Preschoolers' Narrative Abilities Are Related to Gesture Accuracy but not to Gesture Rate

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Màster: Lingüística Teòrica i Aplicada
Edició: 2018-2019
Directors: Dra. Pilar Prieto Dr. Alfonso Igualada
Any de defensa: 2019

Col·lecció: Treballs de fi de màster

Departament de Traducció i Ciències del Llenguatge
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ACKNOWLEDGMENTS

First and foremost, I would like to thank my supervisors, Dr. Pilar Prieto and Dr. Alfonso Igualada for the patience and dedication with which they have guided me towards the completion of this thesis. I would also like to thank the members of the Prosodic Studies Group at Pompeu Fabra University whose previous data-collecting work has made this thesis possible. Most notably, I would like to thank Mariia Pronina, PhD candidate, and Eva Castillo-Sánchez, my fellow graduate student, for helping me with data-coding and inter-rater reliability tests, and for being there to answer all my questions.

Secondly, I would like to thank the participants in the experiments in this study and their schools for helping me in conducting the research.

My gratitude also goes out to Dr. Laia Mayol, my MA tutor, for her unwavering dedication and support during my studies.

Finally, I would like to thank my family. Their support and unconditional devotion to my dreams has been the first form of education I have ever received, as well as the most valuable one. Starting with mathematics and physics, they have introduced me to the world of science and art and have been by my side through numerous questions about statistics, late-night calls and many other emotional moments. For all of this, I remain forever grateful.

To my Mother.
ABSTRACT

Gesture accuracy has been related to the development of grammar between 24 and 30 months of age (Bates & Dick, 2002) and to the development of narrative skills (Castillo-Sánchez, 2019). However, less is known about whether narrative skills are also related to gesture frequency in younger populations in naturalistic settings and how gesture accuracy and gesture frequency differ in this context.

The present study asks whether preschoolers’ narrative abilities are related to two measures of gesture use, namely (i) gesture rates, and (ii) gesture accuracy. A total of 34 3- to 4-year-old children participated in a multimodal imitation task, gesture production task and a narrative task. Results show that narrative abilities positively correlate with gesture accuracy, but not with gesture rate, proving that language and gesture are integrated systems and that complementary measures of gesture performance can help us assess the relationship between gesture and language development.

Keywords: gesture accuracy, gesture rate, narrative abilities, language acquisition, preschoolers’ language development
1. Introduction

1.1. General overview

Co-speech gestures form an integral part of human communication. As such, they are present in the linguistic repertoire of speakers of all ages. Nowadays, researchers agree that language and gesture form an integrated system that exhibits a strong pragmatic, semantic and prosodic parallelism (e.g., Butterworth & Hadar, 1989; Levinson & Holler, 2014; McNeill, 1992, among many others). Furthermore, gestures can have both abstract and concrete referential meanings, and perform both a complementary and supplementary role in relation to the information conveyed by speech (e.g., Kendon, 1980; Levinson & Holler, 2014; McNeill, 1992).\footnote{According to McNeill’s classification, there are four types of gestures: deictic (or gestures of pointing with referential content only), iconic (or gestures depicting aspects of objects, entities or events), metaphoric (or gestures representing abstract concepts) and beats (or prosodically aligned gestures which typically reinforce a message).}

In the context of language acquisition, gesture stands out as a precursor to verbal communication, as well as a predictor of future development of a variety of language skills at different points in time. On the average, children start using the pointing gesture communicatively at 11-12 months of age (Camaioni, Perucchini, Bellagamba, & Colonnese, 2004; Carpenter, Nagell, & Tomasello, 1998). With time and the onset of language, children become better at producing gestures (Colonnese, Stams, Koster, & Noom, 2010). Importantly, many studies have shown that this pointing behavior has the role of a predictor and a precursor in relation to later language skills (Butterworth & Morissette, 1996; Goldin-Meadow, 2007). Firstly, the frequency with which children produce pointing gestures at 12 months of age positively correlates with the size of their lexicon at 20 months (Camaioni, Castelli, Longobardi, & Volterra, 1991). Secondly, evidence shows that already at the
babbling stage, infants not only combine deictic gestures and vocalizations, but also align them temporally, marking the transition onto the one-word language (e.g., Esteve-Gibert & Prieto, 2014). Prior to the onset of single-word utterances, children use pointing to refer to objects and entities around them and manipulate the attention of the people in their environment (Bavin, 2014; Ozçalişkan & Goldin-Meadow, 2005). Some months later, the production of two-word utterances is also preceded by a particular form of gesture use, namely, the gesture-plus-word pairings where both gesture and words have either the same (complementary use) or different (supplementary use) referents (Ozçalişkan & Goldin-Meadow, 2005). In a longitudinal observational study that focused on children between 10 and 24 months of age, Iverson and Goldin-Meadow (2005) found that deictic gestures predict the content of child’s later vocabulary, as well as that children using supplementary gesture-plus-word pairings were the first to switch to two-word communication. Furthermore, cross-linguistic evidence shows that children exhibit pragmatic skills through gesture before they do so through language, and combining gestural and prosodic patterns, they learn to produce and comprehend different speech acts (Hübscher & Prieto, 2019). All this evidence shows that gesture both precedes verbal skills and predicts future linguistic development, suggesting a facilitating role in language acquisition (Iverson & Goldin-Meadow, 2005, p. 370).

