

MANUAL AND MOUTH GESTURES IN HEARING AND DEAF CHILDREN MULTIMODALITY IN A DEVELOPMENTAL PERSPECTIVE

SABINA FONTANA, ELENA TOMASUOLO

ABSTRACT: The present paper explores the notion of multimodality in a developmental perspective both in deaf and hearing children with the aim of showing that the nature of gesture in language is functional to the mode of communication. Research on various sign languages has revealed that mouth actions often accompany sign language utterances, along with other bodily components, and has paralleled them to co-speech gestures. Mouth actions will be described from a developmental perspective and compared to the co-speech gestures of hearing children. Specifically, mouth actions and manual gestures will be investigated in two groups of 10 bilingual italian/italian sign language (lis) deaf and hearing children, aged 6 to 14, using a naming task. The goal is to quantitatively and qualitatively compare mouth actions and co-verbal gestures to understand their roles in sign and vocal naming. Additionally, three adult signers were analyzed as control group to understand the types and occurrences of mouth actions in adult signing for a naming task and to compare these with the signing of children.

KEYWORDS: multimodality, gesture, mouth actions.

RIASSUNTO: Il presente lavoro esplora la nozione di multimodalità in una prospettiva di sviluppo sia nei bambini sordi che in quelli udenti, con l'obiettivo di dimostrare che la natura del gesto nel linguaggio è funzionale. La ricerca su varie lingue dei segni ha rivelato che le mouth actions spesso accompagnano gli enunciati della lingua dei segni, insieme ad altre componenti corporee, e le ha messe in parallelo con i gesti co-speech. Le mouth actions saranno descritte da una prospettiva di sviluppo e confrontate con i gesti co-speech dei bambini udenti. Nello specifico, le azioni della bocca e i gesti manuali saranno studiati in due gruppi di 10 bambini sordi e udenti bilingue italiano/lingua dei segni italiana (lis), di età compresa tra i 6 e i 14 anni, utilizzando un compito di denominazione. L'obiettivo è confrontare quantitativamente e qualitativamente le mouth actions e i gesti co-verbali per comprendere il loro ruolo nella denominazione segnica e vocale. Inoltre, sono stati analizzati tre adulti

segnanti come gruppo di controllo per comprendere i tipi e le occorrenze delle mouth actions nel segnato degli adulti in un compito di denominazione e per confrontarli con il segnato dei bambini.

PAROLE CHIAVE: multimodalità, gesto, mouth actions

1. Introduction

The present study intends to explore the notion of multimodality in a developmental perspective both in deaf and hearing children with the aim of showing that the nature of gesture in language is functional to the mode of communication. Gesture is respectively bodily action in spoken language (Kendon, 2004; McNeill, 2005) and mouth action in sign language (Pizzuto, 2003; Fontana, 2008). The role and function of gestures in the acquisition and development of spoken language have been investigated in several studies (Bates, Camaioni & Volterra, 1975; Volterra *et al.*, 2005; Goldin-Meadow, 2003; Weisberg *et al.*, 2020; Caselli & Pyers, 2020; Kayabaşı & Gökgöz, 2022). Research indicates that the role of gestures in spoken language acquisition and development changes across various stages and communicative contexts. Studies (Stefanini *et al.*, 2009; Novogrodsky & Meir, 2020) have shown that children between the ages of 2 and 7 use gestures when labeling pictures of objects or actions. In this setting, deictic and representational gestures are commonly observed. These gestures are vital for communicative interactions and for constructing and conveying meaning during the first two years of life (Volterra & Erting, 1990; Butcher & Goldin-Meadow, 2000; Iverson & Goldin-Meadow, 2005; Volterra *et al.* 2005; Krebs, 2020). Among deictic gestures (such as requesting, showing, giving, and pointing), pointing is particularly noteworthy as it is often the first cross-modal combination (gesture plus vocalization/word). The use of co-speech gestures decreases with age and improved spoken naming abilities, but they never entirely vanish. In later stages, gestures such as metaphoric, abstract, deictic, and beats become more prevalent in narrative production by school-aged children (Colletta, 2004; Kita & Ozyurek, 2003) or during problem-solving activities (Alibali & Goldin-Meadow, 1993; Pine, Lufkin & Messer, 2007), and

these gestures are rarely found in naming contexts.

