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Iconicity as a communicative strategy: Recipient design in multimodal demonstrations for adults and children

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Abstract

Humans are the only species that uses communication to teach new knowledge to novices, usually to children (Tomasello, 1999; Csibra and Gergely, 2006). This context of communication can employ ''demonstrations'' and it takes place with or without the help of objects (Clark, 1996). Previous research has focused on understanding the nature of demonstrations for very young children and with objects involved. However, little is known about the strategies used in demonstrating an action to an older child in comparison to another adult and without the use of objects, i.e., with gestures only. We tested if during demonstration of an action speakers use different degrees of iconicity in gestures for a child compared to an adult. 18 Italian subjects described to a camera how to make coffee imagining the listener as a 12-year-old child, a novice or an expert adult. While speech was found more informative both for the novice adult and for the child compared to the expert adult, the rate of iconic gestures increased and they were more informative and bigger only for the child compared to both of the adult conditions. Iconicity in gestures can be a powerful communicative strategy in teaching new knowledge to children in demonstrations and this is in line with claims that it can be used as a scaffolding device in grounding knowledge in experience (Perniss et al., 2010).

Keywords: Recipient design; Natural pedagogy; Child-directed communication; Demonstration; Gesture

It has been claimed that the transmission of knowledge is a human specific form of behavior (Tomasello, 1999). In fact, humans are the only species that uses communication (linguistic or non-linguistic) in order to deliberately transmit knowledge, a phenomenon recently called ''natural pedagogy'' (Csibra and Gergely, 2006, 2009). The transmission of knowledge, however, is effective only if one chooses the proper recipient design (that is, the ability to shape the intended message taking into account the need of the addressee; i.e., Sacks et al., 1974; Bruner, 1983; Clark, 1996; Galati and Brennan, 2010). In spite of the significance of the role of recipient design in the transmission of knowledge and in general in communication, very little is known about the specifics of how this is achieved, designed for the needs of different types of addressees (i.e., adult versus child) and is accomplished using multiple channels of communication (i.e., multimodally).

Numerous studies suggest that engaging in recipient design affects the production of speech both for other adults as well as for children (Snow and Ferguson, 1977; Isaac and Clark, 1987; Stoll et al., 2009; Galati and Brennan, 2010). Moreover, it seems that recipient design has a role in shaping not only speech, but also other communicative means, such as co-speech gestures, that are usually defined as the spontaneous and meaningful movements of the hands and the arms that people perform while they speak (Kendon, 1980; McNeill, 1992) and considered to be part of an integrated

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system with speech (Clark, 1996; Kendon, 2004). While some aspects of co-speech gestures have been found to be sensitive to other adults' communicative needs (i.e., shared common ground or not (Holler and Stevens, 2007; Jacobs and Graham, 2007), how gestures are designed for children compared to adults is less understood. Most studies on gestures directed to children, in fact, have been limited to those toward very young children (1–3 yrs). However, since transmission of new knowledge is a continuing process throughout childhood, we also need to understand the sensitivity of multimodal recipient design to older children and compared to other adults.

Thus in this paper we ask whether and how Italian adults employ different strategies in both their speech and gestures to transmit a practical knowledge (i.e., demonstrate how to make coffee) to an expert versus a purportedly novice adult and to an older child (12 years old). Different from most other studies that have looked at the sensitivity of multimodal recipient design in narrative tasks among adults (Jacobs and Graham, 2007; Holler and Wilkin, 2009) and following Gerwing and Bavelas (2004), we focus on demonstrations – a form of communication (Clark and Gerrig, 1990; Clark, 1996) that has the goal to enable the addressee to experience something that she cannot perceive directly (i.e., how a tool works). Also going beyond studies that have looked at the nature of multimodal communication to very young children and using objects (Bekken, 1989; Iverson et al., 1999; O'Neill et al., 2005), we focus on older children and on the design of demonstration without objects (i.e., speech and co-speech gestures). In particular, we are interested in whether iconicity might be used as a strategy (for instance, conveyed through iconic gestures about objects or actions) as a scaffolding device to ground meaning in the bodily and perceptual experiences (Perniss et al., 2010) for children in demonstrative communication – illuminating further the specifics of the ''natural pedagogy''.

1. Background

1.1. Recipient design to adults: speech and gesture

Today there is ample of evidence showing that speakers design their speech according to the addressee they are facing. In general, in a discourse context when speakers introduce a referent, they tend to use a full noun phrase and, when they mention the same referent again, they use a shortened form such as a pronoun or null arguments depending on the specific language they are using (Chafe, 1976; Ariel, 1990; Grosz et al., 1995; Hickmann and Hendriks, 1999).

Further it has been shown that manipulating the common ground among participants affects different aspects of speech production. In one of the first studies on this topic, Isaac and Clark (1987) investigated how people build common ground during a joint task of arranging some postcards of New York. They found that speakers use fewer proper names but more descriptions for novices (non-New Yorkers) than for the experts (New Yorkers). In a recent experiment, Galati and Brennan (2010) have shown that if speakers tell the same story for the second time to the same addressee their descriptions are more attenuated in terms of the number of words, number of events mentioned and number of details compared to when they tell the same story to a new addressee. Furthermore, as participants build common ground during conversation there is a progressive decrease in the number of words. Finally, some general expectations about the online status of the addressee shapes speaker's message as well. For instance, Kuhlen and Brennan (2010) shows that when the speakers are told that they will tell a joke to an attentive addressee the narration is longer and more detailed than when they expect a distracted addressee. Thus many aspects of the conversational partner's knowledge and online feedback shape speaker's speech in duration, number of words, details and grammatical choices (i.e., nouns vs. pronouns).

