Non-referential beat gestures as a window onto the development of children's narrative abilities

Ingrid Vilà i Giménez

TESI DOCTORAL UPF / 2020

DIRECTOR DE LA TESI

Dra. Pilar Prieto

DEPARTAMENT DE TRADUCCIÓ I CIÈNCIES DEL LLENGUATGE

Universitat Pompeu Fabra
Barcelona

Als meus pares, Joan i Pilar,

Als meus avis

Acknowledgments

Writing a thesis is not only one big thing. A thesis consists of a lot of small things that help and encourage you through an exceptional journey. But things end and another chapter is about to open —and that's life! Throughout the course of my PhD, I have not only grown professionally, but also on a personal level, and I have been enriched by the multiple experiences and people that I have come across on my way. In this section, I would like to take time to acknowledge all those people who gave me their support during these years, and that have contributed, in one way or another, to make this journey an unforgettable experience to me.

First and foremost, there are no proper words to convey my deepest gratitude for my thesis supervisor, Pilar Prieto, for giving me a chance to start my research career and for having trusted me, and having counted on me since the first minute. Pilar, your patience, positivity (above everything), research enthusiasm, passion and dedication have been constant sources of energy, guidance and encouragement. Thank you for having offered me your unconditional time, your endless help and big doses of constant support. Also, thanks for appreciating me on my every little step I made and for helping me to be independent —this has meant a lot to me. And for giving me the great opportunity to participate in many scientific projects and conferences. Finally, I appreciate that I always could share both my professional and my personal life with

I would also like to thank the members of my thesis committee, Dr. Şeyda Özçalışkan (Georgia State University), Dr. Maria Graziano (Lund University) and Prof. Dr. Katharina Rohlfing (Paderborn University), and also to the substitute members Dr. Núria Esteve-Gibert (Universitat Oberta de Catalunya) and Dr. Melina Aparici (Universitat Autònoma de Barcelona). Thank you for accepting to be part of my thesis committee, as well as for taking the time to carefully read my work and for your inspiring comments. I am very grateful.

My sincere thanks must also go to Prof. Susan Goldin-Meadow (University of Chicago) and to Dr. Ö. Ece Demir-Lira (Iowa University). Thank you for welcoming me so warmly during my three-months research stay at the Goldin-Meadow Laboratory (Dept. of Psychology). I feel very fortunate and honored to have met you, and also to have attended your Lab meetings (with nice food!) and to have learned a lot from all the Goldin-Meadow Lab team. You have inspired me a lot. Thank you for providing me with a great amount of knowledge in the field of gestures and cognitive and language development, apart from other related fields. Discussions with you and your team have been illuminating. Also, thank you to Natalie Dowling, with whom I shared most of my time

the office, deep conversations, lunches, sweets (at any time!), conference trips, seminars, but especially warm hugs. You are such a great team. Extra thanks also go to the visitors in our group Alice Cravotta, Martina Garufi and Glenda Gurrado, who have also been part of the GrEP team. Thank you, Alice and Judith, and also Cristina Roura, for our great moments together around sunny Banyoles and Girona. Additional thanks to other PhD colleagues in other research groups at the Department, with a special thanks to Núria de Rocafiguera and Alexandra Navarrete: thank you for also being part of this journey, for all our conversations and for always appearing by surprise knocking on my office door. To all these people, you made the work much easier and I wish you the best of luck.

My heartfelt thanks to my beloved friends, Laia Soler, Clara Nogué, Marina Mascort, Júlia Recasens, Mireia Reixach and Anna Reixach. Thank you for sharing all the ups and downs, for cheering me on, and for celebrating each accomplishment, big or small. A special thanks also goes to the *Pixolet* team (you know who you are) —I love seeing how we are getting older all together. Many thanks also to Alba Ribas, Sandra Masó and Alba Ribas Serrano: thank you also for being part of my life. Finally, thank you to the *R&W* family and also thank you very much to all these friends that, despite not being able to see each other as much as we would like, they are always there: Anna Enríquez, Judit Ripoll, Eduard Montiel, Anna Rossell, Alba Albet, Patrícia Rodríguez and Marta Codina. Also, thank you to Pau and Llorenç, my friends in Chicago, who did so much to

make me feel at home during my stay abroad. I feel so lucky to have you all. My appreciation also goes to all these people who have shown interest in my research and have followed its development along this journey. Gràcies, Noelia, per encomanar-nos la teva alegria durant moltes tardes de dissabte. Gràcies, Josep Clara, per tenir sempre bones paraules cap a mi.

Finally, and most importantly, a very special word for thanks goes to my dear parents, Joan and Pilar, for always believing in me, showing me how proud they are of me, and encouraging and helping me to follow my dreams. *Papa*, *mama*, tot el que us agraeixo no es pot expressar en dues línies escrites. Gràcies per ser els millors pares del món, per haver-me donat sempre el millor de vosaltres, per fer-me veure i creure que tot és possible, i per tota una vida plena d'amor. Si he arribat fins aquí, és gràcies a vosaltres. Us estimo. I am also truly thankful to the rest of my family (gràcies per haver estat sempre al meu costat) and, especially, to my beloved grandparents, who I miss and love so much. Avi Joan, sé que estaries molt orgullós de poder compartir aquest moment amb mi. Thank you to my dogs, Nick (I miss you) and Luke, who laid at my feet many times when working at home. I am also thankful to Francesc's family, Xavi, Teia and Jordi: gràcies per haver-me rebut sempre amb els braços ben oberts.

Last but not least, a gigantic thank you to Francesc. Gràcies per fer-me veure sempre el millor costat de les coses, per la paciència, per recolzar-me en aquest gran repte, i, sobretot, per ser el millor

company de vida. Without you, this journey would not have ended this way.

Many thanks to anyone else who has supported or who feel close to this work in any way.

Abstract

Co-speech gestures are children's first path towards communication. Further in development, research has primarily focused on the role of iconic gestures in boosting children's narrative abilities, while less is known about the effects of non-referential gestures. The main goal of this PhD dissertation is to investigate the scaffolding role of non-referential beat gestures (i.e., rhythmic hand movements that are associated with prosodic prominence in oral discourse) in the development of oral narrative abilities in children. Given the fact that beat gestures act as highlighters of linguistic properties such as rhythm, information focus or discourse structure, we hypothesize that these gestures can help children frame discourse. In order to test this general hypothesis, this thesis includes three empirical studies —each one described in a separate chapter.

Study 1 is a longitudinal study which analyzes the speech and gestures produced by 45 14- to 58-month-old children in naturalistic interactions with their caregivers. Results show that the early production of beats, as opposed to the production of iconic gestures and hand flip gestures (i.e., non-referential gestures performed by turning the wrist of the hand), predicts later narrative abilities at 5 years of age. The other two studies (Study 2 and Study 3) use a between-subjects narrative training task with a pretest–posttest design to investigate whether non-referential beat gestures can be key in bolstering narrative discourse performance in a total of 91 5- to 6-year-old children. While the first study examines whether

multimodal training in which children observe beat gestures can contribute to improving their narrative performance in terms of narrative structure, the second study analyzes whether training which encourages children to produce beat gestures —as opposed to merely observing them— can have the same effects in terms of narrative structure and fluency. The results of both studies demonstrate that children who observed beat gestures during training (Study 2) and children who were encouraged to produce them (Study 3) showed a significant gain in the quality of their posttest narrative performance as opposed to children who were exposed to the control conditions.

Altogether, the results of the abovementioned studies show the importance of a less-studied gesture in children's language development, i.e., beat gesture, and how this type of non-referential gesture has a strong link to children's narrative development. While results from the Study 1 demonstrate the predictive role of beats in children's later narrative abilities, results from Studies 2 and 3 reveal the essential role of training with beat gestures for short-term improvement in children's narrative discourse performance. Moreover, these findings are relevant not only to understand the value of the multimodal integration between gesture and speech in child development, but also have important methodological implications for teachers and speech therapists working on narrative abilities.

Resum

Els gestos de la parla constitueixen una part essencial dels inicis de la comunicació. Més tard en el desenvolupament, la recerca s'ha focalitzat principalment en el paper que tenen els gestos icònics en la promoció de les habilitats narratives dels nens i nenes. Tanmateix, no s'ha fet gaire recerca sobre els efectes dels gestos no referencials. El principal objectiu d'aquesta tesi doctoral és investigar el rol potenciador dels gestos rítmics no referencials (i. e., moviments rítmics de les mans que estan associats amb la prominència prosòdica en el discurs oral) en el desenvolupament de les habilitats narratives orals dels nens i nenes. Tenint en compte que els gestos rítmics actuen com a marcadors de propietats lingüístiques com el ritme, el focus d'informació o l'estructura del discurs, esperem que aquests gestos puguin ajudar els nens i nenes a organitzar el discurs. Per demostrar aquesta hipòtesi general, aquesta tesi inclou tres estudis empírics —cadascun descrit en un capítol.

L'Estudi 1 és un estudi longitudinal que analitza la parla i els gestos produïts per 45 nens i nenes de 14 a 58 mesos en interaccions naturals amb els seus cuidadors. Els resultats mostren que la producció primerenca de gestos rítmics, en comparació amb la producció de gestos icònics i de gestos de volteig de les mans (i. e., gestos no referencials realitzats girant el canell de la mà), prediu les habilitats narratives posteriors, als 5 anys d'edat. Els altres dos estudis (Estudi 2 i Estudi 3) utilitzen una tasca d'entrenament narratiu entre subjectes amb un disseny pretest–posttest per

investigar si els gestos rítmics no referencials poden ser essencials per reforçar el discurs narratiu en un total de 91 nens i nenes de 5 a 6 anys. Mentre que el primer estudi analitza si un entrenament multimodal en què els nens i nenes observen gestos rítmics pot contribuir a millorar les seves produccions narratives en termes d'estructura narrativa, el segon estudi analitza si un entrenament en què es motiva els nens i nenes a produir gestos rítmics —a diferència de la seva simple observació— pot tenir els mateixos efectes en termes d'estructura narrativa i fluïdesa del discurs. Els resultats dels dos estudis demostren que els nens i nenes que van observar gestos rítmics durant l'entrenament (Estudi 2) i els nens i nenes que van ser motivats a produir-los (Estudi 3) van mostrar un guany significatiu en la qualitat de les seves produccions narratives posteriors, a diferència dels nens i nenes que van ser exposats a les condicions control.

En conjunt, els resultats dels estudis mencionats mostren la importància d'un gest menys estudiat en el desenvolupament del llenguatge dels nens i nenes, i. e., el gest rítmic, i com aquest tipus de gest no referencial té un fort lligam amb el desenvolupament narratiu dels nens i nenes. Mentre que els resultats de l'Estudi 1 demostren el rol predictiu dels gestos rítmics en les habilitats narratives més tardanes dels nens i nenes, els resultats dels Estudis 2 i 3 proven que l'entrenament multimodal amb gestos rítmics pot ajudar a millorar a curt termini les produccions narratives dels nens i nenes. A més, aquests resultats són rellevants no només per entendre el valor de la integració multimodal entre gest i parla en el

desenvolupament dels nens i nenes, sinó que també tenen implicacions metodològiques importants per als mestres o logopedes que treballin les habilitats narratives.

Resumen

Los gestos del habla constituyen una parte esencial de los inicios de la comunicación. Más tarde en el desarrollo, la investigación se ha focalizado principalmente en el papel que tienen los gestos icónicos en la promoción de las habilidades narrativas de los niños y niñas. Sin embargo, no se ha hecho mucha investigación sobre los efectos de los gestos no referenciales. El principal objetivo de esta tesis doctoral es investigar el rol potenciador de los gestos rítmicos no referenciales (i. e., movimientos rítmicos de las manos que están asociados con la prominencia prosódica en el discurso oral) en el desarrollo de las habilidades narrativas orales de los niños y niñas. Teniendo en cuenta que los gestos rítmicos actúan como marcadores de propiedades lingüísticas como el ritmo, el foco de información o la estructura del discurso, esperamos que estos gestos puedan ayudar a los niños y niñas a organizar el discurso. Para demostrar esta hipótesis general, esta tesis incluye tres estudios empíricos —cada uno descrito en un capítulo.

El Estudio 1 es un estudio longitudinal que analiza el habla y los gestos producidos por 45 niños y niñas de 14 a 58 meses en interacciones naturales con sus cuidadores. Los resultados muestran que la producción temprana de gestos rítmicos, en comparación con la producción de gestos icónicos y de gestos de volteo de las manos (i. e., gestos no referenciales realizados girando la muñeca de la mano), predice las habilidades narrativas posteriores, a los 5 años de edad. Los otros dos estudios (Estudio 2 y Estudio 3) utilizan una tarea de entrenamiento narrativo entre sujetos con un diseño

pretest–postest para investigar si los gestos rítmicos no referenciales pueden ser esenciales para reforzar el discurso narrativo en un total de 91 niños y niñas de 5 a 6 años. Mientras que el primer estudio analiza si un entrenamiento multimodal en el que los niños y niñas observan gestos rítmicos puede contribuir a mejorar sus producciones narrativas en términos de estructura narrativa, el segundo estudio analiza si un entrenamiento en el que se motiva a los niños y niñas a producir gestos rítmicos —a diferencia de su simple observación— puede tener los mimos efectos en términos de estructura narrativa y fluidez del discurso. Los resultados de los dos estudios demuestran que los niños y niñas que observaron gestos rítmicos durante el entrenamiento (Estudio 2) y los niños y niñas que fueron motivados a producirlos (Estudio 3) mostraron una ganancia significativa en la calidad de sus producciones narrativas posteriores, a diferencia de los niños y niñas que fueron expuestos a las condiciones control.

En conjunto, los resultados de los estudios mencionados muestran la importancia de un gesto menos estudiado en el desarrollo del lenguaje de los niños y niñas, i. e., el gesto rítmico, y cómo este tipo de gesto no referencial tiene un fuerte vínculo con el desarrollo narrativo de los niños y niñas. Mientras que los resultados del Estudio 1 demuestran el rol predictivo de los gestos rítmicos en las habilidades narrativas más tardías de los niños y niñas, los resultados de los Estudios 2 y 3 prueban que el entrenamiento multimodal con gestos rítmicos puede ayudar a mejorar a corto plazo las producciones narrativas de los niños y niñas. Además,

estos resultados son relevantes no solo para entender el valor de la integración multimodal entre gesto y habla en el desarrollo de los niños y niñas, sino que también tienen implicaciones metodológicas importantes para los maestros o logopedas que trabajen las habilidades narrativas.

List of original publications

CHAPTER 2

VILÀ-GIMÉNEZ, I., DOWLING, N., DEMIR-LIRA, Ö. E., PRIETO, P., & GOLDIN-MEADOW, S. (submitted). The predictive value of beat gestures: Early use predicts narrative abilities at 5 years of age. *Child Development*. [Web of Science, 2018 Impact factor: **5.024**; 5-Year Impact Factor: **6.151**. ISI Ranking 2018: 3/76 (Q1 Psychology, Developmental); 4/59 (Q1 Psychology, Educational). Google Scholar Metrics: 4th (Child & Adolescent Psychology); 16th (Psychology)]

[First submission: May 6, 2020]

CHAPTER 3

VILÀ-GIMÉNEZ, I., IGUALADA, A., & PRIETO, P. (2019). Observing Storytellers Who Use Rhythmic Beat Gestures Improves Children's Narrative Discourse Performance. *Developmental Psychology*, *55*(2), 250–262. doi: 10.1037/dev0000604 [Web of Science, 2018 Impact factor: **3.342**; 5-Year Impact Factor: **4.798**. ISI Ranking 2018: 16/76 (Q1 Psychology, Developmental). Google Scholar Metrics: 3th (Child & Adolescent Psychology); 15th (Psychology)]

[First submission: February 2, 2017; First Major Revision requested: May 17, 2017; First Major Revision submitted: July 31, 2017; Second Major Revision requested: December 27; 2017; Second Major Revision submitted: January 29, 2018; Third Minor Revision requested: April 11, 2018; Third Minor Revision submitted: May 11, 2018; Accepted: June 22, 2018]

CHAPTER 4

Table of contents

1

CHAPTER 1:
GENERAL INTRODUCTION

1.1 Why this topic: Motivation for children's gestures and oral narrative discourse abilities

Communication is so much more than talking. Speakers accompany their everyday interactions with visual information encoded by *co-speech gestures* or, using fewer words, *gestures*. Gestures have been generally described as spontaneous and communicative movements of the hands and body that are universally co-produced with speech. As Kendon (2004) describes it "'gesture' […] is a name for visible action when it is used as an utterance or as part of an utterance" (p. 7). Gestures produced while speaking are not only relevant for the speaker when uttering speech, but also help the listener to better understand speech by providing redundant or additional information to the message. Extensive research in the last decades has shown that gestures are integral to speakers' communication and thought, and thus offer compelling evidence that gestures are acts of cognition and communication. For this reason, the study of language should be understood as a multimodal manifestation of a communicative act which groups in an integrated way information expressed in both vocal and visual channels (gesture, body movements, prosody, etc.). Understanding the multimodal integration patterns between co-speech gestures and the accompanying speech is crucial in order to figure out how people communicate and, more specifically, how gestures pave the way for language development.

Previous investigations have demonstrated that co-speech gestures are tightly linked to speech production and perception, which suggests that both modalities are systematically combined at all levels of linguistic structure (see Abner, Cooperrider, & Goldin-Meadow, 2015, for a review of the role of gesture in linguistics), forming a well-integrated communicative system (e.g., Kelly, Özyürek, & Maris, 2010; Kendon, 1980; McNeill, 1992, among many others). Apart from their rich communicative side, gestures also have cognitive dimensions. Gestures reflect speaker's thoughts and observing or producing them can alter a gesturer's cognitive state, contributing to knowledge change (see Goldin-Meadow, 2009, 2014, and Novack & Goldin-Meadow, 2015, for reviews). For example, gestures can guide children towards a better learning of strategies for problem solving, in mathematics (e.g., Goldin-Meadow, Cook, & Mitchell, 2009; Ping & Goldin-Meadow, 2008, among many others) or in spatial tasks (e.g., Alibali, Spencer, Knox, & Kita, 2011, among many others). These studies showed that the use of spoken explanations with corresponding gestures in problem-solving tasks leads children to understand notions that are not expressly conveyed in speech, hence boosting changes in thought processes, affecting both thinking and speaking as well as further learning. These investigations have also reported that using co-speech gestures triggers a decrease of the speaker's working memory load; thereby enhancing cognitive memory processes in language (e.g., Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001, among many others).

Gesture and language go hand in hand and may provide unique insights into language learning through childhood (see Goldin-Meadow, 2018, and Goldin-Meadow & Wagner, 2005, for reviews). A large number of studies have examined the role of co-speech gestures in language acquisition at different timespans. Gestures not only precede but can also predict the oncoming changes in language acquisition and learning. Previous investigations have provided evidence that referential gestures (e.g., pointing or iconic gestures) precede and predict first children's linguistic milestones in lexical (Igualada, Bosch, & Prieto, 2015; Iverson & Goldin-Meadow, 2005; Murillo, Ortega, Otones, Rujas, & Casla, 2018; Rowe & Goldin-Meadow, 2009; Rowe, Özçalışkan, & Goldin-Meadow, 2008, among others) and syntactic development (Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005, among others). However, most of the developmental research up to now has been devoted to the role of *referential* gestures (i.e., deictic and iconic gestures, which visually depict some aspect of the semantic content of the speech they accompany), and the use of *non-referential* gestures (i.e., those that do not visually illustrate any aspect of the meaning of the message) has not been extensively investigated (see section 1.2.2 on the classification of co-speech gestures), and little is known about the role of non-referential gestures later in development.

The goal of the present thesis is to investigate the bootstrapping role of non-referential beat gestures in the development of narrative discourses produced by 5- to 6-year-old children. Drawing on previous literature showing the effects of referential gestures in

children's language development, and specifically in children's development of narrative abilities, in the present dissertation, we follow the standard categorization of gestures proposed by McNeill (1992) and we focus on a less studied type of gesture, the *non-referential beat gesture*. Non-referential beat gestures (also referred to simply as *beats*) have been defined as rhythmic hand movements —usually of the fingers or hand— that do not reflect contextual meaning of the spoken message, but are *typically* associated with prosodically prominent positions in speech and emphasize important information said by the speaker, as well as they serve other linguistic functions in discourse (e.g., Shattuck-Hufnagel, Ren, Mathew, Yuen, & Demuth, 2016).

Importantly, these non-referential beat gestures are the last to emerge ontogenetically (e.g., Nicoladis, Mayberry, & Genesee, 1999), and it is not until children are between 5 and 6 years of age that they use them to accompany complex discourses (e.g., Mathew, Yuen, & Demuth, 2017; see Figure 1 for an example of a non-referential beat gesture performed in a child's narrative speech). It is precisely at this age that children are typically able to construct a good *narrative* and thus start acquiring the capacity to use language in a decontextualized manner (Applebee, 1978).

Figure 1. Example of a non-referential beat gesture performed on a child's narrative ("i van anar a veure una estàtua que era com un **arbre**" [and they went to see a sculpture that was like a **tree**]) (bold indicates the word associated with the beat gesture). The points mark position of the hand with the stroke of the gesture being shown in the third image.

Extensive research has shown that narrative abilities (i.e., oral language skills) function as an ecologically valid measure and act as a scaffold of children's linguistic development and academic performance, both in typical (e.g., Stites & Özçalışkan, 2017) and atypical language development (e.g., Demir, Fisher, Goldin-Meadow, & Levine, 2014). Importantly, children at this age also start to integrate information from gesture and speech at the discourse level. Previous studies on the development of gestures in children's narrative production have shown that children's speech and their gestures jointly improve with age (e.g., Colletta et al., 2015). The existing body of research on children's narrative abilities suggests that referential gestures still continue to be crucial

6

in later stages of development (e.g., Demir et al., 2014; Stites & Özçalışkan, 2017) and have a predictive value in children's later narrative skills (e.g., Demir, Levine, & Goldin-Meadow, 2015). Such approaches, however, have not dealt with the role of non-referential gestures in children's oral narrative skills and have focused on how children use beats when they are narrating (e.g., Blake, Myszczyszyn, Jokel, & Bebiroglu, 2008; Colletta, Pellenq, & Guidetti, 2010; Mathew et al., 2017; McNeill, 1992, among others). Nonetheless, to our knowledge, no previous research to date has focused on the predictive value (Study 1 of this thesis, Chapter 2) and the scaffolding value (Studies 2 and 3, Chapters 3 and 4) of non-referential beat gestures in children's oral narrative abilities.

The empirical work presented in this thesis consists of three independent studies. The first study (Chapter 2) examines in a longitudinal database the predictive value of the spontaneous early production of beat gestures in children's later narrative abilities. The second and third studies (Chapters 3 and 4) use a brief gesture-based narrative training with a pretest and immediate posttest design to investigate the potential short-term beneficial effects of beat gestures on children's subsequent narrative performance at posttest. While the second study focuses on the effects of observing beat gestures in storytelling tasks, the third study analyzes the effects of encouraging the production of beats by children using the same narrative training procedure. The three studies examined narratives performed by 5- to 6-year-old children. Our rationale for focusing on narratives produced by children at this age frame is

related to the fact that it is during this period that children start acquiring more complex linguistic skills and are able to construct true narratives.

The underlying hypothesis spanning the three empirical studies presented in this thesis is that the discourse–pragmatic properties highlighted by non-referential beat gestures are key in building up children's more complex oral narrative discursive skills. But, why do we think that the use of non-referential beat gestures by children can significantly contribute to children's development of narrative abilities? As previously noted, the multimodal integration of speech and beat gestures —and their concomitant prosodic prominence— can convey a wide range of linguistic functions in discourse. In general, research focusing on beats has revealed that these non-referential gestures help frame discourse. Apart from highlighting information structure in discourse (e.g., Im & Baumann, 2020; McNeill, 1992), beats can also mark other linguistic functions such as discourse structure or rhythm (e.g., Prieto, Cravotta, Kushch, Rohrer, & Vilà-Giménez, 2018; Shattuck-Hufnagel et al., 2016, among others). Thus not only beat gesture alone *per se*, but also its accompanying pitch accentuation contributes to managing discourse, playing an important pragmatic and, specifically, structuring role in children's narrative abilities.

The present chapter focuses on the general review of the literature and introduces the reader to the main concepts and studies. The first section (1.2) reviews how the notion of gesture has been regarded in

past and present work, followed by an explanation of the most used classification of co-speech gestures in current research. It also summarizes the idea of gesture and speech as an integrated communicative system and the main gesture-speech integration models, as well as the embodied cognition paradigms. This section leads to an overview of the previous literature that has focused on the cognitive and linguistic developmental benefits of referential gestures (1.3) and, specifically, of non-referential beat gestures (1.4). The following section (1.5) summarizes the main research that has dealt with the gesture-speech multimodal integration in children's early language development, underscoring the robustness of gesture as a harbinger of children's linguistic steps. Then, section 1.6 contains a discussion of the notion of non-referential beat gesture and its function as a highlighter of discourse–pragmatic and prosodic properties in speech. Next, section 1.7 reviews the importance of narrative abilities and their relationship with co-speech gestures, including the effects of both referential and non-referential gestures on children's narrative development. Finally, a summary of the main goals and hypotheses that this dissertation aims to achieve is described in section 1.8.

1.2 Gesture-speech multimodal integration in human communication

1.2.1 The nature of gesture

The close link observed between gestures and speech has been the object of attention during the last few decades. Theories starting in the second half of the 20th century have supported the idea that gestures are part of language itself as well as the view that gesture-speech ensembles become multimodal units, being closely intertwined in creating meaning. Several gesture researchers have focused on a variety questions which concern how gestures are connected to speech. Kendon (1980, 1982) was among the first who distinguished and categorized manual gestures of different kinds, arguing that gestures are intimately tied to speech. These labels were then lined up by McNeill (1992) on a continuum named "Kendon's continuum," in Kendon's honor. In this continuum, the author distinguished manual expressions that can take many forms: gesticulation, pantomime, emblem, and sign language. At the extreme left end of the continuum, *gesticulation* encompasses gestures being used in conjunction with speech, described as being "global and holistic in its mode of expression, idiosyncratic in form and users are but marginally aware of their use of it" (Kendon, 2004, p. 104–105). As explained by McNeill (1992), gesticulation (also named *co-speech gestures* or *gestures*) includes all the spontaneous movements of the hands and arms, even though not restricted to these body parts (e.g., also included head, face, legs…).

An example of a gesture can be a movement raising the hand upward while saying "and he climbs up the pipe" (p. 37). *Pantomime* is located in the middle of the continuum, as it does not require its combination with speech. Pantomimes are typically hand movements that depict objects or actions, having the possibility to create different sequences of meaning or a narrative line, as opposed to successive gestures, which are not able to combine. Next, *emblems* are conventionalized signs created in accordance with the rules of a particular system, being grammatically correct, and can be used in the absence of speech (e.g., placing the thumb and index finger in contact to produce the OK sign in agreeing with someone, McNeill, 1992, p. 38). Finally, at the extreme right of the continuum, *sign languages* refer to a complete linguistic systems used by a specific community, such as Catalan Sign Language (LSC) or American Sign Language (ASL). Both are natural languages that have the same linguistic properties as spoken languages.

Importantly, all gestures in Kendon's continuum are communicative in nature and can be distinguished from adaptors or self-grooming movements (e.g., Blonder, Burns, Bowers, Moore, & Heilman, 1995; Butterworth, Swallow, & Grimston, 1981), which are other types of spontaneous non-meaningful bodily movements that do not convey a communicative intention (McNeill, 1992). For example, a movement performed when the speaker changes his/her body position, scratches his/her chin, touches his/her hair or his/her clothes, etc. These movements are produced by either

accompanying the speech or not and can be produced as a response to shyness or discomfort (Ekman & Friesen, 1969). Similarly, movements that are produced in response to speech failure, or elsewhere called "Butterworth," accompanied or not with speech (Butterworth & Beattie, 1978; Butterworth & Hadar, 1989), are not taken into account at the gesticulation point in Kendon's continuum (McNeill, 1992).

McNeill (2005) enriched Kendon's continuum and claimed that the different kinds of gestures (i.e., the four continua: gesticulation, pantomime, emblem, and sign language) actually differ in concerning different dimensions (a) degree of speech accompaniment, (b) presence of linguistic properties, (c) conventionality, and (d) semiotic character (see also McNeill, 2000; Kendon, 2004) (see Figure 2 for a summary). McNeill (2005, p. 5) stated that, concerning the occurrence of gesture with speech, "the degree to which speech is an obligatory accompaniment of gesture *decreases* from gesticulation to signs"; and, concerning the presence or absence of the semiotic properties of a linguistic system, "the degree to which gesture shows the properties of a language *increases*." In other words, while speech is present obligatorily in gesticulation, it is not in the signs (Continuum 1); and while gesticulation does not have language-like properties, the signs have linguistic properties of their own (Continuum 2). Moreover, while gesticulation and pantomime lack convention regarding their form and meaning, emblems are partly conventionalized and sign languages are fully conventionalized

12

(Continuum 3). Finally, according to their semiotic character, gestures can be global (i.e., they contain meaning only as a whole entity) or segmented, and synthetic (i.e., they can combine different meaning elements) or analytical (Continuum 4). That is, the semiotic character of gestures changes from global-synthetic to segmented-analytic. Gesticulation is global (i.e., "gesture's parts have meanings dependent upon the meaning of the gesture as a whole," McNeill, 2016, p. 24) and synthetic (i.e., "meanings are synthesized into one symbolic form," p. 25) in mode of expression. Pantomime is segmented and synthetic, emblem global and analytic, and sign language is segmented and analytic.

Continuum 1: relationship to speech

Gesticulation ⟶ Emblems ⟶ Pantomime ⟶ Sign Language

| Obligatory presence of speech | Optional presence of speech | Obligatory absence of speech | The same |

Continuum 2: relationship to linguistic properties

Gesticulation ⟶ Pantomime ⟶ Emblems ⟶ Sign Language

| Linguistic properties absent | The same | Some linguistic properties present | Linguistic properties present |

Continuum 3: relationship to conventions

Gesticulation ⟶ Pantomime ⟶ Emblems ⟶ Sign Language

| Not conventionalized | The same | Partly conventionalized | Fully conventionalized |

Continuum 4: character of semiosis

Gesticulation ⟶ Pantomime ⟶ Emblems ⟶ Sign Language

| Global & synthetic | Global & analytic | Segmented & synthetic | Segmented & analytic |

Figure 2. Kendon's continuum separated by the four complex continua, from top to bottom: Continuum 1, Continuum 2, Continuum 3 and Continuum 4 (figures extracted from McNeill, 2005, pp. 7 and 10).

All in all, from Kendon's continuum (McNeill 1992, 2005, 2016), gesticulation (i.e., co-speech gesture or gesture) is the only point along the continuum where gestures convey meaning by combining properties that are not similar at all; that is, properties of gesture and properties of language. In this sense, global and synthetic gesture properties (i.e., imagery) are combined with segmented and analytic speech properties. Therefore, co-speech gesture entails that "speech and gesture combine into a system of their own in which each

14

modality performs its own functions, the two modalities supporting one another" (McNeill, 2005, p. 9). In this sense, McNeill (2016) points out that co-speech gesture is described as "the intrinsic imagery of language" and "language is inseparable from it" (p. 4). This kind of co-speech gesture (or gesticulation) is the particular domain of interest in this thesis. The following subsection provides a description of McNeill's (1992) co-speech gesture classification.