Literature in the field of language development has previously investigated children's narrative abilities in relation to their gesture abilities (Demir, Levine, & Goldin-Meadow, 2015; Vilà-Giménez, Igualada, & Prieto, 2019). Demir and colleagues (2015) performed a longitudinal study which tested children’s story-retelling abilities once a year from ages 5 to

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2 The supplementary function of gestures can carry propositional content such as nominal modification (e.g., a child point to a shoe and says “mommy” to communicate “mommy’s shoe”) or predicates (e.g., pointing to a bird and saying “nap” to convey the message of the bird napping) (Iverson & Goldin-Meadow, 2005). On the other hand, the complementary function of gesture is manifested by the child referring to an item both verbally and manually.
8. They asked the participants to retell the contents of a wordless cartoon and reported that the children’s performance gradually improved with each testing. Their findings showed that those children who used gestures to express character viewpoint at age 5 were more likely to perform better during the later tests. These results suggest that gesture plays the same predicting role with narrative discourse abilities as it does with acquisition of vocabulary and syntax, anticipating the further stages of development. Furthermore, gesture plays a positive role in boosting preschoolers' narrative performances after training. Vilà-Giménez and colleagues (2019) conducted a between-subject study with a pretest and posttest design, including a training session consisting of story-telling in two conditions - (i) with beat gestures marking focal parts of the narrative and (ii) without beat gestures. The results showed that children at the ages of 5 and 6 immediately benefited from being exposed to narratives with beat gestures by being able to better structure their own narratives at the posttest stage. While the precursor role of gesture has been consistently demonstrated at distinct stages of development, less is known about whether gesture performance at a given point in time correlates with language abilities.

Using various tasks where children were asked to reproduce modeled series of communicative and non-communicative gestures, a set of studies showed that gesture imitation skills are strongly related to language in both typically-developing children and children with Autism Spectrum Disorder (ASD) (Bates et al., 1988; Bates & Dick 2002; Bauer, Hertsgaard, Dropik, & Daly, 1998; Ingersoll & Lalonde, 2010; Snow, 1989; Stone, Ousley, & Littleford, 1997). For example, Snow (1989) found that infants’ gesture and vocal imitation skills at 14 months of age predicted their language skills at 20 months of age. Gesture accuracy scores in imitation tasks have been found to be related to the development of grammatical skills between 24 and 30 months of age (Bates & Dick, 2002). Bauer and
colleagues (1998) showed that 24- and 28-month old infants with higher early grammar and vocabulary skills also performed better at imitating more complex, five-step sequences of actions. Interestingly, adding gesture imitation to object-based imitation in the training of children with ASD has stronger benefits for children’s language skills than using object-imitation alone (Ingersoll & Lalonde, 2010). To the best of our knowledge, the only study investigating the link between children’s narrative abilities and their gesture imitation skills (in addition to object-based imitation), is a study conducted by Castillo-Sánchez (2019). She found that the narrative abilities of a set of 31 Catalan-speaking 3- and 4-year-olds were positively correlated with gesture imitation scores, suggesting a strong link between imitation and narrative skills.

Little is known about whether another aspect of gesture performance, i.e. gesture frequency, is related to narrative skill development in young preschoolers. To our knowledge, at least one study seems to point to a positive relationship between the two. Using a narrative retell task, Colletta and colleagues (2015) performed a comparative study of narrative and gesture abilities of three groups of children - American, Italian and French 5- and 10-year-olds. They reported that in all three language groups, gesture and narrative development occurred in parallel and that children produced more complex narratives and more frequent discursive co-speech gestures with age. Specifically, in all three groups, older children were found to tell longer and more detailed narratives than the younger children. Also, older children produced more co-speech gestures that contributed to the structure of the narratives (e.g., beats or gestures that accompany connectors and discourse markers) and that integrate the information conveyed through language. They also produced more referential gestures than the younger children although this difference was not significant. Given the parallelism in gesture and narrative development found by Colletta et al. (2015) and the effects of age on
this development, it emerges as paramount to further investigate whether narrative skills are also directly related to gesture frequency in young preschoolers in naturalistic settings.

