diversity in semantic encoding and in the types of formal devices used that is more similar to the diversity found in the spatial domain in spoken languages.

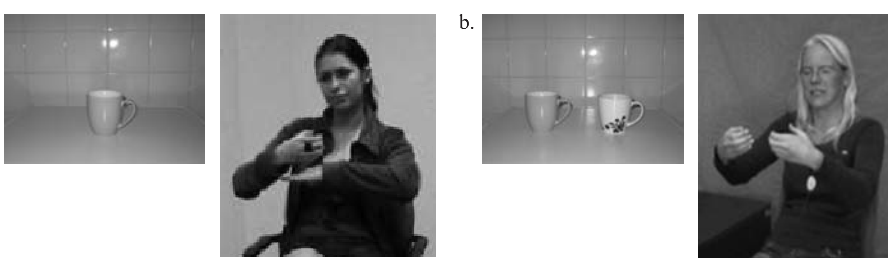
This article provides a first systematic comparison of the encoding of static spatial relationships, as a basic type of locative description, in two sign languages, German Sign Language (*Deutsche Gebärdensprache*, DGS) and Turkish Sign Language (*Türk İşaret Dili*, TİD). We focus on spatial relations involving two or more objects, occurring in FIGURE-GROUND (e.g. cup on table) and FIGURE-FIGURE (e.g. cup next to cup) relationships. We provide both a qualitative and quantitative comparison of the devices used, offering a first insight into what aspects of spatial language can differ across sign languages.

Our choice of DGS and TİD as the two sign languages for comparison is motivated by the fact that they are accessible and familiar to the authors, as well as by the fact that they are historically unrelated and geographically distant, such that similarities between them will not be due to a common ancestor or be the result of contact (even though we cannot rule out recent contact through increased availability of communication between signers using digital media or through the few Turkish deaf immigrants living in Germany). It is also worth noting that German and Turkish, as the surrounding spoken languages, are very different typologically, which makes similarities from contact with the spoken language or from observed cospeech gestures (known to be influenced by the structure of the spoken language; Kita & Özyürek 2003) unlikely. In addition, previous research has indicated that some aspects of spatial expression in TİD, in contrast to other reports of spatial expression in sign languages, do not maximally exploit the affordances of the visual-spatial modality in providing iconic representations of space (Özyürek et al. 2010; see also Perniss 2007a, Pfau & Aboh 2012). The comparative analysis that we present here draws on our previous work on TİD and explores whether and in what way DGS and TİD differ from each other in spatial expression.

Our motivation for looking at figure-ground and figure-figure relationships is twofold. First, we wanted to ensure that all of our elicitation materials depicted prototypical and natural spatial scenes with real, life-sized objects. Much of what we know about locative expression in sign languages—and the assumed similarities between sign languages—comes from descriptions of contrastive spatial relationships between only two objects, a (smaller, foregrounded) FIGURE and a (larger, backgrounded) GROUND object (e.g. car ON bridge vs. car UNDER bridge; man LEFT OF tree vs. man RIGHT OF tree), which have, moreover, been elicited primarily from drawings or from pictures featuring toy objects (e.g. Emmorey 2002, Johnston et al. 2007, Perniss 2007a). The use of contrastive scenes, however, may introduce a variable of markedness (e.g. 'cup on table' is a very prototypical scene, but 'cup under table' is quite marked) that may affect the form of locative expression (Evans & Levinson 2009, Özyürek et al. 2010, Sümer et al. 2013). Similarly, the use of toy objects may violate the scale of real-life objects (e.g. a toy person that is the same size as a toy tree), which may affect referent representation and thus also the form of locative expression. These factors have not been controlled for in previous research. Second, because we are interested in possible variation in the spatial domain in the visual modality, our elicitation materials involve scenes that feature multiple figure objects. Such scenes present a challenge with respect to the maximally iconic form of spatial expression (e.g. the challenge of representing more than two objects with only two hands). These contexts may reveal more differentiation in spatial expressions both within and across sign languages and are thus important to investigate in order to achieve an understanding of the range of devices that a sign language may use to encode space.

The examples in Figure 1 show DGS descriptions of spatial configurations of real, life-sized objects involving both figure-ground (i.e. cup(s) on table) and figure-figure (i.e. cup next to cup) relationships. Moreover, the examples show how locative expression in signed language is heavily influenced by the visual-spatial affordances of modality. There are clear iconic mappings between the form of the signs used (i.e. CLASSIFIER PREDICATES, morphologically complex predicates that simultaneously represent entity and location information) and the real-world entities and spatial relationships (see Fig. 1a for a figure-ground relationship and Fig. 1b for a figure-figure relationship).[1]

a. b.



RH: CLF(cup)-loc
LH: CLF(table)-loc
'cup on table'

RH: CLF(cup)-loc
LH: CLF(cup)-loc
'cup next to cup'

FIGURE 1. DGS examples of locative expressions.[2] In (a), classifier predicates are used to encode a 'cup on table' spatial relationship, and in (b) classifier predicates encode a 'cup next to cup' spatial relationship. The simultaneous classifier constructions encode the figure-ground and figure-figure spatial relationships in an iconic way (i.e. with a rounded handshape for the cups and a flat handshape for the table, and with placement of the hands in the space in front of the signer's body as a direct mapping of the locations of the objects in the spatial scene). LH and RH stand for left hand and right hand, respectively.

In our comparison of locative expressions in DGS and TİD, we assess the extent to which the iconic and spatial affordances of the modality shape expression by looking at the formal devices used and the semantic specificity of encoding in each language. For

[1] We adopt the Leipzig glossing rules in this article (http://www.eva.mpg.de/lingua/resources/glossing-rules.php), with the addition that 'loc' (lower case) stands for a localization in space.

[2] The simultaneous classifier constructions shown in Fig. 1 represent the final part of full locative expressions in which referent identification by means of object nouns (for 'table' and 'cup') preceded the use of each classifier predicate; order of mention of objects in (a) was ground (i.e. table) before figure (i.e. cup), as is prototypical in almost all sign languages studied to date.

spoken languages, semantic specificity refers to the amount of detail or fine-grained meaning distinctions encoded by paradigmatically related forms (Brown 2008, Cruse 1986).[3] We look at three types of information that are strongly associated with the iconic and spatial affordances of the visual modality and that may differ in terms of the semantic specificity of encoding and across languages. First, we look at ENTITY REPRESENTATION: at how figure and ground objects are represented in the locative construction (e.g. with the use of classifiers, as shown in Fig. 1). Second, we look at LOCATION REPRESENTATION: at how the relative spatial locations of these objects are encoded in sign space (e.g. in an iconic, topographic way with respect to real-world object locations, as in Fig. 1). Third, we look at the use of SIMULTANEOUS REFERENT REPRESENTATION: at the representation of one or more referents at the same time to give a direct, explicit representation of the spatial relationship between objects (e.g. the simultaneous representation in Fig. 1 of the figure-ground and figure-figure relationships through the use of both hands at the same time). Our analysis thus focuses on the degree of semantic specificity, known to vary in spatial language across spoken languages, in DGS and TİD locative descriptions with respect to entity, spatial location, and spatial relationship representation.

For these aspects of representation, we operationalize the notion of semantic specificity in terms of (degree of) iconicity in the following way. First, we consider a locative expression to be semantically specific with respect to entity representation if object shape information is encoded in an iconic way, by representing perceptual features of the object (e.g. representing a cup iconically by means of a rounded handshape vs. noniconically by means of an extended index finger). Second, we take a locative expression to exhibit a high degree of semantic specificity with respect to spatial location representation if the locations of the depicted objects are mapped onto the sign space in a highly iconic, topographic way (e.g. respecting the relative distance between objects in the depicted scene in mapping onto sign space vs. not doing so). Finally, with respect to simultaneity, the use of both hands to represent figure-and-ground or figure-and-figure objects simultaneously allows a more iconic, and thus more semantically specific, representation of the spatial relationship between objects as compared, for example, to the sequential representation of single objects in space (which instead requires the exact spatial relationship between the objects to be inferred by the addressee). Our assessment of the formal and semantic features of spatial devices in the two sign languages allows a comparison with the formal and semantic variation that exists across spoken languages in the spatial domain. As such, we may see variation within the visual modality similar to variation found in spoken languages, while still seeing effects of the modality constraining the variation.

This study thus contributes not only to our understanding of spatial language in two specific sign languages, DGS and TİD, but also more generally to our understanding of the influence of language modality on shaping spatial language. Crosslinguistic comparison, within as well as between modalities, is crucial in order to understand and map out the possible design space for linguistic encoding in sign languages, and to tease apart to what extent modality vs. language-specific structure shapes linguistic expression. In providing a detailed investigation of spatial encoding in two sign languages, using the same materials and in comparable communicative contexts, the present study contributes to a more comprehensive understanding of how our perceptual experience

[3] The addition of syntagmatic material can also increase the semantic specificity of an expression (Cruse 1986).

of space gets encoded in language, in general, and of the role of language modality in shaping linguistic expression. Finally, a better understanding of the possible linguistic variation in sign languages enhances our understanding of the possible diversity of expression, as well as constraints on expression, in human languages overall. In the current literature, a comprehensive account of spatial language that takes into account variation in both spoken and signed languages is missing.

In the next section, we provide the necessary background on linguistic encoding of spatial information, mapping out the diversity of linguistic structures found across spoken languages in this domain. We then move on to sign languages and describe various devices known to be used in the signed expression of spatial relations. The details of our study are presented in §3, including the methodology, data collection, and coding, and the results of our analysis are presented in §4. We end with a discussion of our results and outline the implications of our study for both signed and spoken languages (§5).