1.2.2 Classification of co-speech gestures

McNeill (1992, 2005) presented a classification scheme for co-speech gestures (also called gesticulation in Kendon's continuum) based into four major dimensions: iconic, metaphoric, deictic (or pointing), and beat. McNeill differentiated these gestures by their form and referential or semiotic functions. Currently it is one of the standard classifications in the field of gesture research, and the majority of past and current studies are based on this gesture scheme.

Iconic and metaphoric gestures are pervasive in children's speech. In the taxonomy proposed by McNeill (1992), *iconic* gestures are included in the group of representational (i.e., referential) gestures. Iconic gestures imagistically represent properties of an object, actions or a scene and thus have the capability to bear a close relationship to the semantic content of the speech they accompany (for example, as a speaker says "he [bends it way back]," his or her hand appears to grip something and pull it back). The other type of

representational (i.e., referential) gesture is called *metaphoric*. *Metaphoric* gestures are "like iconic gestures in that they are pictorial, but the pictorial content presents an abstract idea rather than a concrete object or event" (McNeill, 1992, p. 14) (e.g., to express the concept of future with a hand gesture moving forward in space) (see also Cienki & Müller, 2008). The third dimension is the *deictic* gesture, also named pointing gesture, as it is typically performed with the pointing finger (e.g., pointing at a pencil while saying, "Can I borrow that, please?"). Even though it is generally used to connect some aspect of speech to an object or location in space, it can also be an "abstract pointing" when referring to something or someone who is absent, or a place or a moment in time (e.g., pointing to the right to mean a specific reference in discourse). Finally, *beat* gestures are non-representational (i.e., non-referential) gestures that do not convey specific semantic information about a referent. They are usually performed by downward movements of the fingers or hands and are typically associated with prosodically prominent positions in natural discourse, remarking "the word or phrase they accompany as being significant […] for its discourse pragmatic content" (McNeill 1992, p. 15). McNeill defined beat gesture as being "a simple flick of the hand or fingers up and down, or back and forth" and that it has "two movement phases —in/out, up/down, etc." (p. 15). See section 1.6 for further details on the definition and description of the prosodic features and discourse functions of non-referential beat gestures.

Throughout this thesis, the term *referential* will refer to iconic, metaphoric and deictic gestures; and the term *non-referential* will be used to refer to beat gestures (Prieto et al., 2018; Shattuck-Hufnagel & Ren, 2018). Even though some gesture research has simplified the concept of beat gestures by defining them as purely "rhythmic, non-meaningful or meaningless hand movements" (e.g., Dimitrova, Chu, Wang, Özyürek, & Hagoort, 2016; Nicoladis et al., 1999; So, Chen-Hui, & Wei-Shan, 2012, among many others), it is essential to also take their discourse–pragmatic functions into account. The three studies that constitute this dissertation (Chapters 2, 3 and 4) aim to extend on this definition by showing the meaningful discourse–pragmatic role of beat gestures and its predictive, as well as beneficial value in children's narrative abilities.

1.2.3 Gesture and speech: An integrated communicative system

This thesis builds on the initial hypothesis that gesture and speech need to be understood as an integrated system (McNeill, 1992, 2005; see Kelly, Manning, & Rodak, 2008, for a review). Many previous investigations have argued that these two modalities are part of the same single communicative system and are coordinated from a temporal and semanticopragmatic point of view (Clark, 1996; Goldin-Meadow, 2003; Kelly et al., 2010; Kendon, 1980, 2004; McNeill, 1992, 2005, 2016; Özyürek & Kelly, 2007; see Wagner, Malisz, & Kopp, 2014, for a review).

McNeill (2005) pointed out that gestures are synchronous and co-expressive with speech, as they "synchronize with speech at the point where the speech and gesture coexpressively embody a single underlying meaning, a meaning that is the point of highest communicative dynamism at the moment of speaking." (p. 1) The *Growth Point theory* proposed by McNeill (1992, 2005, 2012, 2016) suggested that gesture and speech develop from the same "growth point." This theory describes the growth point (GP) as a "new" gesture-action (imagery) combined with linguistic content that is the minimal unit of gesture-speech integration. That is, the GP has both imagistic (imagery is understood as a symbolic form determined by meaning) and verbal content, as "growth begins with a unification of a gesture with some linguistically encoded information" (McNeill, 2016, p. 21). Thus, an utterance comprises both an imagistic and a linguistic side. This model presents a new conception of language in which it is described as being "language-imagery" or "language-gesture dialectic," meaning that gestures and speech are based on the same communicative intention and influence each other, working together to produce a single message.

Based on the assumption that gesture and speech set up a single multimodal unit, nowadays most gesture researchers defend that gestures are co-expressive with speech at the semantic, pragmatic and phonological (i.e., temporal) point of view to convey the speaker's intended meaning in human communication (e.g., Bernardis & Gentilucci, 2006; Kendon, 1980; Levinson & Holler, 2014; McNeill, 1992, 2005, among many others). In order to show

18

how speech and gesture synchronize, McNeill (1992) proposed three rules that govern speech and gesture synchronization (semantic synchrony rule, pragmatic synchrony rule, and phonological synchrony rule). First, the *semantic synchrony rule* postulates that speech and gestures can cover the same idea or concept unit at the same time. For instance, gesture can express redundant (i.e., complementary) semantic information to speech; however, since gesture and speech meanings complement each other, they help create a richer picture. The *pragmatic synchrony rule* means that gesture and speech serve the same pragmatic purpose. Speech and gesture can come together on the same pragmatic level in order to present, for instance, the narrative genre (McNeill, 1992). A speaker's verbal utterance such as "it was a Sylvester and Tweety cartoon" conveys information about the genre of the upcoming narrative and identifies the main characters of the story, helping describe the story context. At the same time, the speaker can produce a metaphoric gesture with hands rising up, accompanying this abstract concept (that is, the genre of the cartoon), by depicting a bounded "object" to represent the story as a whole. In such a way, the idea of the genre is presented as a "bounded, supportable, spatially localizable physical object" (pp. 14–15). Finally, the *phonological synchrony rule* predicts that the stroke phase of the gesture (i.e., the mandatory phase of the gesture, as it contains its meaning and effort; Kendon, 1980; McNeill, 1992, 2005) is temporally aligned with the phonological peak syllable of speech. Along these lines, an existing body of research has shown evidence of clear temporal alignment patterns between the

prominent parts of gesture and speech (Esteve-Gibert, Borràs-Comes, Asor, Swerts, & Prieto, 2017; Esteve-Gibert & Prieto, 2013, 2014; Krahmer & Swerts, 2007; Leonard & Cummins, 2011; Loehr, 2007, 2012; Rochet-Capellan, Laboissière, Galván, & Schwartz, 2008; Shattuck-Hufnagel & Ren, 2018, among many others; for reviews, see also Rusiewicz & Esteve-Gibert, 2018, and Wagner et al. 2014). Children also start to synchronize co-speech gestures early in language development. Focusing on children at the transition between one- and two-word combinations, Butcher and Goldin-Meadow (2000) showed that children start synchronizing gesture and speech modalities in an adult-fashion at the beginning of the two-word period. Esteve-Gibert and Prieto (2014) extended these results providing evidence of a detailed temporal coordination of deictic gesture-speech combinations already at the babbling stage (at around 11 months of age). The authors found that when children start producing their first words, they temporally coordinate their deictic gestures with acoustic prominences of the accompanying speech.

All in all, the strong semantic, pragmatic and temporal interconnection that is observed between speech and gesture lies at the heart of all theories and gesture-speech models. The following subsection provides an overview of the main theoretical frameworks that have accounted for gesture-speech interaction patterns which try to integrate cognitive and speech production and perception processes.

1.2.4 Cognitive models of gesture-speech interaction

Building on the abovementioned Growth Point theory (McNeill, 1992, 2005; McNeill & Duncan, 2000), which argues that gesture and speech are part of a single system and that gesture cannot be considered separately because gesture generation comes from a subprocess of speech production, further empirical results have helped extend and further refine this approach. Several theories of gesture-speech interaction have been put forward which highlight the existence of a cognitive process that underlies the production of spontaneous gestures, specifically representational (i.e., referential) gestures. Most of the models corroborate that speech and gesture modalities are integrated in early stages of the speech production processes and focus on the interaction between gesture and speech production processes (see Goldin-Meadow & Alibali, 2013, and Wagner et al., 2014, for reviews). However, these detailed models show differences in the way in which speech and gesture interact between each other (i.e., gestures as an integral part of the utterance or as semiotic auxiliaries to speech, etc.) and in the specific production stages at which speech and gesture streams are generated as part of the production process (i.e., conceptualization, formulation, articulation phases; see Levelt, 1989, for the speech production stages).

The *Lexical Retrieval hypothesis* (Krauss, Chen, & Gottesman, 2000; see also Rauscher, Krauss, & Chen, 1996) claims that the facilitative role of gesture is active at the level of speech production (during the formulation stage; see Levelt, 1989). This hypothesis

rests on the assumption that speech and gesture are two systems that interact at a later point in the speech production process and that gestures may help speakers to access the items involved in the mental lexicon (i.e., compensatory strategy), boosting activation levels for the to-be-retrieved words. Empirical support for this hypothesis comes from studies revealing that gesturing (e.g., Beattie & Coughlan, 1999, for adults; Pine, Bird, & Kirk, 2007, for children) or producing meaningless movements, such as tapping (e.g., Ravizza, 2003, for adults), help speech production processes during a tip-of-the-tongue (TOT) state (i.e., when the speaker knows the target word but s/he can not actually remember it at that moment) in coming up with the word they are thinking of, and also help speech production in bilingual speakers (e.g., Nicoladis, 2007).

This hypothesis is contrasted to one of the other early models of gesture-speech interaction, named the *Information Packaging hypothesis*, which was defended by Kita (2000). According to this model, speech and gesture interact at an early stage during speech production (i.e., conceptualization or conceptual planning of the message to be verbalized, which results in a "preverbal message"; see Levelt, 1989). Empirical evidence shows that when gestures underlie visuo-spatial representations they help the speaker to select, package and organize the visuo-spatial information in speech; that is, to verbalize perceptual or motor knowledge, or in other words to code the information into a linguistic form of speech. That is, gestures reflect the mental representations activated when speaking, thus "what underlies a gesture is an action in virtual

[imagined] environment" (Kita, 2000, p. 170). Evidence shows that people tend to gesture more and benefit more from the production of gestures when the conceptualization of information for speaking (i.e., packaging information into units for speaking) is more challenging. Results from Alibali, Kita, and Young (2000) showed that, when trying to solve Piagetian conservation problems, children gestured more in an explanation task than in a description task, demonstrating that gestures are involved in the conceptual planning of speech, as explaining is more demanding on the conceptual packaging of information. Moreover, it has been shown that low verbal fluency is related to an increase of gesture production only with speakers with high spatial visualization skills (Hostetter & Alibali, 2007). In Hostetter and Alibali's (2007) study, speakers with strong spatial visualization skills but who were not able to efficiently organize spatial images in speech due to low verbal fluency, gestured more often when they had spatial images in mind but had trouble producing speech.

Kita and Özyürek's (2003) model of speech and gesture performance, named the *Interface hypothesis*, is an extension of the Information Packaging hypothesis by Kita (2000). This hypothesis suggests that speech and gesture are generated by separate systems, e.g. conceptualizing speech through a *message generator* and producing gestures through an *action generator*. However, there is a bidirectional interaction between these two generators or production systems, as they exchange information when speech is conceptualized and formulated. Gestures are generated during the

23

conceptualization stage from an interface representation, which is a spatio-motoric representation (i.e., action and spatial information represented by action), between speaking and spatial thinking. Gestures thus encode the spatio-motoric properties of the referent but, importantly, organize this spatio-motoric information into a suitable form for speaking, according to the constraints of the language production system. Therefore, gestural contents are determined by the linguistic possibilities and constraints that underlie the speech they accompany. In this sense, speech production and gesture production are interrelated and this relationship underlies the cognitive processes involved. For example, speech can lead to cross-linguistic variation in gestural representation. By examining speakers' descriptions of physical motion, Özçalışkan, Lucero, and Goldin-Meadow (2016) demonstrated that linguistic structures shape iconicity in gestures differently across languages (e.g., Turkish and English) (independent from effects of culture) and in both sighted and blind speakers. Importantly, blind speakers gesture like the sighted speakers with whom they share the same native language, and differently from speakers (sighted or blind) which have a different language.

Another framework concerning gesture production is the model proposed by Hostetter and Alibali (2008, 2010, 2019), termed *Gesture-As-Simulated-Action* (GSA) framework. In contrast to the previous hypotheses, the gesture planner is not generated in the spoken interface and thus it does not propose any bidirectional

communication between speech and gesture. This assumption is in line with the Growth Point theory (McNeill 1992; McNeill & Duncan, 2000), as they coincide in that gesture and speech are produced from the same mental process and are inseparable aspects of a single system. Based on an embodied cognitive view (see section 1.2.5), this model holds that gestures emerge from an embodied cognitive system in which they reflect simulations of action and perception in the mind of the speaker (i.e., movements performed without a communicative intention) that support language thinking. Thus, gestures arise as a natural consequence of simulations of perception and action from the speaking process that trigger a motor activation responsible for producing movements (e.g., Beilock & Goldin-Meadow, 2010).

Finally, in a recent comprehensive framework, Kita, Alibali, and Chu (2017) proposed the *Gesture-for-Conceptualization hypothesis*. This theory claims that a representational gesture (a) "activates, manipulates, packages and explores spatio-motoric representations for the purposes of speaking and thinking" and (b) "gesture schematizes information, and this schematization process shapes these four functions." (p. 262). Gestural representation is thus shaped by online interactions with the speech formulation process, as speech and gesture production are intimately related and their relationship underlies the cognitive processes involved (e.g., Alibali & Kita, 2010; Chu & Kita, 2011). In line with previous claims (Kita, 2000; Kita & Özyürek, 2003; Hostetter & Alibali, 2008, 2010, 2019), this hypothesis also supports the claim that gestures

are closely connected to practical actions; the same processes that generate practical actions generate representational gestures (see grounded and embodied cognition paradigms in section 1.2.5). Nevertheless, although this theoretical framework states that gesture and speech emerge from separate processes (in contrast to McNeill, 1992), it also argues that "the action generation system and the speech production system are highly interactive" (Kita et al., 2017, p. 255). This hypothesis may also provide empirical evidence for other theories, such as *the cognitive load reduction hypothesis*, regarding the beneficial effects that gestures have in alleviating the amount of cognitive load needed for encoding or formulating speech (Goldin-Meadow, 2003; e.g., Goldin-Meadow et al., 2001; see section 1.3 for the cognitive and linguistic benefits of referential gestures).

Interestingly, all these theories have been originated in the realm of speech production. Kelly et al.'s (2010) study also argued that the gesture-speech integration extends to the comprehension domain as well, and proposed the *Integrated-Systems hypothesis*. Through two experiments, the authors demonstrated that (a) gesture and speech mutually interact, as they are easier to understand when they convey the same information, and that (b) this integration is obligatory, as when processing one modality this cannot be considered without the other.

All in all, it is worth noting that the theoretical models of gesture-speech production reviewed in this subsection have been mainly

devoted to the role of referential (i.e., representational) gestures (see section 1.3), rather than to non-referential gestures (i.e., non-representational) (see section 1.4). As Hostetter and Alibali (2019) state, even though the GSA framework can also be applied to non-representational gestures, further research needs to examine more empirical data. Although the differences between the abovementioned influential theoretical approaches lie beyond the scope of the present dissertation, we likely consider that the Gesture-for-Conceptualization hypothesis can help frame and interpret some of the results obtained from the studies presented in this thesis (see the conclusions section 5.4 for a discussion).

1.2.5 Language and embodiment: Grounded and Embodied cognition paradigms

Previous research devoted to the benefits of gesture production on language and cognitive processing has been strongly influenced by the grounded (Barsalou, 2008, 2010) and embodied cognition paradigms (Ionescu & Vasc, 2014). The grounded and embodied cognition paradigms claim that gestural perception and production processes are integrated with speech and strongly underlie cognitive and language processing (see Kiefer & Trumpp, 2012, and Wellsby & Pexman, 2014, for reviews). Several studies have suggested that co-speech gestures are an important form of embodiment in language, as producing them enhances word retrieval (e.g., Krauss et al., 2000) and speech comprehension processes (e.g., Alibali,

Heath, & Myers, 2001; Kelly, 2001; Valenzeno, Alibali, & Klatzky, 2003).

On the one hand, the grounded cognition theory relates human cognition to modal simulations, situated actions, and bodily states (posture, arm movements, facial expressions), based on the "modal reenactment of perceptual, motor, and introspective states" rather than "amodal redescriptions of perceptual, motor, and introspective states representing knowledge" acquired during world, body and mind experiences (Barsalou, Niedenthal, Barbey, & Ruppert, 2003, p. 63). For example, when seeing a smiling infant (i.e., amodal redescription), "a parent has sensory experiences of the infant (e.g., visual, auditory, tactile, olfactory). The parent may also imitate motor actions (e.g., cuddling) and experience introspective states as a result (e.g., happiness)" (Barsalou et al., 2003, p. 44). In fact, standard theories of cognition assume that "knowledge of such experiences does not consist of the sensory, motor, and introspective states that constituted the experiences originally" (p. 44). Barsalou (2008) exemplifies the theory with an experience such as easing into a chair and claims that "the brain captures states across the modalities and integrates them with a multimodal representation stored in memory" (p. 618). In other words, information from various sensory modalities activates representations that bear relation to a referent in the world. Later, the brain reactivates all the multimodal representations associated with the experience of easing into a chair, such as the look and feel of the chair, the feelings of comfort and relaxation, as well as the

28

act of sitting, when knowledge is required to represent the category (e.g., chair).

While the grounded cognition approach supports the idea that cognition is grounded in multiple ways (e.g., simulations, situated action, bodily states), on the other hand, the embodied cognition paradigm appeals to the idea that cognition depends on bodily states. This paradigm suggests that bodily physical actions, considering both perceptual and motor systems, impact human cognition. Concerning this embodied system, as Madan and Singhal (2012) contend, "the motor output is integral to cognition, and the converging evidence of multiple avenues of research further indicate that the role of our body in memory processes may be much more prevalent than previously believed" (p. 3) (see Casasanto, 2009, 2011).

While the theories reviewed in subsection 1.2.4 highlight the involvement of representational gestures in cognitive processes in important ways, very little is currently known about the role of non-referential beat gestures as motor actions. To our knowledge, only one study has attempted to investigate the role of non-referential beat gestures in speech production processes (Lucero, Zaharchuk, & Casasanto, 2014). Considering that their findings demonstrated that speakers find words more quickly simply by producing beat gestures, the results of this study lend support to the hypothesis that beats facilitate lexical access because they are motor actions with

communicative functions, and not because of special characteristics they have as gestures *per se*.

In this dissertation, the term *embodied cognition* will be used in its broadest sense to refer to both the "grounded" and "embodied" cognition paradigms, according to the idea that the mind is not only connected to the body, but that the body influences the mind. In general, both grounded and embodied cognition theories are in line with the idea that gestures or, in other words, actions embodied in gestures are tightly interconnected to the language system. Recent experiments in the realm of cognitive neuroscience have addressed the relationship between language and action areas of the brain, pointing out a neural linkage between gesture and speech (see Özyürek & Kelly, 2007, and Willems & Hagoort, 2007, for reviews).

Importantly, as Wellsby and Pexman (2014) point out, further research addressing embodied theories of language development is needed. In this sense, the authors state the implication of embodiment processes in learning (see Hostetter & Mainela-Arnold, 2015, for a review). Kiefer and Trumpp (2012) demonstrated that embodiment can be positively used to obtain higher levels of reading, writing, or to improve memory for events, conceptual memory for objects and for numbers. As such, cognitive processes are shaped by perceptual and motor modalities (see Borghi & Caruana, 2015).

The studies included in this thesis consider a set of developmental hypotheses related to the bootstrapping role of gesture in narrative development. One of the hypotheses entertained in the thesis is related to the idea that encouraging children to produce non-referential beat gestures while narrating will make them involve their own motor system in a way they will connect their spatial and motoric knowledge with what is learned. All of the studies also indirectly focus on the educational implications of embodied cognition (see Shapiro & Stolz, 2019, for a review), highlighting the potential role embodiment (mind and body) can serve in cognition processes, such as in learning (see Goldin-Meadow 2003, 2009, and Goldin-Meadow & Wagner, 2005, for reviews; see also section 1.3).

The following two sections aim at providing a review of previous investigations that have examined the role of referential gestures (section 1.3) and non-referential beat gestures (section 1.4) in aiding language processing and learning.

1.3 Cognitive and linguistic developmental benefits of referential gestures

1.3.1 Effects of observing referential gestures

Gesturing is a powerful tool for learning and can be used to the benefit of language processing. It is well-established from a variety of studies that *observing* referential gestures (e.g., deictic and iconic gestures, which visually illustrate the semantic content of the speech) has a positive effect on adults' and children's cognitive and linguistic abilities (see Goldin-Meadow, 2009, 2014, 2018, and Novack & Goldin-Meadow, 2015, for reviews). For instance, beneficial effects of spoken instructions that include referential gestures were found on both adults' (e.g., Kelly, Barr, Church, & Lynch, 1999; So et al., 2012; Thompson, 1995, among many others) and children's (e.g., Aussems & Kita, 2019; Goldin-Meadow, Kim, & Singer, 1999; So et al., 2012; Valenzeno et al., 2003, among many others) learning. It is agreed that referential gestures provide an additional layer of information to the information expressed in speech, thus triggering a decrease of the speaker's working memory load and an enhancement of cognitive capacity and linguistic processes in the development of learning.

Many studies have reported a positive impact of referential gestures in adults' and children's ability to recall information. Thompson (1995) undertook a comparative study in which young and old adult participants listened to a varied set of spoken sentences in three

conditions: speech alone, with visible speech (i.e., visible articulatory movements on the face), or with visible speech but in which the speaker accompanied speech with iconic gestures. Results showed that the presence of gestures helped younger adults more than older adults in recalling sentences, which suggests that difference in the impact of gesture on recall by age was probably due to reduced working memory capacity. Kelly et al. (1999) conducted four experiments that confirmed the beneficial role that pointing and iconic gestures play in both understanding and remembering pragmatic speech content. Three experiments revealed the benefits of pointing gestures, by showing that (a) pointing gestures accompanied with speech (vs. speech alone and gesture alone) enhanced the interpretation of the indirect requests by college undergraduates (Experiments 1 and 2); and that (b) pointing gestures integrated in speech can potentially contribute to disambiguate the meaning of the message rather than only pointing (Experiment 3). Another experiment revealed the effectiveness not only of pointing, but also of iconic gestures, stressing the fact that the previous findings were also applicable to other types of communicative acts (i.e., descriptions of activities and events) and to other types of gestures (i.e., iconic gestures) (Experiment 4). In So et al. (2012), both adults and 4- and 5-year-old children were presented with three different lists of verbs in three conditions (speech accompanied by either iconic gestures, beat gestures, or no gestures) and were then asked to recall as many of the verbs as they could. The results showed that both groups better recalled familiar words when they observed these words produced with iconic

gestures rather than with no gestures. In addition, positive results were recently obtained by Aussems and Kita (2019) in influencing memory of nonlinguistic information (i.e., recognition memory of action events) in 3-year-old children. Findings revealed that children who saw actions and events performed with semantically related iconic gestures (vs. interactive gestures or no gestures) remembered these events and actors better.

Recent studies have also shown that iconic gestures can serve in processes of novel word mapping. Mumford and Kita's (2014) study demonstrated how the speaker's iconic gestures could influence 3-year-old children's output schematization of an object or event in learning novel verbs (e.g., *blick*) that could be interpreted as manner verbs or change-of-state verbs. As an example, in one trial, children saw a video of a hand moving an object in specific way (e.g., by pushing strips of cloth) into a particular configuration (e.g., aligned vertically), while using a novel ambiguous verb (e.g., "Look! She is *blicking*!"). Results found that iconic gestures enhanced children's mapping of novel verbs to specific referents. When the adult said the novel verb and at the same time performed a gesture that highlighted the manner of action (e.g., pushing), children understood the verb as referring to the manner; whereas when the novel verb was accompanied by a gesture that emphasized the end-state (e.g., making vertical stripes), children grasped the verb as representing the end-state.

Some studies have demonstrated that referential gestures can contribute to boosting comprehension processes in listeners, as they can guide them toward the semantic content of the spoken language (Cocks, Morgan, & Kita, 2011; Hostetter, 2011; McNeil, Alibali, & Evans, 2000). Results of the study by Cocks et al. (2011) showed the effectiveness of iconic gestures integrated with speech in language comprehension in adults. Participants were shown a set of video clips in different conditions and were asked to select the picture that best matched the message expressed in the video. While both older (60- to 76-year-olds) and younger (22- to 30-year-olds) adults comprehended gestures and speech in isolation (i.e., gesture only and verbal only conditions), only younger adults got benefits from the integration of speech and gesture (i.e., verbal-gesture condition) in comprehending information. Hostetter (2011) undertook a meta-analysis of 63 studies on the role of co-speech gestures involving adults and/or children and found strong evidence that gestures foster comprehension in listeners. While the size of the beneficial effect was moderate overall, it varied depending on factors such as the types of meanings encoded in gesture or the semantic overlap of the gestures with speech. Our own scrutiny of the studies included in Hostetter's (2011) meta-analysis revealed that the gestures used in those studies were either iconic, metaphoric, or deictic gestures —e.g., none of them included beat gestures.

Concerning child development, evidence that the meaning-reinforcing nature of representational gestures aids in

35

comprehending spoken language was reported by McNeil et al. (2000). Children in this study were involved in a communication game with two parts in which they had to follow the instructions (the second part contained a more complex message) given by a speaker on a video in order to select the corresponding blocks. The study demonstrated that reinforcing gestures (e.g., saying "up" and "above" while producing gestures depicting "up" and "above") enhanced 3- to 4-year-old children's speech understanding when the spoken messages were complex. By contrast, exposure to conflicting gestures (e.g., saying "up" and "above" while producing gestures depicting "down" and "below") or exposure to no gestures (e.g., saying "up" and "above" with no gestures) did not enhance the comprehension of the message. Along the same lines, a study with 5- to-7-year-old children conducted by Ping and Goldin-Meadow (2008) also revealed that children profit from iconic gestures in understanding verbally explained strategies or instructions for problem solving given by an experimenter, specifically in Piagetian conservation problems. The instructions were given with or without gestures and in the presence or absence of concrete objects related to the problem (i.e., glasses of water). Results demonstrated that instructions in the gesture plus speech condition boosted children's comprehension more than instructions in the speech alone condition, even when gestures refer to objects that were absent during the instruction phase. Moreover, children who were instructed with iconic gestures were more likely to generate their own correct reasoning behind their judgment in the conservation task (e.g., two glasses containing the same amount of

36

water but that were differently shaped). Congdon et al. (2017) also reported that 8- to 10-year-old children learned best in retaining and generalizing what they had learned from a math lesson when gesture strategies were presented simultaneously with speech strategies (i.e., Speech-with-Gesture condition, in which modalities are temporally synchronized) rather than sequentially (i.e., Speech-then-Speech and Speech-then-Gesture conditions).

Other studies demonstrated that observing gestures might benefit the comprehension of complex syntactic and/or semantic structures. For instance, Theakston, Coates, and Holler (2014) showed that the use of abstract representational co-speech gestures which singled out the two participants in an event and the roles they played in it facilitated the comprehension of object-cleft constructions (e.g., *It was the [object] frog that the [subject] man pushed*) by 3- and 4-year-old children. Similarly, McGregor, Rohlfing, Bean, and Marschner (2009) showed that toddlers (age range: 1;8–2;0) learned the meaning of the word *under* better when they were exposed to the gesture condition (i.e., with a symbolic support of an iconic gesture giving the instruction for *under*) than the toddlers who only saw photographs of objects depicting the word *under* (i.e., photo condition) or those who had no symbolic support (i.e., model only condition).

Many studies have also reported benefits of observing iconic gestures in narrative comprehension tasks, in both adults (Dargue & Sweller, 2018a, 2018b, 2020a, 2020b) and children (Dargue &

Sweller, 2020a; Macoun & Sweller, 2016). Dargue and Sweller's (2020a) study showed that both adult participants and 3- to 5-year-old children who were asked to watch a narrator producing iconic gestures comprehended narratives better than participants in the atypical gesture condition (i.e., which included gestures "that are seldom produced, for example pointing up and down numerous times to depict a pumping motion," p. 255). These results were consistent with other Dargue and Sweller's studies (2018b, 2020b), as they did not find benefits of observing atypical gestures in narrative comprehension. A second study also reported in Dargue and Sweller (2020a) performed with adult participants led the authors argue that typical gestures benefitted participants more than atypical gestures because these gestures were more semantically related to the content of the speech. As an important remark, in this study (see also Dargue & Sweller, 2020b) both types of gestures (atypical and typical) varied concerning the viewpoint of the gesture (i.e., character-viewpoint gestures show first-person perspective, as the gesturer assumes the role of the character by enacting the character's actions; observer-viewpoint gestures occur when an entity is depicted from the perspective of an observer; or no viewpoint; see McNeill, 1992, for definitions).

In the realm of second language acquisition, iconic gestures have been shown to benefit novel word learning in adults (Kelly, McDevitt, & Esch, 2009; Macedonia, Müller, & Friederici, 2011). For instance, Kelly et al. (2009) found that a brief training session with congruent iconic gestures (i.e., iconic gestures with the

expected semantic overlap between gesture and speech) helped 28 adult speakers to learn and remember novel words in a foreign language. By contrast, seeing incongruent gestures (i.e., iconic gestures depicting a mismatched referent) or no gestures (speech condition) did not help them. Macedonia et al.'s (2011) study also revealed better novel word memorization when participants were shown words by an experimenter using iconic gestures rather than with meaningless gestures (e.g., touching one's head or touching one's knee).

In broader educational contexts, studies have highlighted the positive role of teachers' gestures in the learning processes. For example, some studies have investigated whether children glean information from their teachers' gestures, for example when revealing problem-solving strategies in enhancing abstract mathematical learning in children. A study by Goldin-Meadow et al. (1999) reinforced the idea that observing nonverbal communication in a teaching atmosphere can have an influence on boosting children's strategies for solving mathematical equivalences. Their study showed that the use of 8 teachers' gestures during an individually instructed math lesson guided 49 8-to 11-year-old children to convey problem-solving strategies. However, only those gestures that emphasized the information expressed through speech (i.e., speech-gesture match) enhanced children's comprehension of teachers' strategies rather than those gestures which were mismatched with the message (i.e., the teacher's spoken strategy was produced in conjunction with gesture

39

that conveyed a different strategy) or than no gesture at all. However, in an instructional setting, it can be that teachers' gestures do not always have the same meaning as they are conveying in the accompanied speech but hint at important information not expressed in speech. Along these lines, Singer and Goldin-Meadow (2005) demonstrated that children take advantage of instruction with gesture-speech mismatches. When children are ready to learn, these mismatches in which gesture conveys different but not necessarily contradictory information conveyed in the accompanied speech are produced, providing insight into their mental processes in this transitional state (Goldin-Meadow & Wagner, 2005, for a review). In this task, 8- to 10-year-olds who were taught to solve mathematical equivalence problems with mismatching gestures (i.e., gesture simultaneously conveys a different, but complementary, strategy than speech) got higher benefits than those children taught matching gestures or no gestures, which suggests that when there is mismatch in instruction, children learn more. Moreover, research also found that the more mismatches a child produced during a problem-solving task in mathematics, the more the adults gave them instructions that contained more variable strategies and more mismatches (Goldin-Meadow & Singer, 2003).