The object of this study are preschoolers’ gesture use and their narrative abilities. In previous research, narrative abilities have been taken as an ecologically-valid measure of language skills with more success of indicating certain language impairments than other, often standardized measures (Demir, Levine, & Goldin-Meadow, 2010; in Paul, Norbury, & Gosse, 2018, p. 124). Representing yet another linguistic milestone in their development, narratives require children to use syntactic and semantic means to form extended discourse with displaced perspective, i.e. discourse about “then-and-there” (Demir & Kuntay, 2014, p. 393). From a young age, narratives form a pivotal discourse form in a child’s life as they encounter them in storybooks, storytelling activities with caregivers and other art forms suited for their age. Around 22 months of age, following the onset of sentential language use, children start referring to past events albeit with substantial help from their caregivers (Eisenberg, 1985; Sachs, 1982; in McCabe & Rollins, 1994, p. 49). What follows is a period of gradual structural improvement of narrative skills, as well as a thematic focus on negative subjects such as personal accidents, ill luck or other types of negative events (McCabe & Rollins, 1994). In a developmental analysis of narrative structure in preschoolers, McCabe and Rollins (1994) state that around the age of 3;6, children produce a sequence of no more than two events. This number increases by the age of 4, when temporal sequencing is still omitted but by the age of 5, children overcome this problem and manage forming full-fledged narratives (branded Classic Narratives, for structural overview see McCabe & Rollins, 1994). Similarly, Applebee (1978) states that children only start producing “true narratives” around ages 5 and 6, and the complexity of the narrative structure keeps developing with age (Berman & Slobin, 1994; McCabe & Peterson, 1991).
The present study aims to assess the relationship between two measures of gesture performance (gesture accuracy and gesture frequency) and narrative abilities in ages 3- to 4-year-old children. To our knowledge, only one study has assessed a variety of gesture scores with typically-developing children (TD) and children with language impairment (LI). Namely, Wray and colleagues (2017) have found that the TD group has higher gesture accuracy scores, but not gesture frequency scores than the LI group (Wray, Saunders, McGuire, Cousins, & Norbury, 2017). Also, the authors found that across groups, language scores (measured through a vocabulary test) correlated with gesture accuracy scores, but did not correlate with gesture frequency.

1.2. Research question and hypotheses

In summary, previous studies on gesture development have shown that gestures are strongly linked to language acquisition and that they function as precursors of language. However, less is known about whether different measures of gesture performance (i.e., gesture accuracy and gesture frequency) are concurrently related to language skills. The aforementioned study conducted by Wray et al. (2017) found clear differences between the two. In the same vein, we are interested in assessing both the quantitative and qualitative measures of gesture use. However, unlike the study conducted by Wray et al. (2017), which focused on school-aged children ages 6-8, we focus on typically-developing 3- and 4-year-old children. It is particularly interesting to focus on this stage, as children have just entered the stage of narrative development (McCabe & Rollins, 1994). Thus, we ask if the relationship between language and gesture is evident both in how frequently children gesture and in the accuracy with which they imitate gestures. Namely, we want to know if preschoolers’
narrative abilities are equally related to their gesture accuracy and their gesture rate scores. The present study has a number of advantages over previous investigations, such as the age of the participants and the analyzed language and gesture measures.

We aim to answer two questions:

1. Do narrative abilities of 3- to 4-year-old children correlate with gesture imitation (e.g., gesture accuracy) measures?
2. Do narrative abilities of 3- to 4-year-old children correlate with gesture frequency (e.g., gesture rate) measures?

In line with previous results, we hypothesize that gesture rate and gesture accuracy are not equally indicative of a child’s language skills and that gesture accuracy scores will be more strongly linked to narrative abilities than gesture rate scores.

2. Methods

The main purpose of the study is to assess the relationship between narrative skills and two measures of gesture performance (i.e., gesture accuracy and gesture rate) in preschoolers ages 3 and 4.