2. Background.

2.1. Locative expression in spoken languages. Spoken languages exhibit a vast degree of typological diversity in the lexical and morphosyntactic structures used in spatial expressions, as well as in the semantic information encoded by them. In contrast to the visual modality of sign languages, the vocal modality does not afford the physical spatial encoding of static spatial relationships, and must thus rely on categorical forms (closed-class grammatical or open-class lexical) that schematize space in different ways.[4]

The main type of categorical form found in spoken languages to encode locative information is the adposition. Adpositions include the spatial prepositions familiar from many European languages (e.g. *in*, *on*, *under*) and case-marking postpositions as, for example, in Turkish. Spatial adpositions typically encode information only about the nature of the spatial relationship, regardless of the types of entities involved (Landau & Jackendoff 1993, Levinson & Meira 2003) and regardless of their specific configuration. For example, the preposition in the English locative description *The cup is on the table* encodes only the relationship of vertical support between the cup and the table. It does not encode information about whether the cup is on the edge or in the middle of the table or any information about the orientation of the cup. Crosslinguistically, while adpositions may cover a similar range of meanings, the sets of adpositions used in individual spoken languages carve up the semantic space in different ways (Bowerman 2003, Bowerman & Choi 2001, Levinson & Meira 2003). For example, English uses the preposition *on* to express a variety of support and attachment relationships (e.g. cup on table, picture on wall), while Dutch uses two different prepositions to express these meanings, using *op* for the support relationship (i.e. on table) and *aan* for the attachment relationship (i.e. on wall).

Another type of form found in locative expression in spoken languages is predicates, including simple locative verbs, posture verbs, and positional verbs. These predicates often provide very specific information about the shape or position of objects involved in the spatial relationship. For example, posture verbs provide information about the postural position of the figure object, sometimes in combination with another device specifying the spatial relation between figure and ground object. In German and Dutch, for example, objects ‘stand’ or ‘lie’ on a table depending on characteristics of their

[4] Though gestures accompanying the spoken expression can provide more specific, analogue representation to varying degrees (e.g. Sauter et al. 2012).

shape and/or their prominent orientational axis (Serra Berneto 1996, van Staden et al. 2006), as illustrated in the examples from German in 1.

(1) a. Das Buch steht auf dem Tisch. (for an upright book)
'The book stands on the table.'
b. Das Buch liegt auf dem Tisch. (for a book lying flat)
'The book lies on the table.'

In other languages, posture verb classes exhibit much richer semantics, including more fine-grained specificity about the nature of the spatial relationship and the position of the figure object (Ameka & Levinson 2007, Hellwig 2011).

Positional predicates are generally even more semantically specific, providing detailed information about the figure object in terms of characteristics of size, shape, and orientation (Ameka & Levinson 2007, Bohnemeyer & Brown 2007, Brown 1994). For example, positionals in Tzeltal (Mayan, Mexico) include *waxal* 'of tall oblong-shaped container canonically standing', *lechel* 'of flat-bottomed object lying on its flat surface', or *latz'al* 'of flat items, arranged in vertical stack' (examples from Evans & Levinson 2009, citing Brown 1994). Other form classes that encode locative information in spoken languages include coverbs, as in Jaminjung (Northern Australia), which can express highly specific spatial relationships between objects, like *nang* 'sticking (on)', *bayirr* 'supported (on)', or *thuny* 'buried in a hole (of animal)' (Schultze-Berndt 2006), and verbal or locative classifiers, which group objects into classes, often according to shape-based properties like 'long, thin' or 'plank-like' (Grinevald 2007). Interestingly, spoken languages tend to provide positional and/or shape information commonly for the figure object, but not for the ground object (Talmy 1983), although information about the ground object can, to some extent, be inferred from the spatial description. For example, if the figure object is IN the ground object, the ground object must be hollow (Jackendoff 1992). Unlike adpositions, many of these forms do not encode the nature of the spatial relationship itself (as e.g. containment, support). Rather, the actual relationship is encoded by another device (e.g. an adposition) or it must be inferred from the semantics of the predicate, using the detailed information about the figure object and/or from general world knowledge.

In addition to differing with respect to the type of categorical form in which spatial information is encoded and the specificity of the semantic information encoded, spoken languages also differ greatly with respect to the size of the word classes involved in spatial expressions. For example, some languages have only a handful of posture verbs or positionals, while other languages have scores to choose from. Thus, overall, the semantic specificity of spatial devices in spoken languages exhibits a large amount of diversity. Both the type and number of semantic distinctions made within each form class varies greatly, with some languages encoding only quite general information and other languages providing very detailed and specific information (Ameka & Levinson 2007, Evans & Levinson 2009).

Finally, the use of different forms within a language is influenced by the prototypicality of spatial relationships, which affects what needs to be minimally encoded and what gets inferred (Evans & Levinson 2009, Levinson & Wilkins 2006). For example, in Turkish, prototypical spatial relationships (especially containment and support relations) are expressed with a general locative case marker *da*/*de* 'at', as in example 2a. The specific nature of an 'on' relationship (i.e. with a spatial noun specifically encoding 'on'-ness) needs to be explicitly expressed only for atypical, noncanonical spatial configurations, as in example 2b, because the relationship could not be pragmatically inferred from the general locative case marker.

(2) a. Fincan masa -da.
cup table -LOC
'The cup is on the table.' (lit. 'The cup is at the table.')
b. Ayakkabı masa -nın üst -ün -de.
shoe table -GEN top -POSS-LOC
'The shoe is on the table.' (lit. 'The shoe is at (the top of) the table.')

In the next section, we describe the primary devices for spatial expression in sign languages that have been previously discussed in the literature. We structure our exposition in terms of entity, location, and spatial relationship representation, as the key features of spatial expression.

2.2 Locative expression in sign languages. Where the spoken language modality requires (for the most part) the linear concatenation of discrete, categorical morphemes, the visual modality of sign languages affords simultaneity and a high degree of iconicity of morphemes. The influence of these affordances of the visual-spatial modality is particularly notable in the domain of spatial language. Here, space can be used to encode spatial relations, allowing an iconic representation of referents and their locations. Uniquely, the modality allows a direct mapping of a figure-ground relationship onto sign space, possible through the use of both hands at the same time (i.e. with one hand representing the figure object and one hand representing the ground object). Sign languages have been documented to use a variety of linguistic forms to encode spatial relations, as is described below.

Entity and spatial location representation.

Classifiers. The primary means for encoding spatial relationships in sign languages is through the use of locative CLASSIFIER PREDICATES (as shown in Fig. 1 above). In these morphologically complex predicates, the location of the hand encodes the location of a referent, while the handshape (the classifier) encodes referent type by classifying it in terms of semantic features, predominantly size and shape features (Supalla 1982, Zwitserlood 2012).[5]

In the example in Fig. 1a, which expresses the spatial relationship of 'cup on table', the rounded handshape (right hand) represents the cylindrical shape of a cup, and the flat hand (left hand) represents the flat shape of the tabletop. In addition, the upright orientation of the right hand (representing the cup) encodes the upright orientation of the cup on the table. If the cup were lying on its side in the picture, the hand orientation would reflect this (although the exact orientation of an object is not always explicitly encoded, depending on what is emphasized in the expression; Wallin 1996). The locations of the hands in space reflect the locations of the cup and table, and the use of both hands at the same time, in a SIMULTANEOUS CLASSIFIER CONSTRUCTION, allows the direct representation of the 'cup on table' spatial relationship (i.e. the right hand, representing the cup, is placed on top of the left hand, representing the table).

In Fig. 1b, a simultaneous classifier construction is used to encode the spatial relationship between two cups next to each other. Each hand represents a cup (rounded handshape), and the placement of the two hands next to each other in space (on the left and right, depicted from the signer's viewpoint) iconically represents the locations of the cups in the spatial scene being depicted. In general, the use of classifier predicates in spatial expression affords a high degree of iconic representation, and provides a high

[5] Locative predicates can combine with several devices to encode referent location, as we show below. Besides locative predicates, classifiers can also combine with motion predicates (e.g. Supalla 1982).

level of semantic specificity in terms of both entity and spatial location encoding. Furthermore, the simultaneous use of classifier predicates provides a direct representation of both objects at the same time and thus provides a high degree of semantic specificity in terms of encoding the spatial relationship itself.

The existence of a system of classifier predicates, which utilizes the iconic affordances of the modality described above for encoding spatial information (location and motion), has been described for most sign languages studied to date (see Emmorey 2003 and, particularly, Schembri 2003, and Zwitserlood 2012 for overviews; and see e.g. Emmorey 2002 for American Sign Language (ASL); Engberg-Pedersen 1993 for Danish Sign Language (DSL); Perniss 2007a for DGS; Zwitserlood 2003 for Sign Language of the Netherlands (*Nederlandse Gebarentaal*, NGT)).[6] The use of simultaneous classifier constructions to depict the location (or motion) of a figure object with respect to a ground object has similarly been found for many sign languages studied (Emmorey 1996, Supalla 1982 for ASL; Engberg-Pederson 1993 for DSL; Perniss 2007b for DGS; Morgan et al. 2008 for British Sign Language (BSL); Chang et al. 2005 for Taiwan Sign Language (TSL); Sümer et al. 2012, 2013 for TİD; Tang et al. 2007 for Hong Kong Sign Language (HKSL); Wallin 1996 for Swedish Sign Language (SSL)).

The examples in Fig. 1 show the use of ENTITY CLASSIFIERS, where the hand represents an object as a whole, which are primarily combined with predicates that represent the location (or motion) of objects. Another major type of classifiers is HANDLING CLASSIFIERS, which represent entities as they are handled or manipulated in space (e.g. a handshape in which the tips of the index finger and thumb touch can represent holding a single flower). These are used when there is an agent in the scene manipulating an object (e.g. putting a cup on table) and are not expected to be used for nonagentive spatial expressions (Benedicto & Brentari 2004, Brentari et al. 2013, Zwitserlood 2012).