Findings from Valenzano et al.'s (2003) study provide further evidence that students' comprehension of instructional discourse improved when gestures accompany speech and when they convey the same meaning relevant to the lesson content. In this study, 25 4-to-5-year-old children were asked to judge (and reason why) six

40

items as symmetrical (e.g., a pair of pants) or asymmetrical (e.g., a cup, as it has an extra feature) after the teacher had explained the visuo-spatial concept of bilateral symmetry (i.e., with respect to two symmetrical and three asymmetrical shapes) in either a verbal-plus-gesture videotaped lesson (i.e., the teacher used pointing and tracing gestures) or in verbal-only videotaped lesson (i.e., no gestures performed). Children who undertook the former lesson learned more than children undertaking the latter. In conclusion, these studies highlight the importance of gesture in instructional settings, specifically when comprehension is of great importance either in problem-solving tasks or in the understanding of a new concept.

In contrast to the abovementioned findings, however, no evidence of positive effects of observing gestures was found in some learning tasks. Yeo, Ledesma, Nathan, Alibali, and Church (2017) explored the learning effect of the teacher's gestures to linked representations, equations (symbolic representations) and graphs (visuo-spatial representations) with 82 7th-grade students. While findings showed that children learned less when the teacher referred to the equations in gesture (vs. no gesture), a non-significant tendency was found for a slightly better learning when children watched the gestures linked to graphs (vs. no gestures). However, overall findings did not show compelling evidence of the benefits of teacher's gestures on student's learning for either visuo-spatial representations (i.e., graphs) or symbolic representations (i.e., equations), the latter being, in fact, detrimental.

41

In sum, the abovementioned studies provide evidence of the beneficial effects of *seeing* referential speech gestures on linguistic and cognitive processes, as well as on learning. Observing referential gestures that encode verbal information present in speech plays a key role in improving adults' and children's performance in comprehension tasks, recall or retention tasks, and problem-solving tasks, among others. However, does the production of these gestures also foster learning? In the following subsection, we focus on previous literature that has dealt with the beneficial effects of *producing* referential gestures.

1.3.2 Effects of producing referential gestures

In this subsection, we review the beneficial effects of *producing* co-speech gestures on some linguistic and cognitive tasks (see Goldin-Meadow, 2009, 2014, 2018; Kita et al., 2017; Novack & Goldin-Meadow, 2015, for reviews). First, it has been revealed that by gesturing people can boost the generation of problem-solving strategies, for example in mathematics (e.g., Broaders, Cook, Mitchell, & Goldin-Meadow, 2007; Cook, Mitchell, & Goldin-Meadow, 2008; Goldin-Meadow et al., 2009; Novack, Congdon, Hemani-Lopez, & Goldin-Meadow, 2014, among many others) or in other spatial thinking tasks (e.g., Alibali & Kita, 2010; Alibali et al., 2011, among many others).

Gesture is a mechanism of change and not only manifests children's implicit knowledge about a problem or concept, but it can also

reveal children's learning potential. Effectively, children gesture spontaneously and those communicative movements are related to language development in many significant ways (e.g., Nicoladis et al., 1999). One of the other most interesting issues in recent literature is the question of how to scaffold school-age children's gesturing and whether the performance of these gestures could promote the improvement of their language and other cognitive skills. Previous research has given extensive evidence that instructing learners to produce gestures encourages them to produce gestures on their own and, subsequently, learners benefit from their own gesture performance in subsequent learning processes. Gesturing can change thought by helping learners access to cognitive resources (i.e., thinking), by affecting how learners will go about selecting and performing strategy choices in problem solving tasks or their cognitive state in other tasks (i.e., learning).

Gesturing can enhance both adults' and children's memory recall while performing a mathematical task, suggesting that gesture production lightens demand on working memory (e.g., Cook, Yip, & Goldin-Meadow, 2012; Goldin-Meadow et al., 2001; Wagner, Nusbaum, & Goldin-Meadow, 2004). In Cook et al.'s (2012) study, college student participants had to remember some letters while explaining the solution to math problems and, at the same time, produce either iconic meaningful gestures, non-meaningful gestures or no movement at all. The results of the experiment demonstrated that participants remembered more items when they were instructed to perform meaningful iconic gestures than when they were

instructed to produce no gesture at all or non-meaningful gestures. Likewise, in Wagner et al.'s (2004) study, college-aged adult participants had to explain some mathematical problems in a movement-permitted condition and some in a no-movement condition (gesture was not mentioned in either of the two conditions) while they were asked to hold, at the same time, either a verbal stimulus (e.g., a string of letters) or a visuo-spatial stimulus (e.g., a dots array) in memory. Results demonstrated that adults had better recall of both the verbal and visuo-spatial items when they were allowed to perform gestures, which suggests that speech and gesture conveying the same meaning lighten working memory load. The same positive effects of gesture production on item recall with a similar experiment procedure were found in Goldin-Meadow et al. (2001) for both children and adults. Children here were asked to hold a list of words and adults a list of letters in their memory while explaining how they solved a mathematical problem in either the gesture permitted or the gesture not permitted conditions. Along the same lines, Cook, Yip, and Goldin-Meadow (2010) found that both using gestures spontaneously as well as being encouraged to produce gestures (vs. keeping the hands still while describing the events) had positive immediate and long-term effects on adult's recall of these events.

On the other hand, producing gestures has also been shown to significantly help both adults and children to retain and create new knowledge more fluently. Beilock and Goldin-Meadow (2010) carried out two experiments that consisted in solving and explaining

the Tower of Hanoi task (TOH) with gestures. Children were asked to explain how they had solved the problem also using their hands. Gesturing during the task positively influenced later speech performance, but just when the components of the action reflected in the gesture were compatible with future actions. In this sense, gestures helped participants to change thought, adding action information to their mental representations of the task. Results supported evidence to the idea that gestures can have an effect on changing participants' mental representations in explaining the TOH tasks. Moreover, the two experiments conducted by Kirk and Lewis (2017) with 9- to 11-year-old children demonstrated the effects of spontaneous gesture production (vs. gesture-restricted condition) (Experiment 1) and gesture encouragement (vs. gesture-allowed condition) (Experiment 2) on generating creative novel uses for everyday items in a divergent-thinking task. Both gestures that were produced spontaneously as well as those that were produced through encouragement helped children both in thinking and creating ideas (i.e., novel uses for everyday objects) more fluently. Interestingly, Kita's (2000) study showed that gesture performance facilitated the selection and organization of visuo-spatial information (e.g., to describe a set of actions or a range of objects) into units that were congruent with the sequential order of the speech. These results prompted the Information Packaging hypothesis (section 1.2.4).

As it has been noted, the use of spoken explanations with correlated gestures in problem-solving tasks leads children to understand

notions that are not expressly conveyed in speech, predicting knowledge change (see Goldin-Meadow & Alibali, 2013, for a review on different studies). Cook et al.'s (2008) experiment revealed that only children (84 third and fourth graders aged 9–10 years old) who learned how to solve a math problem through being pre-instructed to perform gestures with or without speech (i.e., gesture + speech condition and gesture condition) remembered the knowledge of the instruction better than those children who were taught in the speech only condition. Results suggest that, when mimicking the experimenter's hands during instruction in the gesture conditions, children retained more new knowledge approximately one month later. Another study by Goldin-Meadow et al. (2009) extended these findings by manipulating both whether children gestured or not and the particular gestures children produced in a math lesson, in order to show *how* gesturing can boost the acquisition of new learning strategies. Results showed that 9- to 10-year-old children who were instructed and asked to produce gestures in the correct-gesture condition (vs. partially-correct-gesture condition and no-gesture condition) in a problem-solving task during a math lesson got more efficient grouping strategies for math operations and hence, more correct responses in the posttest after the math lesson (see also Cook & Goldin-Meadow, 2006). Using the same procedure as in Goldin-Meadow et al. (2009), Novack et al. (2014) reported similar findings. In this study, children between 8 to 10 years of age were trained to solve a mathematical problem either in the action condition (i.e., physical actions performed on objects), concrete gesture condition (i.e.,

46

concrete gesture performance representing that action), or abstract gesture condition (i.e., abstract gesture performance). Results indicated that gestures are more effective than using concrete hand movements that simply represent an action, lending support to the fact that gesturing is not only a physical action but rather a body movement which has the powerful role of representing abstract ideas. Going beyond these results, in Brooks and Goldin-Meadow's (2016) study, 8- to 10-year-old children were told how to move their hands (either with relevant or irrelevant movements) and were asked to repeat them without accompanying speech (i.e., manipulation phase) prior to receiving explicit instructions on how to solve mathematical equivalence problems (i.e., instruction phase). Results revealed that children in the relevant movement condition (vs. irrelevant movement condition, in which gesture motions do not provide useful information about how to solve the problem) showed evidence of better learning and conceptual change after instruction.

Along the same lines, benefits were also found when asking children to simply gesture, without training them to produce a specific kind of gesture (e.g., Broaders et al., 2007). Findings from Broader et al.'s (2007) Study 1 revealed that encouraging 106 third- and fourth-grade children to gesture while explaining problem-solving strategies to math problems (i.e., told-to-gesture group) often provided them with new (previously unexpressed) and correct solution strategies expressed in gesture, bringing out their implicit knowledge already present in their repertoire (vs. told-not-to-

gesture group and control group). Findings from their Study 2, with another group of 70 children (third and fourth graders) also revealed that the implicit knowledge conveyed in gestures and speech enhanced children's learning across ages, showing that children in the told-to-gesture group were better at solving math problems across ages than children in the told-not-to-gesture group.

In science tasks, some studies have pointed out that gesturing serves to highlight perceptual-motor information which is important for solving the task. For instance, Alibali et al. (2011) reported that undergraduate students and adults who were exposed to the gesture-allowed condition tended to select perceptual-motor strategies "which involve depicting of the actions" (p. 1139) (vs. abstract strategies which "involve reasoning based on rules," p. 1139) when solving a problem that required the prediction of gear movement than those participants who were not allowed to gesture (i.e., gesture-prohibited condition). The findings obtained by Alibali and Kita (2010) also revealed the effectiveness of gesture production for 5- to 7-year-old children when having to solve and explain Piagetian conservation tasks. Children who were allowed to gesture (i.e., gesture-allowed condition) were more likely to express present and perceptual information in the problem-solving explanations than those participants who were restricted from using them (i.e., gesture-prohibited condition). Therefore, both studies lend support to the idea that gesturing can be associated with strategies based on perceptual-motor information rather than with abstract information, which are then more highly activated and integrated into the

conceptual planning of speaking. The study by Chu and Kita (2011) also found that adults benefitted from being encouraged to gesture during spatial problem solving, in contrast to gesture-allowed and gesture-prohibited conditions. Importantly, encouraging the use of gestures tended to improve people's ability to mentally transform spatial information.

Concerning learning words in a foreign language, Tellier (2008) analyzed the impact of producing iconic gestures on second language word long-term memorization with twenty 4- to-5-year-old French children. Children were taught eight English words in two conditions: the no-gesture condition, in which words were taught accompanied by pictures; and the gesture condition, in which words were taught accompanied by gestures that were to be reproduced by children tested in this group. Participants were able to memorize more words in the latter condition than in the former. Similarly, in a classroom-training study, Macedonia, Bergmann, and Roithmayr (2014) found that older children (mean age 11;2) learned foreign vocabulary items more effectively when they were asked to imitate the teachers' gestures related to the word's semantic content than in the audio-visual baseline condition or the observation condition.

Lastly, there is evidence that the use of gestures acts as a positive scaffold in lexical ambiguity tasks. In their study, Kidd and Holler (2009) examined how 3-to 5-year-old children's gestures contribute to resolve lexical ambiguity in retelling stories that contained

homonym pairs to an experimenter. While 3-year-olds still had difficulties when disambiguating the two meaning of the homonym pairs (and using pointing gestures to disambiguate), at 4 years of age children managed to disambiguate the two meanings more often by using iconic gestures. Finally, 5-year-olds were able to make verbal disambiguation attempts by using less iconics than 4-year-olds, thus being the most competent communicators. Wakefield, Hall, James, and Goldin-Meadow (2018) also found that learning by both doing and seeing gestures (i.e., gesture condition) was more effective than learning by both doing and seeing actions (i.e., action condition) in promoting 4- to 5-year-old children's generalization in a word learning task (e.g., in learning the meaning of verbs performed on new objects). In this case, children performed equally in both producing and observing conditions. Moreover, according to the results on word recall, children profited more from their own gesture production rather than from observing others' gestures. However, importantly, no effect was found between action and gesture, which suggests that observing and producing gestures may share the same underlying mechanism in retaining information.

Other studies have compared the effectiveness of producing gestures versus seeing them. For example, learning anatomy in adults has been found to be more efficient when participants were asked to imitate the model's gestures during learning rather than just observing these gestures (i.e., keeping their hands on the table). However, these differences were found to be significant just in a long-term evaluation (Cherdieu, Palombi, Gerber, Toccaz, &

Rochet-Capellan, 2017), which may suggest that knowledge could be positively affected by sleeping. Another study by Goldin-Meadow, Levine, Zinchenko, et al. (2014) asked 6-year-old children to either produce a *move* gesture relevant to the task, observe a *move* gesture, produce a *point* gesture or observe a *point* gesture on a mental transformation task. Results revealed that doing gestures had more learning effects than just seeing gestures. Particularly, producing a *move* gesture that contained information relevant to solving the task during instruction helped children more than producing a *point* gesture, which did not facilitate learning.

Along these lines, a study by Dargue and Sweller (2020b) examined under which conditions gesture could benefit adult's comprehension of narratives. Contradictory results were found when adult and children participants were asked to produce gestures during free recall in narrative comprehension (e.g., Cameron & Xu, 2011; Dargue & Sweller, 2020b). In Dargue and Sweller's (2020b) study, participants observed a narrator producing typical gestures, atypical gestures or no gestures. Then, during the recall phase, participants were instructed to produce gestures, restrained from gesturing or were not given gesture instructions. Results found that adult participants who watched typical iconic gestures (vs. atypical gestures and no gestures) improved their narrative comprehension. However, participants, who after having observed the stories, were encouraged to produce gestures during recall (vs. restrained or no instruction conditions) did not improve their narrative comprehension. Moreover, no interaction between gesture

production and observation was found. Interestingly, participants who were instructed to produce gestures during recall and who previously observed typical gestures produced more typical gestures (vs. observing atypical gestures or no gestures) at recall. However, as producing gestures was not itself beneficial, the authors suggest that "the type of gesture observed may have been more important than producing the same type of gesture" (p. 9). These results on gesture production are in contrast to findings obtained by Cameron and Xu (2011) in children. Cameron and Xu (2011) found that instructing children to produce representational and pointing gestures, as performed by the experimenter, while retelling helped children (mean age 4;7) retrieve more information about the story (vs. when children were asked to keep both hands still).

All the aforementioned studies showed that *producing* some type of referential gestures in learning tasks tends to benefit later performance across different age spans. Encouraging children to produce gestures has significant effects on learning from their own gestures. Also, introducing actions into speaker's mental representations by gesturing results in thought change processes (e.g., Beilock & Goldin-Meadow, 2010), which suggests that children successfully integrate information from representational gestures. All in all, these results strengthen the importance of body language and, specifically, hand movements in human nonverbal communication and learning across development. Importantly, by moving their hands in a problem-solving scenario, learners are performing instances of embodied cognition (section 1.2.5).

However, previous literature has also offered contradictory findings about the effectiveness of the use of gesture during learning. For instance, following Cook et al.'s (2009) experimental design, Byrd, McNeil, D'Mello, and Cook (2014) tested 70 children (mean age 8;9) by comparing the effectiveness of three instruction modes on math equivalence explanations, namely speech only condition (i.e., the child was shown a video of a teacher giving speech instructions), gesture condition (i.e., the teacher gave gesture-speech instructions), and eye movement condition (i.e., the teacher gave speech instructions while moving the eyes across the problem). Results showed that children who were instructed to mimic the teacher's behavior when solving mathematical problems on their own in the gesture condition (vs. speech only and eye movement conditions) retained less knowledge during instruction. By contrast, children in the speech only condition differed in how well they learned and retained the knowledge gained during instruction over a 4-week delay. And children in the eye movement condition solved more problems correctly during instruction, but not in posttest nor in the follow-up test. Similar claims have been made in other studies that reported null or negative effects of gestures on second language learning. In the same way, the study by Hirata and Kelly (2010) investigated whether 60 English-speaking adults improved their learning of Japanese vowel length contrasts and found negative results for audio-hands (that is, conveying information about the length of the vowels with hand movements) and audio-mouth-hands conditions (with both mouth and hand

movements) (vs. audio-only and audio-mouth conditions), showing that mimicking hand gestures did not help learners to perceive phonemic contrasts.

Despite some negative findings, the dominant results in the literature tend to back up the claim that *producing* referential gestures has positive effects on various linguistic and cognitive domains. In comparison with the large body of literature on the positive impact of referential gestures, much less is known about the beneficial effects of both observing and producing non-referential beat gestures. The following section reviews the main findings related to the role that non-referential beat gestures play in language processing and learning.

1.4 Cognitive and linguistic developmental benefits of non-referential beat gestures

To our knowledge, some studies have assessed the role of non-referential beat gestures. Nonetheless, the fact that beat gestures have been relatively understudied may be due to the general theoretical consensus that these gestures lack abstract semantic content (McNeill, 1992). This idea induced previous studies to consider beat gestures as a non-meaningful subcategory of co-speech gestures in both adults' and children's development and thus would have less benefits (e.g., Macoun & Sweller, 2016; So et al., 2012, among others).

Similar to the positive impact of referential gestures (see section 1.3), in general beat gestures seem to have a positive effect on adults' and children's ability to recall information (e.g., Austin & Sweller, 2014; Igualada, Esteve-Gibert, & Prieto, 2017; Kushch & Prieto, 2016; Llanes-Coromina, Vilà-Giménez, Kushch, Borràs-Comes, & Prieto, 2018; So et al., 2012). In So et al.'s (2012; see section 1.3.1) experiment, only adults (and not 4- and 5-year-old preschool children) displayed better recall scores when words were accompanied with beat gestures compared with no gesture. These findings suggest that the saliency (i.e., prominent) effect of beat gestures in speech fosters memory recall. However, the fact that only adults could benefit from beats seems to suggest that beats trigger a higher cognitive demand for children than for adults.

Notwithstanding these results, three recent studies have reported that beat gestures also improve word recall in children (Austin & Sweller, 2014; Igualada et al., 2017; Llanes-Coromina, Vilà-Giménez, et al., 2018). In contrast with So et al.'s (2012) study, in a between-participants design, Austin and Sweller (2014) found that both beat gestures and combined gestures (i.e., including 5 deictic, 5 beat, 5 iconic, and 5 metaphoric gestures) (vs. no gesture) facilitated the verbal recall of spoken spatial directions by 3- to 4-year-old children. However, information related to spatial location information was better recalled than spatial movement information across conditions (e.g., in a target path as *Lego man walks through a café and stops for a glass of milk*, there is location information, *through a café*, and the spatial movement, *stops for a glass of milk*, p. 96). In line with Austin and Sweller (2014), Igualada et al.'s (2017) study revealed that 3- to 5-year-old children who were asked to retell a to-do list containing contextually relevant items recalled the target words significantly better when they were performed together with a beat than when they were not performed with a beat. Following up on the study by So and colleagues (2012), it is worth noting here that the relevance of beat gestures was obtained by assessing their role within pragmatically relevant discourse contexts (e.g., small-scale route directions and list of things that an elephant needs to do before travelling).

In addition, the study by Llanes-Coromina, Vilà-Giménez, et al. (2018) corroborated that beat gestures positively influence information memorization within contrastive discourse by 4-year-old children. In this experiment, target contrastive items were

56

presented in three conditions: non-prominent speech (L*), prominence in speech alone (L+H*), and prominence in both speech (L+H*) and gesture (beat gestures) and the latter condition was the most effective for children's target word recall. Similarly, Kushch and Prieto (2016) investigated the role of prosodic prominence (pitch accents) and gestural prominence (beat gestures) on the recall of contrastive information in natural discourse with adults. In a within-subjects experiment, undergraduate students (mean age: 20.5 years) were shown videotaped discourses each containing two sets of contrasting items, for example *The fish shop/The grocery shop*, which were covered in either *snow/ice*, in two different conditions. In the first condition, one of the two items (i.e., the target word) was accompanied by prosodic prominence (L+H* pitch accent), whereas in the second the word was accompanied by prosodic prominence and gestural prominence (L+H* pitch accent and a beat gesture). Participants who were exposed to the latter condition recalled contrastive information more than participants who watched discourses without beat gestures. Finally, the study by Kushch, Igualada, and Prieto (2018) also reflects the benefits of beats in second language word learning. The results of this study revealed that the combination of beat gestures and prosodic prominence was optimal for second language novel vocabulary learning. The aforementioned studies state that beat gestures induce a stronger listener's perception of prominence, which subsequently leads to higher memorization and comprehension performance rates.

Another study conducted by Morett and Fraundorf (2019) went further in examining how contrastive pitch accenting and beat gestures are integrated and how they affect memory for specific words in a discourse. In Experiment 1, adult participants (18 years or older) were presented with a set of audiovisual discourses in which each critical word was presented under one of the following conditions: (a) beat gesture with contrastive accenting (L+H*), (b) no beat gesture with contrastive accenting (L+H*), (c) beat gesture with presentational accenting (H*), and (d) no beat gesture with presentational accenting (H*). Results obtained in this study are consistent with previous findings, as pitch accents accompanied by beat gesture benefited the participants more than when beat gesture was absent. Moreover, words accompanied by beat gesture and contrastive pitch accent were better remembered than words accompanied by a beat gesture and a presentational pitch accent. In Experiment 2, the authors tested the effects of no-gesture conditions with a new group of adult participants in order to assess the relevance of prosodic prominence cues alone. In this case, when beat gestures were absent, words performed with a contrastive pitch accent helped participants to memorize more items rather than words accompanied by a presentational pitch accent.

In general, although the evidence suggests that both children and adults benefit from the presence of beat gestures when having to recall information, Feyereisen (2006) found conflicting results. In this within-subjects study with Psychology students, the authors did not find a facilitative effect of non-representational gestures (vs.

representational gestures) in a written free recall task of target sentences. Negative results for beats were also found in a study carried out by Austin and Sweller (2017) in a route direction task. Three- to five-year-old children were assigned to either the iconic/deictic gesture condition, the beat gesture condition, or the no gesture condition, and were presented with three videos of the head zoo-keeper verbally giving route directions through the zoo. Results indicated that iconic and deictic gestures (vs. beat gestures and no gestures) accompanying the spoken route directions helped children to recall more information verbally. Location information was recalled more than movements and descriptive information across all gesture conditions. A possible explanation given by the authors for these findings is that referential gestures "may be processed more deeply due to their semantic value, leading to great recall without the presence of environmental cues" (p. 10). Finally, observing beats during storytelling was found to have no positive effects on recalling path and event information by 5-year-olds and adults, in contrast to iconic gestures (Kartalkanat & Göksun, 2020).

While some studies have addressed the potential role of beat gestures on information recall, very little research has addressed the potential role of beat gestures in narrative comprehension processes. Apart from examining effects on memory recall, Llanes-Coromina, Vilà-Giménez, et al. (2018) performed a second experiment in which they tested the benefits of observing beats in narrative discourse comprehension in 5- to 6-year-old children. Each child was shown a set of narrative discourses either with

prosodic prominence and no beat gestures (i.e., no-beat condition) or with prosodic prominence and beat gestures (i.e., beat condition) in target words within the story. Stories performed in the beat condition were better comprehended than those performed in the control condition.

To our knowledge, only one study (Macoun & Sweller, 2016) has dealt with the effects of beats on narrative comprehension by younger children, and with negative results. Macoun and Sweller (2016) investigated the effects of four gesture conditions (e.g., iconic, deictic, beat gestures, or no gesture) on preschoolers' (between 3.25–5.58 age range) narrative comprehension and recall of information. In their experiment with a between-subjects experimental design, children were asked to listen to the same discourse in one of the four gesture conditions. Results showed that whereas iconic and deictic gestures provided benefits in comprehending and recalling information in narratives, the other two conditions (e.g., beat gestures and no-gesture) did not have a beneficial effect.

In order to investigate how the presence of beats affects L2 vocabulary acquisition, Morett (2014) conducted a study with undergraduates (mean age: 20.15 years) in an interactive learning task. Participants in pairs were assigned either the *Explainer* role (i.e., sees 10 words with representational gestures and 10 without, and then teaches the novel vocabulary to the learner) or the *Learner* role (see pp. 839–841 for more details on the experimental

procedure). Both types of participants were then administered a memory recall test of the target words after the teaching phase. Findings showed that gestures produced during this conversational setting (vs. gesture viewing) supported all three L2 interrelated cognitive processes: communication, encoding (i.e., storage in memory) and recall (i.e., retrieval from memory) of these 20 novel words. The results showed that the representational gestures produced by explainers fostered, on the one hand, their own encoding of the L2 target words and, on the other hand, the recall of the new L2 vocabulary by the learners. Specifically, the explainers' production of beat gestures enhanced, on the one hand, their own recall and, on the other hand, the encoding of the words by the learners. All in all, beat gesture production was shown to have a greater impact in recall of L2 novel words than merely observing them in input. Finally, concerning communication (i.e., exchange of ideas), beat gesture production seems to facilitate communication about the target language more than representational or deictic gestures.

Interestingly, neurophysiological studies have provided evidence of the cognitive advantages of beat gestures on speech processing in adults, showing their integration with the language system. Many studies have accounted for these effects using event-related potentials (ERPs) or functional magnetic resonance imaging (fMRI) (i.e., methods of measuring brain activity during cognitive processing) (e.g., Biau, Fernández, Holle, Avila, & Soto-Faraco, 2016; Biau & Soto-Faraco, 2013; Holle et al., 2012; Wang & Chu,

2013, among others). Findings have revealed the influence of beat gestures in speech processing, such as in perception and comprehension (Biau & Soto-Faraco, 2013; Dimitrova et al., 2016; Hubbard, Wilson, Callan, & Dapretto, 2009), as well as in syntactic (Holle et al., 2012) and semantic integration or processing (Wang & Chu, 2013), compared with the null effects found for other potential visual highlighters of speech (e.g., a moving visual stimulus, nonsense movements, etc.). In general, these studies interpret the positive results found for beats as an attentional effect that activates language-related areas instead of just stimulating the visual-perception areas of the brain. That is, beat gestures seem to trigger a cognitive attentional effect to language because of their relationship with the neural substrate of speech. See also Pouw, Harrison, and Dixon (2019) for the reported biomechanical interdependence between speech and beat-like movements.

The review outlined in this section shows that some studies have investigated the beneficial effects of non-referential beat gestures on learning processes. Nevertheless, the research to date has tended to focus on observing this type of gestures rather than producing them (e.g., Lucero et al., 2014). In their study, Lucero et al. (2014) carried out two experiments focusing on beats and their relationship with boosting and improving speech production. In Experiment 1, adult participants were asked to produce different target words that were related to some definitions either in the iconic gesture condition (i.e., participants were asked to depict the word with their hands as they searched a word that matched the definition), the beat

gesture condition (i.e., participants were asked to perform a beat gesture), or the no gesture instruction condition (i.e., no reference to gesturing). Participants in the beat gesture instruction condition produced more words with ease. Reaction times in the beat gesture condition were greater than in the other conditions, and reaction times in the iconic gesture condition were significantly higher than in the other conditions. In Experiment 2, the authors focused on the results obtained by beat gestures in enhancing word production. Another group of participants were administered a task using similar materials and a similar procedure as in Experiment 1, but under four gesture instruction conditions, namely no gesture instruction, bimanual beat, right hand beat, and left hand beat. Results showed that participants who undertook the bimanual beat instruction were significantly faster at word production in terms of reaction times, rather than in the right hand beat or no gesture instruction conditions. Reaction times in the left hand beat instruction condition were not significantly different from those in the bimanual beat condition. According to these findings, the authors suggested that left hand beats, more than right hand beats, have a neural connectivity with the right-hemisphere circuits implicated in language processing. This study also suggests that the effectiveness of beat gestures on production may result from wide principles of motor action. Importantly, in both Experiments 1 and 2, lexical accuracy was not different between conditions.

To summarize, although some research has been carried out on the positive effects of beat gestures (and their concomitant prominence

in speech) on cognitive processes (recall and comprehension tasks) and linguistic tasks (vocabulary acquisition), little is known about their value in building up more complex linguistic abilities, such as in oral narrative discourses. Following the aforementioned findings, the present dissertation seeks out to demonstrate that beat gestures can act as multimodal pragmatic cues which highlight important linguistic functions in oral narratives, hence boosting the improvement of children's narrative abilities.

However, having outlined the main research addressing the learning effects of both referential and non-referential gestures, what is the role of gesture-speech multimodal integration and language development in earlier stages in life? The following section focuses on the literature dealing with the precursor and predictive role of gestures in children's early linguistic milestones.

1.5 Gesture-speech development: Multimodality in infancy

Children's gestures have been shown to serve as forerunners of linguistic change (e.g., Goldin-Meadow, 2003, for a review). Early on in language development, gestures offer children a helping hand to communicate with their parents and caregivers. Infants start using gestures to communicate prior to using language (Acredolo & Goodwyn, 1988; Bates, 1976; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Butcher & Goldin-Meadow, 2000; Greenfield & Smith, 1976; Iverson, Capirci, & Caselli, 1994). From a developmental point of view, both children's speech and their gestures become better with age, and the combination of gesture-speech productions helps children to keep expanding their communicative repertoire (e.g., Özçalışkan & Goldin-Meadow, 2005). Many studies crucially show that there is not only continuity in development between the children's use of gestures and their linguistic development but also that co-speech gestures act as precursors and predictors in the early stages of acquisition and language learning (see Gullberg, Volterra, & De Bot, 2008, and Rohlfing, 2019, for reviews).

A growing body of literature has demonstrated that the use of nonverbal communication by infants and toddlers facilitates the development of oral language. Between 9 and 12 months of age, children start producing their first gestures, *deictic* gestures (Acredolo & Goodwyn, 1985; Bates, 1976; Bates et al., 1979;

Behne, Liszkowski, Carpenter, & Tomasello, 2012; see Rohlfing, Grimminger, & Lüke, 2017, for a review on the development of deictic pointing in infancy). Deictic gestures are the most commonly used type of gesture at early stages of language development, as children use them to identify objects, people, events or locations with the pointing finger before they have words to refer to them (e.g., Iverson & Goldin-Meadow, 2005). That is, by using a pointing gesture the child is drawing the interlocutor's attention to something in the environment (e.g., infants at 6 months of age are capable of directing their attention to dynamic points, rather than to static points; Rohlfing, Longo, & Bertenthal, 2012). During the initial stages of language learning, previous investigations have underscored the importance of the use of pointing gestures by children in predicting word learning (i.e., vocabulary growth). Importantly, early pointing at 10 to 12 months old is correlated to receptive vocabulary development (Mumford & Kita, 2016). A meta-analysis performed by Colonnesi, Stams, Koster, & Noom (2010) demonstrated that pointing gesture is concurrently and longitudinally linked to language development and that this relation becomes stronger with age. Not only the production but also the comprehension of pointing gesture with a declarative motive (vs. imperative) is related to development. Another study by Igualada and colleagues (2015) revealed that using simultaneous pointing gesture-speech combinations at 12 months with the purpose of sharing joint attention with the adult to the same referent predicts later expressive vocabulary and morphosyntactic measures at 18 months. A more recent study by

66

Murillo et al. (2018) found that the coordination of gestures and vocalizations before the two-word period (i.e., 15 months) was related to lexical development 3 months later. Iverson and Goldin-Meadow (2005) reported that the specific lexical items conveyed through the children's gestural repertoires videotaped between ages 10 to 24 months turned up in children's verbal vocabulary approximately three months later. Therefore, not only pointing gestures precede but can also predict the emergence of early speech combinations, with particular lexical items that the child produced initially in gesture eventually becoming part of a child's later verbal repertoire.