2.1. Participants

A total of 28 (N=28) 3- to 4-year-old native Catalan-speaking children participated in the study (15 male and 13 female, M age = 45.88 months, SD = 4.2; range 39 – 52 months). Participating children attended preschool programs at two public schools (Escola Antoni Brusi and Escola Bogatell) in the middle-income area of Sant Marti in Barcelona, Catalonia,
Spain. The schools’ population is Catalan-Spanish bilingual and the main language of instruction is Catalan. The initial sample included 34 (N=34) typically-developing children. However, some participants had to be excluded from the study. In addition to 4 children who had to be excluded for issues of technical nature, such as missing video material, another 6 children were excluded from the analysis because they had insufficient levels of proficiency of or daily exposure to Catalan. In order to determine participants’ overall proficiency levels, a standardized test of vocabulary size was administered prior to the experiment (ELI, Saborit Mallol, Marzá & Navarro Lizandra, 2005). This test, used as a screening measure, is designed for Catalan-speaking children up to the age of 6. It consists of a picture-naming task including 30 every-day items. For each correctly named item, a child scores 1 point, leading to a maximum score of 30 which was then normalized on a scale of 0-100. Children with less than 20% of the maximum score were excluded from the study.

Prior to the experiments, the parents were asked to sign a consent form and fill in a questionnaire on children’s linguistic profile that focused on daily exposure to Catalan and Spanish (M = 55.75; SD = 21.6). Only children with reported 50% or above of daily exposure to Catalan were included in this study.

2.2. Procedure

The experiments in this study are part of a larger project, as well as the sample of participants, form a part of a larger within-subject research design that was conducted in the year of 2018 by the Prosodic Studies Group (GrEP) at Pompeu Fabra University. The main purpose of the project was to collect a varied set of behavioral and language data on language and pragmatic development in a preschool setting. The data collection was mainly performed
by Mariia Pronina and Eva Castillo-Sánchez in two Barcelona schools for the purposes of other studies by the Research Group for Prosody Studies (GrEP) at Pompeu Fabra University (Pronina, 2019, PhD Research Proposal; Castillo-Sánchez, 2019, MA Thesis). The data has been adapted from the GrEP research group’s corpus for the purposes of this thesis.

For the present study, a total of three tasks were taken from the original research project. Two were taken in their entirety (Multimodal Imitation Task and Renfrew Bus Story Test), and the remaining task in an altered form. This other task, the Audiovisual Pragmatic Test (APT) was altered with the aim of addressing the research question of this study. We analyzed a limited number of target items and used the task to obtain gesture rate scores.

The analyzed corpus consists of videos of children’s performance during the three aforementioned tests. The three tasks were conducted in a quiet room at each corresponding school with one child at a time and one experimenter. The child was seated at a table with a tablet device behind which camera was placed facing the child and the experimenter. In the following subsections, we provide further details on the procedure and the process of data collecting and analysis for each of the three tasks.

2.2.1. Renfrew Bus Story Test

2.2.1.1. Main goals and task description

The purpose of this task was to assess participants’ ability to form well-structured narratives about characters and sequences of events. Narrative retell tasks are frequently used in studies about children’s narrative skills. This particular task was based on the Renfrew Bus Story test (Renfrew, 1997) and adapted for Catalan speakers. The test consists of a story
including a sequence of events revolving around a bus, a set of colorful imagery for visual support, and a toy to which the child should retell the story.

Participants were told the story revolving around the main character (the bus), accompanied by visual aids in the form of computer images outlining the contents of the story. Subsequently, the children were instructed to retell the story to a plushy toy. The toy was only introduced when the child was asked to retell the story so that they would be motivated to perform the task, because they were aware that the experimenter was already familiar with the story. In case the participant produced no answer even after further prompting by the experimenter or clearly indicated that they wished not to proceed, the task would be discontinued.

2.2.1.2. Data analysis

Narrative performance was assessed using a narrative structure score scale ranging from 0 (minimum score) to 6 (maximum score) (adapted from Vilà-Giménez, Igualada, & Prieto, 2019). The scale was designed to reflect the children’s ability to form narratives (see Appendix 1 for the detailed scoring system). While narratives that included only characters and other descriptive details fell in the lower end of the scale, narratives producing sequences of events that were causally related fall in the higher end of the scale. This score was also normalized on a 0-100 scale.

2.2.1.3. Inter-rater reliability

Inter-rater reliability test was conducted by the author and two other independent coders to establish the reliability in coding. The results of the test for the narrative structure

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3 The author expresses gratitude to Eva Castillo-Sánchez and Mariia Pronina for help and participation in inter-rater reliability tests.
score suggest high agreement between coders, with 80.95% of overall agreement and the free-marginal kappa of 0.78.