Size and shape specifiers (SASSes). In addition to classifiers, signers may also represent objects with SIZE AND SHAPE SPECIFIERS by tracing the outline or depicting the perimeter of objects (e.g. Engberg-Pedersen 1993 for DSL; Schick 1990, Supalla 1986 for ASL; Zwitserlood 2003 for NGT; Perniss 2007a for DGS). SASSes have a modifying function: they indicate the shape of a particular object. Like classifiers, they can be combined with a locative predicate in order to indicate that an object (of the shape indicated) is located at a particular location. For example, in Figure 2, the signer uses SASSes to represent paintings located on a wall (previously localized) by outlining their rectangular shape with her thumbs and index fingers. The placement of the SASS forms to the right and left sides of the sign space (rather than in the space directly in front of the body) indicates their combination with locative predicates.

FIGURE 2. TİD example of SASSes representing two paintings located on a (previously localized) wall.

[6] Crosslinguistically, differences in the systems of sign language classifier predicates are known to be present mainly in the inventory of the handshapes used to denote certain classes of objects—that is, in the inventory of classifiers themselves (Schembri et al. 2005).

Like classifiers, SASSes are semantically specific with respect to entity representation. However, (entity) classifiers encode entity type by means of general shape features (e.g. flat object, rounded object; Fig. 1), and SASSes represent entities by encoding specific shape features (e.g. long, narrow, rectangular object; Fig. 2). As such, classifiers are relatively less specific with respect to the size and shape features of entities due to the fact that they classify entities into types, while SASSes can be more specific about the entities they depict.[7] That is, in many cases, using a SASS to trace the outline of an object allows signers to provide even more detailed and iconic information about an object's shape (e.g. tracing the outline of a star-shaped mirror; Zwitserlood 2003) than, for example, the use of an entity classifier handshape (e.g. a flat hand to represent the surface of a mirror, regardless of its specific shape). SASS locative predicates can also represent entity location and the spatial relationship between entities in a highly specific way (e.g. in the case of simultaneous constructions, as in Fig. 2).

Relational lexemes. In addition to classifier and SASS constructions, some sign languages also have specialized signs to encode spatial relationships (like 'in', 'on', 'under') in a more categorical way (Emmorey 2002 for ASL; Arık 2013, Sümer et al. 2012, 2013 for TİD; Perniss 2007a for DGS; Meir 2003 for Israeli Sign Language). Following Arık (2013), we call these signs RELATIONAL LEXEMES, diverging from the often-used term 'prepositions' in the literature (Emmorey 2002) since their grammatical status as prepositions has not been verified (in fact, it has been suggested that these elements are predicative in nature; Johnston et al. 2007). These more categorical forms are akin, however, to the spatial adpositions found in many spoken languages in that they encode only the spatial relationship, and not information about the specific objects involved. Figure 3 shows a relational lexeme from TİD encoding the meaning 'on' (as could occur, for example, for a figure-ground relationship) and a relational lexeme from DGS encoding the meaning 'next-to'.

a. b.

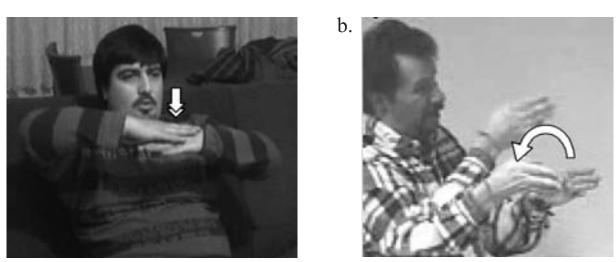


Figure 3. Example of (a) TİD relational lexeme for 'on', and (b) DGS relational lexeme for 'next to'.

As the examples in Fig. 3 show, even though relational lexemes encode spatial relations categorically, they clearly exhibit some iconicity with respect to encoding the spatial relationship. In the examples, the semantics of the spatial relationship is reflected in the simultaneous placement of the hands: one hand on top of the other; one hand moving to a location to the side of the other hand. However, these relational lexemes are not as semantically specific as the classifier and SASS constructions described above. The relational lexeme for 'on' may be used to encode a support relationship between any two objects, regardless of object shape and the exact spatial relation of the figure to the ground. Thus, in contrast to the use of entity classifiers (as in Fig. 1), where the classi-

[7] In fact, entity classifiers need not be iconic at all, like the classifier used in ASL for the semantic class of vehicles (vertically held hand with thumb, index, and middle finger extended).

fier depicts the object type in an iconic way, the hand here does not encode object shape in any way. In addition, the placement of the hands in relational lexemes, unlike in classifier predicates, cannot be more specific about the exact nature of the spatial relationship—for example, about whether a cup might be located in the center of a table or more to the left or the right.[8]

Previous studies suggest that signers prefer the use of classifier predicates to the use of relational lexemes for spatial expression (Arık 2013, Özyürek et al. 2010, Sümer et al. 2012 for TİD; Emmorey 2002 for ASL; Johnston et al. 2007 for Irish Sign Language (ISL) and Flemish Sign Language (*Vlaamse Gebarentaal*, VGT); Perniss 2007a for DGS). Thus, the use of forms that allow a higher degree of iconic representation with respect to encoding entity and spatial information seems preferred in sign languages over the use of more categorical spatial terms that are less specific with respect to entity and spatial information. However, certain contexts—for example, contexts that highlight spatial contrasts—may promote the use of relational lexemes, sometimes in addition to classifier predicates. For example, signers have been found to use relational lexemes in higher proportions in locative descriptions when presented with pictures of directly contrasting spatial relationships (e.g. car UNDER bridge vs. car ON bridge; tree BEHIND house vs. tree IN FRONT OF house) (Johnston et al. 2007 for ISL and VGT; Sümer et al. 2012 for TİD). This may be due to the fact that, in contrastive settings, specification of the locative relationship is more important than information about the referent (e.g. shape information), and locative information is exactly what relational lexemes focus on. Note, however, that controlled studies to support this claim are lacking.

In previous research on TİD, we have also found other locative devices that are less specific about encoding entity and spatial location information, especially when relationships between more than two entities are involved. In Özyürek et al. 2010, we describe the use of a NEXT-TO construction, which highlights the 'side-by-side' relationship of multiple figure objects placed next to each other in a less semantically specific way compared to the use of (simultaneous or sequential) classifier predicates. This form is shown in Figure 4.[9] In this construction, extended fingers represent a corresponding number of objects in a linear configuration. The finger-to-object mapping is noniconic: the fingers can be mapped to any object type, and the predicate thus exhibits a very low level of semantic specificity with respect to entity representation. In addition, given that the hand is anatomically constrained with respect to the possible distance between spread fingers, the form does not allow highly iconic encoding of spatial locations in terms of the distance between individual objects. Thus, the NEXT-TO construction also exhibits a low level of semantic specificity with respect to spatial location. As we argue in Özyürek et al. 2010, this predicate is used in TİD for encoding a side-by-side configuration of objects in a categorical and abstract way. We return to discussion of this form in §4.

Lexical signs. Finally, in addition to classifiers and SASSes, the literature has described the localization of lexical signs in sign space as a strategy for expressing object location (de Beuzeville et al. 2009 for Australian Sign Language (Auslan); Nijhof & Zwitserlood 1999 for NGT; Özyürek et al. 2010, Sümer et al. 2012 for TİD). For exam-

[8] This is not entirely true for all relational lexemes, however. For example, in the DGS relational lexeme 'next-to' (Perniss 2007a), the direction of movement (i.e. of the upward arc movement of one hand away from the other) can be varied, and the resulting forms can be translated by English prepositions like *in front of*, *to the (right/left) side of*, *in back of*. In addition, the length of the movement can indicate a location closer or farther away.

[9] Note that, unlike DGS, TİD does not have a separate relational lexeme for 'next-to' (cf. Fig. 3a).

Figure 4. Example of TİD next-to construction used to represent the side-by-side configuration of three plates on a table.

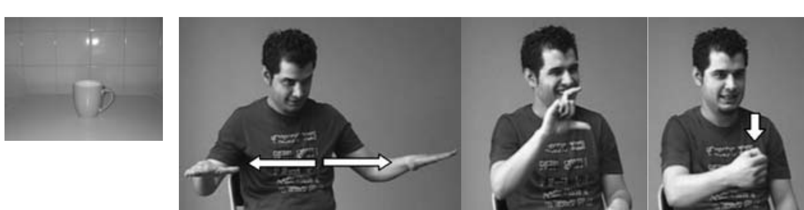
ple, the TİD sign for 'boat' is produced by touching the fingertips of both hands together to form a wedge shape (iconically representing the bow of a boat) and moving the hands forward (iconically depicting the forward motion of a boat), as shown in Figure 5. This sign is not phonologically specified for a location, and in citation form (i.e. the form that would be produced in isolation, as in a dictionary), it is produced directly in front of the signer's body. Because it lacks location specification, it can be combined with a locative predicate—that is, it can be articulated at a particular location in space for purposes of locative expression—and thus allows semantically specific spatial location representation. Figure 6a below shows a TİD signer producing the sign for 'boat' on the right and then the left side of the sign space to indicate the relative locations of two boats.[10] (Note the difference between the use of a localized noun vs. the use of an entity classifier or SASS here: the entity classifier used for a boat in TİD is a flat hand (shown in Fig. 6b for comparison); with a SASS, the outline of the whole boat would be traced.) In addition, other types of signs, like adjectives, may also be articulated at a location in space to indicate the referent being modified. For example, a signer could produce the DGS sign for 'purple' (L-handshape, with back-and-forth rotation of the wrist) on the left side of the sign space to indicate the location of a purple entity there. As the examples illustrate, lexical sign localization may provide iconic information about an object and may thus be semantically specific with respect to entity representation, depending on whether the sign itself is iconic (e.g. the TİD sign for 'boat') or not (e.g. the DGS sign for 'purple').