In adult communication, gestures and speech interact to facilitate clear understanding of utterances (Kendon, 1981, 1988, 1997, 2004; McNeill, 1992, 2000, 2005; Kita, 2000). They are closely timed, highly synchronous, and reciprocally related, each contributing to the utterance's meaning. According to McNeill (1992, 2005), gestures function in the process of thinking for speaking and form a single unit with speech, conveying additional dimensions of meaning. Gestures play crucial linguistic and cognitive roles, helping speakers by modeling thoughts to be expressed linguistically and providing listeners with visual cues to the vocal message (Alibali & Kita, 2010). Thus, gestures and speech constitute two distinct material carriers of thought, co-expressive but not redundant, each expressing the same underlying idea unit in its own way (McNeill, 2005).

Sign language, spoken language, and gestures share common perceptive, motor, and cognitive systems. The view of adult language as an integrated gesture-speech and gesture-sign system highlights the need to understand how this relationship develops in infancy and evolves into the adult system (Capirci & Volterra, 2008; Volterra, Iverson & Castrataro, 2006). If signed and spoken languages are functionally equivalent communication modes (Stokoe & Marschark, 1999), gestures should serve similar linguistic and cognitive functions in both. In a multimodal perspective, Kusters *et al.* (2017) introduced the notion of semiotic repertoires, where gestures are not only communicative resources but also material carriers of thinking, adding substance to the speaker's cognitive being (McNeill & Duncan, 2000). Therefore, gestures in sign language should function similarly to those in spoken language, albeit in a different modality.

In sign language, there is a gestural level similar to co-verbal gestures, which may be oral or involve the mouth in a gestural way alongside signing (Fontana, 2008, 2009a; Pizzuto, 2003; Sandler, 2009; Perniss, Vinson & Vigliocco, 2020). Research has explored the form and function of oral components in adult signing. Mouth actions, encompassing all mouth movements that accompany manual signs, are traditionally grouped into two categories: mouth gestures and mouthings. Mouth gestures are grounded in perceptuo-motor experience.

They consist of mouth configurations or sounds that may be onomatopoeic, evoking aspects associated with certain referents (e.g., ‘woof, woof’ for a barking dog, puffed cheek for a fat man), or metaphorical, conveying abstract meanings through concrete images (e.g., air emission with the sign RELIEVE). Mouthings refer to identifiable spoken language lexemes, consisting of mouth movements as if a word or part of a word is being pronounced (e.g., the Italian word “casa” (house) with the manual sign HOUSE) (Fontana & Fabbretti, 2000; Volterra *et al.*, 2022). Mouthings are communicative options originating from the spoken language used by the hearing majority, resulting from the linguistic contact experienced by the deaf community (Johnston, van Roekel & Schembri 2016; Giustolisi, Mereghetti & Cecchetto 2017). Both types of mouth actions convey different information regarding signs, interfacing signing with another dimension of meaning related to some inherent aspect of the object/referent. Their function in signing is constrained by the neural motor-perceptual structure linking oral articulation to sign execution time (Woll, 2001).

2. Mouth actions in sign languages: a controversial phenomenon

Research on various sign languages (Boyes-Braem, Sutton-Spence, 2001; Bisnath, 2022) has shown that mouthings occur more frequently than mouth gestures, both co-occurring with manual signs. While mouth gestures are typically considered part of sign language, mouthings are viewed as a sociolinguistic phenomenon due to the oral education of most deaf children (Hohenberger & Happ, 2001) to the bilingualism of most deaf adults (Boyes Braem, 2001; Bogliotti & Isel, 2021), as well as to the interplay of signed, spoken, and written languages (Bauer & Kyuseva, 2022).

However, although mouthings have been seen as remnants of oralist education (Hohenberger & Happ, 2001), they persist in signing and are considered part of the language by native signers (Fontana, 2015; Bisnath, 2022), who find signing without mouthings ‘unnatural.’ In addition, Van De Sande and Crasborn (2009) found no difference between late and early signers of NGT (Sign Language of the

Netherlands) regarding mouthings. Lin (2019) showed that mouthings are necessary to identify the exact meaning of interrogatives in Chinese Sign Language (CSL). Finally, Deaf signers with no oral education and no contact with the local deaf community tend to use mouthings linked to the local dialect (Torigoe & Takei, 2002; Fontana, 2009b).

