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Cognitive, Cultural, and Linguistic Sources of a Handshape Distinction Expressing Agentivity

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Abstract

In this paper the cognitive, cultural, and linguistic bases for a pattern of conventionalization of two types of iconic handshapes are described. Work on sign languages has shown that handling handshapes (H-HSs: those that represent how objects are handled or manipulated) and object handshapes (O-HSs: those that represent the class, size, or shape of objects) express an agentive/non-agentive semantic distinction in many sign languages. H-HSs are used in agentive event descriptions and O-HSs are used in non-agentive event descriptions. In this work, American Sign Language (ASL) and Italian Sign Language (LIS) productions are compared (adults and children) as well as the corresponding groups of gesturers in each country using "silent gesture." While the gesture groups, in general, did not employ an H-HS/O-HS distinction, all participants (signers and gesturers) used iconic handshapes (H-HSs and O-HSs together) more often in agentive than in no-agent event descriptions; moreover, none of the subjects produced an opposite pattern than the expected one (i.e., H-HSs associated with no-agent descriptions and O-HSs associated with agentive ones). These effects are argued to be grounded in *cognition*. In addition, some individual gesturers were observed to produce the H-HS/O-HS opposition for agentive and non-agentive event descriptions—that is, more Italian than American adult gesturers. This effect is argued to be grounded in *culture*. Finally, the agentive/non-agentive handshape opposition is confirmed for signers of ASL and LIS, but previously unreported *cross-linguistic* differences were also found across both adult and child sign groups. It is, therefore, concluded that cognitive, cultural, and linguistic factors contribute to the conventionalization of this distinction of handshape type.

Keywords: Agentivity; Sign Language; Gesture; Handshape; Conventionalization; Cross-linguistic variation; Culture; American Sign Language (ASL); Italian Sign Language (LIS)

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1. Introduction

The agentive/non-agentive opposition is fundamental to semantic and syntactic structure, and it has a long history in linguistic theory (see Pustejovsky, 1991, for a review). In many sign languages, the agentive/non-agentive distinction is expressed by the opposition between two types of handshapes. Handling handshapes (H-HSs) are those that represent how objects are handled or manipulated; object handshapes (O-HSs) are those that represent the size and shape of objects (for American Sign Language [ASL], see Benedicto & Brentari, 2004; Janis, 1992; Kegl, 1990; Schick, 1987; for Hong Kong Sign Language, Brentari, Tang, & Benedicto, 2001; for Sign Language of the Netherlands [NGT], Zwitserlood, 2003; for Italian Sign Language [LIS], Mazzoni, 2009; for Nicaraguan Sign Language, Goldin-Meadow, Brentari, Coppola, Horton, & Senghas, unpublished data).

Fig. 1 shows an H-HS and an O-HS used by an ASL signer (top) and by an Italian gesturer (bottom). Both types of handshapes are iconic, but in different ways. H-HSs have been described as having "hand-as-hand" iconicity because the hand continues to represent how the hand acts on an object, while O-HSs have been described as having "hand-as-object" iconicity because the hand represents size and shape properties of the object itself (Brentari, Coppola, Mazzoni, & Goldin-Meadow, 2012). In sign languages, the distribution of these handshape types has been argued to interact with morphological and syntactic rules. While other properties of gestures and sign may contribute to this distinction, such as movement or non-manual behaviors, they have not been studied cross-linguistically and so we focus on handshape due to the body of work establishing this distinction.

This study analyzes the H-HS and O-HS productions of signers and gesturers (adults and children) in descriptions of motion and location events to determine whether: (a) ASL and LIS differ in H-HS and O-HS use when producing the agentive/non-agentive distinction; (b) the landmarks of acquisition related to this opposition are achieved at the same time in ASL and LIS; (c) the use of this handshape opposition is systematic in gesture; and (d) gesture groups from the United States and Italy differ in the expression of these two types of handshapes in event descriptions.

The results of this study will be analyzed first according to *type of system*—sign language results will be presented first (ASL, LIS), then the gesture results will be presented (American and Italian gesture groups). Next, the data will be analyzed by *country*—first the American sign and gesture groups together, then the Italian sign and gesture groups—in order to determine the similarities and differences among the groups who interact with each other in daily life.

Our hypothesis is that language, culture, and cognition will affect the phenomenon in question in different ways, and this work will help tease apart the contributions of each. Fig. 2 schematizes the possible explanations for the patterns we might find in the data. To the extent that the results for all groups show a similar pattern, a *cognitive* explanation will be proposed (Fig. 2a). Patterns that are specific to sign languages, but not to gesture, will be considered *linguistic* (Fig. 2b). Patterns common to signers and gesturers

Fig. 1. Handling handshapes (H-HSs) and object handshapes (O-HSs) in sign language and gesture: (top) an adult ASL signer using an H-HS to describe someone putting a book on its side (with an agent [left]), and an O-HS to describe a book falling on its side (without an agent [right]); (bottom) an adult Italian gesturer using an H-HS to describe someone putting a toy airplane on the table upside down (with an agent [left]), and an O-HS to describe a toy airplane on the table (without an agent [right]).

of one country but not to the other will be considered *cultural* (Fig. 2c). If all four groups exhibit different patterns, such differences will be attributed to an interaction culture and language (Fig. 2d).

1.1. Sign language background

The two types of handshapes investigated in this paper have been well described in classifier constructions in sign languages, which are a type of predicate in the sign languages in which they appear.[1] Classifier constructions are often defined as polymorphemic, spatial verb complexes with a root signified by a movement, and a handshape functioning as an affix on the root. The handshape typically conveys information about the semantic class, size, and/or shape of the object and may include other properties of the event as well, such as how the object is handled. Specifically for this study, ASL and LIS have such classifiers, and the literature has established that they have stable, discrete, and productive meanings, and thus are morphological affixes (for ASL, see Benedicto &

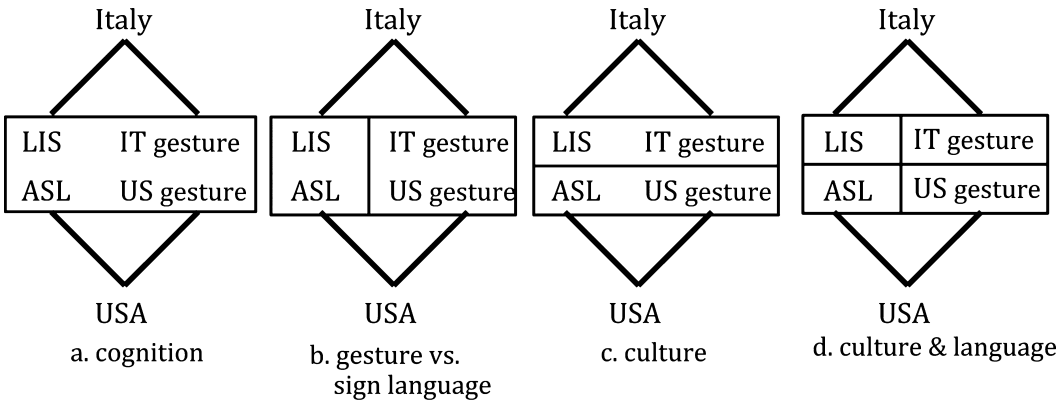

Fig. 2. Possible patterns in the data and the explanations that will be attributed to them if they appear in the results of this study: (a) all groups pattern alike, which will be attributed to *cognition*; (b) the sign groups pattern alike as compared with the gesture groups, which will be attributed to *language*; (c) the Americans pattern alike as compared with the Italians, which will be attributed to *culture*; (d) all four groups show distinct patterns, which will be attributed to an *interaction of language and culture*.

Brentari, 2004; Emmorey, 2003; Schick, 1987; Shepard-Kegl, 1985; Supalla, 1982; for LIS, see Corazza, 1990; Mazzoni, 2009; Pizzuto & Corazza, 2000).

There are several types of classifiers in ASL and LIS, but only three are relevant to our current study: *handling* classifiers, in which the handshape represents the hand that manipulates the object; *whole entity* classifiers, in which the handshape represents the object as a whole rather than its parts, and *size-and-shape specifiers (SASSs),* in which the handshape represents a subset of the properties of an object. Both whole entity classifiers and SASSs are referred to as *object* classifiers throughout this paper, since both represent the properties of objects, while handling classifiers also includes an expression of the object's manipulation. One important linguistic role of object and handling classifiers in sign languages is to express the agentive/non-agentive opposition.