Importantly, at the single-word period children start combining gesture semantically (i.e., related to the meaning of the speech) and temporally (i.e., in synchrony) with speech (e.g., Butcher & Goldin-Meadow, 2000; Esteve-Gibert & Prieto, 2014). To examine the temporal integration between gesture and speech in early development, Butcher and Goldin-Meadow (2000) conducted longitudinal observations of 6 children during the transition from one-word to two-word speech (between the ages of 12 and 27 months). The authors found that around 14 to 23 months old (i.e., at the end of the single-word period) children started to produce gestures in combination with meaningful words and that it was not until the beginning of the two-word period that these combinations were temporally aligned in an adult-like fashion. A study by Esteve-Gibert and Prieto (2014) confirmed and expanded those results by examining the patterns of gesture and speech combinations and

their temporal alignment from the babbling to the one-word period. Results showed that infants start to use gesture-speech combinations in an adult-like way at the beginning of the single-word period. Already in the transition between the babbling stage and single-word period infants were found to combine and temporally coordinate their pointing-speech combinations. In these cases, gesture and speech hold semantic and temporal coherence, as gesture is used to complement or reinforce speech. For example, children can point at a *bird* to identify this element in the environment (e.g., if they want to indicate that there is a bird flying around there), while saying "bird."

Pointing gestures have been also shown to be strong predictors of early syntactic acquisition. The appearance of gesture-word combinations at the one-word stage heralds the onset of two-word speech (word + word combinations), when supplementary gesture-speech combinations emerge in children's linguistic repertoire (e.g., "play" + point at ball, to express the desire to play with the ball). That is, children begin to produce gesture-speech combinations in which gesture conveys other different information from that conveyed in speech. These gesture-speech combinations allow children to express sentence-like information before they convey this idea in a single spoken utterance (e.g., "play ball"). Importantly, the combination of a deictic gesture and a word describing either the action to be done (e.g., pointing at a ball while saying "play") or an attribute (e.g., pointing at a ball while saying "big") predicts the acquisition of children's first two-word

utterances later in development (e.g., "play ball") (Bavin, 2014; Goldin-Meadow & Butcher, 2003; Iverson, Capirci, Volterra, & Goldin-Meadow, 2008; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005). The findings of the longitudinal study by Iverson and Goldin-Meadow (2005) also showed that complementary gesture-plus-word combinations that communicate a single semantic element in a communicative act did not correlate with the onset of first multi-word combinations. Therefore, the authors pointed out that the predictive value of gestures is not the performance of gesture *per se* but the ability to communicate two different semantic elements together through gesture and speech.

Importantly, supplementary pointing-speech combinations change over time and can both precede and signal child's more complex linguistic steps. Özçalışkan and Goldin-Meadow (2005) conducted an analysis of gesture-speech combinations in children from 14 to 22 months. The authors found three linguistic constructions that can be produced across gesture and speech modalities four months before conveying them in speech (e.g., "mommy cookie", "eat cookie" or "I like to eat it"). Particularly, a child can point at a cookie while saying "mommy," reflecting an argument-argument construction. The child can also perform an eating gesture while saying "cookie," reflecting a predicate-argument construction, or also while saying "I like it," reflecting a predicate-predicate construction. A follow-up study by Özçalışkan and Goldin-Meadow (2009) with the same children reported a change in the role of

69

gesture as a language-learning tool at 22–34 months. In this period gestures continue to act as being harbingers of linguistic steps, but only when signaling the emergence of new constructions. That is, children gesture when they take their initial steps into learning a new syntactic construction (e.g., two-argument construction: e.g., pointing at a cup while saying "mommy"). However, they tend not to rely on gesture when they have already established those linguistic constructions into their repertoires and just want to incorporate additional arguments to complement these constructions. For example, when learning the three-argument construction, where a child may point at the mouth while saying "Emily cereal."

Shortly after in development, children start performing other types of gestures, such as *iconic* gestures (Acredolo & Goodwyn, 1985, 1988; Bates, 1976; Bates et al., 1979; Iverson et al., 1994). Children's use of these gestures allows them to express information about a referent in speech, such as an object, an action or a space (e.g., referring the form of a ball by depicting a round shape with the hands). Interestingly, Özçalışkan and Goldin-Meadow's (2011) study observed spontaneous gestures performed by 40 children from 14 to 34 months of age and reported a spurt in iconic gesture production roughly around 26 months of age. Importantly, not only children increased their production of iconics but they also conveyed more varied sets of meanings.

Previous evidence has also showed that iconic gestures children produce can predict their later verbal vocabulary. For instance, children's verbal vocabularies at age 2 tend to be larger when children have more iconics in their communicative repertoires at 1.5 years of age (Acredolo & Goodwyn, 1988). However, a longitudinal study (Özçalışkan, Gentner, & Goldin-Meadow, 2014) with 44 children (14 to 34 months) examined the role of iconic gestures in paving the way for children's first verbs and yielded some contradictory results in comparison with those showing that deictic gestures do precede and predict children's first words. The results showed that (a) children's iconic gesture production was very low in comparison to verb production and that (b) children performed their first iconic gestures 6 months later than their corresponding verbs. Even though these findings are not fully conclusive regarding the precursor and predictive status of iconic gestures, results also revealed that between 22 and 26 months children increased their production of verbs as well as their production of iconics. The results also demonstrated that children frequently used iconic gestures to communicate action meanings not yet conveyed in their first verbs, which contribute in expanding their communicative repertoire and to fill lexical gaps in their action vocabularies. The authors suggest that, when children already understand and use verbs in their language, "they may develop a sense of possible verb meanings and begin to be aware of the lexical gaps they have in their verb vocabularies." (p. 14) Taking together these results, one of the explanations the authors give for the low production of iconics in early development is that, given the fact that these

71

gestures deserve much more effort and cognitive demand in comparison to pointing gestures, as they convey the information of a referent, they appear later in development than deictic gestures.

Other gestures that children produce during the early years of language development and that can be found in children's gestural repertoires at around 9 and 13 months of age are *conventional* gestures (also called *emblems*) to convey cultural social meanings (e.g., nodding or shaking the head to affirm or negate something) (see Rohlfing, 2019). Although gesture researchers have primarily focused on manual gestures, head movements such as these types of conventional gestures have also been commonplace in children's first forms of communication. The most predominantly used emblems are headshakes and nods, used for children when they are negating or affirming something (Bates et al., 1979). In general, these gestures appear to be first performed when the child has approximately reached one year of age (e.g., Beaupoil-Hourdel, Morgenstern, & Boutet, 2015; Guidetti, 2002, 2005). Along the same lines, a longitudinal study conducted with 53 English-speaking parent-child dyads who were visited every four months when children were aged between 14 and 34 months, demonstrated that children who gestured more, conveying different meanings, (e.g., deictic gestures, representational gestures and conventional gestures) during their ordinary activities at 14 months (e.g., toy play, book reading, meal or snack time) had larger vocabulary sizes at 42 months (Rowe et al., 2008). And similarly, observations from another longitudinal study with 52 children at 18 and 42 months by

72

Rowe and Goldin-Meadow (2009) revealed that skills reflected in gesture selectively predict later language learning. The study showed that (a) the ability of expressing different meanings through gesture (i.e., pointing, iconic and conventional gestures) at 18 months of age is a predictor of later verbal vocabulary size at 42 months, but not of sentence complexity; and that (b) performing gesture *plus* speech conveying sentence-like information predicts later verbal sentence complexity at 42 months, but not vocabulary growth.

Flip gestures are also among the earliest gestures to appear in children's repertoires. Flip gestures are non-referential gestures which are performed by turning the wrist of the hand and opening it up to present the flat palm, accompanied or not with a shrug of the shoulders, and usually convey a judgmental or epistemic value of ignorance (Ferré, 2011). Gesture researchers have also called this gesture type *palm-up* (see Cooperrider, Abner, & Goldin-Meadow, 2018). An observational study by Acredolo and Goodwyn (1985) has reported that it is during the second year when children start to spontaneously convey ignorance though the use of flips (or shoulder shrugs). The results of their analysis of the multimodal utterances produced by one child from 12 to 17 months old demonstrated that these gestures were being used to signal ignorance at 15 months of age. Along the same lines, 64 14- to 42-month-old children included in a longitudinal study of early language development (Goldin-Meadow, Levine, Hedges, et al., 2014) were analyzed in Bartz's (2017) study. Findings showed that one-fifth of the children

produced a flip to signal ignorance at 22 months, and that half of the children produced a flip to convey ignorance by 42 months of age (see Harris, Bartz, & Rowe, 2017, for a review on the emergence and prevalence of flip gestures in the conveyance of ignorance). Nevertheless, to our knowledge, no previous investigations have dealt with the precursor and predictive role of flip gestures in children's language development.

During toddlerhood, a new gesture type, called *beat* gesture, also emerges. Nicoladis and colleagues (1999) reported the appearance of beat gestures (i.e., moving the hands up and down) in bilingual children between the ages of 2 to 3 years and 6 months (24–42 months). Five French-English bilingual children were videotaped every six months interacting with their caregivers (eating a meal, reading a book, etc.) in order to investigate how the combination of language and cognitive development could affect gesture development. Results of this study showed that there is a link between language development and the production of iconic and beat gestures. First, beat (and also iconic) gesture performance increased as the mean length of spoken utterances (MLU) increased. The authors stated that children begin to produce beat gestures when they perform sentence-like or more linguistically complex spoken utterances (i.e., increasing MLU development), suggesting a link between the onset of the production of these gestures and the emerging complex linguistic skills in one particular language. Second, as the relationship between the development of verbal skills and iconic and beat gestures seemed to be weaker for the children's

French (their less dominant language) than for their English, the authors pointed out that, as a group, the children's gesture skills were higher in their dominant language. See section 1.7.3 for further details in how children start to integrate beat gestures in more complex discourse (i.e., narrative speech). However, to our knowledge, no research up to now has investigated the precursor and predictive role of beat gestures in children's language development.

In this section, we have reviewed the relationship between gesture and speech in early language development, and specifically its role in preceding and signaling oncoming changes in children's first linguistic milestones. Nevertheless, most of these studies have focused on the role of deictic and iconic gestures, and less is known about the predictive and beneficial role of non-referential beat gestures in children's later more elaborated language abilities (e.g., narrative skills), a gap that this thesis intends to address. Moreover, further research is needed in language and gesture development with children older than 2 years of age. In the following section, we motivate why we think that the use of beat gestures might play a prominent role in children's language development and can have bootstrapping effects on narrative abilities in children.

1.6 The linguistic functions of non-referential beat gestures

1.6.1 What is a non-referential beat gesture?

Non-referential beat gestures have been historically described by their *rhythmic properties*. For instance, this kind of unique gestures have been termed *batons* or *rhythmic batons* (Efron, 1941; Ekman & Friesen, 1969) and *punctuating*, according to Freedman and Hoffman's scheme (1967). These terms focus on the rhythmic nature of beat gestures as hand or arm movements beating in tune with the rhythm of speech. More specifically, these definitions match with the temporal synchronization between gestures and prosodically prominent speech (*phonological synchrony rule* by McNeill, 1992, 2005, section 1.2.3).

As previously noted, this thesis follows the classification scheme for gestures proposed by McNeill (1992), in which the beat gesture movement is defined by being a rhythmic short and quick "simple flick of the hand or fingers up and down, or back and forth" (p. 15), "zeroing in rhythmically on the prosodic peaks of speech" (i.e., pitch accents) (McNeill, 2006, p. 301) (Figure 3). See section 1.2.2 for a summary of the classification of co-speech gestures. Importantly, however, McNeill's traditional definition of beat gestures has distinguished beats from other gestures (i.e., referential gestures) for having two movement phases (i.e., bi-phasic movement, such as in/out, up/down, etc.) and for their lack of

76

referentiality in speech. Although the McNeillian concept has highlighted the rhythmic and prosodic properties of beat gestures together with a specific discourse function in highlighting important information of speech, many studies have tended to use a more simplistic definition of beats. This idea also led some authors to define beat gestures as being non-meaningful in discourse; for example, gestures "which represent rhythmic non-meaningful hand movements" (Dimitrova et al., 2016, p. 1255) or "simple, rhythmic gestures that do not convey semantic content" (Alibali et al., 2001, p. 169; see also Abner et al., 2015).

Figure 3. Illustration of a beat gesture, extracted from McNeill (1992, p. 16). The beat is produced in a summing up statement, which is referring to the theme of an episode: "when[ever she] looks at him he tried to make monkey noises." The beat is performed in the speech segment marked within brackets.

In the present dissertation, we adopt an inclusive definition of beat gestures that highlights the rhythmic, pragmatic and discursive properties of beats already outlined by McNeill (see subsection below). Recent studies have challenged a simplified view of beats

77

as non-meaningful biphasic hand movements that act mainly as rhythmic highlighters of speech (Prieto et al., 2018, see also Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016). Crucially, within this view beats are non-referential gestures that contribute clear pragmatic and discursive meanings. Beats can also adopt different hand shapes and also involve other body parts, something which is in line with Krahmer and Swerts (2007), who stated that "visual beat gestures" can also be coordinated to other articulator movements, such as head nods and eyebrow raises. Therefore, although beat gestures do not directly support the semantic or referential content of spoken language, this view highlights the fact that beat gestures strongly contribute to the pragmatic and interactional interpretation of discourse.

In the following section, we review work that has described the pragmatic, discursive, and prosodic value of beat gestures and we further discuss how these features can help frame oral discourse structure.

1.6.2 Pragmatic, discursive and prosodic properties of non-referential beat gestures

1.6.2.1. Pragmatic and discursive properties

On the pragmatic side, beat gestures have not been treated in much detail and have been generally claimed to emphasize important information in discourse. McNeill (1992) argued that beats appear to be connected to discourse, by providing important functions in it.

That is, beat gestures highlight the locus of important information expressed by the speaker compared to information which is not considered to be relevant in discourse. In particular, the author states that a beat "indexes the word or phrase it accompanies as being significant, not for its own semantic content, but for its discourse-pragmatic content" (p. 15). Other authors, such as Loehr (2012), also state that the combination of a high pitch accent and a beat gesture can also be typically used to either draw additional attention or to emphasize an entity. Therefore, *focusing* and *emphasis* have been highlighted as important pragmatic functions of prosodic prominence and gestural prominence. In our view, one of the clear pragmatic contributions of beat gestures at the discourse level is that they act not only as focus markers, but more generally as information structure markers. Im and Baumann's (2020) recent study showed that prosodic prominence (i.e., pitch accents), in conjunction with non-referential gestures, encodes information status in speech by highlighting new, accessible, and contrastive information (see also Shattuck-Hufnagel et al., 2016). Moreover, Dimitrova et al. (2016) also highlighted the function of beat gestures as nonverbal indicators of information focus of the message in language comprehension.

Importantly, other studies have pointed out that beat gestures not only can signal a great variety of discourse functions (e.g., information structure) but also highlight other important pragmatic functions that are part of discourse. Concerning discourse management, following on Kendon's (1995, 2004, 2017) gesture

typology, an important distinction is made between gestures that have either a *substantial* function (i.e., related to the utterance content) or a *pragmatic* (also illocutionary or discourse gestures) function (i.e., gestures that do not convey clear semantic information in their hand shape, but that manage the communicative discourse organization). Beat gestures are included in the category of these pragmatic gestures which do not have a contextual meaning but "express aspects of utterance structure, including the status of discourse segments with respect to one another, and the character of the 'speech act' or interactional move of the utterance" (Kendon, 1995, p. 247). Kendon (1995) also referred to beat gestures as "rhetorical," since they mark information about the rhetorical purpose of the discourse. Within the pragmatic category of gestures, Kendon (2017) identifies four specific functions. First, the *operational function*, which serves as an operator in relation to the speaker's spoken meaning (e.g., head or hand actions that add negation). Second, the *modal function* helps to indicate how the listener should interpret the discourse (e.g., the speaker's attitude/epistemic stance related to the message, such as certainty). Third, the *performative function* shows the speech act that the speaker is conveying (e.g., a question, a refusal, etc.). Fourth and finally, the *parsing function*, which refers to the role of the speaker's hands in marking discourse structure (i.e., which punctuate or mark some aspects or units, without given any reference to the speech content). Specifically, Kendon (2017) states that "the kinesic action appears to make distinct different segments or components of the discourse, providing emphasis, contrast,

parenthesis, and the like, or where it marks up the discourse in relation to aspects of its structure such as theme-rheme or topical focus" (p. 168). According to the author, beat gestures are associated with the aforementioned larger class of pragmatic gestures that are "related to features of an utterance's meaning that are not a part of its referential meaning or propositional content" (Kendon, 2004, p. 158). For instance, Kendon (1995) proposes that, in Southern Italy, the *Finger Bunch* gesture distinguishes the topic from the comment, having a parsing function, and that the *Ring* gesture emphasizes a specific discourse unit in a large context. These pragmatic correlates of beat gestures have also led other authors, such as Bavelas, Chovil, Lawrie, and Wade (1992), to refer to these gestures as interactive conversational gestures that control discourse, and thus contribute to the "nature of dialogue itself, rather than with the specific topic of discourse" (p. 476).

Following Kendon's (1995, 2004, 2017) pragmatic classification of gestures, some studies have provided evidence of the use of these gestures, but have focused on specific hand shapes or movements. Graziano (2014a) carried out a study about the pragmatic gestures from the *Open Hand Supine family* produced by 4- to 10-year-old children while performing a narrative task. Results showed that the Palm Addressed gestures, such as the Palm Presentation and the Palm with a Lateral Movement in children's narrative were found to either convey a metadiscursive meaning of expressing sequences of episodes and events, or the end of the discourse. Moreover, Graziano (2014b) found that using different pragmatic gestures

(performative, modal and parsing) in narrative discourses were correlated with the use of textual connectives, which help structure a text with a hierarchical organization. For example, temporal connectives develop in parallel with parsing gestures. Cooperrider and colleagues (2018) have also distinguished different types of palm-up gestures according to its form and meaning, *palm-up epistemic* gestures, which frequently co-occur with a shoulder shrug and express absence of knowledge, ability, or concern; and *palm-up presentational* gestures that metaphorically present information or request an interlocutor's contribution. Ferré (2011) also provided a description of pragmatic gestures focusing on the palm up hand shape (i.e., *palm-up open-hand gestures*, which are beat and flip gestures) and shows that a single gesture can perform multiple pragmatic functions (i.e., beat gesture having parsing and modal functions).

As an additional remark, before recording the materials for the gesture-based narrative training in Studies 2 and 3 of this thesis, we first conducted a preliminary set of recordings which consisted of a child-directed dramatization task. In this task, two female preschool teachers were asked to read in a "theatrical" way some narratives with child-directed speech. The results showed that beat gestures accompanied both focal content words (e.g., new characters in the story) and discourse markers (e.g., key temporal adverbs like *after*, *then*, etc.), which suggests that beats are meaningful cues that mark both information structure and discourse structure in speech. See more details in Chapters 3 and 4.

McNeill (1992) related the semiotic value of a beat gesture in the marking of discourse–pragmatic content (e.g., to introduce new characters or themes, or summarize the action, etc.). McNeill, Levy, and Duncan (2015) referred to beat gestures as being complex semiotically, due to the fact that they can serve different relationships to a larger discourse, and are co-expressive with prosodic marking. For instance, "beats alone highlight that content (otherwise not imagined) is new in the context" (p. 274), for example when enumerating successive features of a new story character. Beats can also be produced after another gesture ("the weight came down [iconic gesture] and he got clobbered [beat]," p. 275) and "synchronizes with a stress peak but its function is not to tap out this rhythm but to indicate the point in speech that related to the first gesture semantically" (p. 275).

McNeill and Levy (1993) exemplified the use of cohesive beat gestures being performed with the purpose of marking the presentation or the reappearance of a thematic idea (i.e., when the speaker returned to his/her theme). As a case example, a single speaker performed lots of continuous beats with the right hand when, after a pause, s/he returned to his/her theme (e.g., Chicago's grimness): "it jus' [seems everything's so serious][and so concentrated]" (p. 376) (the continuous beats are performed in the speech segments marked within brackets). When produced in succession in order to emphasize the continuity of various points related to a common main idea, beat gestures can also be termed as *cohesive* or *discourse* gestures. McNeill (1992) pointed out that

83

beats (as well as other gesture forms, e.g., deictic, iconic, or metaphoric gestures) can also act as cohesive gestures that "tie together thematically related but temporally separated parts of the discourse" (p. 16) and exemplifies it with a common gesture performed by a politician (i.e., when repeating the same movement in the space).

Concerning the role of gestures in the creation of discourse units (i.e., development of cohesion), a special mention is given to gesture catchments, "which occur when space, trajectory, hand shape, and so on recur in two or more (not necessarily consecutive) gestures," p. 268) (McNeill et al., 2015; see also Ferré, 2009, and McNeill et al., 2001). Interestingly, as noted by Levy and McNeill (2013), "cohesion in adult speech relies on a combination of speech and gesture, and gestural catchments play a particularly important role" (p. 560).

Finally, a beat gesture can also indicate temporal sequence, by being performed in advance of another gesture, "so the next thing he does [metanarrative with a beat] is go in front door [iconic]" (McNeill et al., 2015, p. 275). In the same way, McNeill (1992) already claimed that beat gestures have discourse structure marking functions, as they "mark information that does not advance the plot line but provides the structure within which the plot line unfolds" (p. 15) (see also McNeill & Levy, 1993). Based on these assumptions, beats can serve a metapragmatic function, which can signal movement between narrative levels (narrative →

metanarrative → paranarrative), and can accompany metanarrative speech, repairs, reported speech as well as metalinguistic comments (McNeill, 1992). Therefore, there is evidence that "beats thus reveal that a movement away from the temporal axis of the story is taking place in order to present some of the discourse–pragmatic content that also is part of storytelling" (p. 195).

Taking the abovementioned studies into consideration, as well as the specific notion that non-referential beat gestures perceptually enhance information structure and discourse structure functions, we suggest that beats may be important in framing and managing narrative discourse. All in all, the review presented in this subsection shows that the main pragmatic and discursive features of non-referential beat gestures are strongly related to the marking of *narrative structure* (e.g., Demir et al., 2014, see sections 1.7.2 and 1.7.3 for a review on the emergence of narrative abilities and its relationship with gesture development). This is why one of the main underlying hypotheses in this thesis is that the use of beat gestures can bootstrap children's narrative abilities.

1.6.2.2. Prosodic and rhythmic properties

Studies in audiovisual prosody have offered some insight into the temporal coordination between the gesture and speech modalities (section 1.2.3 for the *phonological synchrony rule* by McNeill, 1992). These studies have shown that beat gestures naturally occur in tight synchrony with prosodically prominent positions in speech

(e.g., Krahmer & Swerts, 2007; Leonard & Cummins, 2011; Loehr, 2004, 2007; McClave, 1994; McNeill, 1992; Roustan & Dohen, 2010; Shattuck-Hufnagel & Ren, 2018; Shattuck-Hufnagel et al., 2016; see Wagner et al., 2014, for a review; see Cole, 2015, for a prosody review). As an example, Leonard and Cummins (2010) conducted two studies in which they tested (a) the sensitivity of observers to altered temporal alignment of a beat gesture and speech, and (b) the variability in the temporal relation between different reference points in each modality. Findings showed that participants were able to detect temporally desynchronized gesture-speech combinations, specifically late gestures (i.e., a gesture following the accompanying sound) which were less than 0.2 seconds desynchronized. Regarding proximity to pitch accents, findings revealed that the closest speech landmark to the apex was the peak of the pitch accent in the stressed syllable. Interestingly, in a close analysis of the multimodal utterances produced in an academic lecture, Shattuck-Hufnagel and Ren (2018) found that in 83.13% of the time, there was an overlap between a non-referential gesture stroke and a pitch-accented syllable. These findings are consistent with Loehr (2004) and Yasinnik, Renwick, and Shattuck-Hufnagel's (2004) reports. For instance, both Yasinnik et al. (2004), and Shattuck-Hufnagel, Yasinnik, Veilleux, and Renwick (2007) found that manual gestural *hits* (i.e., strokes with short sharp end points) were aligned with a spoken accented syllable. The acoustic effects of the presence of beat gestures on speech were also fleshed out by Krahmer and Swerts's (2007) study. Overall findings of their experiments revealed that (a) producing beat gestures has

significant acoustic effects on the spoken realization of the associated target words, that (b) hearing beats has significant effects on the perceived spoken prominence of the associated words, and that (c) seeing visual beat gestures produced on target words increases the prominence perception of that information; that is, listeners perceive that word as being more prominent (see also Ferré, 2018).

We believe that the prosodic properties of beat gestures (which highlight the rhythmic properties of speech) can help promote better narrative production and thus *oral fluency*. As noted before, McNeill (1992, 2005) considered beats mainly as rhythmic markers which helped in making timing and other prosodic properties in speech more visible. In this thesis, we follow Segalowitz's (2016) definition of oral fluency, which refers to the "subjective judgments of L2 speakers' oral fluency" based on their perceptions of how fluent the speaker is (p. 86) (see Study 3 in Chapter 4). Four main pieces of evidence back our hypothesis. First, previous evidence reveals a strong relationship between gestures and fluency (e.g., Graziano & Gullberg, 2018, for a review). Graziano and Gullberg (2018) examined narratives from 4- to 9-year-old children, adult Italian native speakers, and adult Dutch native speakers (also second language learners of French). Speech was analyzed in terms of fluent or disfluent fragments (i.e., filled pauses, unfilled pauses, interruptions, and lenghtenings). Findings showed that gestures were significantly more likely to occur with fluent than disfluent

87

speech in all groups, showing general evidence that when speech is disfluent or interrupted, gesture production stops.

On the other hand, a handful of studies have shown the positive role of beat gestures in lexical access and lexical processing tasks (e.g., *Lexical Retrieval hypothesis*, Krauss et al., 2000, section 1.2.4; Beattie & Coughlan, 1999; Lucero et al., 2014; Ravizza, 2003). In Beattie and Coughlan (1999), 60 undergraduate students were presented with a set of 25 definitions of target words and were asked to say the word matching a given definition in two conditions: they were either prevented to use gestures or allowed to produce them freely. Results showed that tip-of-the tongue (TOT) rates were greater when participants were free to gesture, rather than when they were not, and more TOTs were resolved when producing gestures. Similarly, Ravizza (2003) demonstrated that the use of meaningless or non-iconic movements that have no semantic relationship to speech (i.e., tapping) (vs. participants who were asked to not move) helped recall more items in both the TOT and DK (*don't know* states or not in a TOT state) equally. However, tapping did not have the same effects in all retrieval tasks (e.g. letter fluency tasks, generate as many words as possible starting with the given letter). This suggests that since beat gestures have a similar repetitive rhythmic function to tapping, they may also prompt similar effects. In accordance with Lucero et al.'s (2014) findings (see section 1.4 for a more detailed explanation), "beat gestures should be less cognitively taxing for the speaker" (p. 898), as they are rhythmic hand movements that appear more repetitively during

88

discourse. The authors also hypothesize that it may be that both language and motor production processes (i.e., movements and lexical search) boost the activation of some neural areas involved and shared between both speech and movement. In line with these findings, a review by Nicoladis (2007) also pointed out that gestures performed by bilingual speakers could somehow be regarded as strategies that enhance their speech production across languages; that is, speakers transfer their language production not only by speaking, but also by gesturing.

In addition, studies on the effects of freely using gesture or encouraging the use of gesture in narrative elicitation tasks revealed that using gesture has an impact on narrative length and complexity, both in adults (Cravotta, Busà & Prieto, 2019; Jenkins, Coppola & Coelho, 2017) and children (Nicoladis, Marentette, & Navarro 2016). Jenkins et al. (2017) found that allowing 10 undergraduate students to gesture freely in a narrative task helped them produce more complex utterances (as measured by number of subordinated clauses) and better organized narratives than if they were restricted to gesture. Cravotta et al. (2019) analyzed the effects of producing gestures in participants who were asked to describe short stories to a listener by either being freely allowed to gesture or encouraged to gesture. Encouraging speakers to produce gestures during retelling triggered an increasing in discourse length and in boosting prosodic acoustic features. Nicoladis et al. (2016) analyzed narrative retellings from French-, Spanish-, and English-speaking children between 4 and 10 years and found that a greater length of narratives

predicted children's higher gesture rates, suggesting that they have a strong reliance on imagery. Concerning the restriction of gesture use, some studies have revealed that prohibiting speakers to gesture did not help them achieve fluent speech (in other words, they showed more pauses, slower speech and more disfluencies) (e.g., Graham & Heywood, 1975; Morsella & Krauss, 2004; Rauscher et al., 1996).

Finally, recent studies have shown that rhythmic training is relevant for the development of literacy skills in children with typical development (e.g., Bonacina, Cancer, Lanzi, Lorusso, & Antonietti, 2015; Tierney & Kraus, 2013) and also for boosting L2 pronunciation patterns (e.g., Gluhareva & Prieto, 2017; Llanes-Coromina, Prieto, & Rohrer, 2018) and general speech production patterns in different speech-impaired populations (e.g., François, Grau-Sánchez, Duarte, & Rodríguez-Fornells, 2015). Furthermore, it has been reported that hand clapping the prosodic structure of words helps both adolescents (Brodsky & Sulkin, 2011; Zhang, Baills, & Prieto, in press) and children (Baills, Zhang, & Prieto, 2018) to improve pronunciation in a foreign language.

In conclusion, the review presented in this section shows that the pragmatic, discursive, and rhythmic features of non-referential beat gestures might be key in helping to boost narrative abilities in children, both in terms of narrative structure and oral fluency. While Studies 1 and 2 (Chapters 2 and 3) will focus on beat gestures' effects on narrative structure, Study 3 (Chapter 4) will examine beat

gestures' benefits on both narrative structure and speech fluency. In the following section we revise the literature on the relationship between the development of narrative abilities and the appearance of co-speech gestures.

1.7 Narrative discourse abilities and gestures

1.7.1 The development of narrative discourse abilities and its importance

The development of narrative discourse abilities as an oral language skill is an important achievement for children, as it has been typically associated with children's linguistic development and thus has important implications for their successful school literacy (Demir & Küntay, 2014; Naremore, Densmore, & Harman, 1995; see Demir, Levine, & Goldin-Meadow, 2012, for a review). Narrative abilities function as a powerful measure and predictor of long-term language abilities, and specifically of children's communicative competence. For this reason, narratives are typically used as an ecologically valid measure of a child's linguistic abilities (e.g., Demir, Levine, et al., 2015; Stites & Özçalışkan, 2017). Moreover, recent research has used this measure for theoretical and clinical implications in speech-language pathologies, such as in children with language disabilities or impairments (e.g., Demir et al., 2014; Demir, Levine, & Goldin-Meadow, 2010; Demir, Rowe, Heller, Goldin-Meadow, & Levine, 2015; Duinmeijer, de Jong, & Scheper, 2012).

