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# Gestures and words in naming: Evidence from cross-linguistic and cross-cultural comparison

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## Running head: LANGUAGE AND CULTURE IN GESTURES AND WORDS

Gestures and words in naming: Evidence from cross-linguistic and cross-cultural comparison

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## Abstract

We report on an analysis of spontaneous gesture production in 2-year-old children who come from three countries (Italy, UK and Australia) and whom speak two languages (Italian and English), in an attempt to tease apart the influence of language and culture when comparing children from different cultural and linguistic environments. Eighty-seven monolingual children aged 24-30 months completed an experimental task measuring their comprehension and production of nouns and predicates. The Italian children scored significantly higher than the other groups on all lexical measures. With regards to gestures, British children produced significantly fewer pointing and speech combinations compared to the Italian and Australian children, who did not differ from each other. In contrast, Italian children produced significantly more representational gestures than the two other groups. We conclude that spoken language development is primarily influenced by the input language over gesture production, whereas the combination of cultural and language environments affects gesture productions.

*Keywords:* Pointing and representational gestures, lexicon, cross-cultural, cross-linguistic

### Gestures and words in naming: Evidence from cross-linguistic and cross-cultural comparison

Motor, gestural and vocal productions are closely linked in typically developing children (Iverson & Thelen, 1999; Capirci & Volterra, 2008; Goldin-Meadow & Alibali, 2013). Both verbal and gestural productions emerge at around one year of age, and infants show an early preference to communicate via gesture over speech (Iverson, Capirci, & Caselli, 1994). Although spoken language quickly becomes the dominant form of communication, the gestural and verbal modalities are closely coupled developmentally. For instance, gesture use predicts subsequent gains in spoken language (e.g., Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Butcher & Goldin-Meadow, 2000; Capirci, Iverson, Pizzuto, & Volterra, 1996), and in the adult system the two modalities are closely integrated. While the use of gesture for early communication appears common to all humans (e.g., Liszkowski, Brown, Callaghan, Takada, & de Vos, 2012), cross-cultural differences in gesture use are manifest. However, cross-cultural comparisons are invariably confounded by linguistic differences between groups.

In the present study we attempt to tease apart the influence of language and culture on both gestural use and vocabulary development. Using a picture naming task, we compared two groups of children who shared the same language but were culturally distinct – Australian and British children – to a group of Italian children, who differ both linguistically and culturally from the former groups.

#### *Pointing, representational gestures and word development*

The developmental course of gesture use has been well described. During the first year of life, infants begin to produce deictic gestures (i.e., POINTING, RITUALIZED REQUEST, GIVING, SHOWING<sup>1</sup>), which direct another's attention to an external object, and often precede or accompany the appearance of the first words, usually nouns (Bates, Camaioni, & Volterra 1975). At the same time, infants also begin to repeat behaviors that were successful in gaining adult attention (e.g., CLAPS HANDS, BYE-BYE). Just before the onset of naming at around 12 months,

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children start to reproduce brief meaningful ‘actions with objects’ (e.g., PLACING A COMB ON OWN HAIR), and soon after, perform the same actions without the objects. These actions are frequently used by children to communicate in a variety of situations and contexts, similar to those in which first words are produced (Acredolo & Goodwin, 1988; Caselli, 1994). The type of gestures, referred to as *representational* gestures (Caselli, Rinaldi, Stefanini, & Volterra, 2012; Pettenati, Sekine, Congestrì, & Volterra 2012; Volterra, Caselli, Capirci, & Pizzuto, 2005) include a large set of hand or body movements or facial expressions that come to be associated with relatively stable meanings across different contexts of productions. These representational gestures ‘stand for’ or ‘represent’ a referent, class of referents, or relation between referents (e.g. fingers wrapped around the imaginary handle of a comb, flapping the hands for bird, fingers of the hand represent the teeth of a comb, bringing a closed fist to the ear to represent a telephone).

At around 16 months, children become easily able to map both words and gestures to objects, actions or events, resulting in a substantial ‘equipotentiality’ between the verbal and gestural modalities (Abrahamsen, 2000; Volterra, et al., 2005). Hence, the onset of pointing is a reliable predictor of the appearance of first words (Bates et al., 1979; Tomasello, Carpenter, & Liszkowski, 2007), in particular nouns (Iverson, & Goldin-Meadow, 2005). Further, the production of gesture-word combinations that convey two distinct pieces of information (supplementary combinations) predicts the emergence of two-word utterances (Butcher & Goldin-Meadow, 2000; Fasolo & D’Odorico, 2012; Pizzuto & Capobianco, 2005).

On the other hand, the findings that looked at the onset of representational gestures that depict actions with the onset of word productions are not consistent. The literature seems to indicate that the link between the word and representational gesture productions seems to be cultural. In Italian children representational gestures have been reported to emerge as early as 12 months, occur with increasing frequency between 16 and 20 months, and precede or are simultaneously produced with infants’ first verbs (Iverson, Capirci, Volterra, & Goldin-Meadow, 2008). In contrast, in

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North American children representational gestures emerge around six months later, and typically precede the production of first verbs (Özçalışkan, Gentner, & Goldin-Meadow, 2014).

Overall, gesture use is a key predictor of progress in verbal language abilities (Capirci et al., 1996; Iverson & Goldin-Meadow, 2005; Longobardi, Rossi-Arnaud, & Spataro, 2012), and as such gestures likely scaffold early language development. The tightly coupled relationship between gesture and language suggests a close link between motor programs associated with actions and gestures and spoken linguistic representations in children (Capirci, Contaldo, Caselli, & Volterra, 2005; Iverson et al., 1994; Volterra, Capirci, Caselli, Rinaldi, & Sparaci, 2017).

*Gesture production in cross-cultural and cross-linguistic spontaneous interactions in the first two years*

Work on the role of gestures in language development has directly explored the similarities and differences across children acquiring different languages (for a review see Gullberg, de Bot, & Volterra, 2010). The picture is currently complex, and points to similarities in early gesture use accompanied by discernible differences later in development.

In a pioneering cross-cultural and cross-linguistic study comparing the gestural and vocal repertoires of 25 Italian and American infants observed between 9 and 13 months of age (Bates et al., 1979), striking similarities were found between early vocal and gestural productions in which both groups performed similar schemes of symbolic play (e.g. holding an empty fist to the ear for TELEPHONE). Similarly, Blake, Vitale, Osbourne, and Olshanksy (2005) reported remarkably similar gesture development in 9 – 15 months old infants of Anglo-Canadian, Italian-Canadian, European French, and Japanese origin, although there were some group differences in the relative use of different gesture types. Tamis-LeMonda, Song, Leavell, Kahana-Kalman and Yoshikawa (2012) analysed four types of gestures including pointing, showing objects, giving objects, and conventional gestures (e.g., waving, or open fist to request objects) in infants at 14 months and 2 years of age among three US ethnic groups (Mexican, Dominican, and African American). No



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differences were found in the gestures use, possibly because the infants lived in the same geographical areas and therefore had shared cultural experience. Finally, Liszkowski et al. (2012) provided evidence for the universality of pointing gestures by 10-14 months in seven cultures, revealing similar handshape (i.e., extended index finger) and frequencies of use.

Other research suggests larger effects of culture on the spontaneous production of representational gestures. Iverson, Capirci, Volterra and Goldin-Meadow (2008) followed three American and three Italian children longitudinally between the ages of 10 and 24 months, and reported more frequent production of representational gestures in the Italian children. The American children, in contrast, relied primarily on deictic gestures, which were also found in the Italian children's gesture repertoires but to a lesser extent. The exposure to a rich gestural model may attune Italian children to the ways in which representational information can be captured by the manual modality. Indeed, the representational gestures produced by Italian children included object/action gestures (e.g., EATING) and attributive gestures (e.g., BIG), whereas American children almost exclusively produced conventional gestures (e.g., HI, YES). Despite these differences in gesture vocabulary, in both cultures gesture + speech combinations (co-speech) reliably predicted the onset of two-word combinations.