2.2.2. Multimodal Imitation Task

2.2.2.1. Main goals and task description

The purpose of the Multimodal Imitation Task (Pronina, 2019) was to test children’s ability to accurately reproduce meaningful gestures. The task involved a 12-item test which was designed based on items the Reciprocal Imitation Training technique used in the behavioral training of children with ASD (Ingersoll & Lalonde, 2010) (see Appendix 2 for a full list of target items). The twelve items were preceded by a familiarization item and presented in the form of pre-recorded videos of a Catalan-speaking actor presenting conversation prompts. The prompts consisted of exclamatives, imperatives and questions revolving around a teddy-bear character named Esmolet and a toy lizard.

Each child was tested separately by one experimenter in a quiet setting. The child was seated at a table with a tablet on it behind which a camera was set up. First, the children were presented with the familiarization item so that the demands of the task would be clear to them. Each item was repeated two times in the video format and once by the experimenter themselves before the child was asked to repeat it. A pause of 7 seconds was included between each item.

2.2.2.2. Data analysis

Elicited gesture accuracy was rated on a three-point scale from 0 to 2 per item (total $12 \times 2=24$), where 0 stood for no or very low performance manifested by an absolute lack of
resemblance between the model gesture and the child's imitation, 1 for an approximation between both, and 2 for an accurately imitated gesture. The total score was then normalized on a scale of 0-100.

2.2.2.3. Inter-rater reliability

Inter-rater reliability test for gesture imitation score was conducted by the same group of coders as in the case of the previous task. The results of the test suggest a high level of agreement between coders with 84.13% of overall agreement and the free-marginal kappa of 0.76.

2.2.3. Audiovisual Pragmatic Test

2.2.3.1. Main goals and task description

The purpose of this task was to assess children’s gesture abilities using a quantitative measure (gesture rate) with the aim of assessing how frequently children would produce gestures in a semi-natural context. With this purpose in mind, a subset of items was selected from the Audiovisual Pragmatic Task (APT), developed by Pronina, Hübscher, Vilà-Giménez, & Prieto (2019). The original purpose of the APT is to test pragmatic and prosodic skills of typically-developing children who are native speakers of Catalan and it is based on similar pragmatic tests oriented to children (e.g., the Test of Pragmatic Language (TOPL-2) (Phelps-Terasaki & Phelps-Gunn, 2007); the Clinical Evaluation of Language Fundamentals–5 (CELF-5) instrument (Wiig, Semel, & Secord, 2013); and the Comprehensive Assessment of Spoken Language–2 (CASL–2) tool (Carrow-Woolfolk, 2017)). The full APT consisted of 47 items that presented children with everyday contexts to elicit natural and spontaneous
responses to given scenarios. These scenarios were presented in a manner that was comprehensible to and appropriate for the participants’ age and potentially further adapted to the participant’s individual needs (i.e., if need be, items were further explained by mentioning entities and people that were familiar to the child).

For the purposes of the present study, a total of 10 items were selected from the original version of APT (see Appendix 3). Items were selected based upon an initial analysis of the corpus which determined that they were the most likely to result in children’s a spontaneous use of gesture as children were generally rare to produce any gestures. A bar chart at the end of the section illustrates the gesture response rate per item. The items were presented in a fixed order determined by the gradual increase in difficulty. The task was administered to a total of 100 children (N = 100), during a span of one hour (together with other tasks that formed the study, in two blocks) for the purposes of a PhD thesis research (Pronina, 2019). Thirty-four children out of the initial 100 were included in this study.

Children were presented with the scenarios from the 10 selected items by the experimenter in a lively conversational manner suitable for children. Visual support in form of images accompanied the content on the tablet screen. The children were asked how they would respond to each of the situations depicted by the given scenarios.

2.2.3.2. Data analysis

Data pertaining to this task was coded solely by the author of this thesis. Gesture rate was coded on a two-point scale. For each of the 10 items, the child was awarded either 0 or 1 based on whether a context-appropriate gesture was produced or not, yielding to a maximum score of 10. However, since not all children responded to all items in the original experiment
the task was discontinued if the child showed inability to provide a response to a number of consequent items), gesture rate was assessed by calculating proportion of gestures out of the number of items the child did answer, as follows:

\[ x = \frac{z \times 100}{y} \]

where \( x \) corresponds to the child’s score in the task, \( y \) to the number of items they answered, and \( z \) to the number of gestures the child produced.