In recent years, the acquisition of children's narrative abilities has been of growing interest, and some studies have investigated the link between early narrative abilities and later reading abilities, which have been demonstrated to be positively related to each other (Fazio, Naremore, & Connell, 1996; Feagans & Appelbaum, 1986).

Demir and colleagues (2012) defined narrative skill as "an oral language skill that is argued to provide the missing link between oral language and later reading comprehension" (p. 6). Moreover, the authors claim that "oral language skills that develop during early ages and provide the foundation for later reading comprehension include vocabulary, syntax, narrative and academic language use" (p. 5). Early acquired narrative abilities by kindergarten children have been shown to be predictive of better reading comprehension later in 7th grade (Griffin, Hemphill, Camp, & Wolf, 2004; Tabors, Snow, & Dickinson, 2001). Therefore, it is clear that oral storytelling abilities are highly related to the acquisition of more complex linguistic features. Children's familiarization with the oral narrative structure organization of a story (that is, temporal relations, cause-effect relations, problem-attempt-resolution sequences) has been clearly demonstrated to enhance children's comprehension of a written text that is similarly structured (Cain & Oakhill, 2003). Also, narrative features such as causal links and evaluative devices provide evidence of later reading comprehension (Kendeou, van den Broek, White, & Lynch, 2009). Moreover, a study by Kendeou, van den Broek, White, and Lynch (2007) pointed out that children's ability to answer questions about real or deduced audio-visual story events at 6 years of age is related to the ability to answer the same kind of questions about a written text when they are 8 years of age. Similarly, school literacy success can also be predicted by the child's ability to tell a coherent story, a process that involves the acquisition of complex skills associated with communication units (story components) and how they are

related and expressed (coherence and cohesion) (Naremore et al., 1995). Specifically on Catalan, some research has investigated the relationship between written and oral communication in children's discourse development, and specifically how these communicative modes can influence the evolution of the discoursal use of referential expressions (López-Orós & Teberosky, 1998). The study used the narrative task *Frog, where are you?* (Mayer, 1969) and revealed more correct uses of relevant referential expressions within the discourse in written language interaction. Crucially, results suggest that acquiring a written language model influences children not only in developing writing skills, but also in their subsequent oral productions.

Importantly, it is during the preschool years (from 3 to 5 years of age) when basic narrative abilities emerge (Applebee, 1980; Berman & Slobin, 1994; Stradler & Ward, 2005) and continue to improve until roughly age 12. Though infants start to create narratives from the age of 3 with their caregivers' support (Peterson & McCabe, 1996), there are many abilities involved in producing a coherent and cohesive narration, and acquiring these skills requires considerable time (Berman, 1998; Berman & Slobin, 1994; Karmiloff-Smith, 1986). Despite this, Applebee (1978) claimed that it is from 5 to 6 years of age when children are able to produce "true narratives." That is, narratives in which all the important features of a well-produced narrative (central theme, characters and a logically and/or temporally ordered plot line) are involved in the discourse (see also Bamberg, 1987; Berman & Slobin, 1994; O'Neill &

94

Holmes, 2002). Howe and Johnson (1992) pointed out that children at this age could both recognize and use the structure of a story with ease. Some studies focusing on children's narrative discourse structure development have shown that 5- and 6-year-old children start performing more structurally complex narratives (Shapiro & Hudson, 1991) as they include goals, plots, past tense language, and temporal connectives. Nevertheless, children are able to use the knowledge of intentional actions and goal plans to encode events and achieve coherence from ages 4 and 5 (Trabasso, Stein, Rodkin, Munger, & Baughn, 1992; see also Berman, 1988). Trabasso and colleagues (1992) pointed out that 4-year-old children can use the story goal plan to interpret and integrate the set of episodes and actions shown in a picture book. While children of this age start to narrate producing sentences in a temporally ordered way, unlike 5-year-olds who include more links between goals and actions, they still do not produce causally structured stories that are more clearly guided by a goal plan. Thus, 5-year-old children have more knowledge of goal-directed actions in narratives than 4-year-olds. Therefore, this study revealed differences between narratives produced by 3- and 5-year-old children, showing the main narrative changes at age 4. Similarly, Trabasso, Stein, and Johnson (1981) found that 5-year-old children start to narrate actions related to a story goal when they are asked to tell a story by showing them pictures. It is not until the age of 7 when narratives with multiple episodes appear, and until the age of 9–10 when they use considerably more story details and tell complete episodes (Muñoz, Gillam, Peña, & Gulley-Faehnle, 2003). Moreover, a well-formed

95

episodic structure also involves the consideration of children's representation of characters in narrative, which react to the story events. Nicolopoulou and Richner (2007) found that, while by age 4 children are able to include some goal-related action to the character description of an "agent" and by age 5 children are able to convey a more complex representation of characters, at age 3 children tend to focus on physical and external aspects of characters.

Indeed, one of the essential features involved in oral narrative production and comprehension is *narrative cohesion*, or the ability to convey causal and temporal relationships through linguistic cohesive mechanisms on a microstructure level. A narrative emerges from oral descriptions of story goal-connected events related to story characters that are involved in the narrative (Davies, Shanks, & Davies, 2004). In this connection, significant changes are observed in narrative cohesion between 5 and 7 years of age. For example, as noted by Demir and Küntay (2014), 5-year-old children can typically link their utterances by using sequential conjunctions or discourse markers like *then*, *after*, or *that*, whereas older children can use more complex structures. However, these authors report that major changes in children's narrative discourse structure and in the use of linguistic means to mark it (i.e., story-level structure or macrostructure, such as organization of story events, character representation, etc.) do occur around 5 to 6 years of age, since around that time children begin to create stories that more reliably include the main components of a story line and start to be able to refer to the story's goals, at the same time they improve *narrative*

coherence, another important feature of oral narrative discourse development. In contrast, 4-year-old children can narrate by combining more than two events together, but the narratives are short and the events are often out of sequence. As a case in point, Rossi, Pontecorvo, López-Orós, and Teberosky (2000) showed that first graders (6-year-olds) know how to manage the use of referential expressions, specifically the maintenance of null forms in a language such as Catalan (i.e., reference to entities that have been previously mentioned in the discourse) and reintroduction functions through noun forms (i.e., reference to entities which have not occurred in the previous discourse clause), showing a development in reference reintroduction from first- to third-grade children, at the same time that discourse became less ambiguous. However, it is not until age 7 or 8 that children start to introduce referents to their narratives with the adequate strategy, such as by using indefinite articles (see Aparici, 2019, for a review).

Concerning the development of discourse markers specifically in oral language, a study by Vion and Colas (2005) investigated how and when 7- to 11-year-old French children used connectives while narrating comic strips, which showed either arbitrary (i.e., events presented in any order) or ordered (i.e., events presented in order) event sequences. Comic strips were either displayed in a simultaneous mode (i.e., all pictures showed in one page) or in a consecutive mode (i.e., one picture per page). Moreover, comic strips also differed depending on whether they maintained the topic versus if they changed it. The layout of the characters was also

controlled. Each child was administered only one frame display mode and one type of sequence, but in both maintained and changed topic conditions. Findings revealed a higher use of discourse markers in narratives elicited by pictures that were shown simultaneously. Connectives were used more in ordered sequence presentations, and temporal markers such as *and then*, *when*, and *so now* were used more in the simultaneous display mode. When events were presented arbitrarily, there was a greater use of *after that* and *next*, whereas when they were ordered, *and* and *after that* were more used. Moreover, 11-year-old children produced more connectives than 7-year-olds in the arbitrary sequence narratives. When there was maintenance of the topic, 7-year-olds produced more temporal-link marking strategies (vs. 9- and 11-year-olds); whereas 11-year-old children performed more causal-link marking strategies (vs. 7- and 9-year-olds). Along these lines, many authors have reported that by age 9 children become dominant users of cohesive mechanisms (e.g., Berman & Slobin, 1994; Karmiloff-Smith, 1986, among others; see Aparici, 2019, for a review).

All in all, previous research has assessed the development of children's narrative skills and has demonstrated how these abilities are intimately related to higher-level linguistic abilities such as discourse organization and reading abilities. Bearing in mind that oral narrative production is a key factor in children's communication about the world, does its development rely on children's gestural repertoire? The next two subsections provide an overview of the research that has dealt with the role of referential

(section 1.7.2) and non-referential gestures (section 1.7.3) in children's narrative development.

1.7.2 The role of referential gestures in children's narrative development

Children are able to accompany their narratives with representational gestures at around 4 or 5 years of age (McNeill, 1992). Concerning the achievement of producing a good narrative (section 1.7.1), the span between 3 and 6 years of age is a "particularly relevant age range to observe children's burgeoning narrative abilities in gesture and speech" (Stites & Özçalışkan, 2017, p. 1021). Most of the research in this field is aimed at analyzing the impact of gesture-speech combinations and how the two jointly develop in acquiring and developing more complex linguistic abilities, such as oral narrative discourse abilities (Alamillo, Colletta, & Guidetti, 2013; Colletta et al., 2015; Colletta et al., 2010). Children's multimodal integration of speech and gesture in oral discourse has been one of the major topics of investigation of the *EcoGest* project (https://scs.techfak.uni-bielefeld.de/ecogest/about/); principal investigators: Prof. Dr. Katharina Rohlfing, Prof. Dr. Friederike Kern, and Prof. Dr.-Ing. Stefan Kopp.

Colletta et al. (2015) investigated multimodal narrative development in 5- and 10-year-old French, American and Italian children's narratives of a wordless cartoon. Their results revealed

that there was a common developmental trend in multimodal discourse skills in all three languages. Gesture and speech go hand in hand; that is, children's gestures, specifically those related to narrative organization (that is, discursive/cohesive gestures, which include beat gestures), develop at the same time that children's narratives become more complex, in terms of length and amount of details and comments (see also Alamillo et al., 2013). Sekine and Kita (2015) also pointed out the co-development of speech and co-speech gestures through elicited narratives in 3-, 5- and 9-year-old children, as well as in a group of adults, in terms of sentence and discourse level. Two main important findings were reported, namely (a) two-handed gestures with a two-handed stroke were predominant in 3-year-olds rather than in 5- and 9-year-olds, who produced gestures with a single-handed stroke and a simultaneous hold; and (b) in contrast to children, adults packaged information related to landscape elements both in clauses and in two-handed gestures, and used both gesture and speech when referring to previous or subsequent elements. Regarding speech-gesture integration abilities, Alibali, Evans, Hostetter, Ryan, and Mainela-Arnold (2009) examined gesture-speech integration patterns of narratives produced by 17 5- to-10-year-old children and by 20 college students. Results showed that children produced more non-redundant gestures (that is, gestures with codable meanings, and that do not convey the same meaning as the accompanying speech; e.g., "[he] tried pushing it back into place," with an iconic gesture expressing "jump," p. 10) than those produced by the college students in their narratives. All in all, results showed that children

100

were less redundant in the use of gesture than adults, which suggests that patterns of gesture-speech integration change over the years.

Beyond these findings, it has been shown that gesture production changes with age. Gestures that children produce are primarily intended to achieve cohesion. For example, Colletta (2009) analyzed spontaneous narratives produced by 6- to 11-year-old French children by focusing on the discourse dimension and all kind of co-speech body movements. Results revealed that by the age of 9 children accompany their spontaneous narratives with co-speech gestures in order to convey the narrated events and characters' attitudes, to symbolize the objects, places or people which the speaker refers to, to mark discourse cohesion, and to help the pragmatic framing and discourse connotation of the utterance, among many others. It is important to highlight that both narrative and co-speech gestures were performed in an adult-like fashion.

Finally, Levy and McNeill (2013) analyzed the emergence of gesture-speech integration in a child's first identifiable stories. The authors specifically examined gesture production during the early development of cohesion (from 1;5 to 2;9), limiting their investigation to examples of pointing and representational gesture-speech combinations. The analyses revealed that in speech conversation from 2;7 to 2;9, gestures were more adult-like and early cohesive devices started to appear. In this period, representational properties of the gestural catchments seem to help

101

mark new information by carrying presuppositions from earlier speech, thus contributing to the cohesive link between utterances, and helping push the communication forward. In this conversational setting, beat gestures were documented accompanying connectives in the second and transitional period from 2;5.

Furthermore, previous research has examined how referential iconic gestures, specifically character-viewpoint gestures (CVPT), serve as precursors (Stites & Özçalışkan, 2017) and predictors (Demir, Levine, et al., 2015) of narrative abilities in development. Interestingly, Stites and Özçalışkan (2017) found that children use iconic gesture *plus* speech combinations at 5 years of age to introduce new characters in the story, specifically by using CVPT gestures, before doing so in speech. It is one year later, at age 6, when children start to introduce these story referents in speech using noun phrases and, later on, pronouns. In the longitudinal study by Demir, Levine, et al. (2015), 5-year-old children who were able to express character viewpoint by means of gestures performed better goal-structured verbal narratives when they were older.

Additionally, the use of character-viewpoint gestures also boosts children's narrative abilities. For example, both 5-year-old children with early brain injury who had difficulty in structuring narrative and typically developing children were more likely to produce better-structured narrative retellings when the storyteller performed story-relevant gestures while speaking (vs. auditory modality, auditory and visual modalities with no gestures, and cartoon)

(Demir et al., 2014). In the same vein, Parrill, Lavanty, Bennett, Klco, and Demir's (2018) study reported significant positive benefits of training children to produce CVPT gestures (vs. observer-viewpoint gestures) in enhancing their narrative structure scores immediately after training. Moreover, children who were encouraged to produce CVPT gestures also produced more of them at posttest.

In summary, the literature on children's gestures as harbingers of change in narrative development shows that studies have mostly focused on referential gestures. To our knowledge, little is known about the bootstrapping effects of non-referential beat gestures on children's narrative abilities.

1.7.3 Non-referential beat gestures and children's narrative development

As previously noted, the last gestures that emerge in language communication are beat gestures. However, the literature on the acquisition of these gestures within narrative discourse is very scarce and has primarily focused on how children gesture with beats while they are narrating. McNeill (1992) argued that the production of beat gestures connected to the pragmatic structure emerges at a later stage, at around 6 years of age, as gestures that refer to discourse content (at metanarrative level) are the last to appear. Moreover, the author claims that beat gestures are cognitively complex and that their production requires a good understanding of

the relationships between entities and different levels of structure. For instance, "young children do not have beats because they lack the additional levels of structure in terms of which such new contexts can be sought" (p. 321). Mathew et al. (2017) showed that, during narrative and explanation discourses, 12 5- to 7-year-old typically developing Australian English-speaking children produced beat gestures with a well-defined stroke phase that resembled those performed by adults, and that these beat gestures were closely related to the organization of speech. The study contained two tasks: a story-retelling task and an exposition task. In the story-retelling task, children were asked to watch a two-minute movie clip and then narrate the story to their caregiver, who had not been listening to the clip. At the end, the caregiver had to complete a picture-puzzle based on the video. In the exposition task, both the caregiver, who had to elicit information from his/her child, and the child were encouraged to plan a "fantasy" family holiday trip to any destination with the money that they were supposed to have to won in the lottery.

Despite the fact that the early appearance of beat gestures in bilingual children as young as 2 years of age has been reported (Levy & McNeill, 2013; Nicoladis et al., 1999), beats in complex narrative discourses marking clause relations have been demonstrated to emerge later, at around 5–6 to even 10 years old (Blake et al., 2008; Colletta et al., 2010; Mathew et al., 2017; McNeill, 1992). The longitudinal study by Nicoladis et al. (1999) revealed that beat gestures were performed in more complex and

longer utterances, suggesting that the development of these gestures from 2 years of age is related to language development. Even more interestingly, the authors also claim that beat gestures "illustrated the temporal structure of utterances" and that they "developed as a function of [children's] ability to use carrying stress patterns with multimorphemic utterances" (Nicoladis et al., 1999, p. 524). This is also confirmed by the abovementioned results by Mathew et al. (2017), who found that 6-year-old children start producing a variety of gestures including stroke-defined beat gestures for discourse functions in both storytelling and explanation tasks. Consistent with Blake et al.'s (2008) findings, the stroke-defined beat gestures co-occurred more often with open class lexical words rather than closed class function words. And interestingly, beat gestures did not always align with pitch accents, which suggests that at age 6 children might have not have yet established this temporal link between gestural prominence and prosodic prominence.

Colletta et al. (2010) carried out a narrative task with French-speaking children of ages between 6 and 10, and adults. In contrast to the average number of representational gestures, the average number of non-representational beat gestures increased more across ages. Non-representational beat gestures served both discursive functions (by accompanying connectors, highlighting important linguistic units, or performing anaphoric functions) as well as framing functions. While gestures serving the former function help structure speech and discourse, the latter refers to those gestures that appear during the telling of an event or during a comment on

105

the narrative, expressing the speaker's emotional or mental state, such as showing a certain facial expression when s/he is surprised or amused. Additionally, adults were significantly more likely to perform non-representational discursive and framing beat gestures than children, which also suggests that discourse cohesion develops with age. Thus, gestures in discourse development seem to go hand in hand with narrative production, which becomes shorter and more complex in adulthood. In the transition between 6 and 10 years of age, children acquire the capacity to perform discursive gestures serving a functional meaning in narratives. These findings are consistent with Alamillo et al.'s (2013) study. An analysis of oral narratives and explanations in 6- and 10-year-old children revealed that cohesion markers (anaphors and connectives) were more present in narratives rather than in explanations, and that the development of discourse production is associated with more complex gesture use (representational, discursive, and framing gestures). Finally, in the cross-linguistic study by Colletta et al. (2015) with 5- and 10-year-old French, American, and Italian children, the analysis revealed that when older, children tend to produce more discourse or cohesive gestures (i.e., beat gestures that help to structure speech or mark cohesion) than representational, framing (expresses an emotion or mental state of the narrator), performative (expresses the illocutionary value of a speech act), interactive (refers to the interlocutor) or word searching gestures.

To sum up, even though previous studies have related the use of beat gestures to children's more complex linguistic skills (e.g., narrative abilities), as far as we are concerned, no previous evidence

106

has dealt with the predictive (see Study 1, Chapter 2) and short-term beneficial effects of narrative training with beat gestures (see Studies 2 and 3, Chapters 3 and 4) on narrative skills. All the studies presented in this thesis (Chapters 2, 3, and 4) will deal with the bootstrapping effects of the use of non-referential beat gestures in the improvement of children's narrative abilities. While the first longitudinal study (Chapter 2) presented in this thesis will assess whether the early production of non-referential beat gestures (as well as flip gestures and iconic gestures) can predict narrative abilities at later developmental stages, the other two experimental studies (Chapters 3 and 4) will examine children's improvement of their narrative performance after having completed a narrative training task with both observing and encouraging the production of beat gestures.

1.8 Scope of the thesis, main goals and hypotheses

This current dissertation aims at investigating the bootstrapping role of non-referential beat gestures in children's narrative abilities, focusing on the general question about whether the use of these gestures can positively impact narrative discourse performance. This type of non-referential gesture has been characterized by many previous investigations as a meaningless gesture, predicating on the idea that it does not convey substantive semantic content in relation to the speech rather than signaling emphasis (in contrast to referential gestures, e.g., iconics). Nevertheless, building up on previous approaches and on the idea that non-referential beat gesture has a strong pragmatic communicative value in discourse, this thesis asks whether it can have an impact on the development of children's oral narrative abilities. Specifically, the research presented in this dissertation will assess (a) the predictive value and (b) the beneficial effects of this specific unique type of co-speech gesture (i.e., non-referential beat gesture) —and its concomitant prosodic prominence— on children's narrative productions.

Three main research questions will be addressed, each one in a separate chapter:

1) Does the early frequency of use of non-referential beat and flip gestures (vs. referential iconic gestures) between 14 and

58 months of age predict narrative abilities at 60 months (5 years of age)? (Study 1)

2) Does a brief narrative training promoting the observation of beat gestures have an impact on 5- to 6-year-old children's narrative performance (in terms of narrative structure scores) at posttest? (Study 2)

3) Does a brief narrative training encouraging 5- to 6-year-old children to produce beat gestures have an impact on their narrative performance (in terms of narrative structure and fluency scores) at posttest? (Study 3)

The general hypothesis underlying the three studies included in this thesis relates to the bootstrapping effects of beat gestures, based on evidence that suggests that beats associate with key positions in discourse and thus they can perform a range of pragmatic and discourse functions which will help frame discourse structure. The early acquisition of beat gestures and their use in narrative tasks have the potential to represent a milestone in narrative development. As previously mentioned, beat gestures are rhythmic non-referential (i.e., non-representational) hand movements typically associated with prominent prosodic positions in speech. They do not reflect contextual meaning of the spoken message, but rather signal information structure (Dimitrova, et al., 2016; Im & Baumann, 2020; McNeill, 1992), as well as mark rhythm and discourse structure (Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel, et al., 2016, among others). Moreover, in our view, the basic tenets of the *Gesture-for-Conceptualization*

hypothesis (Kita et al., 2017) and the embodied cognition paradigms (see sections 1.2.4 and 1.2.5 for a review of these theories) can motivate the potential beneficial role of beat gestures in cognitive and linguistic processing. Following up on this evidence, the central working hypothesis of this thesis is that these discourse–pragmatic functions of beat gestures may be at the root of their beneficial effects in language development and thus can have a potential role in building up children's oral narrative discourse abilities. Therefore, for Study 1 (Chapter 2), we hypothesize that the early frequency of use of non-referential beat gestures in children's spontaneous interactions between 14 and 58 months old will be a predictor of better later narrative abilities at 60 months of age (i.e., 5 years old). Moreover, for Studies 2 and 3 (Chapters 3 and 4) we hypothesize that a brief multimodal narrative training task with observing beat gestures and with encouraging the use of beats will successfully promote children's short-term narrative performance.

To answer the research questions outlined above, the current thesis is organized into three empirical studies, which are presented in Chapters 2 to 4. It is important to remark that these chapters consist of three independent self-contained papers that are closely related with the main research topic of the thesis and that follow the same structure (introduction, methods, results, and discussion and conclusions), which can result in the existence of some unavoidable overlap between them. Moreover, these three papers can also have small variations in style. Whereas Study 1 (Chapter 2) has been submitted to a peer-reviewed JCR scientific journal, the other two

studies (Chapters 3 and 4) have been published in two different JCR journals (*Developmental Psychology* and *Developmental Science*).

The author of the thesis is the main corresponding author of all three studies, all of them directed or codirected by Dr. Pilar Prieto (thesis advisor). Interestingly, the thesis also has led to some fruitful research collaborations between other academic and scientific institutions. The first study (Study 1) is the outcome of collaborative research which was established during a three-month research stay (March–June 2017) at the University of Chicago (IL, USA). The collaborators are Dr. Ö. Ece Demir-Lira (University of Iowa), as well as the PhD student Natalie Dowling and the director of the Goldin-Meadow Laboratory, Prof. Susan Goldin-Meadow (University of Chicago). The study focuses on narratives collected from American-speaking children from the Chicago area (IL, USA). The second study (Study 2) has been done in collaboration with Dr. Alfonso Igualada (Universitat Oberta de Catalunya). The data collected in the two other studies (Studies 2 and 3) are from Catalan-Spanish bilingual children, with a large exposure to the Catalan language, from the Girona area of Catalonia.

Following a longitudinal approach, the first study (Chapter 2) investigates the predictive role of non-referential beat and flip gestures in children's narrative abilities, in comparison to referential iconic gestures. To examine whether the early production of beats and flips at 14 to 58 months of age (vs. iconics) predicts later narrative production performance at 60 months (5 years old), a

stepwise regression analysis was undertaken with a longitudinal database including 45 child-parent dyads who were visited every four months between 14 and 58 months of age. Each in-home visit consisted of 90 minutes of parent-child naturalistic interactions. A narrative production task was administered at 60 months (data from Demir et al., 2014). The main research question of this investigation also addresses the role of another type of non-referential gesture, the flip gesture. As explained in section 1.5, similar to beat gestures, flip gestures (or *palm-up* gestures; see Cooperrider et al., 2018) do not convey referential information and can be accompanied (or not) with a shrug of the shoulders, showing the speaker's judgment or an epistemic value (e.g., Ferré, 2011). Importantly, flips differ from beat gestures in hand form. The hypothesis is that children's early frequency of use of beat gestures in spontaneous speech between 14 and 58 months of age will forecast their narrative abilities at a later stage in development (5 years of age), and that this predictive role may be likely due to the pragmatic and structuring properties that beat gestures have in children's early discourse.

The second study (Chapter 3) examines the impact of observing beat gestures performed during a brief narrative discourse training task on the retelling performance of wordless cartoons. Our question is whether a brief narrative training session with beat gestures can contribute to improve children's overall narrative performance scores in terms of discourse structure in a subsequent narrative task. Forty-four 5- and 6-year-old children participated in a between-subjects training study with a pretest and posttest design.

112

They were exposed to a training phase which contained a total of six one-minute stories, presented under two between-subjects experimental conditions: (a) *no-beat condition*, where narratives were performed with prosodic prominence and no beat gestures in target positions within the story; and (b) *beat condition*, where narratives were performed with prosodic prominence and beat gestures in target positions. In each condition, children were simply asked to observe the stories. The hypothesis is that children exposed to the beat condition will show significant gains in the quality of their posttest narratives (i.e., better narrative structure scores).

The third study (Chapter 4) extends the previous method to incorporate whether also encouraging children to produce beat gestures also can have the same effects. In this study, 47 5- to 6-year-old children performed the same narrative training task as in Study 2 (Chapter 3), under two between-subjects experimental conditions: (a) *beat non-encouraging condition*, and (b) *beat encouraging condition*. In both conditions, children were first shown a total of six narratives performed with prosodic prominence and beat gestures in target positions within the story. In the beat non-encouraging condition, children were just asked to retell the stories without any instructions regarding gesture. By contrast, in the beat encouraging condition, children were asked to retell the six one-minute stories while producing the hand movements like those they had just observed from the narrator (that is, beat gestures). The hypothesis is that children encouraged to produce beat gestures will

report significant increases in the quality of their posttest narratives in terms of narrative structure and fluency scores.

Finally, Chapter 5 summarizes the achievements of the work described in these studies (Chapters 2, 3, and 4), and discusses the main thesis conclusions and their implications for the study of multimodal narrative development.

2

CHAPTER 2: THE PREDICTIVE VALUE OF NON-REFERENTIAL BEAT GESTURES IN CHILDREN'S LATER NARRATIVE ABILITIES

117

2.1 Introduction

Children's early gesturing not only precedes, but also predicts simple linguistic milestones (e.g., Iverson & Goldin-Meadow, 2005). Given the fact that oral language skills play a role in subsequent successful school literacy (Demir, Levine, & Goldin-Meadow, 2012; Naremore, Densmore, & Harman, 1995), it becomes important to ask whether the early production of gestures also predicts more complex language skills, such as narrative skills, at later stages of development. Previous studies have focused on the role of referential gestures (and more specifically, iconic character-viewpoint gestures) in predicting later narrative skills (Demir, Levine, & Goldin-Meadow, 2015). To our knowledge, no previous investigation has examined the role of non-referential gestures (e.g., beat and flip gestures, which contribute pragmatic–discourse meaning to communication; Ferré, 2011; Kendon, 2004, 2017; McNeill, 1992; Shattuck-Hufnagel, Ren, Mathew, Yuen, & Demuth, 2016) in predicting narrative skills. Here we focus on the use of beats and flips (vs. iconic gestures) produced by children in parent-child naturalistic interactions prior to school entry (14 to 58 months old), and explore their role in predicting children's later narrative performance at 60 months (age 5). To extend this analysis and assess the types of pragmatic discourse that these gestures are associated with in child naturalistic discourse, we examined the pragmatic function of the utterances children produced along with their beat, flip, and iconic gestures.

118

During the early stages of communicative development, children use gestures before speaking. At around 10 months of age, children produce their first gestures, called *deictic* (or pointing) gestures, which they use to indicate an object, event, or location before they have words to refer to that object, event, or location (e.g., Bates, 1976; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Esteve-Gibert & Prieto, 2014). The specific lexical items that label the objects indicated by those points then turn up in a child's verbal vocabulary approximately three months later (Iverson & Goldin-Meadow, 2005). By the end of the first year of life, children start producing gestures along with speech (e.g., Butcher & Goldin-Meadow, 2000; Esteve-Gibert & Prieto, 2014; Volterra & Iverson, 1995), and particular types of gesture-speech combinations (combinations in which gesture and speech convey different referents, e.g., point at a ball while saying "mommy" or "play") predict the onset of children's first two-word utterances (e.g., "mommy ball" or "play ball," Bavin, 2014; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005).

A second type of gesture produced as early as 10 months of age is the *iconic* gesture (Bates, 1976). According to McNeill's (1992) classification of gestures, iconic gestures (a type of referential gesture) bear a close relationship to the semantic content of the segments of speech they accompany, as they depict properties of an object, action, or scene; thus, their meaning is given by the form of the gesture in context (e.g., as a speaker says "he [bends it way

119

back],'' his or her hand appears to grip something and pull it back. Previous research has explored the relation between children's early iconic gestures and their acquisition of first verbs. A longitudinal study by Özçalışkan, Gentner, and Goldin-Meadow (2014) found that iconic gestures did not pave the way for children's first verbs. The results showed that 44 children, ages 14 to 34 months, produced their first verbs six months before they produced the corresponding gestures. However, the study also found that iconic gestures help expand children's communicative repertoire as they gave them a way to express meanings not yet conveyed in their first verbs. Moreover, iconic gestures produced later in development (at around 5 years old) have been shown to predict and positively affect children's subsequent narrative abilities (Demir, Fisher, Goldin-Meadow, & Levine, 2014; Demir et al., 2015; Parrill, Lavanty, Bennett, Klco, & Demir, 2018; Stites & Özçalışkan, 2017).

Later in development, children begin to produce *beat* gestures. Beat gestures are rhythmic fingers or hand movements that are typically associated with prosodically prominent parts of the discourse (for example, discourse entities which receive prosodic prominence in the form of pitch accentuation) (e.g., McNeill, 1992; Prieto, Cravotta, Kushch, Rohrer, & Vilà-Giménez, 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel & Ren, 2018). These gestures are non-referential, that is, they do not have semantic meaning and instead signal "the temporal locus in speech of something the speaker feels is important with respect to the larger discourse" (McNeill, 2005, p. 40). Beat gestures appear in complex

discourse when children are 5-6 years of age and are related to an emerging system of more complex discursive skills (e.g., Mathew, Yuen, & Demuth, 2017; McNeill, 1992). Some studies have suggested that beat gestures mark clause relations in storytelling in children between 5-6 years and 10 years of age (Blake, Myszczyszyn, Jokel, & Bebiroglu, 2008; Colletta et al., 2015; Colletta, Pellenq, & Guidetti, 2010; Mathew et al., 2017; McNeill, 1992). For instance, a cross-linguistic study with 98 5- to 10-year-old French, American, and Italian children by Colletta et al. (2015) pointed out that, cross-linguistically, children at the older ages produced more discourse or cohesive gestures (beat gestures that help to structure speech or mark cohesion) than representational, framing (expresses an emotion or mental state of the narrator), performative (expresses the illocutionary value of a speech act), interactive (refers to the interlocutor) or word searching gestures. Moreover, in a narrative task performed by 6- to 10-year-old monolingual French-speaking children and adults (Colletta et al., 2010), the average number of beat gestures with a discursive function (e.g., accompanying connectors, highlighting important linguistic units, or performing anaphoric functions) and gestures with a framing function increased significantly with age, indicating that children produce discursive gestures with a functional meaning in narratives between 6 and 10 years of age. Moreover, some studies have suggested a link between the onset of beat gestures and emerging complex linguistic skills. In a longitudinal study with 5 French-English bilingual children observed from the ages of 2 to 3 years and 6 months, Nicoladis, Mayberry, and Genesee (1999)

found that the appearance of beat gestures in development was linked to both English and French language development. Beat gestures (and also iconics) increased as the mean length of spoken utterances (MLU) increased, suggesting that beat gestures "illustrated the temporal structure of utterances" and that they "developed as a function of [children's] ability to use carrying stress patterns with multimorphemic utterances" (p. 524). The evidence for this relationship was higher for English than for French, revealing that children's English was more developed than their French.