Crasborn *et al.* (2008) proposed a typology of mouth actions based on three properties: (1) the independent or dependent meaning carried by the mouth; (2) whether the mouth action is lexically associated with the manual sign; and (3) whether the mouth component is borrowed from the spoken language. Comparing the frequency of mouth actions in Dutch Sign Language, British Sign Language (BSL), and Swedish Sign Language, they observed a similar trend: 50% to 80% of manual signs were produced with mouth actions, with mouthing being the most frequent, aiding in the lexical specification of a sign. Balvet and Sallandre (2014) noted that mouth gestures and mouthings play different roles in narration: mouthings mark lexical units, topic changes, or new participants, while mouth gestures, along with facial expressions, modify depicted objects (e.g., size or detail).

According to Vinson *et al.* (2010), manual and mouthing components do not form a single lexico-semantic representation, as semantic errors did not always co-occur in both channels during a picture naming task. This suggests that mouthing may not be part of the sign language system. However, Bogliotti and Isel (2021) argue that mouthing is crucial for lexical access.

Given the complex, controversial role and variability associated with mouthings (Fontana & Fabbretti, 2000; Ajello *et al.*, 2001; Boyes Braem, 2001; Rainò, 2001; Sutton Spence, Day, 2001; Vogt-Svendsen, 2001; Woll, 2001; Van De Sande, Crasborn, 2009; Mohr, 2014; Roccaforte, 2017), a developmental perspective can further illuminate mouth actions at various levels:

- revealing the relationship between mouthings and spoken language as deaf children learn spoken language through speech therapy.
- understanding whether the role of mouth gestures in signing is comparable to adults' and whether it represents a developmental stage.
- confirming or refuting the hypothesis that mouth actions function

as gestures in sign language (Fontana, 2008, 2009).

While several studies have investigated gesture-speech relationships in children, no research has focused on mouth actions in preschool or school-aged children's signing. Our hypothesis is that mouth actions interact with signing similarly to manual gestures and that the study of mouth actions in a comparative perspective can contribute to a better understanding of multimodality under a developmental point of view.

3. Manual and mouth gestures in hearing and deaf children: a naming task

3.1. Participants

3.1.1. Deaf children

The data we analysed are a sample of a wider corpus used in the studies of Tomasuolo (2005) and Tomasuolo *et al.* (2010). For the present study we have selected 10 deaf children and adolescents (6 females and 4 males) out of 30, with an age ranging from 6 years 1 month to 13 years 9 months, (mean age 10 DS 2,5). Some of them have deaf parents and were exposed to and use LIS at home, other learned LIS in preschool contexts (see table below). All deaf children were mainstreamed, from primary to secondary school and were enrolled in a bilingual program Italian/LIS (For more details see Author 2010). We have chosen our sample according to the following criteria: 1) severe or profound bilateral deafness; 2) lack of other deficits; 3) daily use of LIS; 4) absence of cognitive impairments: abilities were taken from health record and were measured via non verbal Visual Motor Integration test (VMI) and were in the normal range. All relevant information about deaf participants are reported in Table 1. In particular: gender (F =female; M= male), chronological age, degree of deafness (severe or profound), parent hearing status (D= at least one deaf parent; H= both hearing parents), the first environments where children were exposed to LIS (family from 0 to 3 years, pre-school from 3 to 5 years, the use

of LIS in the family (Y= yes; N= absent). Table 1: Information about deaf participants

Table 1. Information about deaf participants.