Figure 5. Citation form of the lexical TİD sign for 'boat'.

[10] In addition to expressing locative information, the localization of signs may be motivated by a number of semantic-pragmatic considerations related to discourse cohesion, narrative perspective, semantic association, and comparison (Engberg-Pedersen 1993, Winston 1995). Not all signs can be localized, however. Body-anchored signs—that is, signs phonologically specified for location and thus produced at a certain location on or around the body (e.g. forehead, chin, shoulder, chest)—cannot be localized for spatial/locative or semantic-pragmatic purposes.

FIGURE 6. Localization of (a) lexical signs versus (b) classifier predicates in TİD to indicate the locations of the two boats in the stimulus picture relative to each other.

SIMULTANEITY IN SPATIAL RELATIONSHIP REPRESENTATION. We now turn to the modality-specific affordance of direct representation of the spatial relationship between objects through the use of simultaneous referent representation. In our previous research on TİD (Özyürek et al. 2010), we found that the majority of analyzed locative descriptions did not make use of simultaneity (as is done in Figs. 1 and 2), although this is assumed to be one of the central features of 'canonical' locative constructions (e.g. Emmorey 2002, Supalla 1982, Tang et al. 2007), allowing signers to maximally exploit the iconic and spatial affordances of the visual modality. In the example in Figure 7 below, the TİD signer uses a classifier predicate to localize a cup on a table, but without representing the ground physically in place, that is, without the use of simultaneous figure-ground representation (cf. Fig. 1a). Here, the cup is placed in relation to a ground object that is conceptually present in space, due to previous mention and placement of the table at the same location. Overall, the resulting locative description is thus less iconic and less semantically specific with respect to expression of the spatial relationship, since the relationship between figure and ground is not directly represented and made visible in sign space. The reliance on conceptually present referent locations in this way, where the exact spatial relationship is not directly shown but rather inferred, seems to be determined in part by the prototypicality of the spatial relationship (e.g. 'cup on table' vs. 'shoe on table'; cf. Özyürek et al. 2010, Pfau & Aboh 2012; see also the discussion in §5).



RH:	table	cup	CLF(cup)-loc$_{table}$
LH:	table		

'There's a table, and a cup, it (the cup) is at/on it (the table).'

FIGURE 7. TİD example of figure localization (i.e. cup) with respect to ground (i.e. table) without the use of a simultaneous construction (final still). During the localization of the figure, the ground object is conceptually, but not physically, represented in space.

This review of the literature, including our own previous research, shows that sign languages may not always exploit the full affordances of the visual modality for iconic representation of spatial scenes, but rather may have a range of devices at their disposal—as is the case for spoken languages—that can vary in semantic specificity and that are used differently for pragmatic purposes. The range of devices available in individual sign languages for locative expression has rarely been explored, and we know little about whether and to what extent sign languages vary from each other both qualitatively and quantitatively in the use of spatial devices for the same descriptions and in similar communicative contexts. Furthermore, we know little about the extent to which the use of spatial forms may be driven by certain communicative contexts, the type of spatial relationships, or the nature of the entities depicted. Thus, as a next step, we compare DGS to TİD using the same scenes and the same discourse context we have used in previous research to elicit spatial descriptions in TİD, in order to see which aspects of spatial expressions either are shared or differ between the two languages.

3. The present study. In this study, we investigate the spatial domain in the visual modality by comparing the expression of spatial relationships in Turkish Sign Language (TİD) and German Sign Language (DGS). If properties of the modality drive spatial encoding in sign languages, we would expect to see similarities in the types and quantities of use of spatial devices between the two sign languages. If language-specific structure also plays an important role in shaping spatial representation, we would expect differences between the sign languages in the formal devices available and in their use. Our comparison is based on signers' spatial descriptions in a corpus of data obtained in a discourse context using the same picture-description task. We aim to understand what elements of a spatial scene are linguistically coded, what range of devices are employed, and whether and how these devices differ with respect to the encoding of entity and location information, particularly in terms of how they reflect use of the iconic and spatial affordances of the visual-spatial modality.

In order to accomplish this, our analysis looks particularly at the semantic specificity of devices, defined in terms of the amount of detail provided by a particular form about (i) entity representation: through the extent of iconicity in the representation of the shape of figure and/or ground objects; (ii) location representation: through the extent of iconicity in the representation of the relative locations of figure and/or ground objects; and (iii) spatial relationship representation: through simultaneous (more iconic) vs. nonsimultaneous (less iconic) representation of figure-ground and figure-figure spatial relationships. For each of these, we provide both a qualitative and quantitative analysis, treating (i) and (ii) in §4.1, and dealing with (iii) in §4.2. We assume that the more a device exploits the visual-spatial affordances of the modality, the more semantically specific it is in terms of entity, location, and spatial relationship representation.

3.1. Languages of study. As noted above, the choice of DGS and TİD for comparison is motivated by the authors' access to and familiarity with these languages. In addition, a further advantage of comparison between DGS and TİD is that the two languages are historically unrelated, but sociolinguistically similar in a number of ways (Deringil 2002, Vogel 1999). For example, compulsory education of the deaf was implemented in the early nineteenth century in both Germany and Turkey. In addition, both countries followed a program of strict oralism from this time onward, providing instruction in German or Turkish, and discouraging or even disallowing the use of sign language at school.

3.2. Participants. Twelve signer-addressee pairs of deaf adults were recruited for DGS and for TİD, respectively, from the deaf communities in Aachen and Essen (Germany) and in İzmir (Turkey). All participants (i.e. signers and addressees) used DGS or TİD as their primary language of communication, and all had acquired this language from birth (i.e. as native signers from deaf parents) or at an early age (i.e. early signers, aged five to eight) or later age (i.e. late signers, aged nine to twelve) from other deaf adults/children outside of the family (DGS signers: six native, five early, one late; DGS addressees: four native, eight early; TİD signers: eleven native, one early; TİD addressees: six native, six early).[11] Age ranges and gender distribution across participants of both sign languages were similar (DGS signers: eighteen to thirty-six years (mean = 24.75), six male, six female; DGS addressees: seventeen to forty years (mean = 25.25), four male, eight female; TİD signers: twenty to forty-five years (mean = 28.6), six male, six female; TİD addressees: twenty-one to forty-nine years (mean = 32), six male, six female).

3.3. Materials. Stimulus materials were pictures of objects in prototypical spatial configurations. There were a total of twenty-one pictures, comprising seven figure object types (cup, boat, cow, bird, plate, pen, painting), each of which occurred in three different pictures that varied in number of tokens (one, two, three/four) (see Figure 8 for examples). Each picture thus contained a primary figure-ground relationship (e.g. cup(s) on table), and the pictures with more than one figure object additionally contained figure-figure relationships (e.g. cup next to cup). The pictured figure objects were real, life-sized objects (i.e. not toys or drawings, as have been used in previous research, e.g. Emmorey 1996, Pederson et al. 1998, Perniss 2007a, Sümer et al. 2012, 2013) and appeared in typical environments in relation to a ground object (i.e. cup on table, boat on water, cow on meadow, bird on street or meadow, plate on table, pen on table, painting on wall).

Figure 8. Examples of stimulus picture set for figure object 'cup' on ground object 'table'.

3.4. Procedure. Signers described the stimulus pictures, one at a time, to an addressee seated opposite after viewing each picture on a laptop placed to their side. Addressees identified each picture described from a set of thumbnail images containing a range of similar spatial scenes (including other pictures from the stimulus set and pictures not in the stimulus set). All addressees were able to correctly pick the pictures described by the signers. In very few cases, the addressee asked for clarification, in which case the signer repeated part or all of the description. Coding and analysis were performed only on the first description provided by the signer, however.

Video recordings were made from three different angles: (i) front view of signer, (ii) front view of addressee, and (iii) top view encompassing both signer and addressee. The combination of the front and top view of the signer has proven crucial to ascertaining the exact locations of signs in the sign space as well as to identifying signs that were not clearly visible from the front-view recordings. Indeed, we consider it vital to an assessment of the use of space, in general, and localization strategies, in particular (e.g. identifying use of neutral vs. nonneutral space) to have a camera view from the front as well as from the top.[12] Moreover, the simultaneous display of these two views in the data-annotation program ELAN is invaluable for appropriate and correct coding.[13]

[11] Whenever possible, the signer in each signer-addressee pair was a native signer.

[12] This kind of multiple-view recording technique has been the protocol in numerous projects compiling sign language corpora (e.g. in the Netherlands, Germany, Sweden, and the US).

[13] ELAN is the multimedia annotation tool developed at the Max Planck Institute for Psycholinguistics (Wittenburg et al. 2006).

3.5. Coding. All descriptions were annotated sign by sign and coded using ELAN by native (deaf or hearing) and advanced signers of TİD and DGS. We focused on descriptions we identified as full locative expressions. To count as such, descriptions had to contain explicit mention of the ground (e.g. table) and spatial encoding of the figure object(s) (e.g. cup) relative to the ground and/or relative to each other. We identified and quantified all locative devices used to encode the objects themselves, their individual locations, and the spatial relationships between them, including figure-ground relationships (e.g. cup(s) on table) and figure-figure relationships (e.g. cup next to cup).