Children produce another specific type of non-referential gesture, the *flip* gesture. Flip gestures are produced by turning the wrist of the hand and opening it up to present the flat palm, with or without a shrug of the shoulders, and usually convey a judgmental or epistemic value of ignorance (Ferré, 2011). Although children start producing flip gestures before they produce beat gestures, flips have an extended trajectory during which the conveyed meaning changes over time. A few observational studies, such as one by Acredolo and Goodwyn (1985), have reported that during the second year, children start to spontaneously express their ignorance via flips (or shoulder shrugs). The authors observed one child from 12 to 17 months and found that she began using these gestures to signal ignorance at 15 months. Similarly, Bartz (2017) analyzed 64 14- to 42-month-old children included in a longitudinal study of early language development (Goldin-Meadow et al., 2014) and found that one-fifth of the children produced a flip to signal ignorance at 22

months, and that half of the children produced a flip to convey ignorance by 42 months of age (see Harris, Bartz, & Rowe, 2017, for a review of the emergence and prevalence of flip gestures conveying ignorance). Moreover, flips can also convey a modal function (Kendon, 2004), "adding a question-tag to the utterance, therefore adding a certain degree of uncertainty to the statement" (Ferré, 2011, p. 3), often accompanied with a shrug of the shoulders.

Despite the many investigations addressing the role of referential gestures in language development (e.g., iconic and deictic gestures), to our knowledge, none of the research carried out thus far has examined the role of the production of non-referential gestures (beat and flip gestures) in predicting later language outcomes.

The main goal of the present investigation is to assess the role that non-referential and referential gestures play in predicting later narrative outcomes. Recent research provides strong support for the hypothesis that non-referential beat gestures occur at discourse–pragmatic meaningful moments in adult discursive speech (for a review, see Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016). Evidence shows that beat gestures perform a variety of linguistic functions, such as information structure marking, rhythmic marking, and discourse structure marking (Dimitrova, Chu, Wang, Özyürek, & Hagoort, 2016; Im & Baumann, 2020; Shattuck-Hufnagel et al., 2016). In relation to information structure marking, McNeill (1992) noted that beats

"mark information that does not advance the plot line but provides the structure within which the plot line unfolds" (p. 15), relating the semiotic value of a beat to discourse-pragmatic content as a whole (e.g., to introduce new characters or themes, or summarize the action, etc.) rather than to specific events in a narrative. Im and Baumann's (2020) recent study showed that prosodic prominence (i.e., pitch accents) in conjunction with non-referential gestures, encodes information status in speech by highlighting new or accessible and contrastive information. In relation to pragmatic discourse marking, according to Kendon (2017), pragmatic gestures (e.g., beat gestures, flip gestures, negative gestures, etc.) perform the following four pragmatic functions: (a) operational functions (the gestures function as operators in relation to the speaker's spoken meaning; e.g., head or hand actions that add negation); (b) modal functions (the gestures indicate how the listener should interpret the utterance; e.g., the speaker's epistemic stance); (c) performative functions (the gestures show the type of the speech act; e.g., a question, a refusal, etc.); and (d) parsing functions (the gestures mark discourse structure). Other authors have analyzed different pragmatic meanings conveyed by different hand gesture forms. For instance, Graziano (2014) analyzed two types of non-referential Italian gestures used by 4- to 10-year-old children; the gestures were from the *Open Hand Supine family* (following Kendon, 2004), which can either mark sequences of episodes and events, or the end of the discourse. Cooperrider, Abner, and Goldin-Meadow (2018) also distinguished different types of palm-up gestures according to form and meaning, and proposed that the

124

basic flip gesture form is used for two distinct gesture functions: *palm-up epistemic* gestures frequently co-occur with a shoulder shrug and express absence of knowledge, ability, or concern; *palm-up presentational* gestures metaphorically present information or request an interlocutor's contribution. All in all, these findings suggest that beat gestures and flip gestures can contribute to a variety of important pragmatic and discourse meanings. Finally, investigations using event-related potentials (ERPs) or functional resonance imaging (fMRI) in adults have provided evidence that beat gestures can facilitate syntactic and semantic processing (Biau & Soto-Faraco, 2013; Holle et al., 2012; Wang & Chu, 2013). Despite the supporting evidence for considering non-referential gestures as highlighters of linguistic functions, to our knowledge, no study has assessed whether the early use of non-referential gestures —beat gestures and flips— play a role in signaling oncoming changes in children's discourse construction as they begin to produce linguistically complex *narratives*.

The emergence of children's narratives in speech appears in the transitional period between ages 3 to 6 (Stites & Özçalışkan, 2017). During the preschool years, children start telling simple narratives, with a basic goal and character components of a story (Applebee, 1980; Berman & Slobin, 1994; Stradler & Ward, 2005). However, between 5 to 6 years of age, children begin to tell well-structured stories, with all the features that comprise narrative structure (Bamberg, 1987; Berman & Slobin, 1994; O'Neill & Holmes, 2002). Gestures during the early period provide a scaffolding tool

125

for children's burgeoning narrative abilities, and previous research has confirmed the importance of examining children's gestures in narrative contexts. For example, the same developmental changes found in spoken narratives can be found in the gestures that accompany those narratives (Alamillo, Colletta, & Guidetti, 2013; Colletta et al., 2015), as language and gesture develop together during the school-age years. Children are able to produce representational gestures along with their narratives at around 4 or 5 years of age (McNeill, 1992). Moreover, children can accompany their narratives with co-speech gestures that function like adult gestures by age 9 (Colletta, 2009); in particular, they use their gestures to represent the narrated events, to mark discourse cohesion, to convey the pragmatic framing of the utterance that help discourse connotation, and so on.

Across studies, there is evidence that referential gestures might not only co-occur with narratives, but also precede and predict the development of narrative abilities (Demir et al., 2015; Stites & Özçalışkan, 2017) and help to boost them (e.g., Demir et al., 2014; Parrill et al., 2018). Stites and Özçalışkan (2017) found that, before children introduce story referents in speech using noun phrases and pronouns at 6 years of age, they rely on iconic gesture *plus* speech combinations at age 5 to introduce new characters in the story by using character-viewpoint in gesture (CVPT). As for the predictive role, a longitudinal study by Demir et al. (2015) found that children who expressed CVPT gestures in narratives at age 5 produced better goal-structured narratives at later ages, rather than children who did

126

not perform CVPT gestures, which suggests that these gestures seem to reflect that the child has the capacity to take a first-person perspective on events. Interestingly, a study by Demir et al. (2014) found that observing a storyteller produce story-relevant gestures during a narrative task helped both 5-year-old children with early brain injury and typically developing children produce better-structured narrative retellings than observing the teller produce the story in speech alone. Similarly, Parrill et al. (2018) found significant positive effects of training children to produce character viewpoint (CVPT) gestures on their narrative structure scores immediately after training.

A few recent studies have focused on the role that non-referential beat gestures might play in bolstering children's narrative performance. For instance, two studies showed that asking 5- to 6-year-old children to observe (Vilà-Giménez, Igualada, & Prieto, 2019) and encouraging them to produce (Vilà-Giménez & Prieto, in press) beat gestures in a brief narrative training task boosted their posttest narrative performance. Moreover, Llanes-Coromina, Vilà-Giménez, Kushch, Borràs-Comes, and Prieto (2018) also found that children who were asked to watch stories accompanied by beat gestures could remember the story information better than children who did not observe beat gestures in the narratives (see Austin & Sweller, 2014; Igualada, Esteve-Gibert, & Prieto, 2017; Llanes-Coromina et al., 2018, for comparable effect on recall in 3- to 5-year-old children). Up to now, little attention has been paid to the variety of pragmatic and discourse meanings beat and flip gestures

127

play in narrative discourse and, subsequently, in children's language development. The pragmatic value that these gestures convey (and the type of speech they are associated with) may be able to contribute significantly to children's narrative development.

2.1.1 The current study

The current study investigates whether the early production of beats, flips, and iconic gestures predicts later narrative production (in particular, narrative structure) at 5 years of age. The predictive analysis was run on a longitudinal database that includes 45 parent-child dyads visited in their home every four months between 14 and 58 months of age. At 60 months of age (i.e., 5 years old), the same children participated in a narrative task (data from Demir et al., 2014). In addition, in order to assess the discourse role that non-referential gestures (vs. referential iconic gestures) might play in later children's narrative development, we used a representative sample of 18 parent-child dyads from this database to examine the pragmatic function of the speech that children produced along with beats, flips and iconics during the naturalistic interactions. Our hypothesis is that non-referential beat and flip gestures will be associated with speech that encodes a richer variety of discourse meanings (e.g., specifically *biased* assertions or questions), thus serving important pragmatic meaning cues in speech. In contrast to iconic gestures, which involve imagistic or pictorial content of speech, both types of non-referential gestures have been found to convey pragmatic meanings (Kendon, 2004, 2017). We further

hypothesize that beat gestures —in conjunction with prosodic prominence— will help more than flips in framing structure and managing discourse, as they have been shown to highlight important linguistic discourse functions (e.g., discourse structure and information structure) (Dimitrova et al., 2016; Im & Baumann, 2020; Kendon, 2004, 2017; McNeill, 1992; Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016, among many others). In contrast, we think that flip gestures will primarily convey epistemic meanings in discourse (e.g., canonical flips are typically glossed as "I don't know," Cooperrider et al., 2018). Based on these findings, we expect that beat gestures are in a privileged position to scaffold later children's narratives. We therefore predict that early beat gestures will forecast later stages of narrative abilities at 5 years of age.

2.2 Methods

Analysis 1: Do early beat gestures play a role in predicting children's later narrative abilities?

Participants

A total of 45 typically developing children took part in the study. The participants and their families were participating in a larger longitudinal study of language development (see Demir et al., 2014; Demir et al., 2015; Goldin-Meadow et al., 2014; Özçalışkan & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009), and the sample was representative of the greater Chicago area in terms of

ethnicity and income levels. For these 45 children and their families, mean parent education was 16.13 years, corresponding to a college degree on average (*SD* = 1.82, *range* = 12 (high school) — 18 (graduate school)). All children were being raised as monolingual English speakers.

Materials and Procedure

Parent-child dyads were visited in their homes every four months between child age 14 and 58 months. At each visit, children and caregivers were videotaped for 90 minutes of spontaneous interaction. Families were instructed to go about their day as usual and recordings commonly included activities like mealtimes, book readings, and play sessions. These data were collected as part of a larger longitudinal study of language development at the University of Chicago.

Narrative data from the forty-five children were collected at age 5 (*M* = 6, *SD* = .42) (see e.g., Demir et al., 2014). Each child participated in a narrative task in which children were presented two cartoons on a DVD player during a regular home visit. The cartoons were produced in Germany (*Maus* cartoon, Westdeutscher Rundfunk Köln, http://www.wdrmaus.de) and thus were unfamiliar to the children in the study. Each wordless cartoon (30–73 s) was about a small mouse (Maus) and his friends, and followed the same structure with causally connected events: one goal, an initiating event (the problem), multiple episodes (attempts to achieve the goal), and an outcome or resolution. Children were thus not

130

presented with language content, but had to create it on their own based on the cartoon (see Demir et al., 2014, for more details about the procedure and about other conditions).

Transcription and coding

Speech and gesture. All parents' and children's naturalistic interactions in each in-home visit were videotaped, transcribed for speech, and coded for gesture in the original database for all 45 parent-child dyads who participated in this longitudinal study.

Speech was transcribed at the utterance level with utterance unit boundaries determined by pauses, prosody, turn transitions, and syntax. Speech was transcribed verbatim but not phonetically.

All parent and child co-speech gesture was previously coded following McNeill (1992) according to five classes of gesture: *beat*, *deictic*, *iconic*, *metaphoric*, and *conventional*. Gestures were also annotated for form and gloss. This first-level coding schema included a broad array of gesture forms, including deictic points and emblems like "thumbs up;" however, for the current work, we considered a subset of these gestures. Given our prediction that early non-referential beat gestures predict later narrative skills, we focused on non-referential gesture forms coded as beats and flips. In order to account for the possibility that any observed relationship was due to the effect of gesture *per se*, we also included iconic gestures, which occurred at the same rate as non-referential gestures

in our data. We thus report results for *beat* gestures, *flip* gestures and *iconic* gestures.

Transcription reliability was established by having a second coder transcribe 20% of the videotapes; reliability was assessed at the utterance level and was achieved when coders agreed on 95% of transcription decisions.

Beat gestures. McNeill (1992) states that "beats are typically biphasic, small, low energy, rapid flicks of the fingers or hand; they lack a special gesture space, and are performed indeed wherever the hands happen to find themselves, including rest positions" (p. 80). They are typically short and quick movements of the hand in one dimension, up and down, or back and forth, and can occur alone (on a single word) or in a sequence (punctuating syllables or several words). Beat gestures are considered to be rhythmic, non-referential (without adding semantic information to a referent in speech) gestures and are *typically* associated with prominent positions in natural discourse (e.g., emphasizing important information in discourse or marking the introduction of a new discourse).

Flip gestures. Sometimes referred to as *palm-up* gestures, flips are defined as a full or partial rotation of wrist with open palm(s) to present the flat palm, often accompanied by a shrug of the shoulders, showing the speaker's judgment or an epistemic value (e.g., Ferré, 2011). Flips are also considered non-referential

gestures, as they do not convey substantive semantic content in relation to the speech.

Iconic gestures. Representational (or referential) gestures that bear a close formal relationship to the semantic content of the speech are considered iconic. Iconic gestures can refer either to actions or perceptual features associated with objects. An example of an iconic gesture is moving the hand upward while saying "he tried going up inside the pipe this time" to represent the act of going up (McNeill, 1992, p. 78).

For the initial first-level coding, each type of gesture was assigned a gloss or meaning from a drop-down list according to its gesture form and context. For example, after identifying a flip form, the meaning was chosen from the following list: *all gone, all done, don't know, question, exclamation, of course, whatever*. This list is not intended to be exhaustive of all flip meanings, but was sufficient to describe all of the flips observed in this corpus. Beat gestures were always glossed as *emphasis*. Iconic gestures were coded with an open-ended description of form and glossed according to the corresponding referent in speech.

Narrative structure. Scored narratives at 5 years of age were obtained from Demir et al.'s (2014) study. Stories were coded in terms of narrative structure, using a rating adapted from Stein and colleagues (Stein 1988; Stein & Albro, 1997; Trabasso, Stein, Rodkin, Munger, & Baughn, 1992), as follows (see Table 1).

Table 1. Narrative structure scores used for the child's narrative production assessment in Demir et al.'s (2014) study.

Score of 0	A scoreless narrative is a string of sentences that do not contain a descriptive sequence and have no structure.
Score of 1	A descriptive sequence is a narrative that includes the physical and personality characteristics of an animate protagonist with no mention of a sequence of actions.
Score of 2	An action sequence is a narrative with actions described in a temporal order (actions follow one another in time) but in which the actions are not causally organized.
Score of 3	A reactive sequence contains actions that are causally organized but does not include the protagonist's goal, the intention of the protagonist to act to achieve a specific end.
Score of 4	An incomplete goal-based narrative contains a goal statement and/or an attempt but no outcome following the goal.
Score of 5	A complete goal-based narrative with one episode includes not only temporal and causal structure but also a goal of the protagonist, an attempt to achieve the goal, and an outcome of these attempts.
Score of 6	A complete goal-based narrative with multiple episodes includes multiple goal–attempt–outcome sequences.

Analysis 2: The pragmatic discourse functions expressed by the speech that accompany beats, flips and iconic gestures

In order to assess which pragmatic discourse functions of speech were beats, flips and iconic gestures associated with in the children's spontaneous speech interactions, a further pragmatic descriptive analysis of the speech produced by children in 18 of the dyads was conducted.

Participants

A random group of 18 children (8 males and 10 females) out of the total of forty-five children in Analysis 1 were chosen for the second analysis. For these families, mean parent education was 15.5 years (SD = 2.25), not significantly different from the group of 45 families (p = .25). The subsample was therefore representative of the entire sample. Six of the children in the subsample were not included in the larger sample because they did not have later narrative scores.

Pragmatic Coding of Speech

All the 18 children's target utterances accompanied by beats, flips or iconic gestures were analyzed by the first author, following a pragmatic coding scheme adapted from Ninio, Snow, Pan, and Rollins (1994) and based on Krifka's (2015) commitment space semantics framework. Four main pragmatic functions were coded, as follows (see Table 2 for examples). An utterance was annotated

as "unclear" if its pragmatic function could not be determined from the context (2.78% of the utterances were unclear).

(1) *Unbiased assertions.* This category includes unmarked or unbiased assertions (see Krifka's commitment analysis of speech acts, 2015), with a declarative or explanation illocutionary force and with no markers of modality. By asserting a proposition, the speaker makes a public commitment for the truth of that proposition (e.g., Brandom, 1983). The category includes declaratives, explanations, and information responses.

 (2) *Biased assertions or questions.* This category is based on the idea that speech acts are a part of semantics, allowing semantic operators to scope over them (e.g., Krifka, 2015). Thus these assertions or questions express the degree of commitment to the truth of the proposition. We coded three different subcategories: epistemic uncertainty, epistemic agreement, and negation.

(3) *Requesting speech act.* All requests and commands, including both interrogative and imperative structure, were included in this category.

(4) *Expressive speech act.* All expressive and emotional utterances and markings (e.g., exclamations, thanking, greetings, etc.) were included in this category.

Table 2. Examples of children's target utterances conveying different pragmatic functions.

Unbiased assertions	Declarative	"I'm going to get it straight down." (iconic)
	Explanation	"at the end of the day, we went home" (beat – beat)
	Information response	"if you still don't, you have to go back this way" (iconic)
Biased assertions or questions	Epistemic uncertainty	**Confirming question.** "mom, you know what I should do?" (beat) **Information-seeking question.** "why that cover his eyes?" (iconic) **Expressing ignorance.** "I don't know" (flip) **Expressing absence.** "all gone" (flip)
	Epistemic agreement	**Acknowledgment.** "I know there is five" (beat) **Affirmation.** "yes I did" (flip) **Affirmation with agreement.** "you got to practice every time a day. (beat – beat – beat)"
	Negation	**Correction.** "no, her puzzles." (beat – point) **Contradiction.** "yes she do!" (beat – beat – beat) **Negation.** "no" (iconic)

		Negation with disagreement. "I hate egg salad" (beat)
Requesting speech act		**Requesting question.** "wait for games." (beat)
		Request. "say whee!" (iconic)
Expressive speech act		**Exclamation.** "we're at school" (flip)
		Marking. "the end." (flip)

Inter-rater reliability. Coding reliability for speech pragmatic function annotations was established by having a second coder (the second co-author of the study) code 20% of the children's data. Before conducting the reliability test, the two coders tested the speech pragmatic coding scheme in a set of six random parent-child interaction sessions and compared their annotations. Inter-rater agreement for speech pragmatic function was high: $\kappa = .846$ (85%), $p < .001$. After establishing reliability, disagreements were resolved by coder consensus.

2.3 Results

Analysis 1

A stepwise regression analysis was run using SPSS Statistics 23.0 (SPSS Inc., Chicago IL) to test whether the overall mean number of gestures (e.g., beats, flips and iconic gestures) produced in the total developmental window (e.g., from 14 to 58 months) significantly predicted the structure of children's narratives at age 5. Stepwise

138

linear regression is a method where multiple variables are regressed while simultaneously the weakest correlated variables are removed. Narrative structure scores from the cartoon condition, in which the children watched the cartoon and told the story to the experimenter (Demir et al., 2014), was the dependent variable. All analyses controlled for parent education. The overall mean number of beats, flips and iconics produced by the 45 children were the independent variables. On average, children produced 1.1 beat gestures per session (SD = 1.7, $range$ = 0 to 10.23), 1.9 flips per session (SD = 1.9, $range$ = .15 to 9.1) and 3.5 iconic gestures per session (SD = 2.7, $range$ = .31 to 11.46). The average month for onset was 39 months for beats, 28 months for flips, and 24 months for iconic gestures. A linear stepwise regression was calculated to predict narrative abilities at 5 years of age based on the number of beats, flips and iconic gestures produced by children during their parent-child naturalistic interactions ($F(1, 43)$ = 6.030, p = .018). In this model, only the beats remained in the model and the rest of the variables were not included. Results showed that the average number of beats produced between 14 and 58 months significantly predicted narrative skills (p = .018). However, the effects of flip gestures (p = .180) and of iconic gestures (p = .924) were not significant. Children's narrative abilities at age 5 improved by .289 (β = .289, SE = .118) for each beat gesture produced. This model explained 12% of the variability in children's narrative outcomes.

We replicated the results controlling for children's early speech in a subsequent regression analysis. We added overall mean number of

139

word types as a measure of children's early language in the model. We picked word types, which has been used as a measure of vocabulary diversity, rather than other measures of speech for two reasons. First, in our dataset, average number of word types was significantly correlated with later narrative measure, (r =.33, p = .02), but number of utterances, a measure of amount, was not (r = 24, p > .10). Second, number of utterances was highly correlated with the gesture measures creating a possibility of collinearity (correlations reaching up to .5), compared to word types (correlations between .3 and .4). In this linear stepwise regression analysis, only the beats remained in the model and the rest of the variables were not included. Controlling for parent education and children's early language, overall mean number of beats produced in the relevant period still emerged as a significant predictor of later outcomes (p = .018), but flips (p = .180) or iconic gestures (p = .924) did not. This model explained 12% of the variability in children's narrative discourses. Results in both models were confirmed with other regression methods include enter or forward models.

Analysis 2

We next describe the pragmatic functions of the speech children produced along with their beat, flip and iconic gestures. A frequency analysis was run with 18 parent-child dyads to examine the pragmatic functions of the speech that was produced along with each type of gesture (see Figures 1A, 1B and 1C; see also Appendix A for frequency tables). As the objective was to analyze the

pragmatic function of the associated speech, we did not include gestures produced in the absence of speech (79 flip gestures and 119 iconic gestures).

Results from the pragmatic analysis of speech produced with flip gestures ($n = 335$) can be found in Figure 1A (Table 3 in Appendix A). The majority of flips (40,7%) were produced with *biased assertions or questions* (epistemic uncertainty, epistemic agreement and negation); 36,7% were produced with *unbiased* pragmatic functions; 9,3% were with *requesting speech acts*; and 7,8% with *expressive speech acts*.

Results from the pragmatic analysis of speech produced with beat gestures ($n = 222$) are presented in Figure 1B (Table 4 in Appendix A). The majority of beats (69,8% of beats) were produced with *unbiased assertions* (declarative, explanation and information response); 19% were produced with *biased assertions or questions;* 8,6% with *requesting speech acts;* and 1,8% with *expressive speech acts*.

Results from the pragmatic analysis of speech produced with iconic gestures ($n = 553$) are presented in Figure 1C (Table 5 in Appendix A). The majority of iconic gestures (74,5%) were produced with *unbiased assertions*; 12,1% of iconics were produced with *biased assertions or questions*; 10,8% with *requesting speech acts;* 1,4% *expressive speech acts*.
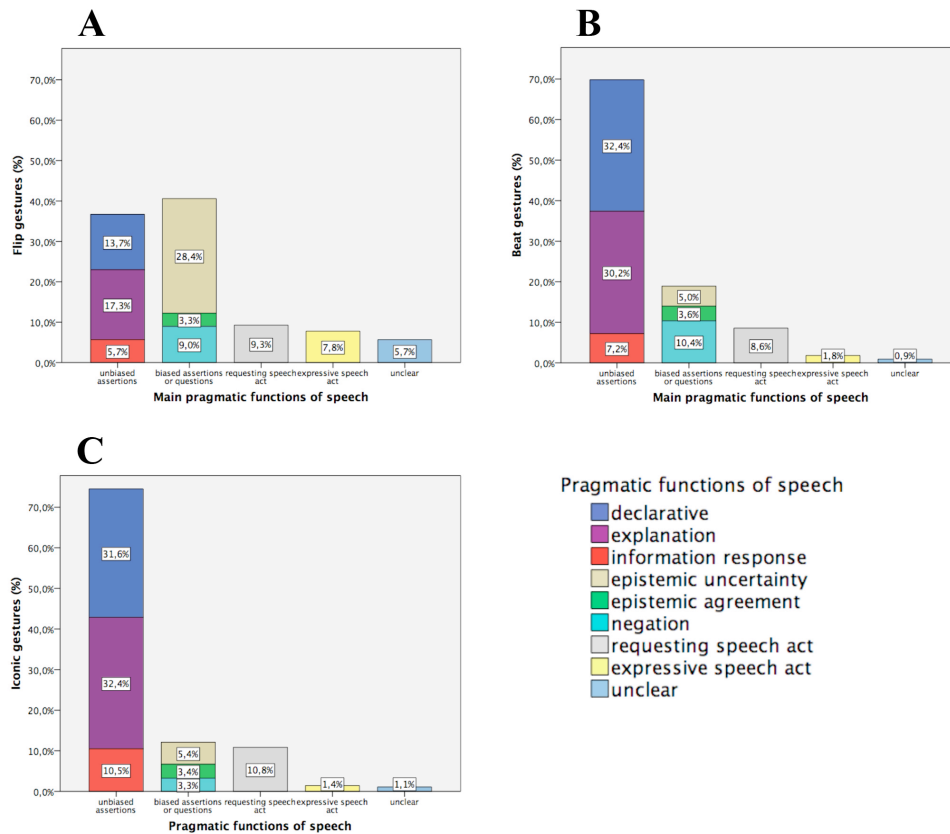
Figure 1. Percentage of flip (top left, A), beat (top right, B) and iconic (bottom left, C) gestures associated with the different speech pragmatic functions: (1) unbiased assertions, which includes declarative, explanation and information response; (2) biased assertions or questions, which includes epistemic uncertainty, epistemic agreement and negation; (3) requesting speech act; (4) expressive speech act; and (5) unclear.

Overall, results from the pragmatic analysis of speech produced with flip gestures indicate that flips (40,7%), compared to beats (19%) and iconic gestures (12,1%), were associated with *biased assertions or questions*, suggesting that they serve a clear pragmatic

epistemic meaning in discourse (e.g., "I don't know it" or "but move what?" were utterances accompanied by a flip).

In contrast to flips, beats and iconics tended to be produced along with *unbiased assertions* (e.g., 69,8% of beats; 74,5% of iconics). Interestingly, flips performed on *unbiased assertions* (36,7%) were mostly used to convey some kind of exclamation meaning (e.g., explanation, "It was an accident") or some discourse epistemicity in the utterance (e.g., declarative, "she wants to be free," or information response, "Umm, I can't decide it"). The fact that non-referential flips seem to be more associated with assertions or questions that involve markers of modality, specifically of epistemic stance, help to distinguish these gestures from other type of non-referential gesture (i.e., beat gestures). For instance, flips were produced primarily in assertions expressing ignorance and absence, such as "I don't know" or "all gone"; in contrast, none of the beats in the database were produced along with these types of assertions.

In relation to the results of Analysis 1, which showed the value of using non-referential beat gestures, but not of referential iconic gestures, to predict later narratives, it is worth asking what difference there is between the speech produced with beats and speech produced with iconics. Beat gestures were 6,9% more likely than iconics to be associated with *biased assertions or questions*, showing a slight tendency for higher frequency of beats serving these biased pragmatic functions. More specifically, beats were

143

associated with biased pragmatic meanings including epistemic uncertainty, in questions ("like -- like a blanket?" and "what if it is really old?"); epistemic agreement, in assertions or acknowledgments ("I know there is five" or "you got to practice every time a day"); and expressions of negation or rejection, in corrections of information ("no, her puzzles") or contradictions ("yes she do!"), negations ("no"), and negations with disagreement ("I hate egg salad").

Taking the absolute numbers of beats and iconics performed on either unbiased or biased pragmatic functions of speech, we run a Generalized linear mixed-effects model with number of gestures as the dependent variable (poisson distribution, log link). Gesture Type (beat, iconic), Pragmatic Function of Speech (unbiased, biased) and their interaction were set as fixed factors. The random structure that provided the best fit according to the AIC criterion (Akaiake Information Criterion) included a random slope for gesture by subject, plus a random intercept for session. Pairwise comparisons were extracted, with a Bonferroni correction applied when necessary. Results indicated a main effect of Gesture Type ($X^2(2) =$ 36.961, $p < .001$), showing higher rates of iconic gestures ($d = 0.96$, $p = < .001$) than beat gestures, and a main effect of Pragmatic Function of Speech ($X^2(1) = 128.564$, $p < .001$), revealing a higher number of gestures were performed on unbiased assertions ($d =$ 1.01, $p < .001$) than on biased assertions or questions. A significant interaction between Gesture Type and Pragmatic Function of Speech was also found ($X^2(2) = 118.460$, $p < .001$), indicating that

144

number of gestures differed depending on gesture type and pragmatic function of speech. Further post hoc analyses showed that Gesture Type differed significantly in both unbiased and biased levels, showing a higher proportion of iconic gestures on both unbiased ($d = 1.21$; $p < .001$) and biased ($d = 0.70$; $p = .024$) assertions or questions. Regarding Cohen's d effect size, this difference was higher in unbiased ($d = 1.21$) rather than in biased ($d = 0.70$) functions. Moreover, Pragmatic Function of Speech also differed significantly in both beat and iconic gesture levels, reporting that both beats and iconics were performed more on unbiased (beats: $d = 1.31$; $p < .001$; iconics: $d = 1.82$; $p < .001$) than on biased utterances. Crucially, the d scores indicated that this difference was stronger for iconic gestures ($d = 1.82$) than for beat gestures ($d = 1.31$). Thus our overall results show that even though both beat and iconic gesture rates are higher in unbiased pragmatic functions, iconics have a slight tendency to appear more often than beat gestures on unbiased rather than on biased functions.

2.4 Discussion and Conclusions

The main objective of the present study was to determine whether the early production of non-referential gestures (e.g., beats and flips) and referential gestures (e.g., iconics) between 14 and 58 months old predicts children's later narrative production at 60 months of age. Findings clearly showed that children's production of beat gestures in the developmental window of 14 and 58 months, but not flips or iconics, significantly predicted the structure of their

later narratives. The field of infant language development has focused almost exclusively on the role of referential gestures (e.g., pointing gestures and iconic gestures) in predicting later language abilities. Our study is thus the first to determine whether non-referential gestures, such as beat and flip gestures, predict narrative abilities. To our knowledge, this is the first study to explore the pragmatic role that beat gestures might play in scaffolding children's later narrative discourse.