One recurrent problem in the interpretation of these studies is the confound between cultural and linguistic factors; that is, to-be-compared groups usually differ *both* linguistically and culturally. The course of oral language development itself, which is, as we have seen, closely linked to gestural development, can vary greatly depending on the language being learned. Such language-specific effects on learning are found for early phonological processing and lexical prosodic processing influencing vocabulary growth (see: Adam & Bat-El, 2009; Bleses et al., 2008; Bouchon, Floccia, Fux, Adda-Decker & Nazzi, 2015; Delle Luche, Floccia, Granjon & Nazzi, 2017; Höhle, Bijeljac-Babic, Herold, Weissenborn & Nazzi, 2009; Nazzi, Floccia, Moquet & Butler, 2009; Thordardottir, 2005). In this context, it is difficult to conclude whether

differences in gestural use observed in cross-cultural studies (e.g. Iverson et al., 2008) are due to cultural environments (such as a rich gestural model from adults for example), or from differences in language growth, which would cascade onto differences in gestural development.

Finally, another problem arising in previous investigations of cross-cultural gestural development is that data were usually collected in spontaneous interactions with caregivers, making a comparison across children less reliable. More recently, studies adopting picture naming tasks (PNT) to assess lexical abilities have found that young children often produce spontaneous gestures accompanying or substituting the requested verbal responses. These PNT have several advantages: they provide a common set of referents for communication that are known to the experimenter and to the coder; they can be used to test different word types (e.g., nouns versus predicates); and they provide a controlled linguistic setting allowing for a comparable set of gestures across individuals and between groups (Stefanini, Bello, Caselli, Iverson, & Volterra, 2009). Using a PNT, Huttunen, Pine, Thurnham and Khan (2013) found that Finnish children aged 2-5 years produced fewer deictic and representational gestures than British children. They argued that the result may reflect the conversational style observed in Finnish adults, which has been described as silence-appreciating, slow-paced, and receiver-oriented. Two additional cross-cultural studies have been conducted using the same PNT adopted in the current study, that is, the 'Words in Game' or 'Parole in Gioco' task (PinG, Bello, Giannantoni, Pettenati, Stefanini, & Caselli, 2012). Using this task, Italian and Japanese two-year-olds did not differ in the frequency of representational gestures (Pettenati, et al., 2012). In contrast, Italian children produced twice as many representational gestures as Canadian English-speaking children, but their gestures had similar form (e.g., similar hand-as-object, hand-as-hand and size and shape gestures, Marentette, Pettenati, Bello, & Volterra, 2016).

*The current study*

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We examined the linguistic/cultural confound associated with past studies by comparing Italian, Australian and British 2-year-old children on a common PNT. Australian and British English are highly similar languages. Although the two varieties possess minor differences in standard vocabulary<sup>2</sup> and have distinct accents, the two are mutually intelligible owing to Australia's status as a former British colony.

To evaluate cultural distance between these three countries we needed to evaluate how the three populations would differ in terms of communication style, particularly via their use of gesture. In the communication style and gesture literature there are qualitative observations collected in the field rather than objective measures of cultural distance (Hall, 1976; Hall & Hall, 1990; Kendon, 2004). The communication style or the 'typical' communication pattern of both Australia and UK is defined as low context (Hall, 1976). In low context culture, most information is transmitted in the message with a heavy reliance on words to explicitly convey the meaning. In contrast, Italian is described as a high context communication style in which a high significance is given to non-verbal communication, and stronger emphasis is given to the role of non-verbal communication than in many other cultures. In addition, Italian is anecdotally categorised as a *high gestural culture* (Kendon, 2004), whereas Australian and British speakers are not particularly known for their frequency and diversity of gesture use. Given the relatively large amount of gestures that adult Italian speakers display, it is quite possible that young Italian children will also develop a relatively large frequency of gestures, presumably larger than those developed by British and Australian children.

Broad scales of cultural distance are scarce in psychology, but a quantification has been developed in the field of international business studies (Håkanson & Ambos, 2010). The authors asked respondents to indicate to what extent, compared to their home country, they perceived foreign countries to be close or far away in terms of a sum of factors such as cultural or language differences, and geographical distance. They showed that the absolute physical geographical

distances are a dominant influence on psychic distance perception. So, following this scale, the most culturally distant countries were Australia and Italy, followed by Australia and the UK, then by Italy and the UK.

By comparing British English, Australian English and Italian preschoolers on a common PNT (Cattani, Krott, Dennis, & Floccia, 2018, accepted; Bello, Caselli, Pettenati, & Stefanini, 2010; Bello et al., 2012), we aim to tease apart the role of cultural and linguistic factors in the gestural and lexical development. If spoken language development is purely affected by the target language, then Australian and British children, who are both acquiring English, should perform similarly in the naming task but may differ from the Italian learners. Finally, if broad cultural distance exerts an effect, either solely or in addition to language, then performance in the three populations may be different, both in terms of vocabulary and gesture production.

We also investigated the relationship between gesture and spoken vocabulary development by examining the lexical-semantic element in the PNT. Specifically, we asked how the lexical category (nouns and predicates) might interface with the pattern of similarities and differences of gesture type in reference to languages and cultures. Using the PNT, Canadian English-speaking and Japanese children, like Italian children, produced more representational gestures in association with the predicate subtest (Marentette et al., 2016; Pettenati et al., 2012). Therefore, we expected Italian, British and Australian children to also produce more representational gestures in association with the predicate than the noun subtests. No comparative work has examined the production of pointing gestures on the semantic categories of the PNT. What we know so far is largely based upon spontaneous interaction studies, which have linked the pointing gestures with the noun referents. Pointing gestures are considered a tool to refer to objects and are often associated with noun productions (Iverson & Goldin-Meadow, 2005, Iverson et al., 2008), therefore we hypothesised that pointing gestures are used more often in the noun than the predicate subtests.

Next, we looked at whether the frequencies of pointing and representational gestures produced alone or with the accompanying spoken responses (i.e. unimodal versus bimodal gesture productions) are equally represented across countries. Typically, two- and three year-old children use gesture+speech combinations (i.e., combinations of words with pointing or representational gestures) more frequently than unimodal gesture expressions in naming tasks (e.g. Italian children: Marentette et al., 2016, Stefanini et al., 2009; Australian children: Hall, Rumney, Holler, & Kidd, 2013; British children: Huttunen et al. 2013; Canadian English-speaking children: Marentette et al., 2016).

Finally, we investigated the relationship between gestures produced during the production task and word accuracy in comprehension and production tasks. As we have seen, gestures play an important facilitating role in communicative development, with deictic gesture production predicting subsequent language development (Bates, Bretherton, Shore, & McNew, 1983; Iverson & Goldin-Meadow, 2005; Iverson et al., 1994, 2008; Özçalışkan & Goldin-Meadow, 2005), and children using representational gestures to expand their repertoire of action meanings (Özçalışkan, Gentner & Godin-Meadow, 2014). However, spontaneous gesture production does not facilitate word production in a naming task. Indeed, when children increase the use of spoken words in a naming task, their use of spontaneous gestures gradually declines with age (Stefanini, Bello, Caselli, Iverson & Volterra, 2009). Here, our narrow age range of 24-30 months could possibly hinder the chance to reveal a negative relationship between gesture and word production. Thus, we did not expect to find any relationship between words and gesture production.

### **Method**

**Participants.** Eighty-seven ( $N = 87$ ) typically developing children participated (chronological age  $M = 26.90$ ,  $SD = 1.87$ , range 24-30 months). Age was normally distributed, with skewness of 0.17 ( $SE = 0.26$ ) and kurtosis of -0.93 ( $SE = 0.51$ ). The data were drawn from a larger database set of children who participated in a naming task. A sample size of 81 children

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was needed for a repeated-measures ANOVA with three groups and four repeated measures,  $\alpha = .05$ , with power = .80,  $\alpha = .05$ , under the assumption of a medium effect size ( $f=0.25$ ). Given that we had a sample of 87 children we were confident to have sufficient power. The sample included 35 British English-speaking children (BC = British children; 19 females;  $M = 26.83$ ;  $SD = 1.77$ ), 30 Australian English-speaking children (AC = Australian children; 19 females;  $M = 26.50$ ;  $SD = 1.67$ ), and 22 Italian-speaking children (IC = Italian children; 12 females;  $M = 27.55$ ;  $SD = 2.15$ ).