### Percent of elicited gestures per item (out of maximum 34)

![Figure 1: A bar chart showing the percentage of children (for each item) that responded with co-speech gestures to the ten items out of the initial 34 participants.](image)

**2.3. Statistical analyses**

Upon normalizing the values for all three measures on a 0-100 scale, two Pearson bivariate correlations were performed to analyze the relationship between children’s narrative abilities on one hand, and gesture performance (gesture accuracy scores and gesture rate scores) on the other. The statistical analysis was performed in SPSS Statistics 25.0 (IBM Corp., 2017) and included scores of 28 children. We calculated (i) a correlation between
gesture rate scores and narrative structure scores; and (ii) a correlation between gesture accuracy scores and narrative structure scores.

3. Results

First, we asked whether children’s narrative skills would be related to the number of gestures they produced during the Audiovisual Pragmatic Test. The results showed no significant correlation between gesture rate scores and narrative structure scores ($r = -0.305, p > 0.05$).

Second, we asked whether children’s narrative abilities would be related to the ability to accurately produce meaningful gestures. The results show that there is a significant positive correlation between these two scores ($r = 0.424, p = 0.024$). Table 1 shows the results of the two bivariate Pearson correlations we performed.

<table>
<thead>
<tr>
<th>Correlations</th>
<th>Narrative structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gesture rate</strong></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>-0.305</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.115</td>
</tr>
<tr>
<td>N</td>
<td>28</td>
</tr>
<tr>
<td><strong>Gesture accuracy</strong></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>0.424</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.024</td>
</tr>
<tr>
<td>N</td>
<td>28</td>
</tr>
</tbody>
</table>

*Table 1:* Results of the bivariate Pearson correlations between the two independent variables (gesture rate and gesture accuracy) and the dependent variable (narrative structure).
4. Discussion and conclusions

The results of the present study show that preschoolers’ narrative abilities are positively correlated with accuracy scores during a gesture imitation task. This result expands upon previous research which shows that gesture imitation is related to various language skills in children (Bates & Dick, 2002; Snow 1989; Wray et al., 2017). Snow (1989) found that gestural imitations at 12 months predicted vocabulary size at 20 months. Also, imitation skills are related to the outburst of grammar skills between 24 and 30 months (Bates & Dick, 2002). Wray et al. (2017) found that gesture imitation and vocabulary are also related in school-aged children. These findings suggest that gesture imitation and language skills show consistent relations across different ages and populations of children.

By contrast, this study finds no correlations between 3- and 4-year-old children’s narrative abilities and gesture rate scores. It is worth noting that there are other, non-linguistic factors which have been shown to affect the frequency with which people gesture. For example, Alibali (2005) offers a review on the matter suggesting that factors such as culture, the employed experimental task, the setting and the content of the conveyed message, as well as individual differences may all affect the rate to which people gesture. In this study, she states that the tasks known to elicit highest rates of gestures in speakers are narrative retell and direction-giving tasks which she contributes to the fact that both involve conveying of spatial information (Alibali, 2005, p. 322). McNeil and Alibali (2001) found that students with higher levels of performance motivation gesture more frequently while giving explanations to math problems. Also, regarding gesture frequency, Demir et al. (2015) note that due to the generally low rates of gesture their participants produced during narrative tasks, gesture rate could not be taken as an indication of their language skills.
These results support previous research which shows that gesture and language are strongly connected and form a multimodal system of communication. This study offers a state-of-the-art insight into the gestural and narrative abilities of children ages 3 and 4 and examines them in relation to two measures of gesture use, namely, gesture accuracy and gesture rate. Firstly, we found a significant positive correlation between gesture accuracy and narrative structure scores, indicating that children who accurately replicated modeled gestures also produced better narratives. Thus, our results support the findings in Colletta et al. (2015) and Wray et al. (2017) and prove the hypothesis of integration of language and gesture. Secondly, we found no significant correlation between gesture rate and narrative structure scores, indicating that children who produced better narratives did not also gesture more frequently. These results indicate differences between gesture accuracy and gesture rate as measures of gesture production. While the results of the tasks examining gesture rates may vary across studies, the accuracy with which children imitate gestures consistently points to strong links with language skills. Together, these results indicate (1) that there is a link between gesture and narrative abilities in typically-developing preschool children, and (2) that gesture accuracy during gesture imitation stands out as a better indicator of children’s language skills.