Each description was coded for the type of locative device used (e.g. localization of classifier, SASS, or lexical sign, relational lexeme), and each device was further coded with respect to semantic specificity of entity representation and location representation. We focus our analysis of localization devices on the localization of figure objects. First, in terms of entity representation, devices ranged in degree of semantic specificity depending on how iconic they were: in other words, depending on how much information they provided about an object—its specific size, shape, or orientation. Forms could be relatively specific about the features of individual objects (exhibiting slightly varying degrees of iconicity) or not specific at all (i.e. generic, noniconic). Second, in terms of location representation, we considered devices that encoded figure object locations in a highly iconic manner (e.g. attending to the exact placement of objects, more to the left vs. more to the right, or attending to the relative distance between objects, closer together vs. farther apart) to exhibit a high degree of semantic specificity; devices with a low degree of semantic specificity did not exploit the spatially iconic affordance of the modality, focusing instead, for example, on the side-by-side relations among entities rather than the distances between them. Finally, in terms of spatial relationship representation, we coded for the use of simultaneous constructions to encode the spatial relationships between objects (figure-figure or figure-ground). Our definition of simultaneous construction included any representation of more than one referent at the same time. This means that we coded both for simultaneous referent representation that was unimanual (i.e. with one hand, where referents are mapped onto individual fingers) and for that which was bimanual (i.e. with two hands, where one referent is referred to by each hand). We considered the simultaneous representation of objects to exhibit a high degree of semantic specificity with respect to encoding of the spatial relationship because it allows a direct, visual representation of the (figure-figure or figure-ground) spatial relationship. When simultaneous referent representation is not used (see Fig. 7), the spatial relationship gets encoded only indirectly, thus exhibiting a lower degree of semantic specificity.

4. Results. Below we analyze separately the semantic specificity—defined in terms of the extent of iconic mapping—in the spatial expressions for entity representation, location representation, and spatial relationship representation (for figure-ground and figure-figure relationships) in both TİD and DGS. For each, we first provide a qualitative analysis, listing and describing the formal categories we find, and then provide a quantitative analysis, comparing their usage frequency and distribution.

4.1. Type and semantic specificity of entity representation. We focus here on the localization devices used to represent figure objects in the spatial expressions. We first describe the localization devices found in each language in terms of form and semantic specificity, and then offer quantification to compare the usage preference of different devices between the sign languages.[14]

[14] A referee was interested to know whether observed differences may have been due to sociolinguistic factors such as region, gender, or age. Such differences were not found, however. All DGS signers and all TİD signers were recruited from the same region of Germany and Turkey, respectively. Furthermore, within each

Qualitative comparison. First, we identified the use of similar as well as nonoverlapping devices for figure object localization in the two sign languages. To begin with, and as may be expected from previous research (Özyürek et al. 2010, Perniss 2007a), both DGS and TİD used entity classifiers and SASSes combined with locative predicates to encode referent location (see the examples in Fig. 1 and Fig. 2 above, respectively). All of the classifiers and SASSes used in DGS and TİD iconically reflected aspects of the size and/or shape of their referents and thus exhibited a relatively high degree of semantic specificity with respect to entity representation.[15] In addition, both DGS and TİD exhibited the localization of lexical signs to encode figure object locations (see the example in Fig. 6a above). Like classifier and SASS predicates, noun localization as a locative device in both sign languages was semantically specific with respect to entity representation, since all of the nouns that were localized were iconic of their referents in some way.

In addition to these semantically specific devices, both sign languages exhibited the use of locative devices that were much less semantically specific, albeit in very different ways. Both DGS and TİD used a language-specific form that did not display an iconic resemblance to the figure object being depicted and that was thus not semantically specific with respect to entity representation. These devices were used in our data set to represent any object type (e.g. boats, cows, paintings, plates, cups, pens), regardless of shape, and we thus refer to them as generic devices. In the generic device found in TİD, extended fingers were used to represent individual referents, and the device was used specifically to indicate side-by-side relations in a categorical, abstract way.[16] An example of this form was shown in Fig. 4 above and is repeated for convenience in Figure 9a below. In the example, the TİD signer represents three plates by means of three extended fingers, with each finger representing a plate. The long, extended shape of a finger has little in common with the shape of a plate, and the device is thus not semantically specific with respect to entity representation.[17] In the generic device used by DGS signers, referents were not in fact represented on the hands. This construction merely indicates the locations of four boats next to each other (see Fig. 9b). The flat hand in this construction is not iconic of the shape of a boat—nor iconic of other objects (e.g. paintings, pens, cups, cows)—and is therefore also not semantically specific with respect to entity representation. Thus, both languages used noniconic, generic forms as locative devices, but these exhibited differences in referent representation, mapping referents to fingers in TİD vs. no referent representation in DGS.

The DGS generic device is very similar to the DGS relational lexeme for ‘next-to’, described in Perniss 2007a and shown in Fig. 3b. In Perniss 2007a, ‘next-to’ occurred only in descriptions of two objects of the same type located side by side, and, moreover,

group of signers (DGS or TİD), there were no differences between men and women, and also no differences related to age of acquisition of sign language or to signer age. (Overall, signer age was relatively homogenous; moreover, the signer and addressee in each pair were of comparable age.)

[15] As noted already, one could argue that classifiers, in general, exhibit less semantic specificity than SASSes, due to the classificatory nature of classifiers. Here, we treat classifiers and SASSes together as more iconic, semantically specific devices compared to the use of noniconic, generic devices.

[16] See descriptions of this form also in Özyürek et al. 2010 and Zwitserlood et al. 2012. There, we provide arguments against the interpretation of this construction as a localized numeral sign.

[17] Note that both sign languages also exhibited the use of a formally similar device for the representation of long, thin objects (e.g. pens): a classifier expressed with an extended index finger, representing object shape features. A plural amount of long, thin entities may thus be represented through a plural form of this classifier, with the number of extended fingers corresponding to the number of entities (cf. Schmaling 2000, Supalla 1982, 1986, Zwitserlood 2003).

it usually occurred with a mouthing component derived from the German word *neben* ‘next to’, which is indicative of its status as a lexeme (Ebbinghaus 1998, Ebbinghaus & Heßmann 1996). While the DGS generic form in the current data set did not usually occur with a mouthing component, the similarity suggests that it may be considered to reflect the use of a ‘next-to’ relational lexeme for the side-by-side configuration of multiple figure objects of the same type, with the number of downward movements of the hand indicating the number of objects. Similarly, one could argue that the TİD generic extended-finger form could be considered to be a kind of relational lexeme representing the side-by-side spatial relationship of multiple figure objects. For figure-ground relationships, we did not observe the use of any relational lexemes (e.g. ‘on’) in either of the sign languages.

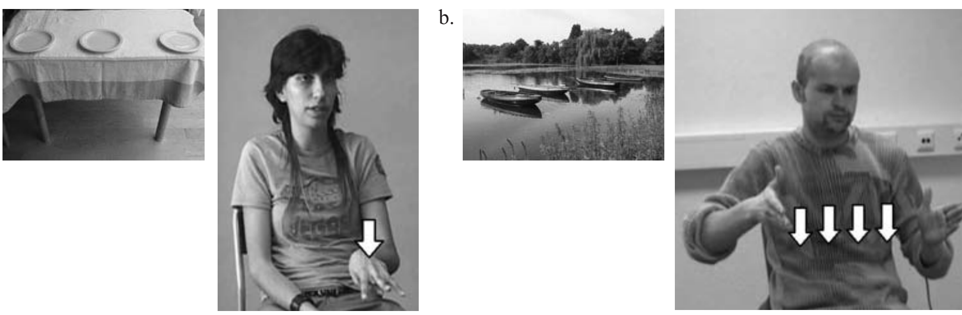


Figure 9. Examples of referent localization by means of a generic device, in (a) TİD, with object-to-finger mapping, where the construction encodes the spatial relationship of ‘three plates’ in a side-by-side configuration, and in (b) DGS, with mere encoding of the spatial relationship of ‘four boats’ in a side-by-side configuration.

Quantitative comparison. Next, we turn to the quantificational analysis to compare the usage preference of these different devices between the sign languages (see Figure 10). The total number of locative descriptions was 206 for DGS and 200 for TİD. A single description could contain the use of more than one spatial device. We report subject-based mean proportions of devices used.

Localization of classifier predicates, SASSes, and nouns occurred in both languages. For these devices, we performed separate one-way ANOVAs with language (DGS, TİD) as a between-subjects factor to compare their use between the two languages. We found that users of both sign languages predominantly used classifier predicates for the localization of figure objects, and did so equally often (DGS: $M = 0.67$, $SD = 0.16$; TİD: $M = 0.60$, $SD = 0.16$; $F(1,22) = 0.974$, $p = 0.334$). Signers of both languages also used SASSes to trace the outline of figure objects at locations in sign space; however, they were used significantly more often in DGS than TİD (DGS: $M = 0.23$, $SD = 0.13$; TİD: $M = 0.08$, $SD = 0.082$; $F(1,22) = 11.649$, $p < 0.01$). In contrast, the direct localization of lexical signs occurred significantly more often in TİD than DGS (DGS: $M = 0.05$, $SD = 0.06$; TİD: $M = 0.33$, $SD = 0.14$; $F(1,22) = 43.592$, $p < 0.001$).