The BC participants were recruited through the Plymouth Babylab database. The AC were Anglo-Celtic children recruited through personal contacts and mothers' groups across metropolitan Melbourne. The IC videos were extracted from a database of children that took part in the Italian normative data collection (PinG, Bello et al., 2010, 2012), recruited from public nursery schools of Parma and Rome. All children had no known hearing problems or developmental delays, were born full-term, and were regularly exposed to a monolingual environment.

The highest education level of the two parents was used for BC and IC as an index of SES. The proportion of parents having completed high school at most was 33% for British and 32% for Italian parents; parents with a degree or above were at 67% for British and 50% for Italian parents. An additional 18% of Italian parents left school at the age of 14.

The parental educational levels of Australian parents were not recorded. However, it is possible to impute the average SES from publicly available statistics, which provide ranked indices of relative socio-economic advantage and disadvantage<sup>3</sup>. The sample was drawn from suburbs within an approximate 8km radius of La Trobe University, Melbourne. Of these 20 suburbs, the median index of relative socio-economic advantage and disadvantage was medium-to-high ( $Mdn$  percentile rank = 77.5), although the range was quite large (5 - 98).

Preliminary nonparametric analyses confirmed that the age and gender of the children did not differ significantly across the 3 groups [age:  $M = 26.90$ ,  $SD = 1.87$ ; Kruskal-Wallis  $p = .16$ ]; gender: males = 37 and females = 50;  $\chi^2 (df 2, N = 87) = .64$ ,  $p = .73$ , Cramer's  $V = .09$ ].

### Materials and Procedure

**Picture Naming Task.** The PNT test was designed to assess verbal lexical comprehension and production of young children. This instrument is validated for Italian and for British English-speaking toddlers (PinG: Bello et al., 2010; 2012; WinG: Cattani, et al., 2018, accepted) aged 19 to 37 months. In both versions the PNT test is divided into four subtests: Noun Comprehension (NC), Noun Production (NP), Predicate Comprehension (PC) and Predicate Production (PP). The test includes 132 picture cards with a picture representing a colour photograph of an object (e.g. “bus”) or context defining an action (e.g. “singing”), a descriptive word (e.g. “short”) or a locative word (e.g. “behind”). Forty-four pictures are assigned as targets for the comprehension set, 44 for the production set, and 44 are used as distractors. The first two picture cards of each set for both comprehension and word production tests are used for the training phase. The NC and NP subtests include 60 photographs divided into 20 triplets (plus two training triplets) depicting pictures in the following semantic categories: familiar objects of everyday use (15), clothing (11), furniture and objects of the house (9), animals (8), places and outside objects (7), food and drink (5), transport (4) and toys (1). The PC and PP subtests include 60 photographs divided in 20 triplets (plus two training triplets) depicting actions (36) and pictures that can be described using adjectives (17) and adverbs (7). Examples of noun and predicate picture sets are presented in Figure 1.

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INSERT FIGURE 1 HERE

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The English version was developed independently in Australia and England. In the comprehension subtests, two targets of the NC subtest were replaced (the Italian picture *bidé* was replaced with *toilet* for AUS set and with *sink* for UK set; and the Italian picture *balcony* was replaced only for the UK set with *backyard*). The replacement items were close to the original target picture, and therefore the total of 20 items were retained in each comprehension subtest. In the production subtests, the AUS team replaced one item of the NP subtest (*radiator*) and two items of the PP subtest (*spinning* and *heavy*) with pictures that were functionally different from the original version. As such, the three pictures were excluded from the current analyses leaving 19 test pictures for the NP subtest and 18 pictures for the PP subtest. The remaining comprehension, production and distractor target words were matched in the three languages.

The PNT test was administered individually, beginning with two training trials that aimed to familiarise the child with the test. The three pictures were displayed in a row in front of the child in a small table or in the floor but in random positions for each set. Each picture triplet contained a comprehension picture (comprehension target card), a related semantic picture (production target card) and a non-semantic distractor picture (distractor card).

The order of picture presentation within each subtest was predetermined according to the record form list. For each set of three pictures the comprehension question was asked first. The experimenter said the corresponding target word, ensured that the child paid attention to all three pictures, and waited for the child to choose a picture. The child responded by pointing, touching or picking up a picture. A trial ended once a child pointed to a picture (correct or incorrect card), but if she spontaneously changed her mind, the new response was scored. When a child did not provide any response (touching or picking up the card), another chance was given (i.e. repeat comprehension word). In the NC subtest, the experimenter's request was a noun such as "*cat*" or "*bus*". In the PC subtest, the verbal requests depended on the target word, i.e. a verb (e.g. "*singing*" or "*sleeping*"), an adjective (e.g. "*big*" or "*full*") or an adverb (e.g. "*outside*" or



“*behind*”).

The production subtests were conducted in parallel with the comprehension subtests. After a child had responded to a comprehension request, the comprehension target picture and the non-semantic distractor picture were removed from display, so that only the related semantic picture was left; this card was used for the production subtest. At this point, the experimenter asked the child to name the picture. For the NP subtest, the request was “*What is it?*” and for the actions in the PP subtest, “*What is s/he doing?*” or “*What is this child doing?*”. For the adjectives and adverbs, the question was “*What is this like?*” or “*Where is this?*”. A maximum of two naming attempts were permitted in the production task. After the child’s response (or absence of response), the experimenter moved on to the next triplet.

The noun subtests were administered first, followed by the predicate subtests, with a short break in between. The average duration of the entire session was approximately 30 minutes. All sessions were video-recorded for later transcription.

### **Coding**

We coded all communicative exchanges between experimenter and child starting when the picture was initially placed in front of the child and ending when the picture was removed.

#### ***Verbal coding***

In the comprehension tasks, children’s responses were coded as correct when the child showed, indicated or chose the photograph corresponding to the comprehension target. When the child pointed to the wrong picture or did not respond, the response was classified as incorrect or as a no response.

In the production tasks, verbal responses were classified as *correct*, *incorrect*, or *no response*. A vocal response was coded as correct when the child provided the expected production target. Phonologically altered forms of correct words and onomatopoeic forms were accepted (e.g. picture *hen*: English “cluck cluck” instead of “hen” and Italian “cocodè” instead of

“gallina”). For some pictures, more than one answer was accepted as correct. For example, the picture *bag* can be called “sacchetto,” “busta,” or “borsa” in Italian, and *lorry* can be called “lorry” or “truck” in English. If children did not respond or gave an initial incorrect response, they had an additional chance to respond. In case of two responses, a “best criterion” response was adopted: if the child provided a correct verbal response on the second attempt, she was given credit. Responses were marked as incorrect if the child answered with a word that was different from the target, or for responses that were unintelligible. Finally, if the child did not answer, produced a gesture but did not say a word, or informed the experimenter that she did not know the answer, a no response was counted.

### *Gesture coding*

Children produced various categories of gestures: deictic, representational, conventional, beats, and self-adaptor [for more details on classification of gesture types see Butcher and Goldin-Meadow (2000), and Stefanini et al. (2009)]. All visible actions (e.g., posture, body movements, and facial expressions) depicting pointing and representational gestures produced by the children interacting with the experimenter during the production (NP and PP) tasks were coded as gestures (Kendon, 2004). These included gestures produced with and without speech, and those occurring both before and after the child’s verbal response. The other deictic (showing and giving), conventional, beats, and self-adaptor gestures were coded but not included in the analyses.

Given the specific nature of the production tasks (asking children to name pictures), the criteria for coding an action as a gesture (Pettenati, Stefanini, & Volterra, 2010) were as follows: (1) the gesture was produced after the experimenter made the request to name the picture until the time the picture was removed; (2) the gesture could be performed with an empty hand or while holding the picture; (3) the gesture was not an imitation of any preceding adult gesture if the experimenter made an accidental gestural production.

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We coded the pointing and representational gesture productions in the production tasks. If a child produced several instances of the same repeated gesture (pointing or representational) for a picture or different representational gestures such as FALLING+BIKE to reproduce one communicative act, only one production was counted.

Further, all productions containing gestures were coded for modality of expression either as unimodal if produced without speech or bimodal if produced together with a correct or incorrect verbal responses.