At the heart of this distinction is the opposition between clauses that have an agent (Eng. *John melted the butter*) and those with no agent (Eng. *The butter melts*).[2] In some spoken languages, this opposition may be expressed transparently in the affixes on the verb or by the pronominal system, as it is in Tuki, a Native American language of Northern California (Mithun, 2008). The pronoun *ap* is used in agentive clauses— ***ap*** *lis k'an la aktekb* (Eng. *I talked fast*)—while ***i:*** is used in non-agentive clauses ***i:*** *k'aptek* (Eng. *I choked*).

H-HSs and O-HSs exhibit similar syntactic alternations in sign languages; these two types of handshapes obtain different results on syntactic tests that are sensitive to agentive subjects versus grammatical objects (see Benedicto & Brentari, 2004; and Mazzoni, 2009; for details on these tests in ASL and LIS, respectively). Fig. 1 (top) illustrates the contrast between object and handling classifiers—Eng. *[Someone] puts the book on its side* versus *The book falls*. Note that the place of articulation and movement is the same in the two ASL clauses. The only difference is the handshape—the H-HS (left) represents the way the book is handled as it is moved; the O-HS (right) represents the book as it

moves by itself. The clause with the flat C-handshape  obtains a positive result on syntactic tests sensitive to both an external agentive subject and an internal object argument, while the clause with the B-handshape  obtains a positive result only on syntactic tests sensitive to an non-agentive internal object argument (Benedicto & Brentari, 2004). Thus, the handshape representing the book is expected to have an H-HS in transitive, agentive event descriptions and an O-HS in non-agentive event descriptions. The opposition between several pairs of handling and object classifiers is shown in (1).

(1) ASL and LIS opposition between agentive and non-agentive handshapes in classifier predicates.

(a) Examples of handling classifiers	(b) Examples of object classifiers
(i) Handle long, thin object: 	(i) Long, thin object: 
(ii) Handle flat object: 	(ii) Flat object: 
(iii) Handle small object: 	(iii) Small, round object: 

Research on the acquisition of sign languages, and on classifier constructions in particular, is also important for our analyses.[3] Work on ASL and British Sign Language has shown that H-HSs and O-HSs are both among the earliest handshapes produced by child signers—for example, H-HSs: the A-handshape  and the closed L-handshape  ; O-HSs: 1-handshape  and the 5-handshape  (Boyes Braem, 1994; Marentette & Mayberry, 2000; Meier, 2006; Morgan, Barrett-Jones, & Stoneham, 2007). The work on the acquisition of classifier predicates in ASL shows that classifier predicates are learned morpheme by morpheme, rather than as unsegmented wholes (Lillo-Martin, 2009; Newport, 1981; Newport & Meier, 1985; Schick, 1987; Singleton & Newport, 2004; Supalla, 1982).

Only three studies have specifically addressed the agentive/non-agentive opposition in child signers (Brentari, Coppola, Jung, & Goldin-Meadow, 2013; Schick, 1987; Slobin et al., 2003). Schick (1987) elicited signs from 24 ASL-learning children (ages 4;5–9;0) using controlled stimuli designed to elicit handling and object classifiers. She found that, although the children used H-HSs and O-HSs correctly a majority of the time, at every age ASL children were more likely to produce correct O-HSs than H-HSs (Table 5.3, p. 78); the complexity of the form also played a role (the use of one or two hands). Slobin et al. (2003) analyzed spontaneous productions of H-HSs and O-HSs in children learning ASL and NGT. They found evidence of both H-HSs and O-HSs as early as age 2;5, but their work considered noun, verb, and classifier uses H-HSs and O-HSs together, so it was not possible to say whether the handshape appeared in a complex classifier predicate or in a noun or verb produced (or created) by the child. Brentari et al. (2013) found, like Schick (1987), that H-HS production in agentive descriptions was more

variable than O-HS production in non-agentive descriptions, and that the agentive/non-agentive opposition is not mastered in ASL children until around 7;0 years of age.

Most other studies have concentrated exclusively on O-HSs in No-Agent contexts (e.g., Fish, Morén, Hoffmeister, & Schick, 2003; Newport, 1981; Supalla, 1982). For example, Supalla (1982) studied three ASL-learning children over a 6-month period (ages 3;6, 4;0, and 5;6 when testing began) and found that, overall, the children produced the expected O-HS a majority of the time (Table 16, p. 92). As in Brentari et al. (2013), Supalla found that when children failed to use the correct object classifier for a "vehicle" (a 3-handshape ), they most often used a phonologically simpler O-HS (a B-hand  or index finger ) and, less often, a finger tip tracing a path, a point, a whole body gesture, or a frozen lexical item. Rarely did any of the children substitute an H-HS for an O-HS (Supalla, 1982, Table 15, p. 90), and this asymmetrical pattern of substitution was taken to be linguistic evidence for the acquisition of these forms.

In summary, the generalization about the agentive/non-agentive opposition in handshape has been demonstrated for ASL and LIS adults, and in ASL children; however, no direct cross-linguistic comparison has been done, and no timetable for the acquisition of this opposition has been proposed for LIS.

1.2. Gesture background

H-HSs and O-HSs have been widely observed in adult gesturers (McNeill, 1992, 2012), and in children (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Pettenati, Stefanini, & Volterra, 2009). Pettenati et al. (2009) have shown that at age 2;0–3;1 similar handshapes appear in the iconic gestures of Italian child gesturers as have been reported for child signers, specifically those mentioned above. The particular agentive/non-agentive opposition addressed in the current study has not previously been investigated.

It is important to draw a distinction between gesture used with speech (i.e., "co-speech gesture") and gesture without speech ("silent gesture"). Previous studies indicate that silent gesture can take on sign-like properties while co-speech gesture does not (Goldin-Meadow, McNeill, & Singleton, 1996; Laudanna & Volterra, 1991; Schembri, Jones, & Burnham, 2005). For example, American gesturers using silent gesture were shown to be more likely than those using co-speech gesture to produce an iconic handshape with a movement, and to produce a gesture order that deviated from the word order of their native language (Goldin-Meadow et al., 1996). Previous findings on child gesturers revealed differences in the use of H-HSs and O-HSs in silent gesture versus co-speech gesture as well (Boyatzis & Watson, 1993; Capirci, Cristilli, De Angelis, & Graziano, 2011; Kaplan, 1968; O'Reilly, 1995; Overton & Jackson, 1973; Tomasello, Striano, & Rochat, 1999). For the research questions addressed here we use silent gesture as the response mode because in order to tap into the potential for sublexical componentiality in gesture, we believe the best way to insure parity between the gesture and sign data is to set up a situation where gesturers are both (a) able to focus all of their communicative attention on

gesturing and thus will come closer to exhibiting their full gestural competence; and (b) likely to produce strings of gestures that convey the entire intended message.

Cross-linguistic and cross-cultural differences have been reported for gesture. Özyürek and Özcaliskan (2000), Kita and Özyürek (2003), and Kita (2009) have shown that the movement portion of co-speech gesture can differ cross-lingustically, based on the typological characteristics of the spoken language (first described in Talmy, 1975). Speakers of "satellite framed" languages (e.g., English) tend to express manner and path simultaneously in both spoken clauses and in the accompanying co-speech gestures—for example, *roll* [path + manner gesture] *down the hill*. In contrast, speakers of "verb-framed languages" (e.g., Turkish) tend to express path and manner of motion in separate spoken clauses, and the co-speech gestures express manner and path separately as well—for example, *descend* [path gesture] *while rolling* [manner gesture]. Cross-cultural differences in facial expressions and head movements have also been demonstrated (Dhillon, Kocielnik, Politis, Swerts, & Szostak, 2011; McClave, Kim, Tamer, & Mileff, 2007).

With regard to English-based (British or American) gesture and Italian gesture, Iverson, Capirci, Volterra, and Goldin-Meadow (2008) have suggested that young Italian children (0;10-2;0) produce more iconic gestures than their American counterparts, and Kendon (2004b) analyzed the spontaneous co-speech gestures of a single British male and a single Neapolitan adult male. He concluded that the Neapolitan gesturer used a higher number of different handshapes than the British gesturer, as well as gestures that served a higher number of different pragmatic functions, thus demonstrating a difference between these two cultures in their uses of gesture.