For the language-specific localization devices—the flat-hand generic device in DGS, the extended-fingers generic device in TİD—we performed one-sample *t*-tests to see whether the respective use of these devices differed significantly from zero. The use of the flat-hand generic device was not very prevalent in DGS descriptions ($M = 0.08$, $SD = 0.11$), but was used consistently enough across signers to differ significantly from zero by 0.08 (95% CI [0.01, 0.15]), $t(11) = 2.661$, $p < 0.05$. Similarly, TİD signers used the extended-fingers generic device consistently ($M = 0.16$, $SD = 0.09$), constituting an

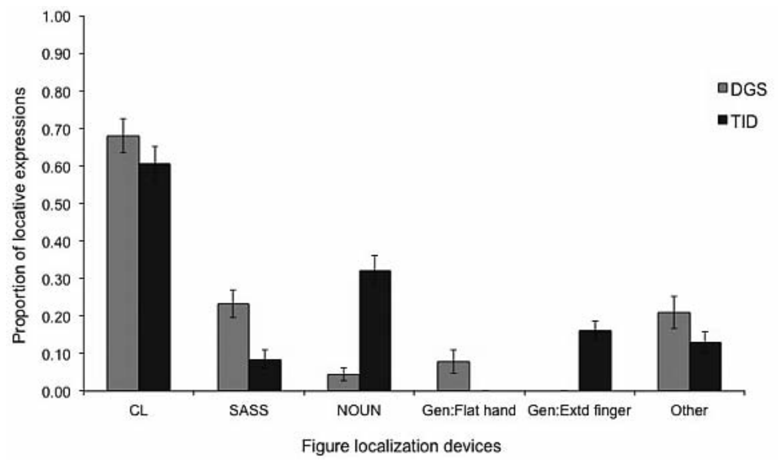


FIGURE 10. Devices used to localize figure objects in locative expressions in TİD and DGS. CL: classifier predicate; SASS: localized size and shape specifier, characterized by tracing shape of entity; NOUN: localized noun; Gen:Flat hand: localized flat hand generic form; Gen:Extd finger: localized generic referent representation by means of extended finger; Other: other devices, like localized numerals, localized existential predicates, hand sweep over area, relational lexemes, localized adjectives. (Error bars represent *SE*.)[18]

amount of use that differed significantly from zero by 0.16 (95% CI [0.10, 0.21]), $t(11) = 6.031$, $p < 0.001$. Finally, the 'Other' category contained a range of different devices in both sign languages, but no single device was used often enough to create a viable separate category. Of note is the inclusion in this category of a small number of occurrences ($N = 5$) of relational lexemes, specifically the signs for 'left', 'right', and 'middle'. These lexemes occurred in only two descriptions in DGS, and not at all in TİD, and there were no occurrences of other relational lexemes (e.g. 'on') in either sign language.

Thus, the use of semantically more specific forms of entity representation was preferred in both sign languages over the use of generic, more categorical devices. Moreover, the two sign languages were comparable in their amount of use of semantically specific devices overall, though individual usage preferences differed. While classifier predicates were used equally often in DGS and TİD, the sign languages differed in their preference for the other types of semantically specific devices, with DGS preferring SASSes and TİD preferring nouns in combination with locative predicates for entity representation. The sign languages differed radically from each other in the type of generic, noniconic referent representation, with TİD exhibiting object-to-finger mapping and DGS not representing the object per se through mapping at all.

4.2. SEMANTIC SPECIFICITY OF LOCATION REPRESENTATION. In this section, we look at the semantic specificity of location representation. The devices described in the previous section in which figure objects were mapped onto the hands exhibited a high degree of semantic specificity with respect to location representation. This includes the localization of classifiers, SASSes, and nouns to indicate object location: their placement corresponded in an iconic and topographic way to object location in the spatial scene being described in both languages. Thus, in both sign languages, all iconic (se-

[18] Number of signers who produced at least one instance of each type of figure localization device: CL: twelve DGS, twelve TİD; SASS: twelve DGS, eight TİD; NOUN: six DGS, twelve TİD; Gen:Flat hand: seven DGS, zero TİD; Gen:Extd finger: zero DGS, twelve TİD.

mantically more specific) forms of entity representation also exhibited iconic (semantically more specific) location representation.

However, the generic devices differed across languages with respect to the semantic specificity of location representation. Using the DGS flat-hand generic form, signers can freely choose the location in sign space with which to associate a referent through the placement of the hand. This allows the location of each referent, as well as the distance between referents, to be represented in a highly iconic, semantically specific way. In the TİD extended-finger form, however, the distance between referents is underrepresented, since the possible spreading distance between the fingers of one hand constrains the representation of distance between referents. The signer is not free to choose for each object the location in space with which to associate it. This (articulatory constraint) thus makes location representation with this form less semantically specific. Quantitative differences between the languages in the semantic specificity of location representation are discussed further in §4.3 below, in relation to encoding of the spatial relationships between objects.

4.3. Type and semantic specificity of spatial relationship representation. In this section, we look at whether signers in both sign languages exploit the visual modality's affordances of simultaneous representation to explicitly encode the spatial relationship between referents. That is, we are interested in whether and how simultaneous referent representation is used to represent the spatial relationships present in our stimulus materials. According to our definition, the more directly and explicitly a spatial relationship is encoded, the more semantically specific the representation is. We first assess and compare the extent of simultaneity used in spatial relationship encoding, looking separately at the figure-ground (e.g. cup on table) and figure-figure (e.g. cup next to cup) relationships in the two sign languages. We then focus only on the figure-figure relationships and look at the type of constructions in DGS and TİD that used simultaneity to represent multiple figure objects in order to see whether there is variation in the formal and semantic distinctions made between the languages in this regard.

Use of simultaneity in figure-ground relationships. We look first at figure-ground relationships, limiting our analysis to descriptions of pictures with just one figure object for ease of exposition. The total number of locative descriptions of one-figure-object pictures was seventy-two for DGS and sixty-three for TİD. We report subject-based mean proportions of descriptions.

Contrary to the expectation motivated by the articulatory and spatial affordances of the modality as well as the literature on some other signed languages, we found an overall low proportion of simultaneity used to encode figure-ground spatial relationships in both sign languages (DGS: $M = 0.07$, $SD = 0.11$; TİD: $M = 0.18$, $SD = 0.16$) (Figure 11). We performed a one-way ANOVA with language (DGS, TİD) as a between-subjects factor and found that TİD signers had a slight preference for the use of simultaneity for these relationships compared to DGS signers, but the difference was not significant ($F(1,22) = 3.337$, $p = 0.081$).[19] Thus, simultaneous figure-ground constructions as shown in Fig. 1a were infrequent in both languages.

An example of a nonsimultaneous representation of the relationship between a figure and a ground object (i.e. cup on table) in TİD is shown in Fig. 7 above. Thus, instead of

[19] We moreover point out that this slight crosslinguistic difference in the use of simultaneous constructions to encode the figure-ground relationships in our stimulus set should be interpreted with caution, given their sparse occurrence overall.

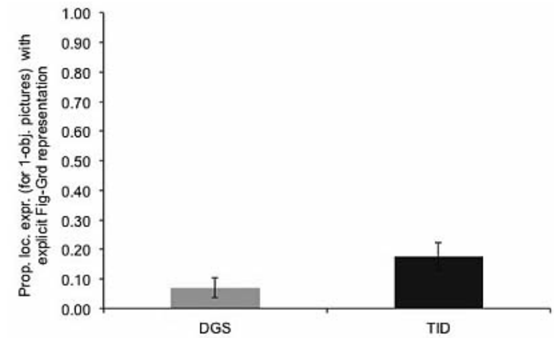


FIGURE 11. Proportion of simultaneous, and thus explicit, representation of figure-ground relationships in locative expressions for stimulus pictures with one figure object. (Error bars represent *SE*.)

providing a highly semantically specific, explicit representation of the spatial relationship (i.e. through the simultaneous representation of both figure and ground objects in space), the signer's encoding of the spatial relationship relies on the conceptually maintained location of the ground referent (i.e. the 'cup' is located at the same location in space at which the 'table' was previously signed).

USE OF SIMULTANEITY IN FIGURE-FIGURE RELATIONSHIPS. To examine the use of simultaneous referent representation to encode the spatial relationship between figure objects (e.g. cup next to cup), we looked at all descriptions of pictures containing more than one figure object (i.e. two to four objects). The total number of locative descriptions of pictures with between two and four figure objects was 134 for DGS and 136 for TİD. We report subject-based mean proportions of descriptions.

To compare the use of simultaneity in representing figure objects, we again performed a one-way ANOVA with language (DGS, TİD) as a between-subjects factor. The simultaneous representation of figure objects did not differ between languages, occurring in roughly half of the relevant descriptions in both DGS and TİD (DGS: $M = 0.47$, $SD = 0.17$; TİD: $M = 0.49$, $SD = 0.23$; $F(1,22) = 0.057$, $p = 0.814$) (Figure 12).

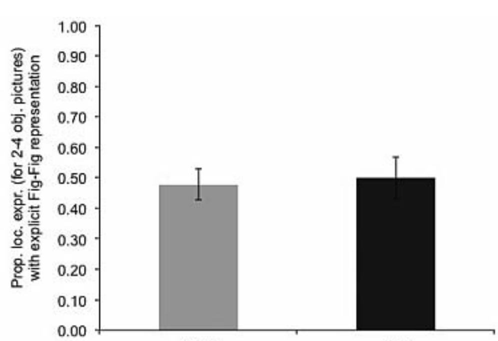


FIGURE 12. Proportion of simultaneous representation of spatial relationship between figure objects in locative expressions for stimulus pictures with two-to-four figure objects. (Error bars represent *SE*.)

In the example in Figure 13, a TİD signer gives a nonsimultaneous representation of four cups on a table. Each of the four cups is localized in space individually, without simultaneous representation, and thus without explicit representation of their side-by-side spatial relationship. Here, as in Fig. 7 above, representation of the spatial relationship relies on conceptual maintenance of referent locations, and not on direct representation.

CLF(cup)-loc$_1$ CLF(cup)-loc$_2$ CLF(cup)-loc$_3$ CLF(cup)-loc$_4$

FIGURE 13. TİD example of nonsimultaneous representation of the spatial relationship between four cups (i.e. four cups side by side).