*Pointing gestures.* Pointing was defined as an extension of the index finger (e.g., asked to label a picture of a *dog*, the child points with the index finger extended towards the picture while saying “dog”; Stefanini, Caselli & Volterra, 2007). Instances of pointing with multiple fingers extended were included, as were instances where children patted an object with the palm extended, which indicated the object on the picture or its location. Show and give gestures were excluded because these communication acts could be confused with the actions involved in the PNT task, i.e. give or show the picture to the experimenter with the intention to place it back in the pile.

*Representational gestures.* These gestures are pictographic representations of the meaning (or meanings) associated with the represented object or event (e.g. moving an arm with hand open and bended fingers for LION, rotating the arms for SWIMMING; holding a hand close to the ear for PHONING).

### **Reliability**

The interrater reliability for the PNT comprehension and production subtests and gesture type was calculated based on the coding by speakers of each language. Two Italian coders (fourth and fifth authors) coded independently the data of all IC (100%). All AC and BC data were processed by two British coders, who also coded independently 9 AC and 10 BC randomly selected from the datasets (30% and 29%) for reliability. All disagreements or uncertainties about

verbal comprehension and production, gesture identity and gesture type, were resolved by discussion between the two coders within the Italian and English-speaking languages.

### *Verbal accuracy*

For comprehension, Italian raters agreed on every decision (100% agreement, Cohen's  $kappa$ ,  $k = 1$ ; level of agreement assessed following Fleiss, Levin, & Paik, 2003) and English raters agreed on 98.8% (355/360 decisions,  $k = .99$ ,  $SE(k) = .006$ ) for AC children and on 98.3% (394/400 decisions,  $k = .99$ ,  $SE(k) = .006$ ) for BC children. For production, Italian raters agreed on 94.1% for IC (766 of 814 labels,  $k = .882$ ,  $SE(k) = .012$ ), and English raters agreed on 99.1%, (330 of 333 labels,  $k = .99$ ,  $SE(k) = .005$ ) for AC and on 97.8% (362 of 370 labels,  $k = .98$ ,  $SE(k) = .008$ ) for BC.

### *Gesture identification*

Reliability checks were calculated for gesture identification (a binary choice: gesture occurred or did not occur) in the production task. Raters agreed on IC: 87.9%, AC: 97.9%, BC: 97.3% of gestures identified. Finally, gestures were further coded for gesture type. For the pointing gestures raters agreed on 92.6% for IC (327 of 353 pointing coded,  $k = .85$ ,  $SE(k) = .020$ ), 93.8% for AC (107 of 114 pointing coded,  $k = .94$ ,  $SE(k) = .023$ ) and 93.6% for BC (73 of 78 pointing coded,  $k = .95$ ,  $SE(k) = .025$ ). For the representational gestures the agreement rate was 90.8 (119/131,  $k = .81$ ,  $SE(k) = .36$ ) for IC, 100% for AC (3 of 3 gestures,  $k = 1$ ), and 83.3% for BC (25 of 30 gestures,  $k = .83$ ,  $SE(k) = .07$ ).

### **Data analyses**

We tested the children's correct verbal responses with a repeated measures ANOVA 3 (Group: IC, AC, BC)  $\times$  2 (Lexical category: Nouns, Predicates)  $\times$  2 (Task: Comprehension, Production), with Group as a between-participant variable and Lexical category and Task as within-participant variables (see Table 1 for the descriptive vocabulary data and Figure 2 for the pictorial representation). Similar ANOVAs were conducted to analyse the 'incorrect' and 'no

response' categories, but only in the production task, as comprehension responses were only coded as correct or incorrect.

Based on Mauchly's test for repeated measures with two levels, the assumption of sphericity was always met (Field, 2013). We report partial eta squared ( $\eta_p^2$ ) as an estimation of effect size for ANOVA terms, and report Cohen's  $d$  (and 95% confidence intervals) for effect sizes following pairwise comparisons.

For the pointing and representational gesture analyses, non-parametric statistics were conducted for the main factors and their single levels because the data were not normally distributed. Kruskal-Wallis test were performed for the analysis of the three groups and when significant, further Mann-Whitney U statistics were conducted for as post-hoc comparisons. Wilcoxon Signed-Rank tests were run for a sample group to measure the different conditions of pointing and representational gestures for each participant. The results of the pointing and representational gesture analyses with the p-values are presented in Table 2 and the effect sizes (absolute  $rs^4$ ) are reported in the text. The alpha level for all analyses was set at .05 (two-tailed).

## Results

### Vocabulary accuracy

*Correct responses.* This analysis revealed a significant main effect for Group,  $F(2, 84) = 10.99, p < .001, \eta_p^2 = .21$  (see Table 1 and Figure 2). The pairwise comparisons showed that the IC ( $M = 13.17, SE = .58$ ) scored higher than the AC ( $M = 10.06, SE = .50$ ) and BC ( $M = 10.01, SE = .46$ ), respectively (mean diff: IC-AC = 3.11,  $p < .001, d = 1.14, 95\% CI [-1.73, -0.55]$ ; IC-BC = 3.16,  $p < .001, d = 1.16, 95\% CI [-1.73, -0.58]$ ), while AC and BC did not differ (mean diff: AC-BC = .05,  $p = .676, d = .02, 95\% CI [-0.51, 0.47]$ ). Further, there was also a significant main effect of Lexical category (comprehension and production tasks collapsed),  $F(1, 84) = 177.31; p < .001, \eta_p^2 = .68$ , with more accurate responses for the nouns ( $M = 12.76, SE = .31$ ) than predicates ( $M = 9.40, SE = .34$ ). Finally, the main effect of Task (noun and predicate tasks

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collapsed) was significant,  $F(1, 84) = 565.36$ ;  $p < .001$ ,  $\eta_p^2 = .87$ , with children's responses more accurate in the comprehension ( $M = 14.66$ ,  $SE = .31$ ) than production task ( $M = 7.50$ ,  $SE = .35$ ).

There were no significant interactions.

All children performed more accurately in the comprehension than the production task and in the noun than the predicate task. The most accurate task was NC for which 5/22 IC and 2/35 BC were at ceiling – no AC were at ceiling. No children reached ceiling in either language group for any of the three remaining tasks. The least accurate task was PP for which 1/22 IC, 4/30 AC and 4/35 BC were at flooring, not producing any correct response.

This first analysis showed an overall language difference so that the accuracy of both English-speaking groups of children for verbal responses was lower than that of Italian-speaking children across the board, revealing a larger vocabulary in Italian-speaking children in production and comprehension. In particular, this vocabulary difference was not affected by lexical categories or tasks.

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INSERT TABLE 1 and FIGURE 2 HERE

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*Incorrect responses.* The only effect was that of Lexical category,  $F(1, 84) = 5.85$ ,  $p = .02$ ,  $\eta_p^2 = .66$ , due to children producing more errors on predicates ( $M = 6.65$ ,  $SE = .34$ ) than nouns ( $M = 5.72$ ,  $SE = .33$ ).

*No responses.* This analysis revealed a significant main effect of Group,  $F(2, 84) = 6.64$ ,  $p = .002$ ,  $\eta_p^2 = .14$ . The Italian children ( $M = 2.43$ ,  $SE = .82$ ) produced less no responses than BC ( $M = 5.77$ ,  $SE = .65$ ) and AC ( $M = 5.97$ ,  $SE = .70$ ). The mean difference and effect sizes were large for IC-AC =  $-3.54$ ,  $d = 0.93$ , 95% CI [0.35, 1.50], and IC-BC =  $-3.34$ ,  $p = .002$ ,  $d = 0.87$ , 95% CI [0.32, 1.43], whilst AC and BC did not differ, mean diff: AC-BC =  $.20$ ,  $p = .84$ ,  $d = 0.05$ , 95% CI [-0.54, 0.44]. The effect of Lexical category was significant,  $F(1, 84) = 15.14$ ,  $p < .001$ ,

$\eta_p^2 = .15$ , with predicates ( $M = 5.46$ ,  $SE = .48$ ) generating more no responses than nouns ( $M = 3.99$ ,  $SE = .43$ ) with mean diff = 1.46, 95% CI (.72, 2.21). The interaction Group x Lexical category,  $F(2, 84) = 1.87$ ,  $p = .16$ ,  $\eta_p^2 = .04$ , was not significant.