In the last decade it became clear that when people engage in recipient design they modify not only their speech but also their co-speech gestures. Studies on the sensitivity of gesture to the communicative situation usually focus on *representational gestures*, usually defined as gestures that have a semantic relation with the content of the speech (McNeill et al., 1994; Alibali et al., 2001; Kendon, 2004). Representational gestures are usually further classified into *iconic*, *metaphoric* and *abstract deictic* gestures according to the type of relation between the form and the meaning they convey (concrete for iconic gestures, abstract for metaphoric gestures and spatial for deictics; i.e., McNeill, 1992; Jacobs and Graham, 2007). Since the tasks used in studies on gesture and recipient design are usually a narration of a short story or a description of a picture or an object, iconic gestures have been the most frequent type of representational gesture in the corpora of the studies that we review below, even though not all the studies have been specific about the types of representational gestures that they coded.

Concerning the way in which recipient design affect representational gestures, we know so far that they are shaped by the different conditions of visibility by the addressees or by the shared space among the participants in the interaction (Özyürek, 2002). It is generally a replicated result that speakers use more representational gestures when they can see their addressees versus when they cannot see them (Alibali et al., 2001). Furthermore, if they can see their addressees they are even sensitive to whether addressees can see them or not (more gestures in the former) (Mol et al., 2009, 2011).

Another component of recipient design, namely the influence of the common ground – the shared knowledge among the participants – also seems to affect gesture production. In a narrative task study similar to that of Galati and Brennan

(2010) mentioned above, Jacobs and Graham (2007) asked speakers to tell the same cartoon story either to the same or to a different addressee and found that the overall rate of representational gestures (gestures per 100 words) was larger when narrations were retold to a new addressee compared to the old one. They also manipulated the attentiveness of the addressee and found higher rate of gestures in the attentive addressee condition compared to the non-attentive one.

Holler and Stevens (2007) manipulated the common ground among participants by asking the speaker to describe a picture (i.e., where is Waldy) to somebody who has also seen the picture (common ground condition) or to somebody who has not seen it (non-common ground condition). By focusing on the speech and gesture encoding the size of big entities in the pictures, the authors found that in the non-common ground condition speakers were more likely to encode size information and more accurately (e.g., tracing the size of a bridge) in their gestures than in the common ground condition. On the other hand, the encoding of size information in speech was more likely to be used in the common ground than in the non-common ground condition.

In another narrative task, Holler and Wilkin (2009) manipulated the common ground among participants having the speaker narrate an episode of a television series to somebody who saw some of the same scenes or to somebody who did not see any of the scenes. However, even if the results show that people use significantly more words and content of information for the novice addressee, no increase was found in the rate of representational gestures per words or in the amount of information they contain for the same comparison. In fact, the common ground condition elicited more gestures per words than the non-common ground condition.

Finally, Gerwing and Bavelas (2004) used a demonstration task, in its aim closer to our study, and asked people to describe what to do with some toys they played with to another adult who either already played with them (common ground condition) or did not play with them before (non-common ground condition). The gestures that depict the objects or actions were then given to other naive subjects and they were asked to compare gestures in each condition to each other in terms of an overall property of ''complexity, informativeness and precision''. They found that, when the toys were not known to the addressees, speakers' gestures were judged to be in total ''more complex, informative and precise'' than the gestures used to an addressee who played with the same toys. Yet in this measure it is hard to know which feature among the three contributed overall to the results.

Thus compared to robust results concerning the sensitivity of speech to other adults' knowledge, a less clear picture emerges with regard to co-speech gestures. Different studies have used different measures and focused on different types/functions of gestures with different tasks that make it hard to draw clear conclusions. Even if it is quite clear today that gestures are shaped by the conditions of the interaction, it is less evident how the iconicity – the form/meaning resemblance – of the gestures *per se* is in general influenced by the addressee's state of knowledge. Finally, such experimental studies have not been used to investigate how co-speech gestures might be designed for children.

1.2. Recipient design to children: speech and gesture

Numerous studies on the role of input in language acquisition show that mothers talk to their children, especially in the first months of life, in a particular way characterized by a higher pitch level and a wider pitch range. This particular register is usually called Motherese or Child-directed speech and it seems to be highly redundant, simple and usually composed of full and grammatically correct sentences (Snow and Ferguson, 1977; Crystal, 1979). Recent studies show that this simplicity is mirrored in syntactic choices as well (Stoll et al., 2009). Finally, it seems that some of the features of Child-directed speech are shared among a lot of spoken languages (Fernald et al., 1989; Mazuka et al., 2008) and sign languages (Masataka, 1992), even if they seem to be not universally shared (Ochs, 1988; Gaskins, 2006).

However, we still do not know very much about how co-speech gestures are shaped for children. There is evidence showing that American, Italian and British mothers use fewer and simpler gestures toward their children (2 years old) and that, among representational gestures, there is a big prevalence of the deictic (with very few iconic gestures) together with the so called *emblems*, that are highly conventionalized gestures (Bekken, 1989; Iverson et al., 1999; O'Neill et al., 2005). It seems also that there is a stage in the development of the child in which the number of iconic gestures increases in Child-directed communication. According to Özçaliskan and Goldin-Meadow (2011), in fact, mothers start to use iconic gestures after the child herself starts to use them, that is around is 26 months. However, iconic gestures are still very few compared to other types of gestures. Unfortunately, nothing is known yet about how this increasing in iconicity of gestures develops in time and how it compares to communication with adults.

To our knowledge, the only study investigating gesture for older children is Gutmann and Turnure (1979). This study addresses whether the age of the child and/or the task influence the production of caregivers' gestures. The authors set up an elegant study with two groups of parent–child dyads (one with 2–3 years old and one with 4–5 years old) and with four different tasks (a description of an event, a storytelling task, a description of an object and toy manipulation task). Interestingly, they found a main effect of task in the distribution of the types of gestures that parents use for their children, with more deictic gestures in the toy manipulation and more pantomimic and *semantic gestures* (defined as ''movements

which add modification, amendment or contrast to the context in the verbal channel'') in the descriptive tasks. Furthermore, they found an increase in the number of pantomimic and semantic gestures for older children but only when no object manipulation is involved in the communicative situation (that is in the description of the event, the storytelling task and the description of the object).