The results of our study add several new insights to research on children's production of beat gestures and its role in the development of language. The findings of the predictive analysis confirm that the production of beat gestures in the window between 14 and 58 months of age can be indicative of better narrative abilities later on in development, specifically at 60 months of age, approximately when children start acquiring these gestures within narrative discourse (Colletta et al., 2015; Colletta et al., 2010; McNeill, 1992; Mathew et al., 2017, among others). Our results thus extend and complement previous findings showing that referential gestures (e.g., iconic gestures and deictic gestures) significantly affect speaker's language development and learning (see Goldin-Meadow & Alibali, 2013, for a review; e.g., Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001; Novack, Congdon, Hemani-Lopez, & Goldin-Meadow, 2014). Our predictive analysis clearly shows that non-referential beat gestures can also have strong effects in a later stage of language development, and specifically for predicting narrative performance at a later age. This result is

consistent with findings related to the predictive effects of gesture-speech integration patterns at 12 months. Igualada, Bosch, and Prieto (2015) showed that using simultaneous multimodal combinations at 12 months to reinforce information when joining attention to the same reference predicts later expressive vocabulary and morphosyntactic measures at 18 months. Moreover, these results are consistent with findings reported for the role of training with beat gestures in improving 5- to 6-year-old children's short-term narrative performance through a brief narrative training task (Vilà-Giménez et al., 2019; Vilà-Giménez & Prieto, in press).

Controlling for beat gestures, non-referential flip gestures and referential iconic gestures were not found to be significant predictors of children's narrative abilities at age 5. According to our pragmatic analysis, children tend to associate flip gestures ($n = 335$) with accompanying verbal acknowledgments of ignorance (e.g., "I don't know") (see Harris et al., 2017, for a review). By contrast, beat gestures ($n = 222$) in this study were not documented in the same proportion as flip gestures in this specific epistemic pragmatic context. Therefore, one possible explanation for the lack of predictive value of flip gestures would be that children tend to rely more on beat gesture's structuring and focusing functions rather than on flip's specific pragmatic function of marking ignorance. Moreover, as beats tend to appear later than flip gestures in children's discourse, it might be the case that beats are more connected to complex linguistic skills (Nicoladis et al., 1999). Interestingly, Nicoladis et al. (1999) did not find that deictic

147

gestures, gives (i.e., empty-handed, palm-up gestures that occur either with the fingers back and forth or still) or emblems were related to language development. This may be due to the fact that deictic, give and emblem gestures are performed before children begin to speak —a similar explanation could be provided for flip gestures in comparison with beat gestures.

On the other hand, one might have expected iconic gestures (n = 553) to be strong predictors of narrative abilities, which we did not find evidence for. Nevertheless, it is important to mention that previous predictive studies have exclusively examined the role of CVPT gestures (i.e., character-viewpoint gestures, in which the gesturer takes on the role of the character) but not iconic gestures depicting properties of a referent (Demir et al., 2015). In Demir et al.'s (2015) study, children who expressed CVPT by means of gestures while narrating showed more structured narratives at later ages than those children who did not produce these gestures, which suggests that CVPT gestures reflect the child's ability to take a character's first-person perspective on events. Although the authors reported no evidence for a causal role, capturing a character's perspective in gesture could boost a child's focus on the character's goals, thus making the child more aware of the narrative structure. In other words, it may be the role the iconic gesture plays in discourse, rather than the fact that it is an iconic gesture *per se*, that is important in its ability to predict subsequent narrative skills. This could be a line for future investigation.

In order to assess what properties of non-referential beat gestures could help in predicting later narratives, a second analysis was carried out to identify the pragmatic functions of the speech that accompanied beats, flips and iconic gestures. The findings of the pragmatic analysis are also important in light of research suggesting the pragmatic value of beat gestures in children's spontaneous speech. As previous research has shown (e.g., Kendon, 2004, 2017; McNeill, 1992; Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016, among others), non-referential rhythmic beat gestures are meaningful pragmatic gestures that act as important linguistic cues in discourse. Specifically, beat gestures have been shown to highlight important structural properties of language such as information structure, discourse structure, and rhythm (Dimitrova et al., 2016; Im & Baumann, 2020; Shattuck-Hufnagel et al., 2016) and to trigger attentional effects that activate language-related areas instead of just simulating the visual-perception areas of the brain (Biau & Soto-Faraco, 2013; Holle et al., 2012; Wang & Chu, 2013). Our study does not tell us whether producing beat gestures simply *reflects* a child's skill in framing discourse or highlighting aspects of prosodic focus (e.g., emphasis). However, producing beat gestures could play a *causal* role in facilitating narrative development. If so, the pragmatic and discursive properties of beat gestures may play a beneficial role in narrative development.

Results from our second analysis suggested that beat gestures are associated with sentences encoding a range of pragmatic and

discourse meanings. Even though the majority of the beats that children produced during their parent-child interactions accompanied *unbiased assertions*, such as declaratives, explanations or information responses, a relatively large proportion of them (19%, in comparison to iconic gestures 12,1%), were also performed on *biased assertions or questions.* Cohen's d effect sizes of the GLMM analysis showed that, although this small difference is not statistically significant, iconic gestures have a slightly greater tendency than beat gestures to be performed on unbiased assertions, rather than on biased assertions or questions. Beat gestures are thus meaningful cues that not only mark certain aspects of the structure of the discourse (parsing function), that is, "the kinesic action appears to make distinct different segments or components of the discourse, providing emphasis, contrast, parenthesis, and the like, or where it marks up the discourse in relation to aspects of its structure such as theme-rheme or topical focus" (Kendon, 2017, p. 168), but also show the illocutionary act that a speaker is engaged in (performative function), and indicate how a specific part of the spoken discourse should be interpreted (modal biased functions) (Kendon, 2017). Crucially, beats may reflect the child's understanding of pragmatic structure in discourse, and this early understanding sets the child up to learn later narrative skills.

Moreover, beats always emphasize speech by visibly "punctuating" prosodic prominence. Iconic gestures, in contrast, are entirely representational, acting as visual representations of some particular referent, rather than calling attention to the prosodic focus or

structure of speech. We suggest that this fundamental difference in referential function between the two types of gestures is also important in explaining the results of our predictive analysis. In other words, when children produce beats, they are highlighting information structure in discourse; when they produce iconics, they are highlighting some particular referential or lexical meaning. Since the challenge of producing early narratives is not just holding many referents in mind, but also creating a cohesive discourse structure, beat gestures may reflect a distinct type of knowledge, not highlighted in semantically-specific iconic gestures.

One possible limitation of the present study concerns the lack of gesture-speech alignment analyses. The pragmatic analysis was performed at the utterance level and no information was available on the specific parts of speech associated with the gestures the children produced. Importantly, further analyses are needed to determine whether there are differences in the speech that accompanies beats vs. iconic gestures. First, this type of analysis would allow us to evaluate whether children temporally align co-speech gestures, and specifically non-referential beat gestures, in an adult-like fashion in discourse. Along these lines, it would be worth to extend the findings obtained by Mathew et al.'s (2017) study, in order to analyze whether beat gestures are associated with prominent positions in speech. Second, future research on gesture-speech alignment could also use this supplementary data to examine the association between beats, flips and iconic gestures and specific content in speech. For example, it would be interesting to see

whether beat gestures are performed in lexical (i.e., focal content words) or in functional words (i.e., discourse markers). All these further steps would nicely contribute to extend and complement the present findings.

In summary, our findings have important implications for our understanding of the role of beat gestures in the development of children's narrative abilities. This study adds to the body of literature showing the relevant discourse–pragmatic role that beat gestures may play from early stages in language development. By having this meaningful role in language, children's beat gestures may reflect the child's understanding of information and discursive structure. This early understanding can act as a harbinger of change in the child's later narrative development.

3

CHAPTER 3: OBSERVING RHYTHMIC BEAT GESTURES IMPROVES CHILDREN'S NARRATIVE PERFORMANCE

155

3.1 Introduction

Gesturing is an integral part of human communication and speakers of all ages often gesture when they talk. In adult speech co-speech gestures[1] have been demonstrated to be meaningfully integrated with speech from a semantic, pragmatic, and phonological point of view (e.g., Kelly, Özyürek, & Maris, 2010; Kendon, 1980; Levinson & Holler, 2014; McNeill, 1992). There is convincing evidence that prosody and gestures are significant precursors of language development and communication, as they play a role in language processing (i.e., production and comprehension). Infants start using gestures to communicate before using language, and there is continuity in development between the children's use of gestures and their subsequent linguistic development. The use of non-verbal communication by infants and toddlers facilitates their development of oral language, as the combination of a gesture and a word (e.g., pointing at a cake while saying the words "cake," "mommy," or "eat") predicts the onset of two-word utterances

---

[1] McNeill (1992) classified gestures into iconic, metaphoric, deictic (or pointing), and beat gestures. Iconic gestures bear a close relationship to the semantic content of the segments of speech they accompany, as they depict properties of an object, action, or scene; thus, their meaning is given by context (e.g., as a speaker says "he [bends it way back]," his or her hand appears to grip something and pull it back). Although metaphoric gestures are similar to iconic gestures, they refer to an abstract concept (e.g., to express the concept of future with a hand gesture moving forward in space). Deictic gestures are used to indicate an object, event, or location and are performed with the pointing finger (e.g., pointing at a pencil while saying, "Can I borrow that, please?"). Beat gestures are rhythmic non-representational (i.e., without semantic information about a referent) gestures—usually of the fingers or hand—that are typically associated with prominent prosodic and pragmatically important positions in natural discourse (e.g., marking the introduction of new discourse by doing short and quick flicks of the hand in one dimension, up and down, or back and forth; see Prieto et al., 2018).

(Bavin, 2014; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005). Additionally, gesture-speech combinations in which infants point at an object while saying, for example, the word "mommy" allow them to express sentence-like information before they convey this idea in speech (e.g., "mommy puppy"). Both children's speech and their gestures improve with age, and likewise gestures precede and signal oncoming changes in speech, as children expand their communicative repertoire through gesture-speech combinations (Özçalışkan & Goldin-Meadow, 2005).

Previous literature has highlighted the close interface between co-speech gestures integrated with speech, language, and cognitive development. However, to our knowledge, the majority of gestures involved in these studies are either concrete representational (iconic and metaphoric) gestures or deictic (pointing) gestures, both of them types of gestures that provide a substantial semantic component or signal an external referent in space. Such gesturing may benefit the comprehension of either semantic or syntactic structures. For instance, findings reported by Theakston, Coates, and Holler (2014) showed that the use of abstract representational co-speech gestures that singled out the two participants in an event and the roles they played in it facilitated the comprehension of a complex linguistic structure[2] by 3- and 4-year-old children. Similarly, in a comparative study undertaken by Thompson (1995), young and old adult participants listened to a varied set of spoken

---

[2] In this instance, the complex structure was an object-cleft construction like *It was the frog [object] that the man [subject] pushed* (Theakston et al., 2014).

157

sentences in three conditions: an audio recording, a video-recording of the speaker speaking, and a video-recording in which the speaker simultaneously represented the semantic content of what he or she was saying with iconic gestures. The results showed that recall was enhanced in both young and old adults when the speaker used these gestures.

Studies on the beneficial effects of gestures on language and cognitive development have typically involved representational gestures, with relatively few studies also dealing with beat gestures. Unlike representational gestures, beat gestures are rhythmic non-referential hand movements associated with prominent prosodic positions in speech. Thus, they do not convey referential meaning but instead signal a variety of pragmatic and discourse meanings (McNeill, 1992; see also Prieto, Cravotta, Kushch, Rohrer, & Vilà-Giménez, 2018). Both iconic and beat gestures have been shown to have a positive effect on adults' ability to recall information in a discourse (e.g., Austin & Sweller, 2014; Igualada, Esteve-Gibert, & Prieto, 2017; Kushch & Prieto, 2016; Llanes-Coromina, Vilà-Giménez, Kushch, Borràs-Comes, & Prieto, 2018; So, Chen-Hui, & Wei-Shan, 2012). In So et al. (2012), both adults and 4- and 5-year-old children were presented with three different lists of verbs in three conditions (speech accompanied by either iconic gestures, beat gestures, or no gestures) and were asked to recall as many of the verbs as they could. The results showed that both groups recalled the information better when speech was accompanied by iconic gestures. However, only adults had better recall when words were accompanied with beat gestures compared with no gesture.

Notwithstanding these results, three recent studies have reported that beat gestures also improve recall in children. First, Austin and Sweller (2014) found that both beat gestures and iconic gestures facilitated the recall of spatial directions in 3- to 4-year-old children. Similarly, when Igualada et al. (2017) asked 3- to 5-year-old children to retell a list of to-do things that was presented with or without beat gestures, they found that recall was significantly better in the former condition. Moreover, a recent study by Llanes-Coromina et al. (2018) showed that beat gestures performed during discourse positively influenced information memorization by 4-year-old children.

In the context of second language acquisition, both iconic and beat gestures have been shown to benefit novel word learning. Tellier (2008) analyzed the impact of iconic gestures on second language word memorization with 20 French children (mean age 5;5). The children were taught eight English words in two conditions, a no-gesture condition, in which words were taught accompanied by pictures, and a gesture condition, in which words were taught accompanied by iconic gestures that were to be reproduced by the children tested in this group. The results showed that the children were able to memorize more words in the latter condition than in the former. Similarly, Kelly, McDevitt, and Esch (2009) showed that a brief training session with iconic gestures helped adult speakers to learn novel words in a foreign language. With respect to the benefits of beat gestures, a recent study by Kushch, Igualada, and Prieto (2018) found that beat gestures together with prosodic prominence was the optimal combination for second language novel

159

vocabulary learning.

Two very recent studies assessed the effects of beat gestures on narrative discourse comprehension with children, yielding contradictory results. Macoun and Sweller (2016) tested the impact of beat gestures on the discourse comprehension processes of children aged 3.25 to 5.58 years and found that they had no effect. By contrast, Llanes-Coromina et al. (2018) found that beat gestures can indeed help 5- to 6-year-olds to comprehend a narrative. Yet, both of these studies focused on narrative comprehension; to our knowledge, little is known about the potential beneficial effects of observing narratives produced with beat gestures on children's ability to *produce* subsequent narratives.

In the present study, we suggest that assessing children's narrative discourse production can provide us with novel insight about the role of training with gestures on communication, specifically in children's narrative production. In other words, we hypothesize that storytellers' gestures (specifically beat gestures) can play a role in children's observation and comprehension of narratives; thereby, fostering their subsequent narrative performances. Our predictions are supported by the Gesture-for-Conceptualization Hypothesis recently put forth by Kita, Alibali, and Chu (2017, p. 6) whereby "(1) gesture activates, manipulates, packages and explores spatio-motoric representations for the purposes of speaking and thinking" and "(2) gesture schematizes information, and this schematization process shapes these four functions." By broadening the scope of Kita et al.'s (2017) proposal to include beat gestures, we suggest

160

that observing short narrative discourses performed with beat gestures may affect the contents of children's subsequent production of narratives, as gesture production influences how information is packaged for both thinking and speaking. In a study that is related to this suggestion, Mumford and Kita (2014) clearly showed the role of the speaker's gestures in enhancing a listener's output schematization of an object or event. Children were asked to watch a video scene in which objects were moved by a hand in a specific way (e.g., by pulling strips of cloth) into a particular configuration (e.g., aligned vertically) while an adult speaker simultaneously used a novel ambiguous verb (e.g., "Look! She is blicking!"). The novel verb could have two possible interpretations: either they referred to acting on objects in a particular manner (pushing) or they referred to the act of bringing about the end state (aligning vertically). Results showed that when the speaker emphasized the manner of action by a gesture accompanying the novel verb, the children understood the verb as referring to the manner, whereas when the gesture highlighted the end state, the children interpreted the verb as depicting the end state.

In a related fashion, listeners' schematization of information has been shown to be influenced by the speakers' use of gestures. Building on these ideas, the Gesture-As-Simulated-Action Framework (Hostetter & Alibali, 2008) holds that gestures and speech emerge from a single embodied cognitive system in which gestures constitute simulations of action and perception (i.e., they are primordially performed without a communicative intention) that support language thinking. By definition, beat gestures are non-

161

referential, and they have been shown to be closely linked to discourse structure. For example, Shattuck-Hufnagel, Ren, Mathew, Yuen, and Demuth (2016) claim that beat gestures not only are typically associated with focus and rhythmic marking but also function as discourse structure anchoring points. The fact that beat gestures perceptually enhance focus and discourse structure, functions that have typically been linked to prosody (Loehr, 2012; Wagner, Malisz, & Kopp, 2014), makes them good candidates to promote abilities related to structuring and focalizing information in narratives. Along the same lines, Dimitrova, Chu, Wang, Özyürek, and Hagoort (2016) highlight the function of beats as indicators of information focus in language comprehension. In the words of Kendon (1995, p. 247), gestures with a pragmatic (vs. substantial) function guide discourse organization or "express aspects of utterance structure, including the status of discourse segments with respect to one another, and the character of the 'speech act' or interactional move of the utterance." Given that beat gestures clearly fit this definition by highlighting pragmatic and linguistic functions in discourse, it is reasonable to conjecture that observing them will boost children's subsequent narrative performance.

In fact, it has already been shown that gestures of various sorts play an important role in narrative discourse development. Narratives are typically used as an ecologically valid measure of a child's language abilities, and many studies use this measure as a control against which children's language pathologies can be analyzed (e.g., Demir, Fisher, Goldin-Meadow, & Levine, 2014; Demir,

Levine, & Goldin-Meadow, 2010; Demir, Rowe, Heller, Goldin-Meadow, & Levine, 2015; Duinmeijer, De Jong, & Scheper, 2012). It has been demonstrated that early acquired narrative abilities (such as being able to provide a well-structured narrative, contextual information, their own comments about the narrative events, etc.) are predictive of later literacy development, reading comprehension, and academic performance and success in school (e.g., Demir & Küntay, 2014; Griffin, Hemphill, Camp, & Wolf, 2004). Regarding the relationship between narrative development and gestural development, Colletta et al. (2015) investigated multimodal narrative development in 5- and 10-yearold French, American, and Italian children's narratives of a wordless cartoon and found that gesture and speech went hand in hand, with the children's use of gestures related to narrative organization developing as their verbal narratives became more complex. Moreover, the use of gestures by both adults and children in narratives has been shown to benefit children's narrative performances. In a longitudinal study by Demir, Levine, and Goldin-Meadow (2015), 5-year-old children who expressed character viewpoint[3] by means of gestures while producing verbal narratives showed greater improvement in their verbal narrative production with age compared with those children who did not produce character viewpoint gestures. Additionally, both children with early brain injury who had difficulty in structuring narrative and typically developing children were more likely to produce well-structured narrative retellings when the

---

[3] Following McNeill's (1992) classification, character-viewpoint gestures show first-person perspective, as the gesturer assumes the role of the character by enacting the character's actions.

163

storyteller performed story-relevant gestures while speaking (Demir et al., 2014).

Taking into account the evidence suggesting that observing gestures influences listeners' schematization of information and that beat gestures highlight pragmatic functions and discourse structure, the aim of this study is to examine the potential effect of a brief training session in which children watch storytellers who accompany their storytelling with beat gestures on the children's subsequent ability to produce a narrative discourse. Following Demir et al. (2014), we will measure this narrative ability in terms of the cohesion and coherence of the narrative structures the children produce.

Many studies of children's language development have demonstrated that the basic narrative abilities emerge during the preschool years and continue to improve until roughly age 12. By contrast, the literature on the acquisition of beat gestures within narrative discourse is very relatively scarce and has primarily focused on how children gesture with beats while they are narrating (see Mathew, Yuen, & Demuth, 2017, for a review). Although the appearance of beat gestures in bilingual children as young as 2.5 (Mayberry & Nicoladis, 2000; Nicoladis, Mayberry, & Genesee, 1999) has been reported, other studies have shown beat gestures in discourse emerging later, between 5 and 10 years of age (Blake, Myszczyszyn, Jokel, & Bebiroglu, 2008; Colletta, Pellenq, & Guidetti, 2010; Mathew et al., 2017). Through a longitudinal study with five French-English bilingual children aged 2.5–3 years,

Nicoladis et al. (1999) investigated how the combination of language and cognitive development could affect gesture development and found that beat gestures tended to be performed in more complex and longer utterances, suggesting that beat gestures "illustrate the temporal structure of utterances" (p. 524). The authors speculated that the fact that the relationship between the development verbal skills and iconic and beat gestures seemed to be weaker for the children's French than for their English "may be due to the fact that, as a group, the children's French was less developed than their English" (p. 520). In a follow-up study, Mayberry and Nicoladis (2000) carried out a longitudinal study with French-English bilingual children aged 2–3.5 in which they assessed the relationship between gesture performance and language development. Their findings showed that both iconic and beat gestures, but not pointing gestures, were significantly correlated with the children's language development. Moreover, they also found that the children started producing iconic and beat gestures at the same time they started producing their first utterances. Mathew et al. (2017) showed that, during narrative and exposition discourses, 12 5- to 7-year-old typically developing Australian English children produced beats with a well-defined stroke phase that resembled those performed by adults, and these beats were closely related to the prosodic organization of speech. For their part, Colletta et al. (2010) carried out a narrative task with monolingual French-speaking children aged between 6 and 10, and adults. Their results showed that the average number of nonrepresentational beat gestures with a discursive function (e.g., accompanying connectors,

165

highlighting important linguistic units, or performing anaphoric functions) and gestures with a framing function (e.g., those that express the speaker's emotions, such as surprise) increased significantly with age, whereas the average number of other types of representational gestures did not, and that adults were significantly more likely to perform discursive and framing gestures than children. These results are consistent with the idea that the use of gestures in discourse development and narrative production co-develops with age, and that children start to produce discursive gestures with a functional meaning in narratives between 6 and 10 years of age.

The present study intends to contribute to our understanding of the relationship between language development and the observation of gestures during spoken language. More specifically, it will examine the impact of observing storytellers who accompany their storytelling with beat gestures on the retelling performance of 5- and 6-year-old children. If beat gestures have a clear pragmatic role in highlighting discourse structure marking, we expect that children who hear stories that are accompanied by beat gestures will improve more on their subsequent narrative performance more than children who hear the same stories but see no beat gestures.

3.2 Methods

The experiment consisted of a between-subject training paradigm with a pretest and an immediate posttest design.[4] The pretest and posttest consisted of child-produced narratives, which were compared with measure improvement in the children's narrative structure.

Participants

Forty-seven children (25 boys and 22 girls) from the Girona area of Catalonia participated in the study. All of them were typically developing children with no prior history of communication disorders in themselves or within their families. Three of the original participants were excluded from the final analysis (two girls and one boy), for the following reasons: one child did not produce any utterances at all during either pretest or posttest; technical problems occurred during the pretest recording session of the second child; and the third child was accidentally shown the same two stories in both pretest and posttest segments. Thus, the results of this study are based on data from the remaining 44 participants (mean age = 5.94, SD = 0.57). The sample size was determined post hoc using G*Power Version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), which showed a small- to medium-sized

---

[4] The study "Observing storytellers who use rhythmic beat gestures improves children's narrative discourse performance" obtained ethics approval from the ethics committee at the Universitat Pompeu Fabra, as part of the approval of the Spanish Ministry of Economy and Competitiveness project FFI2015-66533-P "Intonational and gestural meaning in language."

effect ($\alpha = .05$, power $= 0.70$) and a sample size of 42 participants.

The children were recruited from four different schools.[5] The parents were informed about the main goal of the experiment and signed a form allowing their children to participate in the experiment and be video-recorded in the process. Moreover, because the experimental tasks were all going to be administered in Catalan, caregivers filled out a language exposure questionnaire (Bosch & Sebastián-Gallés, 2001) to ensure that all participating children were coming from a context in which Catalan was the predominant language of daily use. The results of the questionnaires showed that the 44 children were exposed to Catalan daily on average about 90% of the time ($M = 90.50$, $SD = 9.06$).

Materials

The experiment consisted of three parts: a pretest, a training session, and a posttest. The pretest and posttest materials consisted of four different animated cartoons (approximate length 41–50 s) about a small mouse[6] and his friends, characters with which the child subjects were previously unfamiliar. The cartoons had no dialogue or narration, and were intended to serve as prompts for the child to produce a narrative about what he or she had seen in the cartoon. Two of these cartoons featured a single main character, whereas the

---

[5] Children were from the *Escola Casa Nostra* and from the *Escola Can Puig*, both in Banyoles, from the *Escola Pública Joan Bruguera* in Girona, and from the *Escola Bora Gran* in Serinyà.
[6] The cartoons used in this study were taken from online animations available at http://www.wdrmaus.de and were also used in studies such as Demir et al. (2014) and Alibali, Evans, Hostetter, Ryan, and Mainela- Arnold (2009).

other two featured two characters, but all followed the same structure, which is schematically illustrated in Figure 1 (the four cartoon-based narratives can be seen in Appendix B). First, some initiating event presented a goal or challenge to the protagonist. This provoked an action on the character's part, which led to a particular outcome, whether successful or not (the structure was based on the narratives used in studies such as Demir et al., 2014, and Demir, Levine, et al., 2015). Two of these cartoons were used for the pretest and two different ones were used for the posttest. In each case, the first cartoon was one that featured one character, the second cartoon one that featured two.

Cartoon A	**Initiating event**: After the mouse has inflated the inflatable apple tree, he sniffs an apple. **Goal**: The mouse wants to take an apple from the tree. **Attempt**: The mouse picks an apple from the tree. **Outcome**: The tree deflates automatically so the mouse can not eat the apple.

Figure 1. Narrative structure of one of the cartoon stories.

The training session between pretest and posttest involved the use of 24 video-recordings in which two adult female storytellers told different stories. In 12 of these recordings, the storytellers used beat gestures for emphasis and in the other 12 they did not. Each training story was about an animal that lived on a farm and followed a narrative structure similar to that seen in the animated cartoons. An English translation of one of these stories is shown in (1; and translations of all six are reproduced in Appendix C).

169

1. ***Once upon a time***, ***a duck*** *was walking to school.* ***Suddenly,*** *it started to* ***rain***, *and the duck didn't have an* ***umbrella***. ***In the end***, *he came up with a* ***solution***: *he put his hood on his* ***head*** *to protect himself from the rain.*

The preparation of these video-recordings was a fairly elaborate process, which is described in the following section.

Preliminary study. Before recording the final audio-visual stimuli for the training session, we carried out a preliminary study intended to ensure the ecological validity of our materials. In this preliminary study, two female preschool teachers were video-recorded as they performed dramatic readings of five short narratives (that were similar in form to the stories ultimately used in the recordings—see Recordings of experimental materials below) as if speaking to a group of young children. Then, with reference to the MIT Gesture Studies Coding Manual,[7] the video-recordings were analyzed to identify the beat gestures the two speakers had spontaneously produced as they narrated. The two most frequently occurring types of beat gestures used by the speakers were a palm-up movement of the hands outward at waist level (see Figure 2, left panel), and a movement of the hands inward toward the waist, with palms facing the body, fingertips of the two hands sometimes touching (see Figure 2, right panel). Both hand movements were typically

---

[7] Retrieved from http://web.mit.edu/pelire/www/manual/ (Shattuck- Hufnagel et al., 2016).

associated with a head nod, a widening of the eyes, and a raising of the eyebrows. An interesting find was that in our preliminary study, while the open-palm outward gesture accompanied either focal content words (e.g., *a duck*, *rain*, *umbrella* in [1] above)[8] or discourse markers such as metadiscursive (*once upon a time*, *suddenly*, *in the end*), temporal (*before*, *until*), contrastive (*but*), causal (*because*), consecutive (*therefore*, *that way*), or conditional connectors (*otherwise*),[9] the inward gesture occurred only with focal content words. Therefore, we decided that in the subsequent recordings of stimulus materials we would use the outward movement to emphasize discourse markers and the inward movement to mark focal content words stimuli (see section Recordings of experimental materials below).
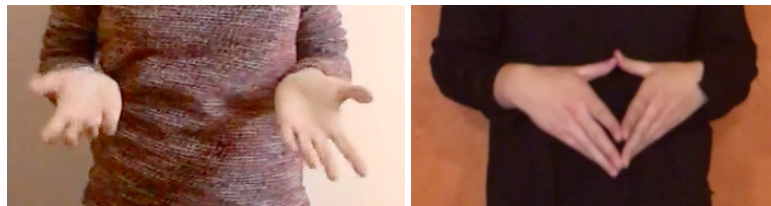
Figure 2. *Examples of the most frequently performed beat gestures from the preliminary study. Left panel: the outward hand movement. Right panel: the inward hand movement. See the online article for the color version of this figure.*

---

[8] Content words are words with lexical meaning, typically nouns, verbs, adjectives, or adverbs. In this study, the stroke phase of beat gestures was typically associated with the content words.

[9] Discourse markers are "sequentially dependent elements which bracket units of talk (. . .). Sometimes these units are sentences, but sometimes they are propositions, speech acts or tone units (. . .). Markers occur at the boundaries of units as different as tone groups, sentences, actions, verses, and so on (. . .)" (Schiffrin, 1987). Our classification and analysis of discourse markers were based on Portolés (1998).

Recordings of experimental materials. For the final video materials, six stories were created along the lines of those used in the preliminary study, each one featuring a farm animal that is confronted by a challenge that it must somehow resolve (see Appendix C for English translations of all six stories). The six stories were expressively read off a teleprompter by the same two preschool teachers from the preliminary study, in two different conditions, one with accompanying beat gestures, and the other without, for a total of 24 stories. When they read a story in the no-beat condition, the storytellers were asked to use child-directed speech but not produce beat gestures. In the beat condition, they were also asked to use child-directed speech, but to use an outward-directed beat gesture whenever they said a discourse marker and an inward-directed beat gesture when they said a focal content word, both of these elements being highlighted in boldface on the teleprompter text they were reading. Moreover, the two storytellers were asked to use a smiling face in a consistent way across items and conditions.

Furthermore, the two storytellers were trained to produce the target items with exactly the same prosody in both the no-beat and the beat conditions. After they had practiced, each storyteller recorded two versions of each of the six stories in the two conditions (6 stories × 2 conditions × 2 versions; see Figure 3). The recordings were carried out in an experimental laboratory at the Universitat Pompeu Fabra. The storyteller performances were carefully monitored by the three authors of the study, in particular to make

sure both storytellers maintained consistency in synchronizing their use of beat gestures with the corresponding target items. After the recording session, the first author compared the two versions of the narrative and selected the best performance.
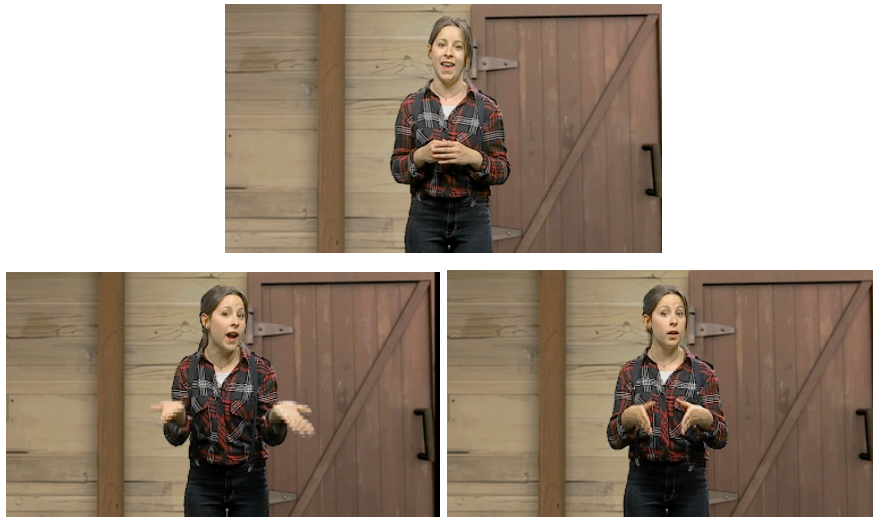
Figure 3. Stills from a stimulus training video showing one of the two storytellers telling one of the six stories in two conditions. Top panel: story being told in the no-beat condition. The storyteller refrains from making gestures as she tells the story. Bottom panels: story being told in the beat condition. Bottom left: the outward movement beat gesture. Bottom right: the inward movement beat gesture. The individual whose face appears here has given signed consent for her image to be published in this article. See the online article for the color version of this figure.