### **Gesture frequencies**

*Pointing gestures.* A total of 863 pointing gestures were coded, of which 202 were unimodal (98 for nouns and 104 for predicates) and 661 bimodal (406 for nouns and 255 for predicates). All but three children produced at least one pointing gesture (maximum pointing gestures per child IC = 31, AC = 36, BC = 31). Figure 3 displays the median and range of pointing gestures produced in the noun and predicate production tasks by language group. The boxplots indicate a wide variability in the children's gesture productions with three outliers in BC in each task and one outlier in the IC and AC in the predicate task.

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INSERT FIGURE 3 HERE

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The distribution of the pointing gestures was not normally distributed across the three groups (Shapiro-Wilk test with all  $p$ -values < .01) and the Levene's homogeneity of variance was violated for the unimodal noun measure  $F(2, 84) = 5.79$ ,  $p = .004$ .

The non-parametric Kruskal-Wallis test carried out for three groups on the overall pointing gestures produced, provided very strong evidence of a difference between the mean ranks of at least one pair of groups  $\chi^2(df 2, N = 87) = 13.87$ ,  $p = .001$ . The Mann-Whitney U test showed that BC produced less pointing gestures than IC and AC ( $U = 202.0$ ,  $p = .007$ ,  $r = 0.40$ , and  $U = 278.5$ ,  $p = .001$ ,  $r = 0.40$ , respectively) but no evidence was found of a difference between the IC and AC pair ( $U = 326.5$ ,  $p = .948$ ,  $r = 0.01$ ).

With regards to the Lexical category (Table 2), the evidence of a strong difference across groups was found in the noun  $\chi^2(df 2, N = 87) = 13.24$ ,  $p = .001$ , as well as in the predicate task

$\chi^2 (df 2, N = 87) = 9.39, p = .009$ . In the noun task, BC produced less pointing gestures than IC and AC (effect sizes  $r = 0.37$  and  $r = 0.40$ , respectively) but no evidence of a difference between the IC and AC pair was found ( $r = 0.06$ ). In the predicate task, BC produced less pointing gestures than IC ( $r = 0.36$ ) and AC ( $r = 0.29$ ) but we found no evidence of a difference between IC and AC pair ( $r = 0.10$ ). The within-group comparisons highlighted that the scores of the pointing gestures to an object/animal set or to action/characteristic set did not vary in most children. Wilcoxon Signed-Ranks test indicated that IC and BC had a similar amount of pointing gestures in association with the noun and the predicate tasks (IC:  $Z = 1.60, p = .111, r = 0.34$ ; BC:  $Z = 1.47, p = .142, r = 0.25$ ), however the pointing gestures of AC were significantly higher in the noun than the predicate task (AC:  $Z = 3.52, p < .001, r = 0.64$ ).

With regards to the Modality of expression, the unimodal pointing expressions (gesture produced without a verbal response) were equally distributed across groups  $\chi^2 (df 2, N = 87) = .48, p = .79$ . For the bimodal expressions (pointing gestures produced with a verbal response) we found a strong difference between the mean ranks of at least one pair of groups  $\chi^2 (df 2, N = 87) = 17.35, p < .001$ . Mann-Whitney U test revealed that BC produced less pointing gestures with a verbal response than IC and AC ( $r = 0.47$ , and  $r = 0.43$ , respectively) but no evidence of a difference between the IC and AC pair was found ( $r = 0.07$ ). Looking at the median values of modality of expressions in Table 2, pointing gestures produced alone occurred rarely in all children. Pointing gestures produced with a verbal response were significantly more likely to occur than gestures produced without a verbal response (Wilcoxon test, IC:  $Z = 3.53, p < .001, r = 0.75$ ; AC:  $Z = 3.71, p < .001, r = 0.68$ ; BC:  $Z = 2.64, p = .008, r = 0.45$ ).

When examining the level under each factor (noun unimodal, noun bimodal, predicate unimodal and predicate bimodal), the bimodal factors showed a significant group differences, noun bimodal  $\chi^2 (df 2, N = 87) = 16.01, p < .001$  and predicate bimodal  $\chi^2 (df 2, N = 87) = 10.7, p = .005$ . In post-hoc comparisons, BC produced less pointing in the noun and in the predicate tasks



than IC ( $r = 0.44$  and  $r = 0.40$ , respectively) and AC ( $r = 0.43$  and  $r = 0.43$ , respectively) with no difference between IC and AC ( $r = 0.01$  and  $r = 0.15$ , respectively).

In sum, British children produced overall less pointing gestures than the other children groups, but this was restricted to when the pointing gesture was produced with a verbal response in the noun and the predicate subtests.

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INSERT TABLE 2 HERE

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*Representational gestures.* Table 3 presents a list of pictures with frequencies of representational gestures. The majority of pictures (33 out of 37) elicited at least one occurrence of spontaneous representational gesture. Highly familiar pictures that could involve manual or body actions were those that elicited the highest occurrences of representational gestures in all groups (e.g. COMB, GLOVES, SWIMMING, WASHING HANDS). The pictures that did not elicit representational gestures (e.g. Bag, Table) were those familiar items that do not usually involve physical interactions in children.

We counted 172 spontaneous representational gestures, which included 48 unimodal (16 nouns and 32 predicates) and 124 bimodal responses (52 nouns and 72 predicates). Forty-nine children produced at least one representational gesture (IC:  $N = 21/22$ , 95%; AC:  $N = 11/30$ , 37%; BC:  $N = 17/35$ , 48%; maximum representational gestures per child IC = 15, AC = 4, BC = 10). The proportion of children who produced at least one representational gesture versus the children who did not produce a representational gesture was higher for IC than AC and BC,  $\chi^2$  ( $df = 2$ ,  $N = 87$ ) = 19.26,  $p < .001$ .

The boxplots (figure 3b) indicate an important variability of the IC's representational gesture productions, particularly in the predicate production subtest; only one outlier was present in the noun production subtest. Three AC extreme outliers were found in the predicate production

subtest and AC were most likely to produce no gestures at all (no box shown). BC had two extreme outliers in the noun and two in the predicate production subtest.

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INSERT TABLE 3 HERE

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Normality checks on the representational gestures across the three groups showed that the assumption of normality had not been met (Shapiro-Wilk test with  $p < .05$ ) and the homogeneity of variance was violated for all levels of the Lexical category and Modality of expression variables, Levene's test all  $p$ -values  $< .05$ .

The Kruskal-Wallis test on the overall number of representational gestures provided strong evidence of a difference between the mean ranks of at least one pair of groups  $\chi^2 (df 2, N = 87) = 29.78, p < .001$ . Mann-Whitney U test showed that there was a difference between IC and AC ( $U = 60.5, p < .001, r = 0.72$ ) and between IC and BC ( $U = 132.5, p < .001, r = 0.56$ ) with IC producing more representational gestures, but no evidence of a difference between the AC and BC pair ( $U = 600.0, p = .271, r = 0.14$ ).

With regards to the Lexical category, a strong difference across groups was found in the noun,  $\chi^2 (df 2, N = 87) = 7.07, p = .03$ , and in the predicate subtest,  $\chi^2 (df 2, N = 87) = 38.53, p < .001$ . In the noun task, IC produced more representational gestures than AC ( $r = 0.36$ ) and BC ( $r = 0.28$ ). There was no difference between AC and BC ( $r = 0.03$ ). In the predicate task, IC produced more representational gestures than AC and BC ( $r = 0.77$  and  $r = 0.65$ ) but no evidence of a difference between the AC and BC pair was found ( $r = 0.21$ ). On the within-group comparisons, the frequencies of representational gestures productions were equally distributed across the noun and predicate tasks within the AC and BC groups (Wilcoxon test, AC:  $Z = .31, p = .755, r = 0.06$ ; BC:  $Z = .48, p = .634, r = 0.08$ ). The IC produced more than twice as many

representational gestures during the predicate task than the noun task (Wilcoxon test, IC:  $Z = 3.34, p = .001, r = 0.71$ ).