2. Methods

2.1. Participants

The countries of Italy and the United States were chosen for this study for several reasons. First, the sign languages are not related (Corazza, 1993; Lane, 1984; Quer, Mazzoni, & Sapountzaki, 2010). Even though the clerics who founded of the first schools for the Deaf in the United States (Thomas Hopkins Gallaudet) and in Italy (Thomas Silvestri) were trained in the methodical signs of the Paris school, the two cases are quite different. Gallaudet brought Laurent Clerc from Paris (a signer of Langue des Signes Française) to assist him in establishing the first American school, and Clerc's presence had an effect on ASL, while Silvestri did not bring a Paris school graduate back to Italy. Historians, therefore, infer that Silvestri's methods were applied more directly to what Italian signers were already using at the time. The second reason for choosing Italy and the United States is due to the difference in the gestures of hearing people. Italian culture has been described as a "gesture rich" (Kendon, 2004a,b) while American culture has not been so described. Finally, we wanted two spoken languages in which there was no morpheme for agentive or causative meanings. Of course, English and Italian can express these notions, but in these languages no morpheme can be isolated that might potentially trans-

fer from the spoken language to gesture—in contrast with Turkish, for example, which is a gesture-rich culture but has a causative morpheme with five variants (*-t, -It, -Ir, Ar, or –DIr*; see Ketrez, 1999) that might be co-opted by a gesture system to use for the agentive/non-agentive distinction.[4]

2.1.1. Signers

Nineteen native signers participated in this study—twelve adults (6 ASL and 6 LIS), and seven children (3 ASL and 4 LIS). They all learned their respective sign language from birth and used it as the primary language in their daily lives. The adult ASL signers (age 29–55) were from the Midwest, either from the Indianapolis or Chicago area. The ASL-signing children (age 4;1, 4;4, and 4;4 at the start of testing) were attending the Indiana School for the Deaf (ISD), a bilingual, bicultural program in Indianapolis. The recording sessions took place at the participant's home, on the ISD campus, or at the University of Chicago. Two of the three native ASL-signing children participated in this study three times, once per year at 4, 5, and 6 years of age; all others participated one time.[5]

The LIS signers (age 24–41) were from the Milan area; all were members of their local Deaf communities. Three of the LIS-signing children (age 3;10, 5;3, 5;7, and 6;0) were attending the School for the Deaf in Rome at via Nomentana, a bilingual, bi-cultural program in which Deaf and hearing children are enrolled, and one (age 5;4) was a student at the school for the Deaf in Modena. The recording sessions of the LIS participants took place at the participant's home, at the school at via Nomentana, or at the headquarters of the Association of the Deaf in Milan.

2.1.2. Gesturers

Nineteen gesturers participants in this study: 12 adults (6 native speakers of English and Italian, respectively) and 7 children (3 English, 4 Italian). None had exposure to a sign language. The adult American gesturers (age 20–52) were from the Midwestern United States and were recorded at Purdue University or the University of Chicago. The American gesturing children (age 4;3, 4;4, and 4;8) were from Southern California and were recorded in their homes.

The adult Italian gesturers (age 20–36) were from Tuscany and were recorded in their homes or in the home of a relative or friend. Three of the four Italian gesturing children (age 4;6, 4;7, 5;0 and 5;3) were from Rome and were recorded in the Volterra laboratory; one (5;0) was from Tuscany and was recorded in her home.

2.2. Stimuli and procedures

The stimulus materials are the same as those used in Brentari et al. (2012). The stimulus items were presented on a computer screen. Each item consisted of one of 11 objects (airplane, book, coin, cigar, lollipop, marble, pen, string, tape, television set, and tweezers exhibiting a range of colors, shapes, and sizes) portrayed in two types of situations: 5 vignettes depicting an item being moved by an *agent*; and 5 vignettes depicting a

stationary item or an item moving on its own *without an agent*. Two objects known to be familiar to children were used in the following analyses—airplane and lollipop—plus 11 vignettes with all of the different objects falling from a table were included in order to sample from all of the objects in the condition that had movement but no agent. All items also have the advantage that the target H-HS and O-HS are clearly distinct from one another. There were thus responses to 31 vignettes included from each participant (see the Appendix, Figure A, for the expected handshapes based on ASL and LIS).

Participants were asked in the participant's language to "describe what you see" (for signers) or "describe what you see without using your voice" (for gesturers). Signers responded in their respective languages (ASL, LIS); gesturers responded in silent gesture. The vignettes were presented in blocks. All of the events involving one object were presented together, vignettes without an agent, followed by vignettes with an agent; falling vignettes were presented last. The same order was used for all participants. The experimenter was a native user of the participant's language, except in four of the sessions.[6]

In this study, silent gesture was used as the response mode for the gesturers because we wanted hearing participants to channel all of their communicative energy into one modality, and gesturers readily produced sequences of gestures rather than one-gesture responses, thus providing responses that were equivalent to the signed responses in terms of number data points provided.[7] All sessions were videotaped.

2.3. Coding

The participants produced utterances that included labels of the objects, descriptions of the objects, descriptions of the event, or all three. For this study, we analyzed only handshapes produced in descriptions of the event. The video files containing the participants' responses were transcribed using ELAN (Crasborn & Sloetjes, 2008). Handshapes were annotated as *specific handshapes* according to the coding system devised by Eccarius and Brentari (2008). They were also annotated as handshape types: *H-HS* or *O-HS* (*iconic* handshapes); otherwise, they were coded as non-iconic handshapes and labeled *other*. The H-HSs and O-HSs were then coded as *matches* or *mismatches* with respect to the agentive or non-agentive vignettes. A handshape was coded as a "match" when an H-HS was used in response to a vignette with an agent or when an O-HS was used in response to a vignette without an agent; as a "mismatch" when an H-HS was used in response to a vignette without an agent or an O-HS in response to a vignette with an agent, or "other." The "other" handshapes were further coded as *points* (1-handshape, a lax B-handshape), *frozen lexical signs*, such as FALL (signers only), or *whole body* gestures (e.g., falling from the chair to indicate the airplane falling). In cases of multiple responses for the same item, only one response was analyzed according to the following procedure: a match was included if one occurred; if not, then a mismatch if one occurred; if not, then "other." In this way, each participant contributed an equal number of responses to each vignette in the analyses.[8,9] Ten percent of the items were coded by a second transcriber

and reliability was 84% for specific handshape, 90% for handshape type (H-HS or O-HS), and 96% for match value (match, mismatch, other).

3. Results

A mixed-effects logistic regression was performed to address two questions concerning subjects and groups: the probability of producing the agentive/non-agentive opposition expressed by handshape, and the probability of producing an iconic handshape (H-HS or O-HS) rather than an "other" handshape. For the agentive/non-agentive analysis of handshape the outcome (dependent) variable was the relationship of the *handshape type* (H-HS, O-HS) when compared to the *vignette type* (agent, no agent), called *match* or *mismatch* as described in the Coding Section. Eight hundred and forty handshapes were analyzed. The predictor variables were *country* (Italy, US), *vignette type* (agent, no agent), *age* (child/adult), and their interactions. Responses to the "falling" vignettes were not included in this analysis because nine of the eleven objects were observed in this vignette alone and thus there would be no basis for comparison (i.e., only the objects airplane and lollipop were analyzed in all 10 conditions).

For the analysis of iconic versus "other" handshapes, the outcome (dependent) variable was the *handshape representation type* (iconic, other), and the predictor variables were *country* (Italy, United States), *vignette type* (agent, no agent), *age* (child, adult), and their interaction. *Participant* and *individual vignette* were considered random variables for both analyses. These data were grouped first according to *type of system* (sign language or gesture) in order to compare the *sign languages* (LIS and ASL together) and *gesture systems* together (U.S. gesture and Italian gesture together). The data were then grouped according to *country* (America, Italy) in order to compare the *American groups* (ASL and U.S. gesture together) and the *Italian groups* (LIS and IT gesture together). In addition to these analyses, a profile of the specific handshapes produced was compiled, regardless of their status as an H-HS or O-HS, as well as a thorough description of the "mismatches" and "other" handshapes (1,264 handshapes were analyzed).