We thus find no difference between the two sign languages in the extent to which signers use simultaneity to provide a direct, visual representation of spatial relationships (figure-ground and figure-figure). The overall prevalence of simultaneous referent representation was surprisingly low, however, given expectations from previous research and the assumption that spatial language in sign languages exploits the iconic and spatial affordances of the modality to a high degree through the use of simultaneous constructions.

TYPE AND SEMANTIC SPECIFICITY OF SIMULTANEITY FOR FIGURE-FIGURE RELATIONSHIPS. In this section, we focus on the descriptions that did use simultaneous referent representation to explicitly encode the figure-figure spatial relationships in stimulus pictures with multiple figure objects (i.e. two-to-four figure objects). Here, we found striking differences between the two sign languages, in terms of formal properties as well as the semantic specificity of encoding the spatial relationships between objects.

With respect to the formal properties, we found differences in the preference for a unimanual vs. bimanual form for simultaneous referent representation (Figure 14). In the unimanual form, referents are mapped to individual fingers, while referents are mapped to the whole hand in the bimanual form. We performed separate ANOVAs with language (DGS, TİD) as a between-subjects factor to compare the use of unimanual vs. bimanual simultaneous referent representation between the two sign languages. DGS signers used both hands (i.e. the bimanual form) for the explicit representation of the side-by-side spatial relationship between figure objects significantly more often than TİD signers (DGS: $M = 0.92$, $SD = 0.16$; TİD: $M = 0.40$, $SD = 0.23$; $F(1,22) = 42.229$, $p < 0.001$). In contrast, compared to DGS signers, TİD signers exhibited a significant preference for use of a unimanual form to explicitly encode the side-by-side relationship between figure objects (DGS: $M = 0.08$, $SD = 0.16$; TİD: $M = 0.60$, $SD = 0.23$; $F(1,22) = 42.342$, $p < 0.001$).[20]

Interestingly, both sign languages used bimanual simultaneous referent representation for encoding the side-by-side configuration of only two figure objects (as e.g. in the

[20] Preliminary data suggests that TİD signers may use the same type of finger-represents-referent form in descriptions of pictures with five referents, and even with more than five referents of a type, and thus requiring the use of two hands to represent all referents. In the present study, we had stimulus pictures featuring up to four objects, such that the forms used are uniquely differentiated by the terms unimanual (for object-to-finger mapping) and bimanual.

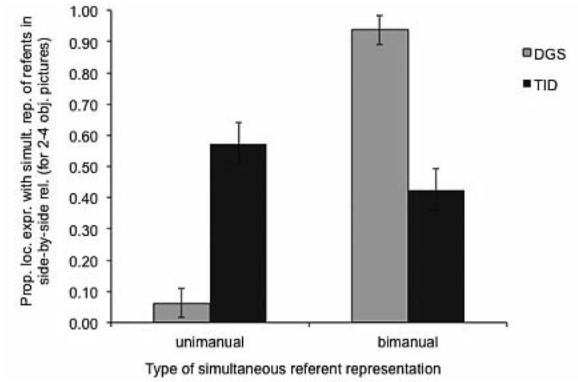


FIGURE 14. Type of simultaneous referent representation, using either a unimanual form (where individual fingers represent individual referents) or a bimanual form (where each hand represents a referent). (Error bars represent *SE*.)

simultaneous SASS and classifier localizations in TİD shown in Fig. 2 and Fig. 6b, respectively), where each hand represents one object. However, DGS signers, but not TİD signers, also used bimanual simultaneous referent representation when MORE THAN two figure objects needed to be represented. To do this, DGS signers used what we call an anchoring strategy. That is, one hand is held in place (i.e. anchored) at the location of the first referent, while the other hand moves to indicate the locations of the remaining referents (see Figure 15). In contrast, TİD signers always used the unimanual form (with referents mapped to individual fingers) for the simultaneous representation of more than two figure objects. For spatial scenes with only two figure objects, TİD signers used both unimanual and bimanual forms. Note that the small amount of unimanual simultaneous referent representation found in DGS came from the use of plural entity classifiers (i.e. for long thin objects such as pens next to each other; see n. 17).

FIGURE 15. Example of DGS bimanual anchoring strategy for simultaneous representation of referents in figure-figure relationship with classifier predicates to represent the side-by-side configuration of four cups.

With respect to the extent to which the two types of simultaneous referent representation exploit the affordances of the visual modality, the bimanual type is more semantically specific compared to the unimanual type. As shown in Fig. 15, where a DGS signer uses an anchoring strategy with classifier predicates to represent four cups located next to each other, the bimanual form can be semantically specific for both entity and location representation of each entity. Note that the DGS bimanual form was also used with the flat-hand generic device, that is, with a noniconic handshape (see Fig. 9b), but with representation of the relative object locations in a highly iconic manner. In contrast, the TİD generic side-by-side construction, due to the fact that objects are mapped onto individual fingers, does not allow a more iconic, topographically accurate representation of object locations and thus provides a more abstract, categorical encoding of the side-by-side configuration of figure objects. The form of simultaneous referent representation thus constrains the semantic specificity of location representation in TİD, but not in DGS.

5. Summary and discussion. In this article, we have presented a first qualitative and quantitative analysis of whether and how spatial expressions in sign languages exhibit similarity in exploiting the iconic affordances of the visual modality in using space to encode space. We investigated the question of the extent to which locative expression is shaped by the iconic and spatial affordances of the modality vs. language-specific structure. Specifically, we tested whether there are differences in terms of form and semantic specificity of spatial devices used to encode spatial expressions, as is the case in spoken languages, and described the nature of the differences found. The affordances of the visual modality are assumed to drive a high degree of similarity in the spatial domain across sign languages (Emmorey 2002, Sandler & Lillo-Martin 2006, Vermeerbergen et al. 2007), but crosslinguistic comparison using the same stimulus materials in similar communicative contexts to test this assumption has been lacking.

5.1. Diversity in the spatial domain: sign languages. In our comparison of locative expression in two historically unrelated and geographically distant sign languages (DGS and TİD), we analyzed the formal means of encoding figure-ground and figure-figure spatial relationships. We focused in particular on the semantic specificity of the devices used, in terms of entity representation (iconic or not), location representation (iconic or not), and representation of the spatial relationship between entities (simultaneous (more iconic) or not (less iconic)), as three features of spatial expression that have been claimed to be particularly shaped by the affordances of the visual modality and thus to be similar across sign languages. We indeed found numerous similarities between DGS and TİD, and this aligned with expectations about the 'canonical' form of spatial expressions in sign languages, that is, with encoding that maximally exploits the iconic and spatial affordances of the visual modality. However, we also found qualitative differences with respect to form type and semantic specificity between the two sign languages, as well as quantitative differences in the usage distribution of individual devices.

With regard to the similarities and confirming previous research and expectations, we found that classifier predicates were the predominant localization device used in both DGS and TİD. Furthermore, both sign languages exhibited the use of localized iconic size and shape specifiers (SASSes) and the use of noun localization. Since the localized nouns represented (shape) aspects of the referents (as did the classifiers and SASSes), both sign languages primarily used devices that are semantically specific with respect to entity representation, and did so to a similar extent. These similarities support the idea that spatial language in sign languages is modality-driven, and that affordances of the modality play a key role in shaping locative expression.

Interestingly, however, we found quantitative differences between the sign languages in their usage preference for these different devices. Specifically, the preference for use of SASS localization and noun localization differed significantly between the two languages, with TİD favoring noun localization over localization of SASSes, and DGS, conversely, favoring localized SASS forms over noun localization. The ability to directly localize a noun (more preferred in TİD) depends in part on the phonological specifications of the sign (i.e. signs that can be localized are not phonologically specified for location). However, the difference between the sign languages in usage preference for noun localization was manifest for nouns that could have been equally localizable in either sign language (e.g. both the DGS and TİD signs for 'boat'). More detailed, language-specific phonological analysis and study of pragmatics may help to interpret this difference in usage preference between DGS and TİD. In addition, future research may provide a more fine-grained phonological analysis of the types of classifiers, SASSes, and nouns in order to allow further differentiations with respect to the semantic specificity of entity representation, adding to our knowledge of sign language diversity in different domains.

In addition, though they were less preferred overall, we also found the use of semantically less specific devices in both sign languages. Both DGS and TİD exhibited the use of a language-specific generic—noniconic, and thus not semantically specific—device to represent referents. In the TİD form, objects mapped onto extended fingers, regardless of their perceptual characteristics (i.e. size and shape). In the generic DGS form, referents are not mapped onto the hand(s) at all; rather, the placement of the hand(s) simply indicates the referent locations. The TİD generic device was moreover not semantically specific with respect to figure-figure location representation, constrained by the spreading restrictions of the individual fingers of a hand. The DGS generic device, however, allows semantically specific location representation, similar to the use of other iconic locative devices (i.e. with classifiers, SASSes, and nouns). These language-specific devices provide an indication of the type of diversity that is possible within the spatial domain in sign languages, and show that sign languages can devise different ways of encoding object and location information in semantically less specific ways, even though the modality allows fuller iconic specification. These devices might be necessary to allow signers to focus on different aspects of a spatial scene, like the relations among objects rather than object properties, in different parts of the spatial utterance (e.g. although we have not included it in the example, the TİD signer in Fig. 13 uses a generic extended-finger device to focus on the side-by-side configuration of the cups after the sequential placement of classifier predicates; cf. Özyürek et al. 2010).