	Gender	Age (years, months)	Degree of deafness	Parent hearing status	First exposure to LIS	Use of LIS at home
1	F	6,1	Severe	D	Family	Y
2	M	7,5	Severe	H	preschool	N
3	M	8	Severe	H	preschool	Y
4	F	9,4	Severe	D	Family	Y
5	M	9,7	Severe	D	preschool	N
6	M	9,11	Severe	H	preschool	Y
7	F	11,2	Severe	H	preschool	Y
8	F	11,9	Severe	H	preschool	N
9	F	13,3	Profound	H	preschool	Y
10	F	13,9	Severe	H	preschool	N

Just one of the children was profoundly deaf. All the children made regular use of hearing aids, except for one who partially used them. None of them had a cochlear implant. All children were enrolled in a speech intervention program based on spoken Italian supported by Signed Italian (bimodal communication). Seven children had hearing parents and three children had deaf parents. Six families used Italian Sign Language (4 cases up to 6); whereas one child (number 5) had deaf parents but they did not use Italian Sign Language at home since he was born. The socio-cultural level of all families was medium-low. Only two children out of ten were exposed to LIS since birth in the family (native signers), whereas eight children were exposed to LIS since pre-school years (early signers).

3.1.2. *Hearing participants*

Hearing participants were recruited for the present study in order to be comparable to the deaf group by age (mean age 10,2; DS 2,4), since the hearing sample of Tomasuolo (2010) was not video-recorded. Hearing

children were recruited at school to match the socio-economic background of deaf children. All came from monolingual Italian-speaking households. Non verbal intelligence was assessed also for hearing participants through the Visual Motor Integration test (VMI) and resulted in the typical range. In Table 2, the characteristics of the hearing sample are reported.

Here is the additional information integrated into the description of the participants:

Table 2. Characteristics of Hearing Participants.

	Gender	Age (years, months)
1	M	6,6
2	F	7,9
3	M	8,3
4	F	9,3
5	F	9,7
6	F	9,9
7	M	11,5
8	F	11,8
9	F	13,2
10	M	13,9

This information describes the characteristics of both the deaf and hearing participants, providing a detailed context for the study's methodology.

3.2. *Materials: Boston Naming Test – BNT*

The Boston Naming Test – BNT – (Kaplan, Goodglass & Weintraub, 1983) is a lexical production task consisting of 60 line drawings representing nouns, objects, and animals. This test has been adapted to other spoken languages, including Italian, and has been widely used with Italian children with typical and atypical development (Bello *et al.*, 2004; Riva *et al.*, 2000).

To ensure all BNT items could be labeled in Italian Sign Language (LIS), we asked a deaf native signer to undertake the test, and his performance was video recorded. Another deaf native signer, a lecturer of LIS, also undertook the test to provide another sample of mouth actions co-occurring with the signs. A further deaf native signer, bilingual in LIS and Italian, watched the “standardized” signs and wrote the corresponding Italian words. The labels he provided matched those considered correct for the Italian spoken version of the test, confirming that the Italian and LIS versions corresponded.

Interestingly, in sign language production, mouth actions were part of the labeling process, leading us to check this aspect in the deaf children group and then compare mouth actions with co-verbal gestures in hearing children. All children were videotaped while naming each picture in the same order of item presentation.

A naming task offers several advantages for investigating gesture:

1. High control over the target word to be produced.
2. Provides a common set of referents for communication, known to both experimenter and coder.
3. Allows focus on the lexical level role of gestures, as many items that are nouns in Italian are actions in LIS (e.g., WHISTLE expressed by the action of whistling).

3.2.1. Procedure

The test was administered individually to children in a quiet room, and responses were video recorded. A deaf native signer administered the task to deaf children, while an Italian hearing experimenter administered it to hearing children. Both groups followed the same procedure, with the only difference being that deaf participants performed the task in LIS and hearing participants in spoken Italian.

Adjustments to the standard procedure included:

- Asking children to name all 60 items (standard administration stops after 6 consecutive errors).
- No time limit (standard is 20 seconds per picture).

- No semantic or phonological cues (standard provides cues).
- Training with three new drawings not included in BNT (standard does not provide training items).
- Experimenters avoided gestures (except for pointing to the target item) to prevent influencing spontaneous gesture production.

Informed parental consent was obtained before starting the observation. Feedback meetings were conducted with all parents following the research.

3.2.2 *Coding*

Gestures and mouth actions were coded using a system based on translation or glossing. For manual gestures, all visible actions produced by hearing children were coded (Kendon, 2004), including gestures with and without speech and those occurring before and after spoken responses.