With regards to the Modality of expression, the representational gestures produced without a verbal response (unimodal expressions) were not significantly different across groups  $\chi^2 (df 2, N = 87) = 5.48, p = .06$ . For the representational gestures produced with a verbal response (bimodal expressions), we found a difference between the mean ranks of at least one pair of groups  $\chi^2 (df 2, N = 87) = 30.70, p < .001$ . Mann-Whitney U test revealed that IC produced more bimodal expressions than AC and BC ( $r = 0.71$  and  $r = 0.59$ ) but no evidence of a difference between the AC and BC pair ( $r = .11$ ). Indeed the within group comparisons highlighted that the representational gestures of IC produced with a verbal response were significantly more likely to occur than gestures produced without a verbal response (Wilcoxon test, IC:  $Z = 3.46, p = .001, r = 0.74$ ), whilst either AC and BC reported no differences in the scores of unimodal and bimodal expressions (Wilcoxon test, AC:  $Z = 1.81, p = .07, r = 0.33$ ; BC:  $Z = 1.18, p = .237, r = 0.20$ ).

The Kruskal-Wallis tests conducted for each factor, the noun bimodal  $\chi^2 (df 2, N = 87) = 8.05, p = .018$ , predicate unimodal  $\chi^2 (df 2, N = 87) = 7.99, p = .018$  and predicate bimodal  $\chi^2 (df 2, N = 87) = 36.80, p < .001$  were significant. In the post-hoc comparisons, IC showed higher representational gestures produced with a verbal response than AC and BC in the noun bimodal ( $r = 0.71$  and  $r = 0.28$ ), and in the predicate bimodal ( $r = 0.65$  and  $r = 0.74$ ). Within the unimodal gesture productions, IC produced more representational gestures than AC ( $r = 0.74$ ) in the sole predicate subtest.

In sum, the Italian children produced significantly more representational gestures than the other two groups. In particular, they produced more bimodal representational gestures overall.

### **Relationship between gestures and vocabulary**

To determine whether gesture production was related to age and/or to the vocabulary accuracy, we correlated the children's pointing and representational gesture scores with the total

accurate comprehension and production PNT scores and with age. Neither of these variables correlated with the pointing gesture scores, but representational gestures were positively associated with age,  $r = .226, p = .04$ , and with vocabulary scores for comprehension,  $r = .240, p = .03$ , but not production,  $r = .035, p = .75$ . We repeated these analyses on individual groups but correlations did not reach significance.

### Discussion

Our main goal was to investigate the degree to which early speech (comprehension and production of words) and gesture development is influenced by language and culture. We compared two groups of English-speaking children, namely British and Australian, and a group of Italian children, who all completed the same picture naming task. Any differences between Italian children and the English-speaking children groups would be attributable to both language and culture, while differences between British and Australian children would be caused by differences in cultural background.

#### *Comprehension and production of words*

In terms of spoken word knowledge, the Australian and British English-speaking children were remarkably similar on all measures of vocabulary. On the assumption that Australian and British lexicons share the same English language heritage, but that linguistic groups are geographically distant and culturally different, we did not exclude *a priori* vocabulary differences. Indeed, large discrepancies have been found in the parental report of the CDIs (Hamilton, Plunkett, & Shafer, 2000) in Britain and the USA, with lower scores in comprehension and production for British children when compared to American children of the same age. Hamilton et al. (2000) argued for cultural differences between the two countries in terms of parental expectations; specifically, it is possible that American parents expected their child to talk more. They also discussed the possibility of differences in word frequency in infant-directed speech (IDS), which would modulate the rate of word acquisition. Of relevance is also

the documented difference in the infant-directed speech style itself, with American parents producing more extreme prosodic variations than British parents (Fernald et al., 1989). Since prosodic cues assist children in extracting words from continuous speech (e.g. Thiessen, Hill & Saffran, 2005), different styles in IDS might modulate the availability of segmentation cues (Floccia, Nazzi, Delle Luche, Poltrock, & Goslin, 2014), and therefore the growth of vocabulary (Bleses et al., 2008). The fact that we found no differences between Australian and British children in their spoken vocabulary suggests that children from these cultures share greater similarity of experience in their early communicative development than they share with North American children.

In contrast, our sample of Italian children outperformed the English-speaking children on all verbal measures. Previous findings from similar cross-language comparisons have reported that Italian children were more accurate in the verbal performance than Canadian English-speaking children (Marentette et al., 2016) and Japanese children (Pettenati et al., 2012). Recent normative data collected on British English children using the same PNT (Cattani et al., 2018 accepted) confirm that British English children tend to acquire words later than Italian children. For example, on the respective normative data of the Italian and the British version of the production subtest, British children in the median percentile at 36 months of age say 25 words, whereas Italian children say 31 words. Thus, although the data is not indicative of the growth of vocabulary in this age group, it does suggest that the Italian children are, all things being equal, slightly ahead.

Notwithstanding the cultural and geographical distance, our word data suggest that Australian and British children follow the same developmental path regarding vocabulary growth, suggesting closer links between these two populations than between British and American children. Having established a strong similarity in terms of vocabulary development between Australian and English children, we can now assume that any differences in terms of pointing and

representational gesture productions would be due to cultural backgrounds rather than linguistic factors.

### *Pointing gestures*

Across all country groups, all but three children produced at least one spontaneous pointing or one representational gesture, and overall produced more pointing gestures than representational gestures (see also Hall, Rumney, Holler, & Kidd, 2013; Pizzuto & Capobianco, 2005).

A previous cross-cultural observational study recording the use of pointing in infants aged 10-14 months reported that its frequency did not differ across seven different cultures (Lizkowski et al., 2012). In the current study, however, we found cross-cultural differences: Australian and Italian children produced overall more pointing gestures than British children. In particular, British children produced significantly less bimodal pointing expressions compared to the Italian and Australian children, who did not differ from each another. The reasons why the Australian children used as many pointing gestures as the Italian children are not yet clear. Different child-rearing practices seem to have an impact on children's gesture production, as demonstrated by Lieven and Stoll (2013) in longitudinal video recordings of naturalistic settings in Nepal (Chintang) and in rural Germany. A similar timetable for the emergence of pointing was observed in both cases, with a peak at 26 and 28 months. However, German children were almost always pointing at higher rates than the Chintang children. This was thought to be due to them experiencing more one-to-one interactions with adults rather than larger groups of children playing together, as in common for Chintang children in Nepal. These cultural differences provided German children with more opportunities to experience pointing from adults, and therefore, imitate this behaviour. In fact, Callaghan et al. (2011), based on data with Canadian and Indian infants, suggested that once pointing is established in the infant repertoire, cultural differences start to develop as a function of parental attitudes to socialisation. Following on from

this, one plausible explanation is cultural: in comparison to British cultural convention, pointing to objects and people in Australia is generally accepted, especially for young children. An additional explanation concerns the physical environment: Australian children spend more time outdoors than British children do, so they may point more often because objects are regularly within sight but out of reach. To our knowledge there have been no experimental investigation of the effect of the size of physical space on the frequency of pointing gesture, and so this explanation awaits empirical confirmation.

We expected that pointing gestures would be produced more often when the target represented an object to label (e.g. noun) rather than a predicate (Bates et al., 1979; Iverson et al., 1994, 2008; Iverson & Goldin-Meadow, 2005), yet this was significantly only in Australian children. Indeed, the first gestures recorded in spontaneous interactions of infants and caregivers are deictic gestures (i.e., pointing at objects and places in the near environment, or showing objects to draw attention to adults). These gestures are linked to the emergence of the first word combinations (Bates et al., 1979), and are mainly directed to noun referents. It is possible that this link changes with age, such that the prevalence of the pointing gesture/noun combinations that was observed at the beginning of the second year, during the first months of infants' speech productions, may become less evident in the third year when two-word utterances emerge. Future longitudinal research using the PNT is needed to investigate the developmental pathway of pointing gestures with the noun and predicate combinations.

### *Representational gestures*

Overall, children produced few representational gestures. This trend mimics the low frequency with which representational gestures occur in the input (Iverson, Capirci, Longobardi, & Volterra, 1999; Quinn & Kidd, 2018).