Furthermore, from a methodological point of view, it proves relevant to assess gesture performance using a variety of tasks to gain a clearer insight into their production. This is due, in part, to the fact that different tasks may lead to different results. For example, in the study by Wray et al. (2017), no differences in gesture rates were found between children during a narrative-retell task. For this task, the children were asked to retell the contents of a wordless cartoon. Their gesture rate scores in the task did not correlate with their vocabulary skills. However, in a more demanding communicative task, the children with lower language
scores gestured more frequently. This task required children to perform a problem-solving activity together with their parents where both parties were encouraged to communicate naturally. The results showed that vocabulary skills and gesture rates had a significant negative correlation. Together, these findings suggest that while there is compelling evidence for gesture-speech integration, different tasks and different measures of gesture production need not point to the same generalizations.

As a potential limitation of our study stands the relatively small sample of participants (N < 30), as well as the fact that investigation into gesture rate and gesture use in young children, warrants for the control of other factors, such as potential discomfort brought about by the experimental environment or the communicative style of the child, which has been shown to affect gesture rates together with some other non-linguistic factors (Alibali, 2005). Future research into gesture use of young preschoolers should thus give insight into gesture rate in the context of communicating with caregivers, which tends to induce little to no anxiety on the child. Similarly, future research should compare gesture accuracy and gesture rate measures in the context of longitudinal correlations with language skills as well as the concurrent one given in this study.

All in all, the present study presents a significant contribution to the research on gesture production and language skills during the early phase of narrative development. Despite the number of participants reduced by technical matters, our sample still provided statistically-significant results suggesting the relationship between narrative skills and gesture use in young children. Importantly, our study confirmed the strong links between imitation and language skills in typically-developing children by finding significant correlations between gesture accuracy and narrative structure scores. Additionally, the study focused on a very important age-span, namely 3 to 4 years of age, which represents the earliest onset of
narrative discourse in children. Finally, our results showed that gesture rate is not as strongly related to language as gesture accuracy. Thus, our results not only prove our initial hypothesis, but also provide detailed insight into the narrative and gestural repertoires of children at a crucial time of language development by comparing two measures of gesture use and relating them to narrative discourse abilities.
5. References


6. Appendices

6.1. APPENDIX 1: Renfrew Bus Story Test

Coding system for narrative structure scores for the Renfrew Bus Story Test (adapted from Vilà-Giménez et al. 2019) (Castillo-Sánchez, 2019, MA Thesis).

<table>
<thead>
<tr>
<th>SCORE</th>
<th>EXPLANATION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No structure or descriptive sequence.</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>Descriptive sequence with the characteristics of the main character but no sequence of actions.</td>
<td>Un autobús (‘A bus’)</td>
</tr>
<tr>
<td>2</td>
<td>Only one action is described (typically, the final action); descriptive sequences may be added.</td>
<td>L’autobús va caure al llac (‘The bus fell into the lake’), I què més? (Anything else?) El conductor va telefonar una grua (‘The driver called for a tow’)</td>
</tr>
<tr>
<td>3</td>
<td>Only one action/event is mentioned but more actions are described after the experimenter asks children if they want to add something else (no temporal or causal order).</td>
<td>- L’autobús va caure al llac (‘The bus fell into the lake’) - I què més? (Anything else?) - El conductor va telefonar una grua (‘The driver called for a tow’)</td>
</tr>
<tr>
<td>4</td>
<td>A sequence of actions is described in a temporal but not causal order.</td>
<td>L’autobús va caure al llac i el conductor va telefonar una grua (‘The bus fell into the lake and the driver called for a tow’)</td>
</tr>
<tr>
<td>5</td>
<td>Actions are temporally and causally organized.</td>
<td>L’autobús va caure al llac perquè no sabia frenar i el conductor va telefonar la grua (‘The bus fell into the lake because he didn’t know how to stop, and the driver called for a tow’)</td>
</tr>
<tr>
<td>6</td>
<td>The narrative is complete, including temporal and causal structures, and details about the story.</td>
<td>-</td>
</tr>
</tbody>
</table>
6.2. APPENDIX 2: Multimodal Imitation Task

The complete list of 12 items of the Multimodal Imitaton Task (Castillo- Sánchez (2019, MA Thesis)).