Gestures were classified into three categories:

- **Deictic Gestures:** Refer to contextual information, identifiable by inspecting the physical interaction context (McNeill, 1992; Pizzuto & Capobianco, 2005). These include pointing gestures (extension of the index or multiple fingers).
- **Representational Gestures:** Pictographic representations of the meaning associated with the object or event.
- **Other Gestures:** Manual gestures like beat gestures (hand moving with speech rhythm) and thinking gestures (gestures made when trying to recall a word, Kendon 2004).
- Mouth actions were classified as mouthings and mouth gestures:
- **Mouthings:** Movements made as if a word or part of a word is being pronounced. Annotated using alphabetic writing and complete explanations if necessary.
- **Mouth Gestures:** Various configurations of the jaw, lips, cheeks, tongue, and air movement or noises. Annotated as alphabetic combinations when possible or described otherwise.

4. Results

Deaf children systematically accompanied their productions with mouth actions. Table 3 shows the number of mouthings and mouth gestures out of the total responses produced by deaf signing participants. Mouthings were more frequently produced than mouth gestures (367 vs. 210). The table also compares mouth actions by deaf signing children with manual gestures by hearing speaking children, reporting the number of mouthings, mouth gestures, pointing gestures, representational gestures, and other gestures for each BNT item.

Table 3. Gesture action and gestures of deaf and hearing children at BNT.

Items	Mouthings	Deaf		Hearing		
		Mouth gestures	Pointing gestures	Representational gestures	Other gestures	
1	Bed	10	0	0	0	0
2	Tree	10	0	0	0	0
3	Pencil	10	0	0	0	0
4	House	9	0	0	0	0
5	Whistle	3	7	0	0	0
6	Scissor	9	1	1	0	0
7	Comb	8	0	1	0	0
8	Flower	10	0	1	0	0
9	Saw	6	5	0	0	0
10	Toothbrush	3	7	1	1	0
11	Helicopter	7	2	0	0	0
12	Broom	8	0	1	1	0
13	Octopus	6	5	0	0	0
14	Mushroom	9	1	0	0	0
15	Hanger	5	2	1	0	0
16	Wheelchair	4	5	2	0	0
17	Camel	8	1	2	0	0
18	Mask	9	1	0	0	1
19	Pretzel	9	2	3	1	1
20	Bench	9	1	1	0	0
21	Racquet	3	7	0	1	0
22	Snail	9	1	0	0	1

23	Volcano	5	6	0	0	1
24	Seahorse	6	0	1	0	1
25	Dart	5	8	0	2	1
26	Canoe	6	4	1	0	3
27	Globe	10	1	0	0	1
28	Wreath	7	4	1	0	3
29	Beaver	6	5	4	0	1
30	Harmonica	0	9	0	2	0
31	Rhinoceros	2	1	1	0	0
32	Acorn	6	3	4	0	5
33	Igloo	4	5	7	0	2
34	Stilts	3	5	9	2	0
35	Dominoes	6	4	1	0	3
36	Cactus	8	3	0	0	2
37	Escalator	4	6	0	1	1
38	Harp	3	4	2	2	0
39	Hammock	6	5	4	2	1
40	Knocker	7	5	11	5	2
41	Pelican	5	6	2	1	0
42	Stethoscope	2	5	3	1	7
43	Pyramid	5	3	2	0	2
44	Muzzle	7	5	2	0	1
45	Unicorn	9	4	2	1	0
46	Funnel	6	5	2	0	0
47	Accordion	1	7	4	4	3
48	Noose	5	2	4	2	1
49	Asparagus	8	1	2	0	3
50	Compass	5	3	5	2	2
51	Latch	6	7	1	3	7
52	Tripod	5	6	7	1	4
53	Scroll	4	3	0	1	9
54	Tongs	6	4	4	2	1
55	Sphinx	8	3	3	0	0
56	Yoke	7	6	5	5	2
57	Trellis	6	4	11	2	5
58	Palette	3	4	3	0	1
59	Protractor	5	2	4	0	2
60	Abacus	6	4	3	1	3
tot		367	210	129	46	83