3.1. Sign language comparisons

Fig. 3 shows both analyses for the sign language groups; each will be discussed in turn.

3.1.1. Sign language groups: Agentive/non-agentive handshape opposition

As predicted, both ASL and LIS signers show a strong tendency to match handshape with vignette type ($\beta = 3.40$; $SE = 0.76$; $p < .001$; 399 observations). There was a main effect for vignette type (all signers matched less when describing vignettes with an agent than without one; $\beta = -2.95$; $SE = 0.82$; $p < .001$), and there was tendency toward an interaction between vignette type and country (the LIS signers match more often than the ASL signers when describing events with an agent; $\beta = 1.57$; $SE = 0.95$;

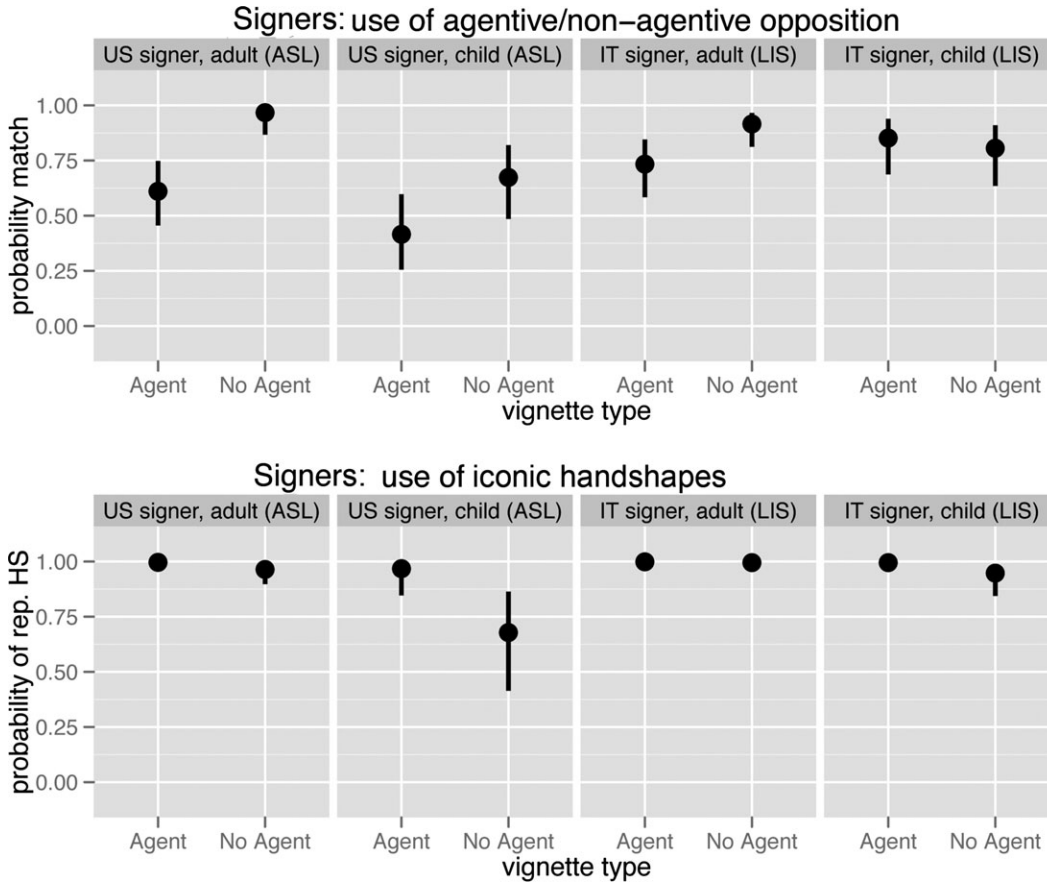

Fig. 3. Sign language comparisons[11]: (top) the probability that an H-HS was produced in response to a vignette with an agent (*agent match*) or an O-HS was produced in response to a vignette without one (*no-agent match*); (bottom) the probability that an iconic handshape was produced in a response rather than a non-iconic one.

p = .09). In addition, there was a significant age effect (the child groups matched less than adults: $\beta = -2.68$; $SE = 0.84$; p = .001), and there was a significant interaction between age and vignette type (children matched more than adults on vignettes with an agent; $\beta = 1.88$; $SE = 0.92$; p = .04). Finally, there was a tendency toward an interaction of age and country (the LIS child matched more than the ASL child group; $\beta = 1.71$; $SE = 1.04$; p = .09). Tukey multiple comparisons of means showed a significant difference between ASL adult and child groups (p = .002) and between ASL and LIS children (p = .005).

3.1.2. Sign language groups: Use of iconic handshapes

There were significant effects for vignette type, country, and age (615 observations). Iconic handshapes (H-HS or O-HS) were used more often to describe vignettes with an

agent ($\beta = 2.68$; $SE = 0.77$; $p < .001$); LIS signers used more iconic handshapes than ASL signers ($\beta = 2.16$; $SE = 0.71$; $p = .002$); and children used less iconic handshapes than adults ($\beta = -2.56$; $SE = 0.68$; $p = .002$). Tukey multiple comparisons of means again showed a significant difference between ASL adult and child groups ($p < .001$) and between ASL and LIS children ($p = 0.007$).

The profile of specific handshapes shows that while 3–4 handshapes were used for each type of response, the distribution was more diffuse for H-Hs than for O-HS (see Appendix, Figure B). For both adult and child groups of signers, one O-HS for each of two objects was used most of the time (between 73% and 95%), while for H-HSs this was not always the case. This is consistent with other cross-linguistic research on these two types of handshapes that shows more variation among H-HSs than O-HSs (Eccarius & Brentari, 2008).

Finally, an error analysis is provided in the Appendix, Figure C. The proportion of *matches*, *mismatches* (O-HSs where H-HSs were expected and vice versa), and *other* responses was calculated. The *other* responses are also subdivided into points, whole body, or lexical. All of the adult and half of the child *other* responses were points; the other half of the children's *other* responses were *core lexical signs* (e.g., FALL) substituted for a classifier predicate.

3.1.3. Discussion of sign language results

Taken together, the sign groups exhibited a robust H-HS/O-HS opposition, and all sign groups match more often when describing events without an agent than when describing those with an agent. The differences between sign language groups are as follows: (a) only the ASL groups (child vs. adult) showed an age effect on both analyses, while the LIS child versus adult groups did not. This finding may be related to the quantity and regularity in the linguistic input, since (b) LIS adults have a marginally more consistent pattern of matching than ASL adults, specifically in their descriptions of vignettes with an agent; and (c) the LIS adults used more iconic handshapes overall than the ASL adults.

The LIS signers (adults and children) tended to match more than ASL signers in response to vignettes with an agent—that is, when an H-HS was the expected form. This may indicate a possible H-HS preference in LIS with respect to ASL and warrants further investigation in other components of these languages. It is possible that this is indicative of a difference in the use of O-HSs versus H-HSs across the sign languages of the world (not just ASL and LIS)—that is, a typological difference demonstrated by a preference for either H-HSs or O-HSs that modulates the general grammatical agentive/non-agentive handshape distinction (see Padden et al., 2013; for such a handshape preference in instrument nouns). Typological variation in this sort may have two possible sources. One possible source may be historical. For example, both in Italy and the United States the use of sign language in educational settings was drastically reduced as a result of the Milan Congress in 1880 (Corazza, 1993; Lane, 1984), and this situation continued until quite recently; however, the effect in Italy was more dramatic. A sign variety, even if not always ASL, has been included in some educational settings continuously during this

period, while from 1880 to 1980 there was virtually no sign language used in the classrooms of the schools for the Deaf in Italy.[10] A second possible source for this difference is the context of the gestural community that signers and gesturers share, which is investigated in the next section.

The LIS signers produced more iconic handshapes than ASL signers, particularly when describing vignettes with an agent. This finding that is due largely to the ASL children, who used a high proportion of "other" handshapes, predominantly points where O-HSs were expected. Perhaps there are more instances of H-HSs and O-HSs for the LIS children to observe in the adult LIS model. A syntactic explanation of the child ASL pattern is possible, which would concur with Supalla (1982) and Benedicto and Brentari (2004), since they both found that points (having no arguments associated with the handshape) are substituted when O-HSs are expected, and O-HSs, having only one argument, are substituted when H-HSs are expected. H-HSs are the most complex, since they are associated with both a subject/agent and object argument. If gesturers show the same pattern, however, other explanations must also be considered. Investigating the same questions in American and Italian gestures will allow us to determine whether these results are consistent with an exclusively linguistic explanation concerning the presence of argument structure, or whether they can be attributable to cognitive strategies or cultural factors as well.