<table>
<thead>
<tr>
<th>Trial</th>
<th>Example</th>
<th>Gesture/ emotional expression and lexical content</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="Image1" alt="Image" /></td>
<td>Hand waving</td>
<td></td>
</tr>
<tr>
<td>Familiarization item</td>
<td><img src="Image2" alt="Image" /></td>
<td><em>Hola Esmolet!</em> ‘Hello Esmolet!’</td>
<td>Conventional</td>
</tr>
<tr>
<td>1</td>
<td><img src="Image3" alt="Image" /></td>
<td>Palm face down, caressing the toy softly</td>
<td>Action</td>
</tr>
<tr>
<td></td>
<td><img src="Image4" alt="Image" /></td>
<td><em>Esmolet, ets tan suau!</em> ‘Esmolet, you are so soft!’</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><img src="Image5" alt="Image" /></td>
<td>Quick downward movement with the right hand</td>
<td>Iconic</td>
</tr>
<tr>
<td></td>
<td><img src="Image6" alt="Image" /></td>
<td><em>Esmolet, anem al parc a baixar pel tobogan?</em> ‘Esmolet, let’s go to the park to go down the slide?’</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><img src="Image7" alt="Image" /></td>
<td>Spinning the finger in circles</td>
<td>Iconic</td>
</tr>
<tr>
<td></td>
<td><img src="Image8" alt="Image" /></td>
<td><em>I després pujarem al carruse!</em> ‘Afterwards we will play with the merry-go-round!’</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| 4 | ![Image](image1.png) | Hand rubbing the stomach  
_Esmolet, per sopar menjarem una truita molt bona!_  
‘Esmolet, we’ll be eating a tasty omelet for dinner!’ | Metaphoric |
| 5 | ![Image](image2.png) | Opening up the palms of the hand and then bringing them back together  
_Esmolet, abans d’anar a dormir llegirem un llibre!_  
‘Esmolet, before going to sleep we will read a book!’ | Iconic |
| 6 | ![Image](image3.png) | Hands pressed together by the face as if sleeping  
_Esmolet, ara anem a dormir!_  
‘Esmolet, let’s go to sleep!’ | Metaphoric |
| 7 | ![Image](image4.png) | Finger to lip  
_Shhh, que l’Esmolet està dormint._  
‘Shhh, Esmolet is sleeping.’ | Conventional |
| 8 | ![Image](image5.png) | Hands covering the eyes  
_Quita por que fa aquest llangardaix!_  
‘This lizard is so scary!’ | Conventional |
| 9 | ![Image](image6.png) | Wagging finger as if scolding  
_Això no es fa, llangardaix!_  
‘No-no, naughty lizard!’ | Conventional |
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Shrugging shoulder with hand palms facing upwards</td>
<td><strong>On us heu ficat?</strong>&lt;br&gt;‘Where are you?’</td>
<td>Conventional</td>
</tr>
<tr>
<td>11</td>
<td>Wrapping one’s hands around oneself</td>
<td><strong>Veig que sou molt amics!</strong>&lt;br&gt;‘I see that you are very good friends!’</td>
<td>Metaphoric</td>
</tr>
<tr>
<td>12</td>
<td>Hand-clapping</td>
<td><strong>Bravo! Ho heu fet molt bé!</strong>&lt;br&gt;‘You have done it great!’</td>
<td>Conventional</td>
</tr>
</tbody>
</table>
6.3. APPENDIX 3: Audiovisual Pragmatic Test

Selected items from the Audiovisual Pragmatic Test (extracted from the original version for the purposes of this study, taken from Pronina 2019, PhD project proposal).

<table>
<thead>
<tr>
<th>Item 1</th>
<th>Item 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>This girl has a sister. And what about you? Do you have any sisters or brothers?</td>
<td>Imagine that your grandmother surprisingly visits you at home. She knocks on the door and you open it. What would you say?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 3</th>
<th>Item 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imagine that today you have gone to the cinema with your family, and your little brother has started talking loudly in the middle of the movie in a disrespectful manner. What would you say to make him be quiet?</td>
<td>Imagine that you mother leaves for work. What would you say as she is walking out the door?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 5</th>
<th>Item 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imagine that you are eating a piece of cake and when you finish, your aunt asks you “Do you want more?” What would you say?</td>
<td>Imagine that you enter the classroom in the morning. What would you say to your teacher?</td>
</tr>
</tbody>
</table>
Item 7
Imagine that you are having lunch with your friend’s parents. Your friend’s mother offers desert to you but you are already full. What would you say?

Item 8
You have come to visit Joan with one of your friends. You entered the room and you immediately saw that his favorite toy was near the door. A moment later your friend tells you that he has lost his toy and asks you whether you have seen it. What would you say?

Item 9
Imagine that you are in your grandmother’s house and she is a bit deaf. You just told her that you want a snack because you are very hungry but she has not heard your well and she asks you “Do you want to go for a walk?”. How would you tell her that that’s not what you want, you want a snack instead?

Item 10
Imagine that you do not like bananas. You are having desert after lunch and your mother gives you one, sure that you like them. She is very sure about it. You want to tell her that you do not like bananas. What would you say?