We turn now to the direct representation of spatial relationships through simultaneous referent representation. While simultaneous representations have been considered a hallmark of spatial representation in sign languages in previous research, here we found an overall low occurrence of direct, simultaneous representation of spatial relationships in both languages (see Nyst 2007 for a similar finding in Adamorobe Sign Language (AdaSL)). That is, in most cases, signers did not fully exploit the iconic and spatial affordances of the modality, and as such, spatial relationship encoding exhibited a low degree of semantic specificity as we have defined it. This was particularly striking—and unexpected—in the case of figure-ground relationships (e.g. cup on table), where the availability of two hands (i.e. with one hand representing the figure object and one hand representing the ground object) allows a direct, simultaneous mapping of the objects and their spatial relationship onto the sign space. The rather low use of simultaneous figure-ground representation in our tasks may be due to the lack of contrastive relationships (e.g. 'on' vs. 'under') in our stimulus materials or to the prototypical nature of the relationships (cf. Özyürek et al. 2010, Sümer et al. 2012). The similarities between DGS and TİD in this respect moreover suggest that the lack of simultaneous representation for unmarked prototypical spatial relations reflects a more general pragmatic principle, rather than being language-specific (also see Pfau & Aboh 2012 for a similar argument for NGT). In addition, the lack of simultaneous figure-ground representation may be due to the nature of the grounds in our stimulus materials. In many cases, the ground objects functioned as (large) surfaces (e.g. meadow, lake). Simultaneous referent representation was substantially more prevalent for figure-figure relationships, but still occurred only about half of the time in both sign languages. Overall, the relatively infrequent use of simultaneous representation in the figure-figure relationships could be driven by the constraints of the modality on linguistic construction (i.e. the need to represent more than two objects but having only two hands to do so). In both sign languages, however, the simultaneous representation of figure referents did not differ between pictures with only two objects and pictures with more than two objects. Again, it may be that configurations of the same type of referent in next-to relationships are prototypical and unmarked enough and thus do not consistently give rise to what may be the more marked construction using simultaneous referent representation.

When signers did use simultaneous referent representation, however, we found a difference in the way that TİD and DGS signers encoded figure-figure relationships, particularly for spatial scenes featuring more than two figure objects located next to each other. Specifically, we found that DGS signers used a bimanual device, mapping referents onto the hands in a classifier construction, or using a flat-hand generic device, and holding one hand in place (like an anchor) at the location of the first referent, while TİD signers used a unimanual device, mapping referents onto individual fingers of one hand. Given the availability of only two hands, the representation of more than two objects presents a particular challenge, and the systematic difference between TİD and DGS is remarkable in demonstrating two very different solutions to the problem. Though the devices used are formally very different, they serve a similar function semantically in that they both explicitly mark and highlight the side-by-side relationship between entities.[21] Thus, both sign languages exhibit a language-specific way of highlighting the spatial relationship, by making the relationship visually explicit rather than encoding it indirectly by relying on conceptually maintained locations in space. The bimanual anchoring strategy in DGS is used for both semantically specific (iconic) and nonspecific (noniconic, generic) referent representation, and moreover allows semantically specific location representation. It is interesting to note that this anchoring strategy is also found in the DGS NEXT-TO relational lexeme (Fig. 3b), showing a convergence of form within a language to express similar semantic information across different contexts. The TİD unimanual strategy, in contrast, is characterized by generic referent representation and by much less iconic location representation (in terms of topographic isomorphism). As a result, the spatial configuration itself (i.e. the side-by-side relationship between referents) is represented in a more categorical, abstract way in TİD compared to in DGS.

Our systematic comparison of spatial language in DGS and TİD thus reveals multiple ways in which sign languages can differ in encoding spatial relationships, and shows that different linguistic devices may evolve in different sign languages, akin to different lexicalization patterns in spoken languages. Our analysis has moreover highlighted ways in which sign languages can encode spatial information in semantically less specific ways that may be more abstract and categorical than the more expected iconic encoding afforded by the modality. We have seen that both sign languages combine forms of varying semantic specificity in language-specific ways in locative expressions.

5.2. Diversity in the spatial domain: spoken vs. sign languages. How does the variation we have found in our comparison of sign languages relate to the diversity that

[21] This analysis is supported by the fact that signers often combined use of these devices with placement of referents in space using another localizing device, like classifier predicates.

we know to exist in the spatial domain in spoken languages? Our approach has allowed us to move beyond a general modality-effect level of comparison between signed and spoken language to a level that captures more fine-grained formal and semantic properties of locative expression in individual sign languages. We saw that, as in spoken languages, aspects of spatial relationships can be expressed in sign languages by means of different formal encoding devices, along a continuum of varying semantic specificity and influenced by the prototypicality of the relationships. The variation, however, remained on a continuum that was still largely shaped by the iconic and spatial properties of the visual modality—by modality-specific properties of sign languages. We did not find expression in the sign languages to exhibit fully arbitrary distinctions, at least in a direct comparison of two sign languages, in line with expectations about how the visual modality shapes expression in the spatial domain. We can now highlight where similarities between signed and spoken languages lie, in spite of the differences in modality, as well as where differences lie, as a result of modality effects or language-specific linguistic structure.

The review of spatial language presented in §2 makes clear that spoken languages exhibit a diverse range of devices in spatial expressions (e.g. adpositions, positionals) that encode different semantic features of the spatial scene and with different levels of specificity (e.g. encoding specific information about object shape). Thus, when we consider the range of typological diversity across spoken languages in terms of the encoded semantics, it is obvious that the ability to encode specific information about objects is not unique to the visual modality (though the way the visual modality depicts object properties remains privileged in this respect). One difference between spoken and sign languages is that specific object information tends to be encoded in spoken languages only for the figure object; it is uncommon for spoken language spatial descriptions to encode shape information about the ground object (Talmy 1983). In sign languages, in contrast, shape information can be easily expressed for both figure and ground objects. Our study suggests, however, that sign languages also exhibit a tendency to focus on figure object information, especially with classifiers and SASSes.

The highly iconic and topographic encoding of spatial location and the direct (simultaneous) representation of spatial relationships is not possible in the vocal modality, but is easily possible in the visual modality, given its unique spatial affordances and the availability of the two hands as primary (visible) articulators. The fact that sign languages can display diversity in encoding of the spatial relationship in terms of how iconic the representation of the relationship is seems truly to reflect modality-specific variation, that is, variation specific to the visual modality. This finding goes beyond general expectations of overall high semantic specificity in the spatial domain in the visual modality, and thus also of crosslinguistic similarity in spatial encoding across sign languages. We have found differences in the encoding of spatial relationships between referents particularly for figure-figure relationships of multiple figure objects. Thus, our initial assumption—that the encoding of spatial scenes including relationships between more than one figure object may reveal more variation than would be found if only figure-ground relationships are investigated (as in previous research)—is justified.

Our last point of comparison concerns encoding of figure-ground relationships (e.g. cup on table). The overall less frequent use of simultaneity than expected to directly represent these spatial relationships, in both TİD and DGS, suggests that the structure of locative expressions may exhibit sensitivity to semantic and pragmatic constraints, perhaps motivated by the prototypicality of spatial relationships (cf. our analysis in

Özyürek et al. 2010), as is found with patterns of locative encoding in some spoken languages (Evans & Levinson 2009, Levinson & Wilkins 2006). (Recall the examples from Turkish in §2.1, ex. 2.) Similarly, in both TİD and DGS, these figure-ground relationships were expressed less explicitly, that is, without a direct representation of the spatial relationship. According to this semantic/pragmatic account, we would expect simultaneity to be used more frequently for spatial relationships that are less canonical (e.g. shoe on table) in both TİD and DGS (Pfau & Aboh 2012 provides converging evidence for this claim for NGT). Similarly, the need to make an explicit contrast between two types of spatial relationship (e.g. 'on' vs. 'in') may encourage the use of simultaneous figure-ground representation. Further research is needed to test this claim.

Overall, our findings suggest that sign languages may display more diversity in spatial language than has been previously assumed, and in a way more comparable to the diversity found in spoken language locative expressions, exhibiting formal and semantic differences with respect to which aspects of a spatial scene are linguistically encoded (Ameka & Levinson 2007, Bowerman 1996). Furthermore, like spoken languages (Feist 2008, Levinson & Meira 2003, Norbury et al. 2009), sign languages may be characterized by the use of both semantically more specific and more general linguistic forms for spatial encoding. Sign languages nevertheless remain unique in the sense that the diversity displayed does not completely move away from iconicity but remains along a continuum of devices that map space to space and form to form.

This study has taken a step in both qualitative and quantitative comparative analysis of locative expression in sign language, using the same task and analyzing a large number of expressions, across a large number of signers where the communicative discourse context was kept constant. We hope that our study may provide a kind of template for similar studies in the future on spatial encoding in other sign languages, thus broadening the current work and ultimately enabling much better crosslinguistic and crossmodal comparisons. Importantly, our study demonstrates differences in the semantic features encoded by individual devices and differences in the semantic specificity of these forms. It also makes clear that sign languages differ in preference of use of different spatial devices, even when the devices themselves exhibit a formal similarity between the languages. Thus, spatial language in sign languages may exhibit crosslinguistic differences to a more substantial degree than has been previously assumed, as evidenced by differences in the degree of semantic specificity (iconicity) of spatial devices, language-specific means of encoding spatial semantic features, and the possible influence of semantic/pragmatic constraints. In this sense, we can say that even in the domain of spatial language, sign languages can differ from each other in the way that they have been shown to differ in other domains of linguistic structure. This position gives us an understanding of spatial expression in sign languages that goes beyond the simple dichotomy between more iconic (sign) vs. more categorical (spoken) spatial encoding. The results presented here open up further avenues of research into the comparative study of sign languages in the domain of spatial language, with a focus on which aspects of a spatial scene are linguistically encoded, the level of semantic specificity of individual spatial devices, and the semantic/pragmatic constraints on encoding spatial information, as well as possible effects on other cognitive domains such as memory, in order to gain new insights into the relation between spatial cognition and language.

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[Received 13 February 2012;
revision invited 14 February 2013;
revision received 15 February 2014;
accepted 2 July 2014]