3.2. Gesture comparisons

Fig. 4 shows both analyses described above for the gesture groups; each will be discussed in turn.

3.2.1. Gesture groups: Agentive/non-agentive handshape opposition

The gesture groups did not show a strong tendency to match handshape (H-HS, O-HS) with vignette type (agent, no agent); $\beta = 0.03$; $SE = 1.034$; $p = .98$; 441 observations. Their scores are approaching chance. There are only marginal effects for country (Italian gesturers matched more: $\beta = 0.76$; $SE = 0.44$; $p = .09$), and for the interaction of age and country (Italian children matched less: $\beta = -1.44$; $SE = 0.74$; $p = .05$). In looking closely at the individual *adult* patterns, however, we can better pinpoint some differences between countries (Fig. 5). Only two adult U.S. gesturers produced matches 60% of the time or more and the range is between 37% and 70%; In contrast, five adult IT gesturers produced matches 60% or more, and the range is 58%–84%.

3.2.2. Gesture groups: Use of iconic handshapes

There was a significant effect for vignette type. Like the signers, all gesturers used more iconic handshapes in describing vignettes with an agent ($\beta = 0.94$; $SE = 0.30$; $p = .002$; 649 observations). Substitutions tend to be points when O-HSs are expected, and O-HSs when H-HSs are expected. There was also a significant effect for age; children produced significantly less iconic handshapes than adults ($\beta = -2.20$; $SE = 1.10$; $p = .045$). If the adult groups are analyzed alone, there is a significant difference between the American and Italian groups; U.S. gesturers use fewer iconic handshapes than Italians

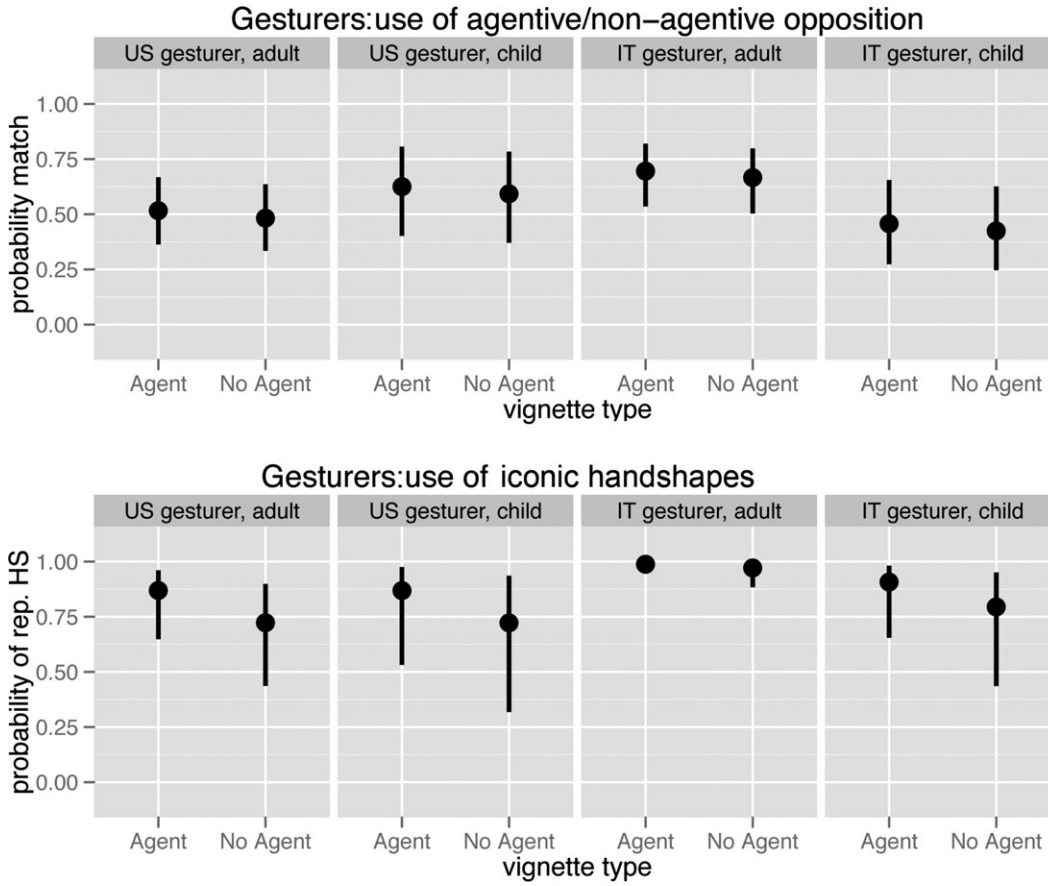

Fig. 4. Gesture comparisons: (top) the probability that an H-HS was produced in response to a vignette with an agent (*agent match*) or an O-HS was produced in response to a vignette without one (*no-agent match*); (bottom) the probability an iconic handshape was produced in a response rather than a non-iconic one.

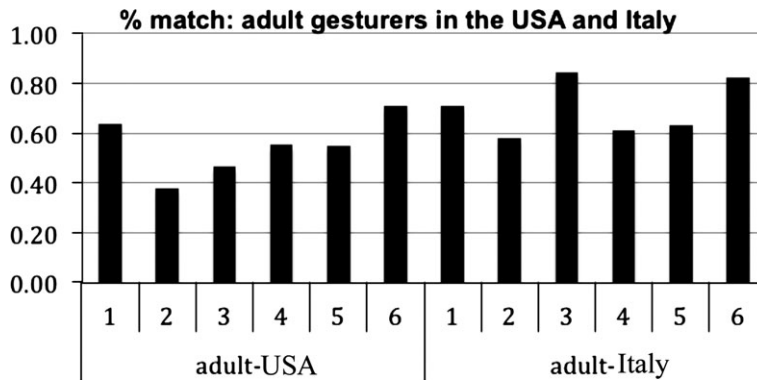

Fig. 5. The proportion of matches for the individual adult gesturers in the United States and in Italy.

($\beta = -2.42$; $SE = 0.74$; $p = .001$; 447 observations). The child groups did not show a significant difference from one another in this aspect, as they did in the Iverson et al. (2008) study. Tukey multiple comparisons of means showed a significant difference between Italian and U.S. adult groups ($p = .036$).

The profile of specific handshapes shows that, like the signers, 3–4 handshapes were used for each type of response, but compared to the signers the distribution was relatively diffuse throughout, with the exception of the Italian gesturers' O-HSs productions for lollipop (see Appendix, Figure D).

Finally, relative to the signers, the gesturers had a higher proportion of "other" responses (non-iconic handshapes)—26% for gesturers 13% signers; see Appendix Figure C). Of the "other" responses among the gesture groups most are points (95% on average), and those that are not are whole body gestures, produced by gesturing children.

3.2.3. Discussion of gesture results

The gesturers did not, as a group, show a significant tendency to make the H-HS/O-HS contrast in agentive and non-agentive descriptions; however, there are a number of findings worthy of discussion.

We would argue that the main results in the adult gesture groups support both a cognitive and a cultural explanation. The cognitive component of these findings, we would suggest, is the association itself of H-HSs with agentive descriptions and O-HSs with non-agentive ones; that is, there are fewer H-HS substitutions for an O-HS than the reverse. This association is likely to be fed by the two types of iconicity ("hand-as-hand" for agentives and "hand-as object" for non-agentives). There are cultural differences with respect to some types of iconicity, for example, sequences in time (Casasanto & Bottini, 2014; Sweetser, 2009); however, the type of iconicity studied here is one that appears grounded in our shared physical experience with the world. This is attributed to an underlying cognitive mechanism, potentially that of embodied cognition. In this case, perceptuo-motor experience is mediating the handshape representation (Wilson, 2002). Casasanto and colleagues have been able to tease apart the somatosensory, cultural, and language influences on cognition (Willems & Casasanto, 2011).