To summarize the state of art of our knowledge of gesture in Child-directed communication, it seems that during the child's first period of life the majority of adults' (usually mothers) gestures are deictic and that they do not convey any meaning that is not already expressed in speech. Iconic gestures start to be used after the child is 26 months old and their number increase again when the child is 4/5 years old. However, it has to be stressed that the majority of the studies focuses on very young children (usually not older then 36 months) and does not include any systematic comparison with adults. This implies that, first of all, we do not know anything about the usual way in which the mothers recorded in these studies would gesture with other adults. Moreover, the data in these studies usually come from free recordings and usually at home, and they usually concern joint attention scenes, when mother and child focus and often manipulate one or more objects (Tomasello, 1999; Stoll et al., 2009). Even when the dyad cannot touch the toys, mother and child talk about the ''here and now'' provided by the objects they see around them. Gutmann and Turnure (1979) provide the only evidence that in tasks without any manipulation of object the number of deictic gestures decreases and the number of iconic gestures (that in their terminology correspond both to semantic and pantomimic gestures) increases with the age of the child, but this study is very scarcely mentioned in the literature. The results have never been replicated or further investigated and has not compared adult–adult to adult–child pairs.

Finally, systematic comparisons between Child-directed communication and communication for adults in a more controlled setting have been reported for a type of interaction called ''Motionese'', defined as the way in which mothers modify their actions involving the presence of an object when they address their one-year-old child (Brand et al., 2002, 2007). In these studies, a closer proximity and a higher level of interactiveness characterize the actions addressed to a child. In addition, the movements seem to be larger and simpler for the child than for the other adult. According to the authors, the results on Motionese show that Motherese is a general way of interacting that goes beyond language and that encompasses non-linguistic actions as well, helping the child in acquiring not only linguistic but also practical knowledge. Yet we do not know whether the results of this study can be extended to co-speech gestures or to older children as well.

1.3. The present study

The general goal of the present study is to investigate the sensitivity of speech and specifically the iconicity as conveyed through gestures to older children compared to adults. We were particularly interested in whether iconicity is used as a scaffolding device to ground meaning in context in the transmission of knowledge and specifically in demonstrations for children.

To do so, we manipulated both the knowledge and age of the addressee as two different variables and we asked speakers, in a within-subject design, to demonstrate an action to another adult who already knows the action (expert), to another adult who does not know it (novice) and to a child. In one study (Study 1) we first analyzed the speech and the use of iconic gestures in each condition. In another study (Study 2) we collected ratings from other independent participants about the informativeness and about the size of the iconic gestures used in each condition.

Following Brennan et al. (2010), we assume that the adaptation for the addressee (both in speech and gesture) usually can be at two levels: *global* and *local adaptation*. The first one concerns the general knowledge that the speaker has about the listener as part of a linguistic and social community or as part of a category or group and it is used for shaping the first moves of the interaction. The second one includes the feedback information that the addressee provides online by means of speech, bodily movements and gaze.

Because it has been shown that the interaction of local and global can elicit different behaviors both verbally (Kuhlen and Brennan, 2010) and gesturally (Holler and Wilkin, 2011; Kuhlen et al., 2012), we decided to focus on global adaptation while controlling for the other and we used a context in which no local adaptation by means of online feedback is possible. For this reason, we asked speakers to explain their demonstrations to a camera so that their instructions will be watched and used by the real addressees and guiding their actions later. This method has already been used in studies on gesture and it produced interesting results. Bavelas et al. (2002), for instance, asked people to talk to an imaginary addressee who later will see the video or only listen to the audio. Interestingly, they found that people are very good in imagining different addressee and they produce different gestures in the two conditions, with more in number and less redundant gestures for the video condition.

Our general hypothesis was that, even in this setting in which the addressee is not actually present but only imaginary, speakers would even then engage in recipient design and that this would affect not only speech but also gestures. Particularly, our specific hypothesis was that, in explaining a common action like making coffee to somebody who has never made it, speakers would use different verbal and gestural strategies – as measured by the rate of iconic gestures

(Study 1) – and with larger informativeness and size (Study 2) based on their assumption of the knowledge state and age of the addressee.

The language we choose for the study is Italian and the region in which we collected the data is Sicily. The reason for this choice is, firstly, that until now Italian gestures have been studied mostly with naturalistic data and mainly in the area around Naples (Kendon, 2004), but never with controlled/experimental settings as well as in other Southern regions of Italy. Secondly, it has been shown that even in Italy, usually considered a ''gesture rich culture'', maternal gestural repertoire is similar to that found in other countries and is void of iconic gestures (Iverson et al., 1999). Thus in conducting the study in Italy, we were also wondering if talking to an older child would elicit similar pattern of gestures to those used for younger children or if speakers would use the same ''rich'' repertoire they usually employ in conversations among adults or even employ them more for children.

2. Method

2.1. Study 1

2.1.1. Participants

Eighteen right-handed participants (ten female) without any knowledge of any sign language took part in the study as speakers for free. All participants were native Italian speakers (born and raised in Sicily) and undergraduate students, ranging from 20 to 30 years old. Participants were aware of the presence of the camera before the recording started and they gave their written informed consent to the use of the data. All participants reported that they knew how to make coffee with the Italian *caffettiera* and made it daily.

2.1.2. Material

The material for the study was a set of simple written instructions with six steps about how to make coffee. However, we chose to present the subjects with the crucial steps in order to unify the responses for comparison.

1. Fill with water the bottom part of the caffettiera (*Riempire d'acqua la parte inferiore della caffettiera*)
2. Insert the funnel in the bottom part (*Inserire l'imbuto nella parte inferiore*)
3. Fill the funnel with coffee (*Riempire l'imbuto di caffè*)
4. Screw the top part (*Avvitare la parte superiore*)
5. Put on the fire (*Mettere sul fuoco*)
6. Wait until the coffee comes out (*Aspettare fino a quando il caffè non sarà uscito completamente*)

2.1.3. Procedure

Data were collected in the cities of Catania and Palermo (Sicily) by an Italian native speaker. Twelve participants were recorded in a classroom at the Faculty of Letters at the University of Catania and six in private houses in Palermo.