For production of representational gestures clear differences were observed across languages, which support the view that they relate to a combination of linguistic background and

communication-style linked to cultural differences. In our work, cultural distance as operationalised by geographical distance (Håkanson & Ambos, 2010) did not predict the use of representational gestures. In fact, Italian children's representational gestures significantly outnumbered those produced by the English-speaking groups, who did not differ from each other. Evidence suggests that children growing up in linguistic environments with a rich gesture input and high context communication style, such as Italy, produce a great variety of representational gestures, and produce them at an earlier age than children learning English in the US (Capirci et al., 2005; Iverson et al., 2008). A similar PNT study (Pettenati et al., 2012) compared Italian and Japanese children, whose cultures are both categorised as high context communication styles (Hall & Hall, 1990). Pettenati et al. (2012) reported that Japanese 2-year-olds did not differ from their Italian peers in the production of representational gestures, and attributed the productions of these gestures to the prevalence of "learning while observing" style typical in the Japanese culture (but it is also possible that representational gestures are used more frequently in Japanese culture, Aiqui, 2004). In addition, we note that Australian children produced fewer representational gestures than British children. However, this difference was not significant. In general, the production of representational gestures was very low in the English-speaking groups.

The higher frequency of representational gestures for predicates as compared to nouns in Italian children was particularly noteworthy. This result is in line with previous cross-cultural comparisons that have reported more representational gestures in association with actions or events over objects words (Pettenati et al., 2012; Marentette et al., 2016). In contrast, British and Australian children did not produce more representational gestures in association with the predicates than the noun subtests. They also produced few predicate words in comparison to the Italian children. These two results may be related: if gesture scaffolds spoken language development, then a lack of gestural representations for actions and attributes may slow down the acquisition of verbal labels.



Overall, children produced more pointing and representational gestures in combination with speech than gestures alone. This is consistent with previous findings that two- and three-year-old children use bimodal combinations more frequently than unimodal gesture expressions in naming tasks (e.g. Italian children: Marentette et al., 2016, Stefanini et al., 2009; Australian children: Hall et al., 2013; British children: Huttunen et al., 2013, and Canadian English-speaking children: Marentette et al., 2016). However, the Italian children produced significantly more crossmodal combinations of speech and representational gesture than the two English-speaking groups, who did not differ in this respect. This finding highlights the intimate link between the motor system and speech in early language acquisition. Stefanini et al. (2009) argued that children's lexical knowledge at this age is not yet fully decontextualised from their sensorimotor experience. That is, when children produce a gesture and a word to describe an action, they do so because the two modalities are connected through the representational properties of the motor system.

Finally, the overall production of representational gestures was positively associated with age. This is not surprising given that previous data show an increase in the production of representational gestures at around 26 months of age (Özçalışkan & Goldin-Meadow, 2011). Representational gestures were positively associated with the accuracy of vocabulary comprehension. Indeed, Caselli et al. (2012) argued that word comprehension constitutes a bridge between action/gesture production and word production, or in other words, that the transition from action/gesture to word production is ontogenetically mediated by word comprehension. This may indicate an indirect cascading effect of culture on spoken language development, whereby living in a high gesture culture could lead to a facilitated word comprehension and subsequently faster early vocabulary production.

There are several limitations to this work. While we compared three samples of a given age range extracted from a corpus of data collected in formal testing situation, we acknowledged

that there are potential confounding variables related to the characteristics of the child populations and the testing environments. Children might invariably differ in the proportion of time spent on daycare attendance, which hereby potentially facilitates or inhibits their willingness to engage during a formal testing setting. Nevertheless, the fact that the vocabulary results are largely the same for the two English-speaking groups argues against the argument that home testing of the Australian children was an issue. It could also be argued that the gesture behaviour (gesture production) of a child could be inhibited in a formal setting but expressed when in everyday spontaneous interactions with caregivers or in children who are used to day-care and are more accustomed to formal testing. Rather, the high use of pointing gestures tells us that all children were highly engaged in the setting.

Further, we found that the Italian children outperformed the Australian and British children in the spoken task of the picture naming test. The difference may have emerged since the word items were originally selected by extracting the age of acquisition from the Italian MacArthur-Bates CDI (Bello, et al. 2010; 2012), reflecting possible cultural difference in the interpretation of the pictures. This limitation in the initial construction of the task could explain why the children from other languages and cultures (Japanese and Canadian children) gave fewer correct responses than Italian children. Future cross-cultural comparisons should ideally include an additional independent measure of linguistic skills (e.g., the MacArthur-Bates CDI). We could not include a cross-comparison of percentiles of the CDIs since the normative data for the vocabulary size of the words understood and said in British children (Oxford CDI, Hamilton et al., 2000) are not yet available for our age range (maximum age 25 months); in addition, there are no normative data for the words understood for Australian children as of yet (Kalashnikova, Schwarz, & Burnham, 2016). Notwithstanding these limitations, the formal controlled linguistic setting and the systematic investigation of the research questions guiding this study have

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contributed to a better understanding of the relative influence of gestures and vocabulary in three cultures.

### *Language or culture?*

Overall, our results suggest that both language and culture affect vocabulary development and gesture production. Spoken language as measured by production and comprehension on a naming task is purely affected by the target language, as Australian and British children performed similarly in the naming task but differed from the Italian learners.

A combination of language and culture, however, shapes the frequency and the type of gestures produced by children. The Italian children, who grow up in a gesture rich culture and are exposed to a high context communication style, produced significantly more representational gestures than British and Australian children. However, we also observed differences between British and Australian children, with Australian children pointing more often – as many as the Italian children - than British children particularly when the pointing gesture was produced in combination with the speech. These differences suggest that the frequency and the type of gestures produced are influenced by cultural differences - which remain to be identified - rather than by the language.

Notes

<sup>1</sup> All glosses for gestures are reported in small capitals following a convention adopted in many studies on children's gestures.

<sup>2</sup> Differences in colloquialism language are larger (e.g., Kidd, Kemp & Quinn, 2011), but in AusE are not typically used in child directed speech.

<sup>3</sup> Data available at:

<http://www.abs.gov.au/ausstats/abs@.nsf/DetailsPage/2033.0.55.0012011?OpenDocument>

(accessed 9/7/18). Note that 2011 data were used because the children of the Australian data were collected in 2010.

<sup>4</sup> Effect sizes for Wilcoxon signed-rank tests were calculated using the formula:  $r = \frac{z}{\sqrt{observations}}$  (as recommended by Field, 2013) and can be interpreted according to Cohen's (1988) criteria (where .1 = small, .3 = medium, and .5 = large).

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Table 1. Means and standard deviations of raw frequencies to the word comprehension and production of Italian (IC), Australian (AC) and British (BC) children in the nouns and predicates subtests.

Words	<i>Country group</i>					
	IC N = 22		AC N = 30		BC N = 35	
	Nouns	Predicates	Nouns	Predicates	Nouns	Predicates
	<i>M (SD)</i>		<i>M (SD)</i>		<i>M (SD)</i>	
<b>Comprehension</b>						
Correct	18.00 (1.69)	14.68 (2.87)	15.27 (2.84)	12.43 (3.48)	15.54 (2.95)	12.03 (4.20)
<b>Production</b>						
Correct	11.41 (3.61)	8.59 (3.89)	8.47 (3.67)	4.07 (2.97)	7.86 (4.12)	4.60 (3.28)
Errors	5.50 (3.85)	6.09 (3.28)	5.80 (2.02)	6.70 (3.15)	5.86 (3.09)	7.14 (2.91)
No responses	1.95 (2.17)	2.91 (3.72)	4.73 (3.67)	7.20 (4.30)	5.29 (4.90)	6.26 (4.91)

Table 2. Summary of the Kruskal-Wallis analyses for the overall and subtasks of the pointing (top) and representational (bottom) gestures of Italian (IC), Australian (AC) and British (BC) children.