All child groups (sign language and gesture) use fewer iconic handshapes than their corresponding adult group. This is not surprising, given previous work showing that the ability to exploit iconicity takes time in sign language (Meier, Mauk, Cheek, & Moreland, 2008) and gesture (Namy, Campbell, & Tomasello, 2004); however, embodied cognition may explain the fact that the gesture groups (like the sign groups) produced more iconic handshapes in response to vignettes with an agent. The fact that human actions are easier to imitate than static objects or actions by objects is well documented by previous research (Piaget, 1952; Werner & Kaplan, 1963). In the present task, there is a person acting on the object in the vignettes with an agent, so it is possible that participants more easily create representations of a concept, object, or event when it involves perceptual, somatosensory, and motoric re-experiencing of the relevant event in one's self; therefore, in the agentive event descriptions, the participants are "experiencing" them in addition to "observing" or "describing" them. This type of phenomenon has also been described in

the literature on embodied cognition (Barsalou, 1999; Beilock, 2009; Kontra, Goldin-Meadow, & Beilock, 2012; Willems & Casasanto, 2011; Wilson, 2002).

We suggest that the iconic motivation for the patterns seen here is cognitive, but the *degree* to which the pattern is exhibited is cultural—both the specific agentive/non-agentive handshape contrast and the general use of iconic handshapes. What might facilitate an increase in the Italian over U.S. gesturers' use of this handshape opposition in silent gesture? One explanation of this finding might be to appeal to the analysis of the Neapolitan gesturer reported in Kendon (2004b). Compared with an Anglo-Saxon tradition of gesture, in Italy there is a stronger tradition of emblems, more varied handshapes, more varied function of gestures, and an ecology where ratified viewers are participants in the conversation; therefore, Italians may be more aware of a wider range of meanings that handshapes can convey. Moreover, emblematic gestures, like language structures, are subject to well-formedness constraints (Kendon, 2004a), and these emblematic gestures may instill in Italians a sense of meaning-to-form relation for gesture that is readily available on a task such as this one. This may allow the Italians to enter a totally gestural world more readily than Americans, and it will be interesting to see if this cultural difference is sustained in co-speech gesture.

3.3. Comparisons by country

The data from the sign language and gesture groups are now analyzed by country in order to see the similarities and differences among the gesture and sign groups that have contact with one another in everyday life. The same mixed models as above were used for the two analyses—*handshape opposition* and *iconic handshapes*—but this time the predictor variable was *type of system* (sign language, gesture) instead of *country*. All other factors remain the same. The results for American and Italian groups are presented (shown in the Appendix, Figures E and F) and discussed together below. Effects seen in the previous analyses will not be repeated.

3.3.1. American groups: Agentive/non-agentive handshape opposition

There was a significant effect for type of system (signers matched more: $\beta = 3.43$; $SE = 0.76$; $p \leq .001$; 444 observations). Tukey multiple comparisons of means showed a significant difference between the U.S. gesture and ASL adult groups ($p < .001$), but no difference between the corresponding child groups.

3.3.2. American groups: Use of iconic handshapes

There was a significant interaction for age and type of system ($\beta = 2.84$; $SE = 0.96$; $p = .003$; 680 observations). Besides the differences between ASL groups reported earlier, Tukey multiple comparisons of means showed significant difference between the U.S. gesture and ASL adult groups ($p < .001$).

3.3.3. Italian groups: Handshape opposition

There was a significant effect for type of system ($\beta = 1.48$; $SE = 0.68$; $p = .03$; 396 observations). Tukey multiple comparisons of means showed a significant difference

between LIS and Italian gesturing children (p = .02), but no difference between the LIS and Italian gesture adult groups.

3.3.4. Italian groups: Use of iconic handshapes

There was a significant effect of age (β = 2.21; SE = 1.08; p = .04; 584 observations); however, Tukey multiple comparisons of means showed no significant differences among the relevant groups.

3.3.5. Discussion of the analysis by country

The sign language and gesture groups were different from one another in both countries, as expected, but the difference between U.S. sign language and gesture groups is more than twice as large as for the corresponding Italian groups; moreover, the U.S. gesture and ASL adult groups were significantly different on the Tukey post-hocs, while the Italian adult groups were not. We appeal here to the cultural explanation as proposed above in the analysis of the gesture groups; namely, the increased use of gestures as emblems and in a wide range of pragmatic contexts (Kendon, 2004b) provides a broader sensitivity in Italian gesturers to what gestures are capable of in communication.

In sum, the adult ASL and U.S. gesture groups are quite different from one another on both measures, while the children perform similarly on both measures. In Italy, adult LIS and Italian gesture groups are alike and it is the children who perform differently, particularly on the use of the H-HS/O-HS handshape distinction.

4. Theoretical implications and conclusions

The specific H-HS/O-HS pattern under investigation cannot be attributed to a single cognitive, cultural, or linguistic explanation, but rather components of all three. There was a significant difference between the gesture and sign groups in both countries, so the fact that LIS and ASL are languages and follow grammatical rules is indeed important in consistently producing this distinction, as Benedicto and Brentari (2004) have argued. But there are also cross-linguistic differences in the use of H-HSs and O-HSs in LIS and ASL. The tendency in LIS signers to produce more matches in response to vignettes with an agent than their ASL counterparts is potentially a typological difference among sign languages. For example, while all sign languages with classifier systems are predicted to exhibit this contrast, it may be stronger in some sign languages than others. Further work needs to be done to consider how the use of these two handshape types is manifested throughout the lexicon: in verbs, in classifiers, and in nouns (e.g., Padden et al., 2013, have shown a cross-linguistic difference in handshape preference in instrument nouns).

A sign-gesture difference was found, but by delving deeper. We find that the adults are responsible for this difference in the American groups, and the children in the Italian groups. *Neither* child group tends to produce matches in the United States, and only the ASL adults do this (the American adult gesturers do not). *Both* LIS and Italian adult gesturers tend to produce matches, while only the LIS children do this (the Italian child

gesturers do not). The Italians also produce more matches and more iconic gestures than the Americans. This leads us to conclude that in addition to the sign language advantage, there is also a cultural, *Italian* advantage on this task. The well-formedness principles associated with emblems, plus the greater range of pragmatic uses of gesture, may increase the Italian gesturers' ability to create form-meaning pairings more readily in a gestural task such as this one. These results will need to be verified with a larger number of participants and in co-speech gesture.

The stronger tendency for both sign and gesture groups to use H-HSs to express agentive descriptions and O-HSs to express non-agentive descriptions (and not the reverse), and the stronger tendency to use iconic handshapes in descriptions of events with agents are results attributed to *cognition*. The embodiment literature provides a cognitive motivation for this insofar as the gesturer or signer may have more access to vignettes where objects are manipulated by another person than in cases where objects move alone or are static—a difference between *experience* versus *observation*. This access may prompt more complete representations of the event (Barsalou, 1999; Beilock, 2009; Kontra et al., 2012; Willems & Casasanto, 2011; Wilson, 2002).

This study has important theoretical implications concerning the relationship between gesture and sign language on two fronts. The first concerns the fact that the LIS child signers perform in a more adult-like manner than the ASL child signers at the same age. Given the patterns in the data, the possibility exists that the adult LIS signers and adult Italian gesturers provide more consistent input. LIS signers provide more consistent input, since they have a more consistent handshape contrast in response to vignettes with an agent. The Italians (signers and gestures) produce more iconic handshapes overall, so the LIS children may see more iconic handshapes. In addition, the handshape patterns of the adult Italian gesture and LIS groups are more similar to one another than those of the U.S. gesture and ASL groups. This environment may provide LIS children with quantitatively more, and qualitatively more consistent, input on this specific use of handshape, which may give LIS children an advantage in acquiring this distinction. These results were using silent gesture, however, and it is an empirical question as to whether these cultural differences will be sustained in co-speech gesture, since this is what the LIS children see in everyday life.

The second issue is the nature of the general gestural competence (knowing how to effectively use the hands and body to communicate) that hearing and Deaf people share. Just how similar are the productions of gesturers and signers, not on isolated forms, but with regard to patterns of distribution, particularly those relative to systematic distinctions exploited by sign language grammars? Controlled studies of silent gesture, such as this one, can quantify this ability in gesture and sign groups and we see that, at least for silent gesture on the question of handshape type (handling/object; iconic/non-iconic), it is a matter of *degree* of difference among our groups. The data we are working with are limited to the physical properties of size, shape, location, and movement of objects and their manipulation in a controlled laboratory setting, but nonetheless we see that the gestural competence of hearing people provides them with the cognitive tools to create a meaningful contrast within the limited scope of this task. This work, therefore, confirms the

importance of using silent gesture to investigate the shared gestural competence present in signers and gesturers.