When participants arrived, we explained them that we were interested in how Sicilian people communicate but crucially we did not mention our interest in gestures. After a warming up section in which the experimenter talked with the participants about their studies at the University and their life in Sicily, we asked the participants to read the set of instructions and then to re-tell them to the camera. We asked them to imagine as much as they could that they were talking to a real addressee and later on somebody would actually see the video and make coffee with the help of their instructions. All the participants were alone in the room during the task, sitting on a chair in front of the camera. The experimenter gave the instructions and left the room. At the end of the task participants signed their consent and they were asked their opinions about the general goal of the study.

2.1.4. Design

A within-subjects design was used. Each participant retold the instructions three times, to three different imaginary addressees, namely

1. An adult who already knows how to make coffee (Expert)
2. An adult who does not know how to make coffee (Novice)
3. A child of 12 who does not know how to make coffee (Child)

We varied the order of the three conditions among participants so that every order is present in the corpus three times. We instructed the participants step by step, so that they did not know at the beginning that they would repeat the same instructions three times to avoid higher level planning across the conditions.

2.1.5. Coding

Speech. The coding of the speech focused on the overall number of words, the number of content words (i.e., words with a stable lexical meaning such a noun, a verb, an adjective or an adverb plus the spatial prepositions) and the number of clauses (one clause = one verb and its arguments).

Gesture. For the gesture annotation and coding, we used a frame-by-frame analysis of digital video. All gesture strokes that accompanied speech (i.e., for the relevant clauses) were annotated using the video annotation software developed at the Max Planck Institute for Psycholinguistics (ELAN, www.lat-mpi.eu/tools/elan/, Sloetjes and Wittenburg, 2008).[1] A stroke is defined as the most effortful part of the gesture (cf. McNeill, 1992; Kendon, 2004). We focused on only those strokes of gestures that contributed to and were related to the meaning of the accompanying speech, that is the so-called *representational* and *pragmatic* gestures.[2]

We coded a gesture as representational if it had a semantic relationship with the content of the speech. Following McNeill et al. (1994), we further divided representational gestures into *iconics*, if the semantic relationship was concrete (i.e., form-meaning resemblance) and *metaphorics*, if it was abstract (i.e., a gesture about time). There were no abstract deictics to previously defined gesture spaces. The majority of representational gestures were iconic gestures with only four instances of metaphorics (e.g., gestures representing time or sounds). We excluded metaphorics gestures from the analysis and we focused only on iconics since our study focused on the role of iconicity in gesture in addressee design. Iconic gestures depicted the shape, the size of the objects (e.g., circle shape of the funnel), actions on objects (e.g., how to close the lid of the *caffettiera*) or motion of objects (e.g., coffee moving upwards).[3]

Following Kendon (2004), we coded all the gestures that conveyed meaningful pragmatic information about the speech act of the utterance, for instance, expressing how an utterance needs to be interpreted (i.e., irony) or which kind of speech act the speaker is performing (i.e., a question) as *pragmatic gestures*. These gestures (also called *interactive gestures* by Bavelas et al., 1992) seem to be very common in conversation and especially in South Italy, where they are also highly conventionalized, they seem to be used with a very high frequency. Among the families of pragmatic gestures that Kendon (2004) describes, we found instances of the so called ''Palm up'' family, in which the hand is open and the palm faces upwards oriented toward addressee (usually considered a gesture of offering), the ''Palm up lateral'' in which the same shape is accompanied by a lateral movement (mainly indicating that something is considered obvious or that something is unknown) and the ''Palm down'' family, in which the hand is open and the palm faces downwards (indicating that something is absolutely necessary or that the speaker has finished her contribute). Finally there was an ''other pragmatics'' category for gestures that were hard to fit in any of the most known categories of pragmatic gestures.

2.1.6. Reliability

A single coder (the first author) annotated and coded initially all the data. Two other independent coders re-coded the 25% of the data for the gesture classification without knowledge of the conditions the gestures were performed in. The agreement between each coder and the original coder was 87% and 89% respectively and between the two independent coders 83%.

2.1.7. Results and discussion

The results are organized in two main sessions, one for speech and one for gestures. For both measures series of repeated measure ANOVA with the type of addressee as a within-subject factor was conducted for all the coded elements (number of words, number of content words, number of clauses, rates of overall number of gestures, iconic gestures, pragmatic gestures).

Speech. The analysis of the speech shows that our speakers treated the three imaginary addressees differently (see Table 1). In fact, we found a significant effect of condition for the means of overall number of words, $F(2,34) = 10.47$, $p < .05$, content words, $F(2,34) = 11.92$, $p < .05$ and the number of clauses, $F(2,34) = 9.20$, $p < .05$. Post hoc analyses with Bonferroni adjustment showed that subjects talked to the child and to the novice with more words, content words and clauses than to the expert ($p < .05$ for each comparison). No significant differences were found between the child and the novice conditions.

Gesture. Across all conditions, 70% of the all gestures speakers used were iconics and the 30% were pragmatics. ''Palm up'' family consisted 51%, ''Palm up lateral'' 19%, ''Palm down'' 18% and the ''other category'' 12% of all the

[1] No gesture occurred in silence, i.e., not accompanying speech.

[2] *Adaptors* (movements of self-adjustment without any relationship with the speech, Ekman and Friesen, 1969) and simple *beats* (bi-phasic movements without a discernible meaning, McNeill, 1992; Alibali et al., 2001) were annotated but not included in the analysis.

[3] The repetition of the same iconic gesture in a rhythmic way without any hold in between (usually called *superimposed beat*, i.e., Alibali et al., 2001) was included and counted as a single stroke.

Table 1
Means and standard deviations of clauses, words and content words across the three conditions.