5. Discussion and Conclusion

The results of our quantitative and qualitative analysis indicate that mouth actions are a robust feature of children's signing, consistently accompanying signed items and providing additional information related to the signs. Although manual gestures are less frequent than mouth actions, they function similarly. Given that the 10 hearing children were chosen to be comparable in age to the deaf group, three major reasons help explain the difference in the frequency of manual gestures and mouth actions:

- Complexity of the Item: Mouth actions and manual gestures seem to function differently concerning co-speech gestures. Our results showed that mouth actions were produced mainly with items considered easiest to label in speech, while more complex items often had supplementary mouth explanations. For example, the sign "TRELLIS" often co-occurred with mouthings such as 'fiori' ("flowers") and 'legno' ("wood"). Similarly, complex items were sometimes described using representational strategies without mouth actions. Manual gestures (representational and thinking gestures) increased with item difficulty, serving as support when children struggled to find a spoken label. This trend aligns with developmental language patterns, where younger children rely more on gestures which decrease with age and improved naming accuracy (Stefanini *et al.*, 2009).
- Lack of Standardization in Signs: Some signs related to BNT items are not standardized, requiring additional explanations through mouth actions or representational strategies. For instance, signs for ASPARAGUS, UNICORN, and TRELLIS are less standardized than those for simpler items like BED or TREE.
- Nature of the Task: The task may influence the use of gestures and mouth actions, which typically occur in an utterance rather than a single lexical item. The low communicative dynamism of the task might explain the absence of gestures. Research on narrative abilities shows frequent use of different gestures in school-age children (Capirci *et al.*, 2011). The BNT might have been too easy to elicit

co-speech gestures in our age-matched hearing children (6.6-13.9 years). For this reason, in future studies, we aim to repeat the analysis following the administration of a narrative test that should better stimulate the use of gestures and mouth actions.

- Despite these critical aspects, the BNT and the controlled setting of data collection allowed us to select a homogeneous sample necessary for our research. The task, although somewhat artificial, enabled us to observe multimodal strategies in lexical processing.

In relation to the control group of adults, mouth actions have been consistent also in the case of the non-standardized signs. Interestingly in this case, mouth actions and non-standardized signs appear to be quite similar.

6. Conclusion

The study reveals that both mouth actions and manual gestures play significant roles in children's lexical production, interacting with signed and spoken language to convey additional information. Mouth actions in signing children are as crucial as manual gestures in speaking children, both acting as gestural correlates. These findings support the hypothesis that gesture and language are tightly coupled at both cognitive and linguistic levels, regardless of the language modality.

In particular, Deaf children systematically produced mouthing and mouth gestures with their signs. Mouth gestures, which often serve iconic and metaphorical functions, provide additional information, enhancing the meaning conveyed by signs. For instance, the child might grit their teeth while signing TOOTHBRUSH or mimic whistling air for the sign WHISTLE. These gestures help illustrate the object's characteristics or actions, similar to how manual gestures work in spoken language.

In relation to manual Gestures in Hearing Children, all but one hearing child produced co-speech gestures, mainly pointing (50%), other gestures (32%), and less frequently representational gestures (18%). Representational gestures often occurred with difficult-to-name items,

providing visual cues to aid the naming process.

Gestures appear to be shaped in relation to the nature of language: if speech is the dominant modality, the gesture occurs as a bodily action; conversely, when gestures shift to sign language, the vocal modality shifts in function and becomes gestural. In other words, the two modalities speech-gesture/sign language-mouth actions interplay in parallel ways according to which modality takes on the traits of a linguistic system. Hence, in conjunction with sign language we have mouth gesture or mouthings, whereas a more articulated mouthing co-occurs with contact signing, a variety strongly interfered by spoken language described in the interaction between deaf and hearing people (Lucas & Valli, 1989; Volterra *et al.*, 2022). Mouth actions in sign language, like co-verbal gestures (except for emblems, which are conventional gestural units – McNeill, 2005), are not independent units nor do they appear to have a stable meaning without their corresponding manual level.

Future studies should explore the developmental pathways of mouth actions and their relationship with signs, as well as manual gestures and speech in spontaneous interactions. This research should consider multimodality of expression, semiotic repertoires, and the sociolinguistic status of the tested languages and communities. Our preliminary evidence suggests that gesture and language are integrated, multimodal phenomena essential for understanding language competence and cognitive processing in children.

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