There are three factors that contribute to the emergence of a sign language. The use of the visual-gestural system (a) as a primary means of communication, (b) within a community of users; and (c) over generations with subsequent language models (Brentari & Coppola, 2013). For gesture, this study addresses the first of these. For some gesturers the silent gesture condition provides an impetus to produce contrasts that look remarkably similar to those of a sign language—that is, not a form-meaning pairing, per se, but an *opposition* between two form-meaning pairings. The Italian gesturers' language-like performance reminds us that sign languages are indeed both *language* and *gesture*.

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Notes

1. Adamarobe sign language is reported not to have classifiers (Nyst, 2010).
2. In many languages, other distinctions, such as transitive/intransitive and causative/non-causative, are also often associated with the agentive/non-agentive distinction, but these details will not be discussed here (see Benedicto & Brentari, 2004; Kegl, 1990).
3. For a general overview of sign language acquisition showing that children learning a sign language as a first language follow the same general timetable as their hearing counterparts in achieving spoken language milestones, see Lillo-Martin (2009) and Chen Pichler (2012).
4. Future work on this topic might compare the results here with those of a population of gesturers who speak a language with morphology that might be usefully exploited in the gesture system for the contrast described here. Turkish is one such community.
5. The sessions in successive years were not statistically different from one another within-child, and were therefore combined.
6. The sessions collected by native and non-native language users were compared, and no statistically significant differences were found; hence, any differences in performance are not likely to be attributed to this factor.
7. A co-speech response mode was also attempted, but it did not result in enough data points from the gesturers to analyze in a way that was comparable to the sign and silent gesture productions. Moreover, if told explicitly to gesture along with speech, participants' speech prosody became unnatural.

8. Six percent of trials had more than one production; the analyses that included all responses had the same pattern as those reported in the next sections.
9. Video examples by adult participants from all four test groups showing a response to a vignette with an agent and a response to a vignette without an agent are available at http://dx.doi.org/10.6084/m9.figshare.943514 and http://dx.doi.org/10.6084/m9.figshare.943513, respectively.
10. Sign language was always used *unofficially* in the Italian schools for the deaf. It was used by students outside of class, but in some situations it was strongly prohibited (Pinna, Pagliari Rampelli, Rossini, & Volterra, 1993).
11. The dot in each visualization represents the model estimate, and the lines represent the 95% confidence interval, given the model's fit.

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Appendix

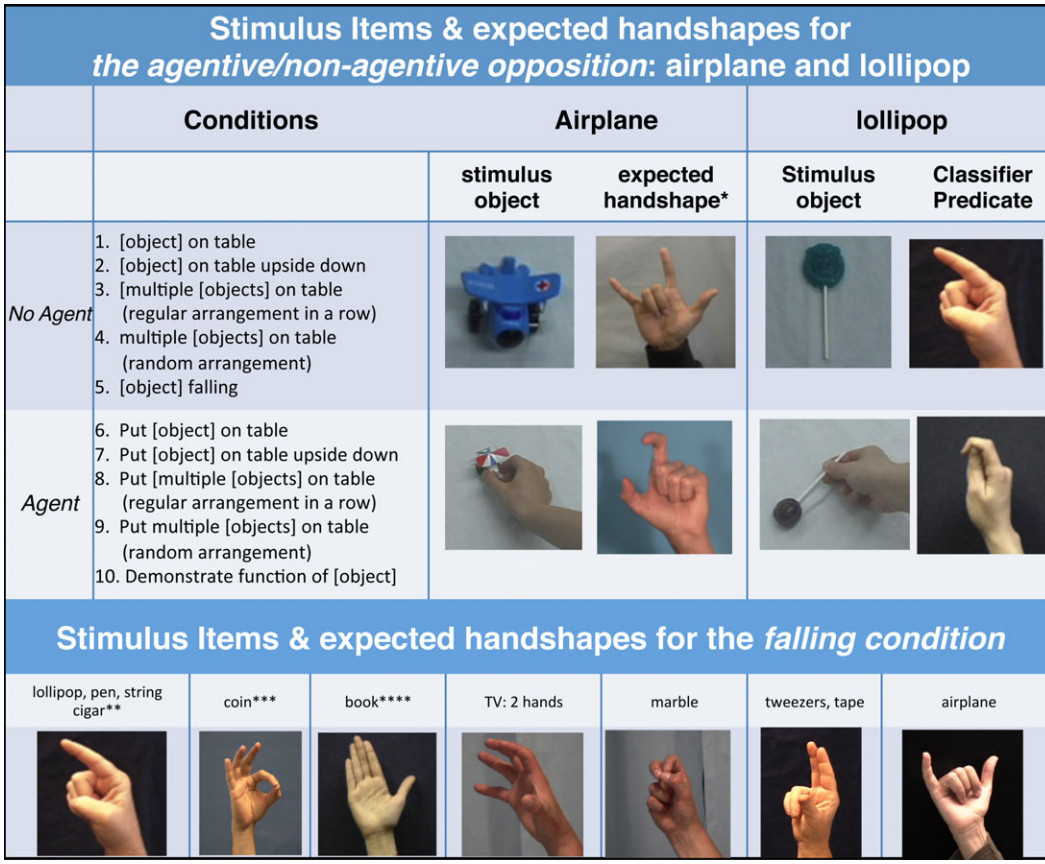


Fig. A. The expected handshapes for the 31 vignettes used in this experimental task: 10 items were designed to elicit stative *non-agentive* descriptions; 10 were designed to elicit *agentive* descriptions; and 11 designed to elicit unaccusative/non-agentive items (moving, non-agentive descriptions, the object *falling*). *The handshape shown is the ASL handshape for airplane, the LIS handshape is shown below in the falling condition. **The handshape shown is also an alternative handshape production for the "tweezers falling." ***The handshape shown is also an alternative handshape production for the "marble falling." ****The handshape shown is also an alternative handshape production for the "TV falling."

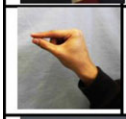
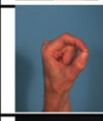
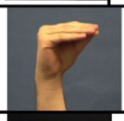
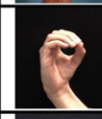
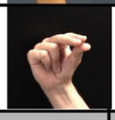
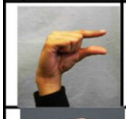
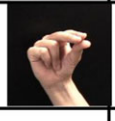
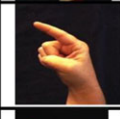
handling handshapes						object handshapes				
lollipop	ASL adult	ASL child	LIS adult	LIS child		lollipop	ASL adult	ASL child	LIS adult	LIS child
	.35	.00	.50	.09			.93	.93	.80	.80
	.30	.67	.35	.36			.00	.00	.10	.00
	.35	.33	.15	.46			.07	.07	.00	.00
	.00	.00	.00	.09			.00	.00	.10	.20
air plane	ASL adult	ASL child	LIS adult	LIS child		air plane	ASL adult	ASL child	LIS adult	LIS child
	.45	.25	.50	.42			.90	.95	.00	.00
	.55	.75	.45	.50			.10	.05	.25	.27
	.00	.00	.05	.08			.00	.00	.00	.00
							.00	.00	.75	.73

Fig. B. The proportions of specific H-HSs and O-HSs used by each of the sign language groups for the objects airplane and lollipop.

	all responses				"other" responses		
total-N=1264	match (N=865)	mismatch (N=192)	other- (N=207)		other-BODY (N=8)	other-Lexical (N=60)	other-Point (N=139)
ASL	**0.64**	**0.16**	**0.20**			**0.58**	**0.42**
adult	0.81	0.10	0.09				1.00
child	0.47	0.22	0.31			0.65	0.35
LIS	**0.85**	**0.09**	**0.06**			**0.43**	**0.57**
adult	0.86	0.07	0.07				1.00
child	0.83	0.12	0.05			0.57	0.43
ENG	**0.53**	**0.15**	**0.32**		**0.06**		**0.94**
adult	0.53	0.14	0.33		0.08		0.92
child	0.53	0.17	0.30				1.00
IT	**0.60**	**0.20**	**0.20**		**0.04**		**0.96**
adult	0.70	0.18	0.13		0.18		0.82
child	0.46	0.22	0.31				1.00
total	**0.65**	**0.15**	**0.20**		**0.02**	**0.25**	**0.73**

Fig. C. (left) The proportions of *matches*, *mismatches*, and *other* handshapes used by the participant groups; (right) the *other* handshapes subdivided by type; *whole body gestures*, *lexical substitutions*, and *points*.