Condition	Subjects	Clauses *M* (*SD*)	Words *M* (*SD*)	Content words *M* (*SD*)
Expert	18	13.77 (5.5)	77.27 (29.6)	39.94 (12.5)
Novice	18	18.77 (9.5)	114.77 (63.7)	63.38 (33.2)
Child	18	21.05 (11.4)	130.55 (69.7)	70.16 (33.3)

Table 2
Means and standard deviations of gesture rate, of iconic and pragmatic gestures (per 100 words) across the three conditions.

Condition	Subjects	All gesture *M* (*SD*)	Iconic gesture *M* (*SD*)	Pragmatic gesture *M* (*SD*)
Expert	18	21.52 (8.3)	13.76 (8.5)	7.76 (6.1)
Novice	18	23.24 (8.9)	16.26 (8.6)	6.98 (4.4)
Child	18	23.88 (6.6)	18.99 (6)	6.87 (3.3)

pragmatic gestures. Since speakers used different amounts of speech across the conditions, we based our statistical analysis of gestures on the gesture rate but not on overall number of gestures.

Table 2 shows the means for the rate of all gestures (iconics and pragmatics) as well separately across the conditions. The rate of overall number of gestures collapsing iconic and pragmatic gestures (adjusted per 100 words) did not change significantly across any of the three conditions. However, a more detailed analysis of the function of gestures shows that the type of gestures they used did change significantly across the conditions. In fact, we found a significant main effect for the rate of the iconic gestures $F(2,34) = 6.94$, $p < .05$. Bonferroni comparisons showed that speakers used more iconic gestures for the child than for the expert, $p < .05$. However, no significant difference was found between the child and the novice or between the expert and the novice conditions. Even though the rate of pragmatic gestures decreased in the other direction, neither the ANOVA not the pair wise comparisons revealed significant differences among the conditions for the overall category of pragmatic gestures or for the different subcategories (Fig. 1).

2.1.8. Conclusion and discussion

Overall, Study 1 shows that when people imagine talking to different addressees about an everyday action like making coffee, they modify their description both in speech and gesture. They talk more to somebody who does not share the same knowledge with them (both an adult and a child) but they produce more iconic gestures when they talk to a child compared to an expert adult, although not significantly more than to a novice adult.

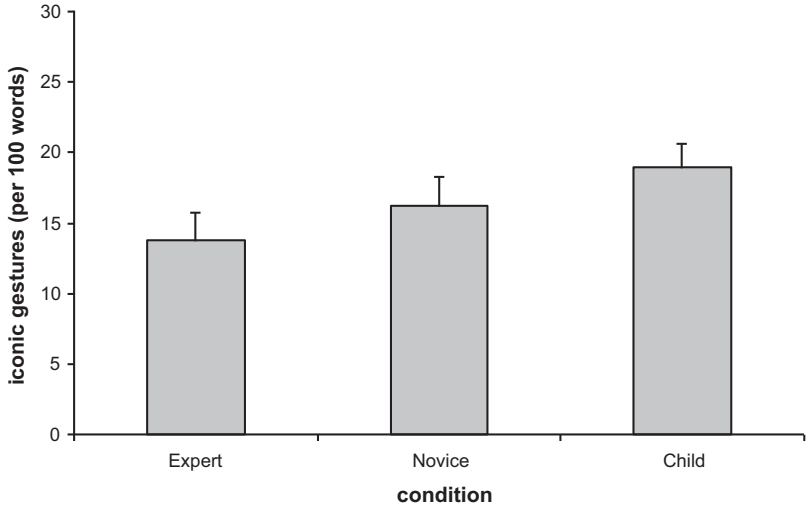

Fig. 1. Mean numbers of the iconic gesture rate (per 100 words) across the three conditions. Standard deviations are represented in the figure by the error bars attached to each column.

In order to find out if these gestures with iconic components also varied in their iconicity across the conditions, we set up a second study to quantify some visible spatial features of the gestures used in these three conditions. Since previous studies on common ground and gesture and on Motionese have indicated that the qualitative aspects such as the informativeness or the size of the gesture can be sensitive to these contexts (Holler and Stevens, 2007; Gerwing and Bavelas, 2004; Brand et al., 2002), we wanted to know if naive people would consider gestures for the child more informative (i.e., iconic) and bigger than gestures for the novice and the expert adult.

This next study was inspired and adapted from a perception study by Mol et al. (2011). Mol and colleagues' study had investigated if people are sensitive to the differences that arise in gestures when speakers talk to somebody they can see but either can see them (visibility condition) or cannot see them (non-visibility condition). In order to achieve this goal, they asked people to rate fragments of 10 s of videos containing speech and representational gestures – taken from the corpus of the visibility study on production – for their ''expressiveness'' in a scale from 1 to 5. They found that indeed people judged the speakers' gestures in a visibility condition more expressive than in the non-visibility condition.

However, in this study participants were shown gestures with speech and in a larger context and their perception of gestures could be influenced by the speech they heard and by other bodily cues as well, i.e., eye gaze or facial expressions (since there was no focus on gesture in their instructions). In order to avoid at least any effect of speech and to make people focus on gestures rather than on more general bodily cues, we decided to show our videos without sound, to select single strokes instead of longer fragments and to openly tell people that they are going to judge the gesture for ''informativeness'' and not the expressiveness of the speaker in general.

In addition, following the results on Motionese showing that movements for children are usually bigger than movements for adults (Brand et al., 2002) and that size of gestures could be sensitive to the common ground knowledge (Holler and Stevens, 2007), we decided to include judgments for the size of gestures as well.

2.2. Study 2

2.2.1. Participants

17 Italian native speakers who did not participate in Study 1 took part in the study for free. 13 of them were undergraduate students at the University of Catania and Palermo, 4 graduate students at the Max Planck Institute for Psycholinguistics. None of them had any knowledge of gestures studies except one (but his results are not affected from this knowledge) or of any sign language.