Pointing gestures

	<i>df, N</i>	$\chi^2$	<i>p</i>	Median			U ( <i>p</i> )	U ( <i>p</i> )	U ( <i>p</i> )
				IC	AC	BC	N = 52	N = 57	N = 65
				IC	AC	BC	IC-AC	IC-BC	AC-BC
<i>Lexical category</i>									
Noun	2, 87	13.24	<b>.001</b>	4	7	2	354.5 (.649)	<b>214.0 (.005)</b>	<b>279.5 (.001)</b>
Predicate	2, 87	9.39	<b>.009</b>	4	3	2	290.5 (.461)	<b>219.0 (.006)</b>	<b>349.0 (.019)</b>
<i>Modality of expression</i>									
Unimodal	2, 87	0.48	.788	1	1	1	n/a	n/a	n/a
Bimodal	2, 87	17.35	< <b>.001</b>	7	8	2	304.5 (.636)	<b>168.0 (&lt; .001)</b>	<b>265.0 (.001)</b>
<i>Lexical category x Modality of expression x</i>									
Noun Unimodal	2, 87	1.81	.404	0	1	0	n/a	n/a	n/a
Noun Bimodal	2, 87	16.01	< <b>.001</b>	4	6	1	332.5 (.963)	<b>183.5 (.001)</b>	<b>267.5 (.001)</b>
Predicate Unimodal	2, 87	0.41	.815	1	1	0	n/a	n/a	n/a
Predicate Bimodal	2, 87	10.7	<b>.005</b>	3	2	1	271.5 (.269)	<b>202.0 (.002)</b>	<b>356.0 (.023)</b>

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Representational gestures

	<i>df, N</i>	<i>χ<sup>2</sup></i>	<i>p</i>	IC	AC	BC	Median U ( <i>p</i> ) N = 52	U ( <i>p</i> ) N = 57	U ( <i>p</i> ) N = 65
							IC-AC	IC-BC	AC-BC
<i>Lexical category</i>									
Noun	2, 87	7.47	.024	1	0	0	<b>207.0 (.010)</b>	<b>270.0 (.033)</b>	540.0 (.804)
Predicate	2, 87	38.57	< . <b>001</b>	2	0	0	<b>48.0 (&lt; .001)</b>	<b>95.5 (&lt; .001)</b>	628.0 (.096)
<i>Modality of expression</i>									
Unimodal	2, 87	5.48	.064	0	0	0	n/a	n/a	n/a
Bimodal	2, 87	30.7	< . <b>001</b>	3	0	0	<b>68.5 (&lt; .001)</b>	<b>126.0 (&lt; .001)</b>	584.5 (.357)
<i>Lexical category x Modality of expression</i>									
Noun Unimodal	2, 87	0.79	.673	0	0	0	n/a	n/a	n/a
Noun Bimodal	2, 87	8.05	<b>.018</b>	1	0	0	<b>206.0 (.007)</b>	<b>273.5 (.036)</b>	563.0 (.514)
Predicate Unimodal	2, 87	7.99	<b>.018</b>	0	0	0	<b>223.0 (.007)</b>	295.0 (.062)	577.5 (.270)
Predicate Bimodal	2, 87	36.80	< . <b>001</b>	2	0	0	<b>66.0 (&lt; .001)</b>	<b>111.0 (&lt; .001)</b>	549.0 (.659)

Note: Each measure in italics was entered for a Kruskal-Wallis analysis. When significant, further Mann-Whitney U statistics and p-values are shown on the columns IC-AC, IC-BC, and AC-BC. P values < 0.05 two-sided are shown in bold.



Table 3. Frequencies of elicited representational gestures for (a) nouns and (b) predicates in the Italian (N = 22), Australian (N = 30), and British groups (N = 35), as a function of the presented picture in the naming task.

a. Nouns	Italian	Australian	British	Total
Beach	0	0	1	1
Lorry/Truck	1	0	0	1
Seal	0	0	0	0
Bag	0	0	0	0
Banana	0	0	1	2
Picture	1	0	0	0
Hen/Chicken	0	1	1	2
Book	0	0	0	0
Socks	0	0	1	1
Comb	8	2	5	15
Table	0	0	0	0
Roof	0	0	0	0
Umbrella	6	0	3	9
Fork	2	1	2	5
Lion	5	1	2	8
Flags	3	2	4	9
Glass	2	0	1	3
Nappy	1	0	0	1
Gloves	3	2	6	11
Total	32	9	27	68

b. Predicates	Italian	Australian	British	Total
Small	3	0	1	4
Swimming	4	3	5	12
Empty	1	0	0	1
In	2	0	0	2
Kissing	6	1	2	9

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Clean	0	0	0	0
Falling	3	0	0	3
Eating	2	0	2	4
Washing hands	12	3	5	20
Smiling	4	1	2	7
In front of	3	0	0	3
Playing	2	0	0	2
Phoning	11	1	2	14
Far apart	1	0	1	2
Driving	4	0	0	4
Opening	6	0	1	7
Long	2	0	1	3
Pushing	3	1	3	7
Total	69	10	25	104

Figure captions

Figure 1. Examples of Picture-Naming Game picture sets of triplets of picture cards for the Noun subtest and Predicate subtest (either of an event or a descriptor) comprising a comprehension target (a. cat; b. building; c. short), a production target (a. dog; b. phoning; c. long) and a distractor picture (a. television; b. ripping; c. wet). Pictures are displayed in order as an example (comprehension, production, and distractor).

Figure 2. Mean number of correct words for (a) Lexical task (comprehension and production) and (b) Lexical category (nouns versus predicates) identified by Italian (IC), Australian (AC) and British (BC) children.

Figure 3. Box plots for the number of (a) pointing and (b) representational gestures produced by task and group (IC = Italian children; AC = Australian children; BC = British children). Outliers are depicted by small circles and extreme outliers by asterisks.

Figure 1

	Comprehension card	Production card	Distractor card
a. Noun			
	“Where is the cat?”	“What is this?”	
b. Predicate – event			
	“Who is building?”	“What is she doing?”	
c. Predicate - descriptor			
	“Which one is short?”	“What is this like?”	

Figure 2

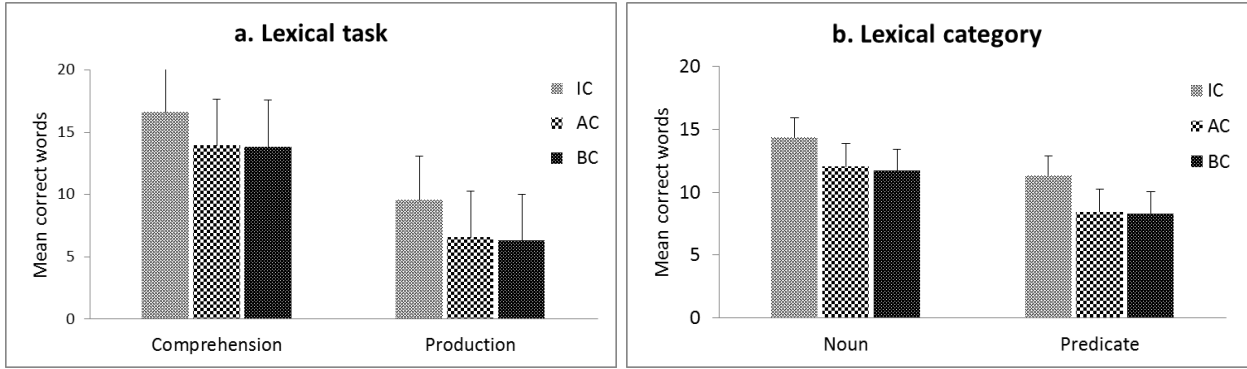
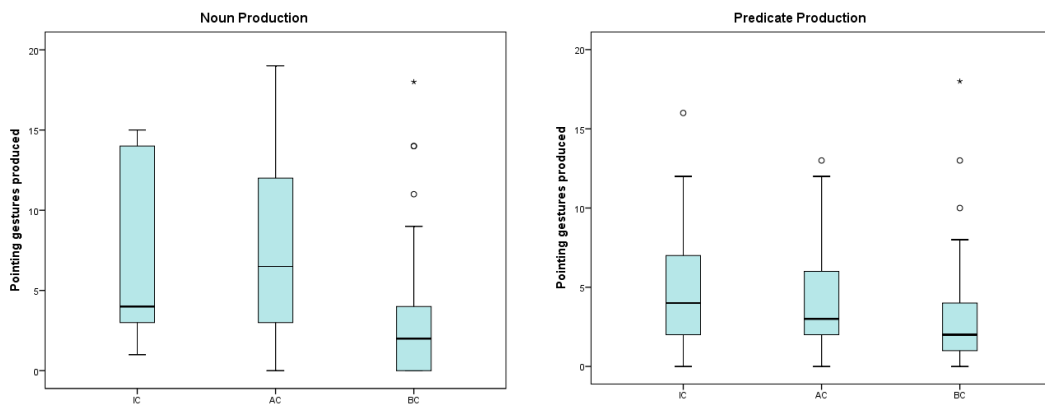


Figure 3

(a) Pointing gestures



(b) Representational gestures