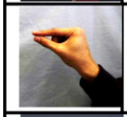
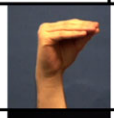
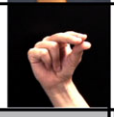
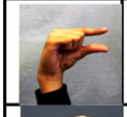
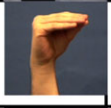
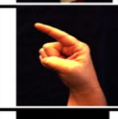
handling handshapes						object handshapes				
lollipop	US adult	US child	IT adult	IT child		lollipop	US adult	US child	IT adult	IT child
	.35	.09	.15	.00			.30	.60	.90	.89
	.25	.73	.25	.33			.00	.00	.05	.00
	.25	.00	.45	.50			.40	.40	.00	.11
	.15	.18	.15	.17			.30	.00	.05	.00
air plane	US adult	US child	IT adult	IT child		air plane	US adult	US child	IT adult	IT child
	.32	.60	.63	.60			.00	.00	.00	.00
	.52	.40	.37	.40			.65	.22	.45	.50
	.16	.00	.00	.00			.35	.78	.55	.50
							.00	.00	.00	.00

Fig. D. The proportions of specific H-HSs and O-HSs used by each of the gesture groups for the objects airplane and lollipop.

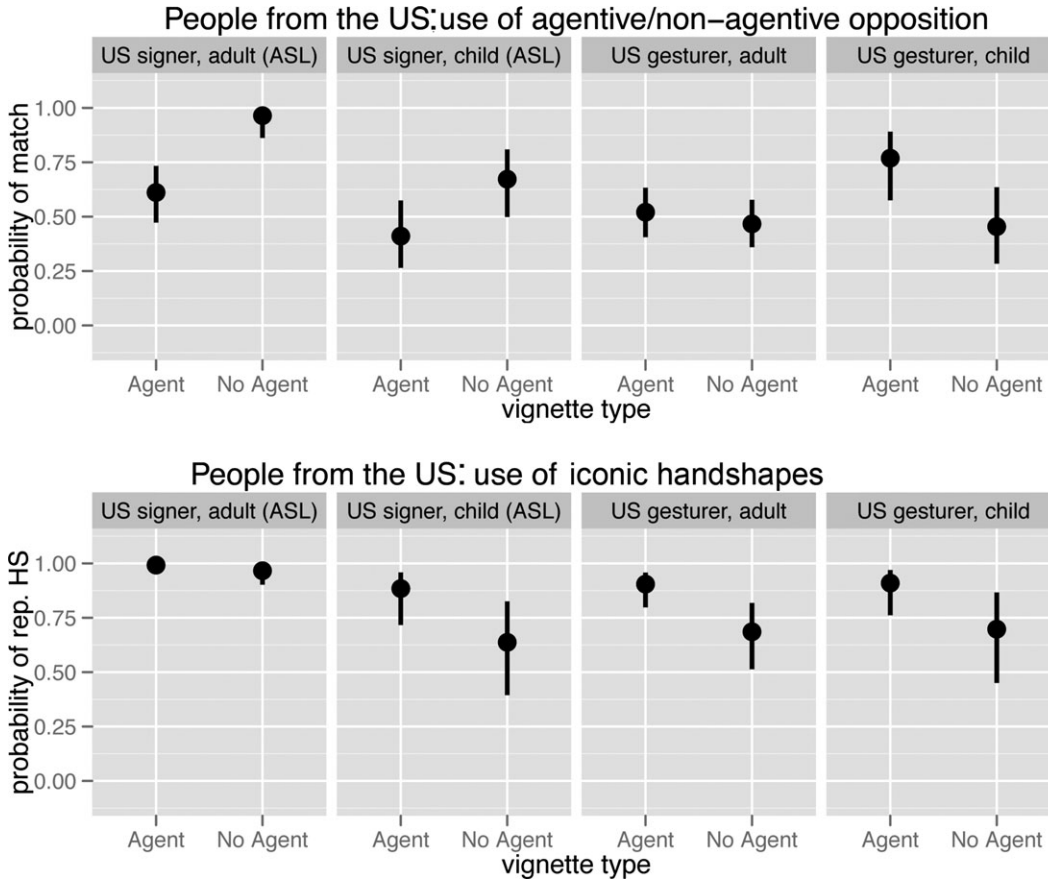


Fig. E. Comparisons of U.S. participants: (top) the probability that an H-HS was produced in response to a vignette with an agent (*agent match*) or an O-HS was produced in response to a vignette without one (*no-agent match*); (bottom) the probability that an iconic handshape was produced in response to a vignette rather than a non-iconic one.

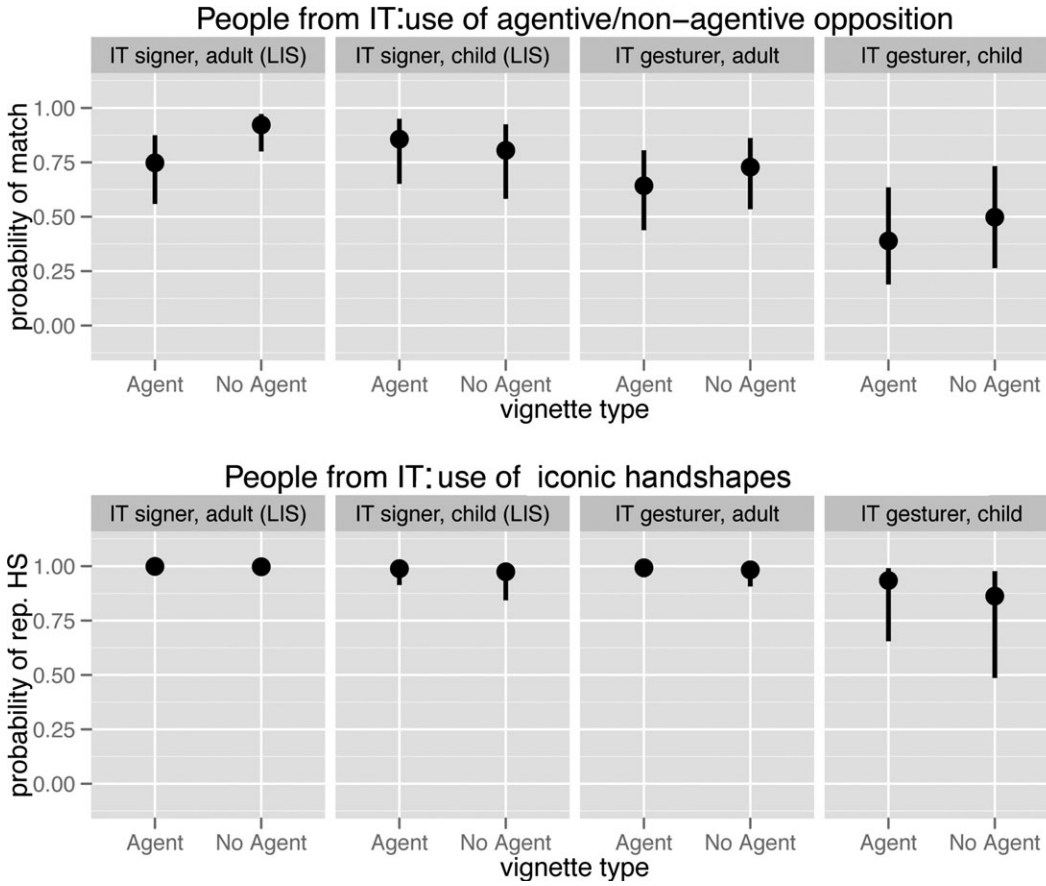


Fig. F. Comparisons of Italian participants: (top) the probability that an H-HS was produced in response to a vignette with an agent (*agent match*) or an O-HS was produced in response to a vignette without one (*no-agent match*); (bottom) the probability that an iconic handshape was produced in response to a vignette rather than a non-iconic one.