2.2.2. Material

144 strokes (48 strokes for each condition, 16% of the overall number of iconic gestures in the corpus) were randomly selected from the iconic gestures of Study 1 with the tool ''Random Generator'' (www.random.org) and then arranged in a Power Point presentation, again in a random order (selected with the same tool) and without any sound. The duration of the strokes ranges from 0.3 to 2.4 s ($M = 0.87$). One stroke was excluded from the analysis because of a mistake in the starting time of the video. So the analyzed strokes are at the end 143.

2.2.3. Procedure

Participants came to a quite room with only a general idea about the task they were going to perform (they were told that the study would concern gestures, but without any further specification). We explained them that we were interested in gesture and, particularly, in how Italians interpret the gestures of other Italians. Then we told them that they were going to see some gestures randomly selected from a corpus in which people were explaining how to make coffee, but that they would see these videos without any sound. In telling them the topic of the descriptions, we wanted to provide them a general framework that could facilitate their interpretation of the gestures. We stressed that these gestures were not pantomimes but movements that accompany a verbal description and these were taken from fluent speech. We did not mention that the speakers were repeating the same description three times and to three different addressees.

Participants were asked to watch carefully each gesture, two times at most, and then to rate it on a Likert scale from 1 to 5 both for its informativeness (1 = *not informative at all*; 5 = *highly informative*) and its size (1 = *very small*; 5 = *very big*) filling a questionnaire. We did not give them any advice about which parameters they should use in judging the gesture. We only asked them not to come back to a gesture previously judged. They did not receive any time constraints or any pressure/control from the experimenter who was sitting in the same room during the task but reading a book. After the task, all the participants signed the questionnaire and they were asked about their general feelings and opinions about the gestures they saw.

2.2.4. Results

The averages for each condition were calculated and a repeated measure ANOVA was used both for the informativeness and the size. The repeated ANOVA showed a significant effect of condition both for informativeness $F(2,32) = 12.17$ ($p < .05$) and size $F(2,32) = 21.71$ ($p < .05$). The post hoc analysis with Bonferroni adjustment showed that iconic gestures for the child were considered more informative than gestures both for the expert ($p < .001$) and the novice ($p < .05$) and bigger than gestures both for the expert ($p < .001$) and the novice ($p < .05$) (Fig. 2 and Table 3).

The following pictures illustrate an example of different degrees of informativeness in gesture in three conditions and taken from descriptions about the same step of the instructions that is, ''put the coffee in the funnel'' (Fig. 3).

In the expert condition, the participant says ''Poi mettere l'imbuto traforato in cui inseriremo il caffè'' (*Then place the perfored funnel where we are going to put the coffee*). When she says: ''in cui inseriremo il caffè'' she performs an iconic gesture with the right hand assuming the shape of the typical affordance of a spoon, but without any movement that represent the action of putting coffee in the funnel. In the novice condition, she says ''Metterci il caffè'' (*put the coffee inside it*). In this case, the hand shape is the same – again the affordance of the spoon – but it is also accompanied by the movement of putting the coffee in the funnel (ideally placed in the empty space in front of her). Finally, in the child condition she says: ''Aggiungere il caffè, non troppo'' (*Add the coffee, not too much*). This time the action of putting the coffee with the spoon is performed with both hands, having the left hand representing the funnel in which the right hand put the coffee.

3. General discussion

Overall, our findings show that both the addressee's age and his/her assumed state of knowledge (i.e., global adaptation) affect the way in which the speaker shapes the intended message during demonstration, in a context where we controlled for local adaptation (the visibility of the addressee and feedback).

The results of Study 1 showed that speakers produce more content in their speech and in more details when they talk to an addressee who does not share some knowledge regardless of whether she is a novice adult or an older child. Our results are in line with previous findings, which show that more words and content is produced by speakers for addressees who share less common ground with them (Isaac and Clark, 1987). Furthermore, the results of the clause analysis suggest that in the non-common ground conditions (both for the child and for the adult) more steps of the instructions were mentioned (given that each clause had one action/motion verb and its arguments). This is in line with Galati and Brennan (2010) showing that in a non-common ground condition more details are provided in speech compared to the common ground condition. Our results contribute to this line of research in the sense that we show this adjustment for older children as well as to adults and also in a demonstration task.

Despite this difference in the speech, the rate of iconic gestures and their informativeness and size increased only for the child condition compared to the expert adult but did not differ between the two adult conditions (unlike, for example, the

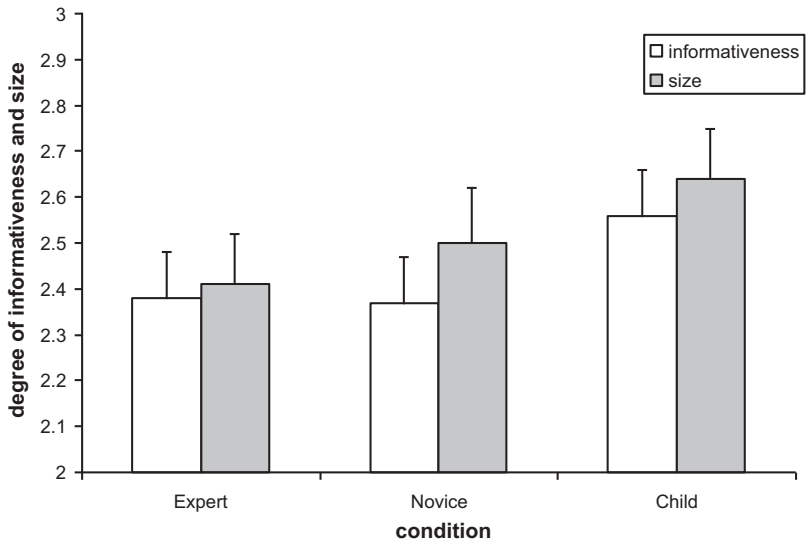

Fig. 2. Mean numbers of degree of informativeness and size of iconic gestures across the three conditions. Standard deviations are represented in the figure by the error bars attached to each column.

Table 3
Means and standard deviations of the degree of informativeness and size of iconic gestures across the three conditions.

Condition	Subjects	Informativeness *M* (*SD*)	Size *M* (*SD*)
Expert	17	2.38 (.4)	2.40 (.4)
Novice	17	2.36 (.4)	2.50 (.5)
Child	17	2.56 (.4)	2.63 (.4)

results in Jacobs and Graham, 2007). This result seems to suggest, in general, that the speech and gesture modalities are highly correlated but they can vary independently – each serving different communicative functions for certain types of communicative contexts. In fact some of the previous studies have also found speech to vary in different common ground conditions but representational gestures to remain unaffected or change only in the size information for example (i.e., Holler and Stevens, 2007; Holler and Wilkin, 2009).

This result can be attributed to the notion of global adaptation which itself is highly linked to the notion of expectation (Brennan et al., 2010). Global adaptation happens at the very beginning of the process of planning communicative

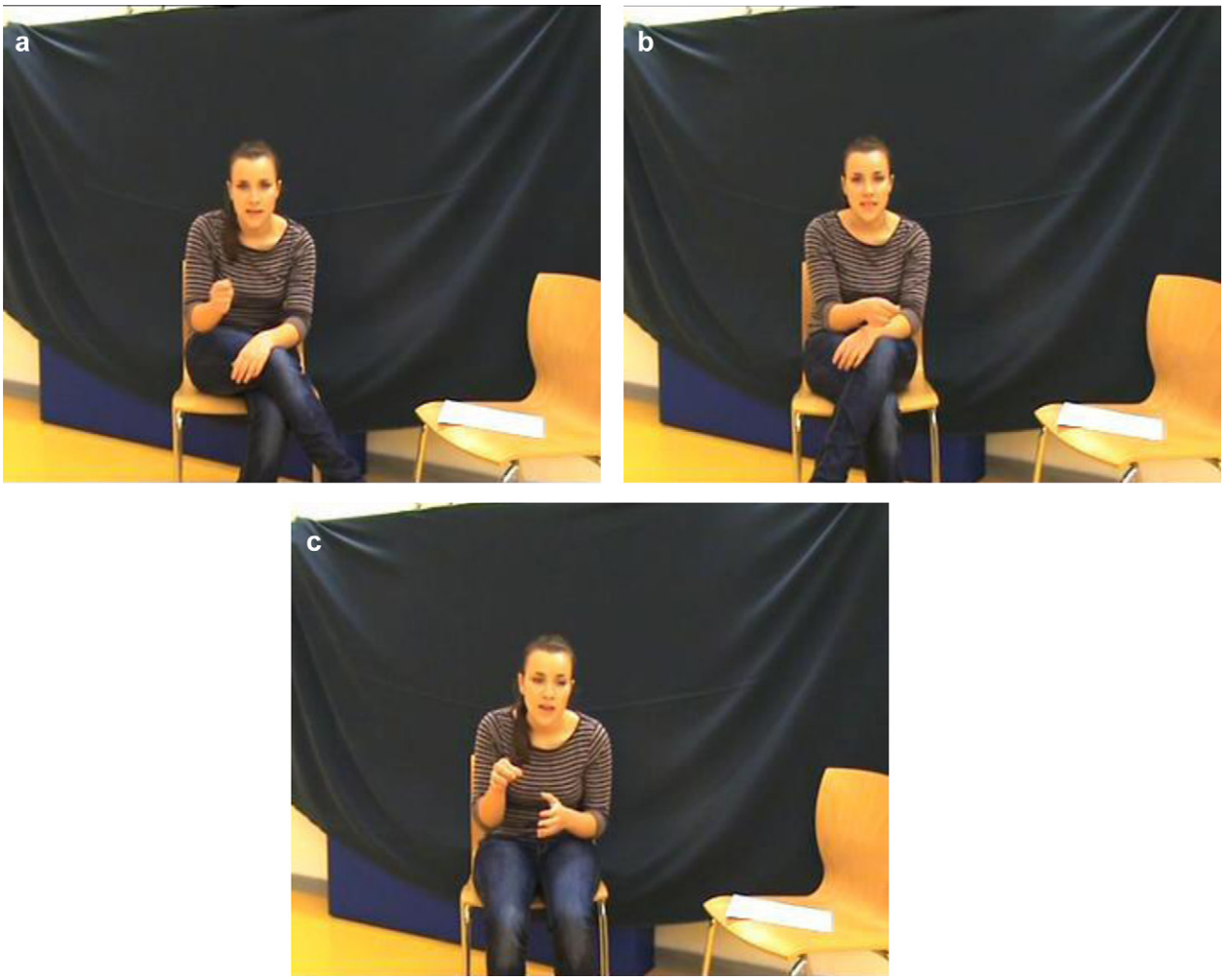

Fig. 3. (a) Example of iconic gesture with a low degree of informativeness for the expert addressee (selected from the part in which the speaker is explaining the step 'Put the coffee in the funnel'). (b) Example of iconic gesture with a low degree of informativeness for the novice addressee (selected from the part in which the speaker is explaining the step 'Put the coffee in the funnel'). (c) Example of iconic gesture with a high degree of informativeness for the child (selected from the part in which the speaker is explaining the step 'Put the coffee in the funnel').

expression and it is grounded on the expectations that speakers have for different audience groups and individuals. It might be the case that in our task, that is demonstrating how to make coffee in Italy, speakers expect that, even if an Italian adult does not know how to make coffee, she certainly has seen a *caffettiera*, its components or coffee being made. So the addressee does not need to ''see'' the objects and actions depicted through iconic gestures. Thus the difference in the shared knowledge in the adult conditions manifested itself in expressing the steps to be followed, rather than the perceptual, visual characteristics of the objects and the actions to be performed manifested in gestures. On the other hand speakers might have needed to visually demonstrate the objects and the actions for children more strongly than to adults and thus used more iconic gestures.

Our results are the first showing an increase in the rate of iconic gestures for children compared to adults. These results are informative in the light of studies conducted with very young children showing that gestures, and particularly iconic gestures, have a marginal role in the input that mothers provide (Iverson et al., 1999) and that they start to appear after 26 months (Özçaliskan and Goldin-Meadow, 2011). In an earlier study Gutmann and Turnure (1979) had found an increase in the number of iconic gestures when the child is 4–5 compared to 2–3. However none of the above studies has compared gestures used to children of different ages compared to an adult in a similar task. Our study, with the massive presence of iconic gestures, seems to be the first one to show that iconic gestures can be a strategy that speakers use to improve the effectiveness of their message for a child compared to an adult.

More research is needed in order to find out which aspects of the child-directed communication triggers the use of iconic gestures. It could be the case that adults' choices are influenced also by some expectations about children's abilities in both language production and comprehension in addition to their knowledge/expectation about their knowledge state. Even though we expect such expectations on linguistic state of children to be less of an issue for our study – since the imagined children were around 12 years of age – this could well have influenced the effects with children younger than this age (i.e., as in Gutmann and Turnure, 1979).

Focusing on the quality of the iconic gestures, we found in Study 2 that the informativeness and the size of these gestures also increase for a child compared to both the adult conditions. The findings on size are also in line with findings on Motionese (Brand et al., 2002) but they show further that this adjustment can also occur with gestures that do not use objects and to older children. Thus, bringing the results of Study 1 and Study 2 together, we can confirm that iconicity is treated as a good tool for improving the effectiveness of transferring new knowledge to children compared to adults (see also Gutmann and Turnure, 1979 for a similar suggestion).

Moreover, the results of Study 2 replicate the results of Mol et al. (2011) who used a similar methodology to investigate the parallels between gesture production and comprehension regarding addressee design. It is noteworthy to mention that, even though unlike in Mol and colleagues' study gestures were presented without a speech context, we obtained similar effects for recognizing the iconicity of the gestures by the addressees. Thus our study confirms further the claims that there are parallels between the way in which speakers design their gestures and addressees perceive them. We propose that the methodology used in Study 2 can be used for future gesture studies in establishing effects of recipient design in different addressee contexts.

Brennan et al. (2010) suggest that engaging in recipient design is a process that can start even only with some global information about the addressee (global adaptation). Even if an on-line feedback is necessary in order to confirm or change the first adaptation, some general knowledge and expectation about the linguistic and social group of the addressee seems to elicit different communicative choices by speakers. Our study provides evidence that global adaptation is indeed a powerful strategy in itself, because speakers adapt both their speech and their gestures even for an imaginary addressee.

Obviously, we are not claiming that the results would be the same if the addressee would be actually present in the interaction and provided feedback. Of course, talking to a camera is not so ''natural'' as talking to a real person and this could make a difference in terms of both speech and gesture production. However, since the goal of the study was to find out how global adaptation influences speech and gestures for addressees of different ages, we think that at this stage using a camera was the only way to completely avoid any feedback effect. In fact, previous research shows that the addressee's feedback can affect speakers' choices in speech (Kuhlen et al., 2012) and in gesture even in a monologue and when the addressee is only a confederate (Holler and Wilkin, 2011). Our results show that speakers engage in recipient design even with some general expectation about an imaginary addressee. Further research with real addressees can show if the feedback they provide will affect these results.

It also needs to be tested in future research whether these effects are specific to a demonstration task or if they are also a strategy used in narrations or descriptions or are generalizable to other types of representational gestures (i.e., about ideas, abstract concepts such as math, time, etc.). We surmise that the effect we found can be generalizable to other demonstration tasks using concrete objects but we do not anticipate any generalizability effects to narrative tasks or gesture types. We think that the strong effects in the demonstration task are due to the strong link of the demonstration to the experience and the iconic gestures provide a scaffolding in this type of knowledge transmission.

Overall Studies 1 and 2 show that the employment of iconic gestures for children follows a trajectory that we still need to identify. We know so far that when the child is very young (from 0 to roughly 2 years old) the number of iconic gestures is very small in comparison to communication for adults but our results show that when children reach a certain age these gestures become a very prominent device as part of the ''natural pedagogy''. More cross-developmental studies with different tasks are necessary in order to understand when iconicity starts to have such an important role in gesture for children. For example, is the increase in iconicity in the gestural input a continuum or does it arise in certain ages? Is this development present in every type of interaction or only in contexts without objects or demonstrations? Are children also sensitive to the increase in iconicity paralleling the changes in adults input or vice versa? And, finally, is this trajectory the same across different cultures? It would be also interesting to see if our current results can be replicated in cultures that are usually considered ''less'' gesture rich.

4. Conclusion

Speakers informed about the general identity of an imaginary addressee are able to engage in recipient design even when the addressee is not present and this engagement influences both speech and gesture. The effects in both speech (more content and details) and gesture (iconicity) were most evident for children compared to expert adults. This study is the first showing the sensitivity of iconic gestures to addressees of different ages, suggesting that having a child as addressee increases iconic gestures in number, size and degree of informativeness.

Perniss et al. (2010) suggest that iconicity and arbitrariness are two fundamental properties of language and that the division of the labor between the two ensures, on the one hand, the link to the human experience (iconicity) and the effectiveness of the message (arbitrariness) on the other. It could be the case that iconicity and arbitrariness are at the core of the efficacy for demonstrations, since they have the goal to make somebody experience something (Clark and Gerrig, 1990). Here we show that iconicity can be used as a scaffolding device in demonstrations, to ground meaning to perceptual/motor experience and can be a main strategy used in transmission of knowledge to older children.

Further investigation with real addressees, with cross-linguistic comparisons and with children of different ages are necessary to know more about the wide range of strategies in which ''natural pedagogy'' (Csibra and Gergely, 2009), a unique human ability, is present in everyday interactions.

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