The selected recordings were edited using the AVID videoediting program (Avid Technology, Inc., 2016). To confirm that each storyteller had consistently used the same prosody across no-beat/beat conditions, the audio tracks were acoustically analyzed using Praat software (Boersma & Weenink, 2016). In terms of their

173

prosodic content, first the target words were prosodically coded using Cat_ToBI (Prieto et al., 2015), with the H and L F0 points in every pitch accent manually marked, as were the starting and end points of the target accented syllables and target words. Next, a set of the three automatic measures were obtained for the speech fragment constituting each full narrative, namely average pitch, average duration, and average intensity. A set of seven Generalized Linear Mixed Models (GLMMs; West, Welch, & Galecki, 2007) were then performed to statistically test for significant differences between the following prosodic measures across the two conditions: (a) pitch range, meaning the distance between the minimum and maximum pitch of L + H* pitch accents; (b) the duration of the target accented syllables; (c) the duration of the target words; (d) the mean pitch of the whole narrative; (e) the mean duration of the whole narrative; and (f) the mean intensity of the whole narrative. In all analyses, Condition was set as fixed factor, and a random intercept was set for both Speaker and Narrative. No statistically significant effects of Condition were found for any of the three prosodic variables, namely pitch range (results either in Hertz: $F(1, 179) = .001$, $\beta = .374$, $SE = 13.228$, $p = .977$; or in semitones: $F(1, 179) = .092$, $\beta = -.269$, $SE = .885$, $p = .761$), accented syllable duration ($F(1, 202) = .865$, $\beta = -.008$, $SE = .008$, $p = .353$), or target word duration ($F(1, 126) = .006$, $\beta = .001$, $SE = .016$, $p = .938$). As for general phonetic measures covering each full discourse, no significant effect was found for mean pitch in Hz ($F(1, 20) = .001$, $\beta = .165$, $SE = 4.735$, $p = .972$), mean duration of the discourse ($F(1, 20) = .003$, $\beta = .075$, $SE = .437$, $p = .865$), or mean intensity of the

174

discourse ($F(1, 20) = .028$, $\beta = .090$, $SE = .534$, $p = .868$). Thus, no significant differences were found in prosody across no-beat/beat conditions.

Experimental Procedure

Prior to the experiment, matched random assignment was used to assign the 44 participating children to one of the two conditions in such a way that the mean ages of the two treatment groups were equivalent. Thus, 21 children were assigned to the no-beat condition (mean age = 5.86, $SD = 0.56$) and 23 were assigned to the beat condition (mean age = 6.01, $SD = 0.58$).

The study used a between-subject pretest–posttest design which is schematically illustrated in Figure 4. First, in the pretest, the child was asked to watch two animated cartoons and then tell the story of what had happened to an experimenter. This part was followed by the training session, in which the child was shown six videotaped stories in one condition (i.e., no-beat or beat). Finally, in the posttest the child repeated the same task as in the pretest, but with two other cartoons. For each condition, a total of eight counterbalanced versions were created in which the order of the pretest and posttest cartoons, the six training stories and the two storytellers alternated. The participants were individually tested in a quiet classroom at their school and videotaped in all phases of the task (see Figure 5 for a diagram of the experimental setup). The whole session lasted approximately 20–25 min.
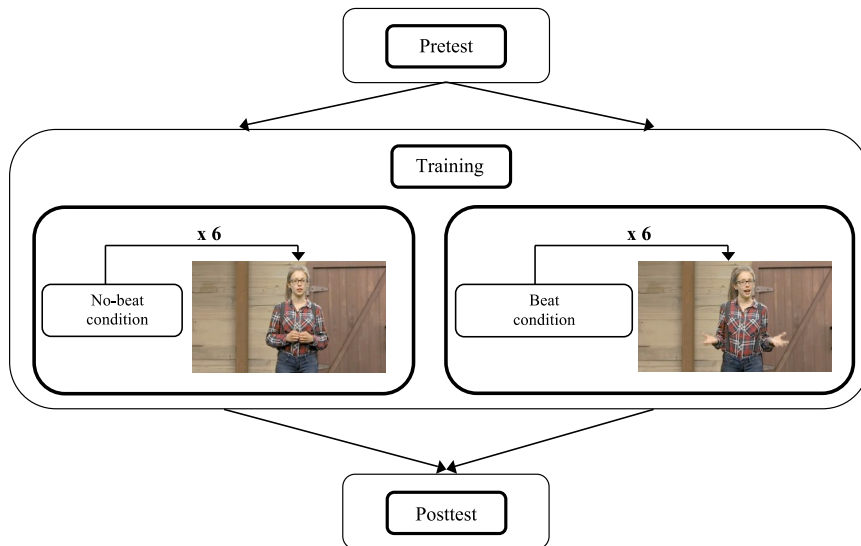
Figure 4. Overall experimental procedure. The individual whose face appears here has given signed consent for her image to be published in this article. See the online article for the color version of this figure.
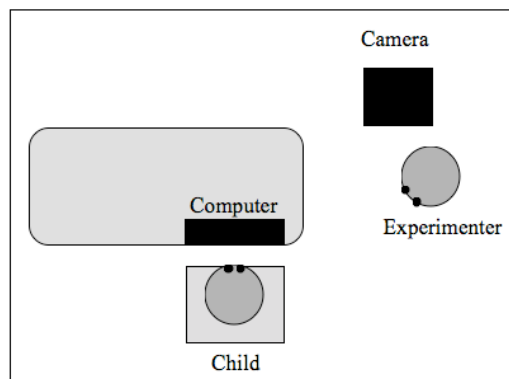
Figure 5. Experimental setup. The child was seated facing a laptop computer on which the pretest, training, and posttest videos were shown but stood in front of the experimenter to recount the story he or she had seen in the pretest and posttest cartoon videos. The experimenter sat in front of the child to interact with him or her but could not see the screen of the laptop. The video camera was located behind the shoulder of the experimenter to record the child's behavior when either sitting or standing.

176

Pretest. For the pretest, the child was seated facing a laptop computer and the experimenter, who explained what was going to happen. The child then put on headphones and watched two cartoons, the first one featuring only one character (see Appendix B for Cartoons A or C), the second featuring two (see Appendix B for Cartoons B or D).

After each clip, the child was asked to stand up and retell the story to the experimenter, who pretended not to have watched the video previously. If the child did not respond readily, he or she was prompted with a question like "Em pots explicar la història?" ("Can you tell me the story?"). The task was presented like a game, since the experimenter had several pictures in her hand from which she had to choose the picture that was most closely related to the story that the child was retelling. The retelling continued until the child indicated that he or she had finished or stopped for more than 10 – 15 s without clearly ending the narrative and had no further comment when the experimenter asked "I, què més?" ("Anything else?"). At this point, the experimenter gave positive feedback such as "M'agrada molt com expliques la història, així puc endevinar quin dibuix és!" ("I like the way you told the story very much, so I can easily guess which picture it is!") and showed the child the picture corresponding to the cartoon.

Training session. After the pretest, the child again put on the headphones and watched six videos showing the two storytellers telling a total of six stories. The same sets of six stories were shown

to each child, in the same condition for each child, but the children were shown them in different orders of story and storyteller.

Posttest. The posttest followed exactly the same procedure as the pretest. The same four cartoons were used for all the children, one pair in the pretest and another pair in the posttest. The pairing remained constant, but the order of the two pairs was varied.

Coding System

The resulting 176 video-recordings (44 children × 4 retellings) of the children's pretest and posttest performances were analyzed according to a speech-coding scheme designed to measure a variety of features related to the quality of the children's narrative structure.

To obtain a measure of overall narrative structure, we used a modified version of the coding system applied by Demir et al. (2014) and Demir, Levine, et al. (2015),[10] which in turn is based on Stein and Glenn's (1979) approach to narrative structure in children. According to this approach, the organizational quality of a child's narrative can be measured in terms of four main features, namely the presence of an animate protagonist, temporal structure, causal structure, and goal-directed action. Each feature is considered to be a prerequisite for the next, and thus narratives with more of these features are rated more complex than stories with fewer of them. The rubric we used to score the narratives produced by child

---

[10] For more details on this narrative coding system, see Demir et al. (2014, p. 819, "Measures" section) and Demir, Levine, et al. (2015, pp. 6–7, "Narrative structure in speech" section).

participants is shown in Figure 6. A child's narrative was rated as a "complete goal-based narrative" and received the highest score if it showed signs of causal and temporal structuring and specified the initiating event or challenge facing the protagonist, his or her consequent goal, how he or she attempted to achieve the goal, and the eventual outcome of that attempt. It should be noted that in retelling the cartoons children occasionally remembered that some object or animal had been involved but could not quite remember which one. In such cases, we counted this as a successful retelling only if the object they named was similar in kind to the object in the cartoon—for example, if the child referred to the mouse as a "squirrel." An example of a scored narrative can be seen in Appendix D.

Score	Features of the narrative
0	A **narrative with no structure**. It does not even contain a descriptive sequence; the story is not remembered.
1	A **descriptive sequence**. This is a narrative that includes the physical and personality characteristics of an animate protagonist with no mention of a sequence of actions (i.e., no temporal structure).
2	An **action sequence**. This is a narrative with actions described in a temporal order (actions follow one another in time) but in which the actions are not causally organized (i.e., if there was one event causing the following event or events, the story was categorized as an action sequence).
3	A **reactive sequence**. This contains actions that are temporally and causally organized but does not include either the protagonist's goal or the attempt to achieve the goal or neither of the two. The outcome is always mentioned here.

4	An **incomplete goal-based narrative**. This includes temporal and causal structure, a goal statement and/or description of an attempt to achieve the goal, but no information about the outcome.
5	A **goal-based narrative**. This includes not only temporal and causal structure as well as a goal statement, description of an attempt to achieve the goal, and the final outcome.
6	A **complete goal-based narrative**. This contains not only temporal and causal structure but also all the main features noted above. Moreover, the story is fleshed out with details including the initiating event.

Figure 6. Rubric for scoring of child-produced retelling narratives (based on Demir et al., 2014, and Demir, Levine, et al., 2015). The goal of the protagonist was regarded as correctly described if the child interpreted it with a mental state verb (e.g., to want). The goal could be explicit (e.g., "he wants to hang up the laundry") or implicit (e.g., "he was fed up with the clothes always falling on the ground"). Moreover, explicit mention of the discovery of a solution (e.g., "he/they found a solution," "he/they had an idea," etc.) was also counted as the description of a goal.

Reliability of the Coding

To test the reliability of the narrative structure coding, two independent coders conducted an inter-transcriber reliability test with a random subset of 20% of the data (40 cases). Overall agreement between the two coders and the author of the study was 66%. The fixed-marginal multirater κ statistic value was 0.43, suggesting a moderate degree of agreement between coders given the high number of categories (from 0 to 6).

3.3 Results

One GLMM was run using SPSS Statistics 23.0 (SPSS Inc., Chicago, IL) with narrative structure scores as the dependent variable.

Narrative Structure Scores

To assess the potential effects of the beat training condition on children's narrative structure abilities, we ran a GLMM with the overall narrative structure ratings as a dependent variable, training Condition (two levels: no-beat and beat) and Test (two levels: pretest and posttest), and the interaction Condition × Test as fixed factors, and Subject and Item (i.e., the four stories used in the pretest and posttest) as random factors. Bonferroni pairwise comparison post hoc tests were carried out for the significant main effects and interactions.

The results of the GLMM analysis showed a main effect of Condition, $F(1, 172) = 8.041$, $p = .005$, with higher narrative structure scores in the beat condition ($\beta = .441$, $SE = .156$, $p = .005$) than in the no-beat condition. Regarding the effect sizes, the β regression coefficient indicates that the probability of a child in the beat condition having a greater narrative structure score is about .441 times higher (in a scale from 0 to 6) than for a child in the no-beat condition. A main effect of Test, $F(1, 172) = 19.691$, $p = .000$ was also found, with posttest narrative structure scores better ($\beta = .597$, $SE = .135$, $p = .000$) than pretest scores. In this case, the

probability of a child's posttest narrative to have higher assessment scores is about .597 times higher (in a scale from 0 to 6) than for a child's pretest score.

A significant interaction between Condition and Test was found, $F(1, 172) = 4.705$, $p = .031$, indicating that narrative performances differed depending on the condition and the test. Post hoc analyses revealed that while beat and no-beat conditions did not significantly differ in the pretest part ($\beta = .149$, $SE = .205$, $p = .467$), they did so in the posttest, with greater narrative structure scores in the beat condition ($\beta = .733$, $SE = .207$, $p = .000$) tan in the no-beat condition. The β scores indicate that the probability of a child's posttest narrative to have higher assessment scores is about .733 times higher (in a scale from 0 to 6) in the beat condition than in the no-beat condition. By contrast, considering differences in terms of condition, post hoc analyses revealed significant differences between pretest and posttest scores in the beat condition, with better narrative structure scores in the posttest ($\beta = .889$, $SE = .186$, $p = .000$) than in the pretest. The probability of a child in the beat condition having a greater quality posttest narratives is about .889 higher (in a scale from 0 to 6) than for the pretest narratives. Crucially, no significant differences between pretest and posttest were found in the no-beat condition ($\beta = .305$, $SE = .195$, $p = .119$). Therefore, the results show that participants who undertook the beat training condition obtained higher narrative structure scores in the posttest than in the pretest part while participants who had training without beat gestures did not.

Figure 7 shows the mean overall narrative structure scores (from 0 to 6), broken down by training condition (no-beat vs. beat) and test (pretest vs. posttest). The graph shows that the posttest narrative structure scores in the beat condition outperformed those in the no-beat condition.
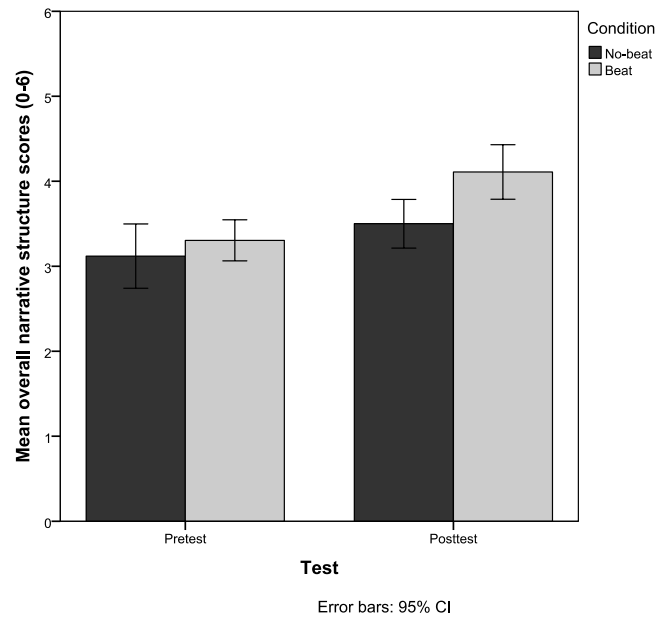
Figure 7. Mean overall narrative structure scores from 0 to 6, broken down by training condition (no beat vs. beat) and test (pretest vs. posttest). Error bars represent 95% confidence intervals of the means.

3.4 Discussion and Conclusions

Previous research has demonstrated that gestures and prosody promote benefits for children's early language development and predict later language abilities. Though previous studies have found that co-speech gestures (mostly representational gestures) play an important role in children's narrative discourse development, as far as we know, this is the first time that a study has tested the effects of observing narratives with beat gestures on the improvement of children's narrative performance. Our goal was to examine whether a short training session with beat gestures could favor children's narrative performances as measured by narrative structure scores in a narrative discourse production task. Through a between-subject training study with a pretest and immediate posttest design, we found that children who were assigned to the beat training condition manifested positive changes in the quality of their posttest narratives, clearly seen in higher narrative structure scores. In our view, it is the supplementary highlighting role that beat gestures play in marking focus and discourse structure in language that most likely boosted the children's subsequent performance, resulting in more detailed, better organized, and more complete goal-based narratives that reflected an understanding of temporal and causal structure.

The results of the present study extend our knowledge about the positive benefits of beat gestures in cognitive processes and language development, which have previously been specifically

reported in connection with information recall (e.g., Austin & Sweller, 2014; Igualada et al., 2017; Llanes-Coromina et al., 2018; So et al., 2012) and narrative discourse comprehension (Llanes-Coromina et al., 2018). In this regard, beat gestures seem to differ from other kinds of potential visual highlighters because they are related to the language-related areas of the brain and not the visual-perception areas (Biau & Soto-Faraco, 2013; Holle et al., 2012; Wang & Chu, 2013).

This study extends the results of previous research showing the benefits of observing beat gestures in promoting narrative performances (Demir et al., 2014; Demir, Levine, et al., 2015; Shattuck-Hufnagel et al., 2016). Importantly, to our knowledge, our study is the first study to demonstrate that a short training session featuring narratives produced with beat gestures can have an immediate positive effect on children's narrative performances, specifically on narrative structure. Including beat gestures in a story thus leads to better narrative retelling scores. As we initially hypothesized, the special role of beat gestures as highlighters of linguistic functions such as focus marking, rhythmic marking, and discourse structure marking (Dimitrova et al., 2016; Shattuck-Hufnagel et al., 2016) suggests that they can play a role in developing narrative performance in children.

As noted above, the basic tenets of the Gesture-for-Conceptualization Hypothesis by Kita et al. (2017) can offer conceptual support for the present findings on the beneficial role of

observing gestures in cognitive and linguistic production. As we have seen, according to that hypothesis a representational gesture "activates, manipulates, packages and explores spatio-motoric representations for the purposes of speaking and thinking" (p. 36). By assuming that the properties of representational gestures also apply to beat gestures, we suggest that these gestures similarly help activate, manipulate, and package discourse and pragmatic information that can help children to produce better narratives (see their discussion about the extension of these findings to abstract domains via metaphoric gestures). Importantly, the model claims that the influence of gesture encompasses both production as well as observation effects. As they contend, "gesture's influence is not limited to speakers; speakers' schematization of information in gesture influences listeners' thinking, as well. In these ways, gesture plays a central role in human cognition" (p. 47).

Some limitations of this work must be acknowledged. The main limitation of this study concerns the use of a brief training paradigm that analyses short-term effects. Though the study demonstrates the positive short-term effects of the storyteller's use of beat gestures on children's narrative structure scores, it can make no claims about possible long-term effects. Thus, future work should explore on the one hand whether this sort of narrative training including beat gestures can have any long-term effect, and on the other the possible impact of longer training periods. Furthermore, one might argue that the naturalness of the training materials used here could be improved upon in terms of their ecological validity. Although

having the adult storytellers read narratives off a teleprompter helped us to control the acoustic features of their speech and the visual features of their gestures, this methodology may not accurately reflect what occurs in a natural and spontaneous context of child-directed storytelling. Finally, it would be interesting to code children's gestures during their narrative productions to assess the influence of gesture use in the improvement of narrative abilities after training.

In sum, this study provides important information about the positive effects of beat gestures on children's narrative performance, lending support to studies that point to a co-development and mutual interaction between co-speech gestures and language (e.g., Colletta et al., 2015; Sekine & Kita, 2015). Specifically, it is of interest to note that even a relatively short training session with beat gestures had a noticeable effect on children's retelling abilities. This may have important implications for our understanding of how children develop narrative skills and for educational practices in the teaching of narrative abilities at the preschool level. Indeed, it is believed that using a variety of storytelling activities, which include the use of beat gestures (as well as other types of naturalistic gestures), may facilitate children's language development.

4

CHAPTER 4: ENCOURAGING THE USE OF RHYTHMIC BEAT GESTURES BOOSTS CHILDREN'S NARRATIVE PERFORMANCE

4.1 Introduction

Narratives constitute a solid measure of children's more complex language skills in both typical (Demir, Levine, & Goldin-Meadow, 2015; Stites & Özçalışkan, 2017) and atypical language development (e.g. Demir, Fisher, Goldin-Meadow, & Levine, 2014; Demir, Levine, & Goldin-Meadow, 2010; Demir, Rowe, Heller, Goldin-Meadow, & Levine, 2015; Duinmeijer, de Jong, & Scheper, 2012). Several studies have also shown that narrative ability is a strong predictor of later school literacy success (e.g. see Demir, Levine, & Goldin-Meadow, 2012, for a review; Naremore, Densmore, & Harman, 1995). As Demir et al. (2012) claim, narrative skill is 'an oral language skill that is argued to provide the missing link between oral language and later Reading comprehension' (p. 6) and 'oral language skills that develop during early ages and provide the foundation for later reading comprehension include vocabulary, syntax, narrative and academic language use' (p. 5).

Research has shown that the development of gesture and speech go hand in hand in the context of narrative development (see Colletta et al., 2015). While the period from age 3 to 6 constitutes 'a particularly relevant age range to observe children's burgeoning narrative abilities in gesture and speech' (Stites & Özçalışkan, 2017, p. 1021), it is only around age 5 or 6 that children begin to produce 'true narratives' containing a central theme, characters and

190

a logically and/or temporally ordered plot line (Applebee, 1978). For instance, Mathew, Yuen, and Demuth (2017) found that 6-year-old children start producing a variety of gestures including stroke-defined beats for discourse functions in both storytelling and exposition tasks. This is confirmed by results in Colletta, Pellenq, and Guidetti (2010) showing that beats in discourse emerge between 6 and 10 years old (see also Blake, Myszczyszyn, Jokel, & Bebiroglu, 2008; McNeill, 1992). Other research has shown that starting at age 9 children can produce spontaneous narratives with accompanying co-speech gestures in an adult-like fashion to represent the narrated events or symbolize the objects, places or persons which the speaker refers to, as well as to mark discourse cohesion, express the pragmatic functions and emotional states that help the framing and discourse connotation of the utterance (Colletta, 2009). Finally, several studies have reported strong developmental links between the use of representational gestures by children and the quality of their narratives (Demir et al., 2014; Demir, Levine, et al., 2015; Stites & Özçalışkan, 2017), suggesting that children's use of gestures to accompany narratives becomes more elaborate as those narratives become more complex. For example, Demir, Levine, et al. (2015) found evidence that 5-year-old children who expressed character viewpoint (CVPT) in their narratives by means of gestures were more likely to show better structure in the verbal narratives they produced when older. Additionally, recent evidence has shown that training children to produce such CVPT gestures also boosts their narrative structure

191

scores immediately after training (Parrill, Lavanty, Bennett, Klco, & Demir, 2018).

At the same time, there is broad evidence that gesturing has beneficial effects on various cognitive and linguistic domains (see Kita, Alibali, & Chu, 2017, for a review). For instance, gesture production was found by Goldin-Meadow, Nusbaum, Kelly, and Wagner (2001) to have positive effects on memory recall in general. Furthermore, there is also evidence that both observing and producing iconic gestures facilitated participant's memory recall. A study by Cook, Yip, and Goldin-Meadow (2010) reported positive effects of producing iconic gestures (vs. no gesture) on adult's memory representation of present events. Similar results were found by Aussems and Kita (2019) in children, showing that observing iconic gestures (vs. interactive gestures and no gesture) facilitated their recognition memory of action events. Gesturing also seems to help people generate problem-solving strategies in mathematics (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007; Cook, Mitchell, & Goldin- Meadow, 2008; Goldin-Meadow, Cook, & Mitchell, 2009; Novack, Congdon, Hemani-Lopez, & Goldin-Meadow, 2014) and execute other thinking tasks (Alibali & Kita, 2010; Alibali, Spencer, Knox, & Kita, 2011). In terms of development, encouraging children to gesture while attempting to solve math problems has been shown to provide them with new and correct problem-solving strategies— expressed only through gesture—of which they had been previously unaware (Broaders et al., 2007). Furthermore, Kirk and Lewis (2017) demonstrated that

when 8- to 11-year-old children spontaneously produced gestures, or were prompted to do so, they came up with more creative novel uses for everyday items, suggesting that the gestures helped them to create ideas more fluently.

In general, previous investigations have tended to focus on representational gestures (also called iconic and metaphoric gestures, i.e., those representing referential properties of objects and concepts; see McNeill, 1992) and this is also true of research on the relationship between gesturing and narrative skills (Demir et al., 2014; Demir, Levine, et al., 2015; Stites & Özçalışkan, 2017). By contrast, so far relatively little attention has been devoted to another type of gesture, namely beat gestures, which are defined as rhythmic non-referential hand movements—usually of the fingers or hand—that are typically associated with prosodic prominence in speech (McNeill, 1992; Prieto, Cravotta, Kushch, Rohrer, & Vilà-Giménez, 2018) and can be coordinated to other articulator movements, such as head nods and eyebrow raises (Krahmer & Swerts, 2007). Beat gestures could also be associated with sequences of prosodic prominence, having complex phasing structures (Shattuck-Hufnagel, Ren, Mathew, Yuen, & Demuth, 2016). Although the majority of the studies have defined beat gestures as essentially non-meaningful, some studies have argued that beat gestures can in fact highlight linguistically relevant information. For example, McNeill (1992, p. 15) claimed that beats have discourse structure marking functions, as they 'mark information that does not advance the plot line but provides the

193

structure within which the plot line unfolds.' It is worth noting that the author relates the semiotic value of a beat to discourse–pragmatic content as a whole (e.g. to introduce new characters or themes, or summarize the action, etc.) rather than specific events in a narrative. Along the same lines, Kendon (2017) states that manual gestures can contribute to a variety of important pragmatic and discourse meanings in general and identifies four pragmatic functions in particular, namely operational functions (function as an operator in relation to the speaker's spoken meaning; e.g., head or hand actions that add negation), modal functions (indicate how the listener should interpret the utterance; e.g., the speaker's epistemic stance), performative functions (show the type of the speech act; e.g., a question, a refusal, etc.) and parsing functions, the latter referring to the role of the speaker's hand in marking discourse structure. As such, Kendon (2004, p. 158) associated beat gestures with the abovementioned larger class of pragmatic gestures that are 'related to features of an utterance's meaning that are not a part of its referential meaning or propositional content.' Indeed, various studies have shown beat gestures performing a range of pragmatic and discourse functions (see Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; and Shattuck-Hufnagel et al., 2016, for a review). To our knowledge, however, only three studies have specifically focused on the effects of observing beat gestures on narrative development. Although one of these three, Macoun and Sweller (2016), found that observing beat gestures showed no benefit for narrative recall and comprehension in children, the other two studies reported positive effects. Llanes-Coromina, Vilà-Giménez,

194

Kushch, Borràs-Comes, and Prieto (2018) found that children's narrative comprehension improved when they watched stories in which beat gestures were aligned with prosodic prominences, and Vilà-Giménez, Igualada, and Prieto (2019) showed that, when asked to retell a narrative, 5- and 6-year olds achieved higher narrative structure scores if the person telling them the narrative to be recalled had accompanied their performance with beat gestures.

While the abovementioned studies have assessed the effects of observing beat gestures on children's narrative development, in this study we ask whether encouraging children to accompany their own storytelling with beat gestures (instead of just observing them while someone else is doing the storytelling) can boost their narrative skills. Given the body of evidence noted above, our underlying assumption is that it will.

4.1.1 The current study

The current study investigates whether 5- to 6-year-old children who are encouraged to perform beat gestures while retelling narratives will then produce higher quality narratives than a control group who merely observe the beat gestures but are not encouraged to produce them. This particular age range was chosen because, as we have noted above, it is in this period that children start to produce 'true narratives.' At age 5 children's narratives begin to get more structurally complex (Shapiro & Hudson, 1991) and show an understanding that characters perform actions to achieve particular goals (Trabasso, Stein, Rodkin, Munger, & Baughn, 1992; e.g.,

195

Berman, 1988). Furthermore, it is also around age 6 that children spontaneously start to produce beat gestures with a functional meaning while they are recounting a narrative (Mathew et al., 2017; McNeill, 1992).

For the purposes of the present study, narrative quality will be assessed in terms of narrative structure and fluency. First, we hypothesize that promoting the production of beats will boost structure scores, given the evidence that beat gestures play an important role as highlighters of linguistic functions such as focus marking and discourse structure marking (Dimitrova, Chu, Wang, Özyürek, & Hagoort, 2016; Shattuck-Hufnagel et al., 2016). For instance, Dimitrova et al.'s (2016) ERP study demonstrated the interaction between beats (i.e. nonverbal emphatic cues) and focus, showing that beats are integrated with the information structure of a message during multimodal speech comprehension and they have the role of enhancing the listener's attention. Moreover, in line with previous studies demonstrating that iconic gestures could serve as meaningful social cues in enhancing memory representation of events (e.g. Aussems & Kita, 2019; Cook et al., 2010, among others), we also predict that beat gestures can equally help children to focus on critical parts of a story and thus parse it better (specifically, focused constituents and discourse markers). This hypothesis is supported by Austin and Sweller's (2014) study, which reported positive effects of both observing beat gestures and iconic gestures on the recall of spatial directions in 3- to 4-year-old children in a discourse pragmatic context. Moreover, So, Chen-Hui,

and Wei-Shan (2012) showed that seeing a list of single verbs accompanied by beat gestures (vs. iconic gestures and no gestures) helped adults recall the information better. Along the same lines, Igualada, Esteve- Gibert, and Prieto (2017) and Llanes-Coromina, Vilà-Giménez, et al. (2018) found that beat gestures also significantly improved recall in 3- to 5-year-old children. All in all, our hypothesis is that children who observe and are encouraged to produce meaningful discourse–pragmatic beat gestures in a narrative training task should produce better structured stories at posttest. Second, we expect the same positive effects on narrative fluency scores, as previous literature has highlighted the positive effects of producing beat gestures on lexical access in adults (Lucero, Zaharchuk, & Casasanto, 2014), as well as on oral fluency (Rauscher, Krauss, & Chen, 1996) and L2 pronunciation (e.g. Gluhareva & Prieto, 2017; Llanes-Coromina, Prieto, & Rohrer, 2018). Our hypothesis is that the rhythmic properties of beat gestures and their tight synchrony with prominent prosodic positions in speech (Shattuck-Hufnagel & Ren, 2018; McNeill, 1992; see also Esteve-Gibert & Prieto, 2013) can enhance oral speech fluency. All in all, given this evidence, it is therefore reasonable to assume that narrative structure and fluency scores will be significantly improved if children are encouraged to use beat gestures during narrative performance.

4.2. Methods

The experiment consisted of a between-subjects study with a pretest and an immediate posttest design. Child participants were assigned to one of two groups, the experimental group receiving a short training session in which they were encouraged to accompany their retelling of a narrative with beat gestures (henceforth the *beat encouraging* condition), and the control group being exposed to the same storytelling activity but not being encouraged to gesture in their retelling performance (the *beat non-encouraging condition*). Pretest and posttest narrative structure and fluency scores of the two groups were then compared to determine the effect of the beat gesture encouraging.

4.2.1 Participants

Fifty-three children (23 boys and 30 girls) from the Girona area of Catalonia participated in this study. The majority of the participants ($n = 49$) were drawn from two schools (*Col·legi Dr. Masmitjà* and *Escola Montjuïc*); the four remaining children were recruited individually. Data from six of the original participants had to be excluded from analysis either because of technical recording problems ($n = 4$) or because they did not want to collaborate in the experimental task ($n = 2$). Thus, the dataset analysed in this study came from the remaining 47 participants (mean age = 5.92, $SD = 0.54$). The sample size was determined post hoc using G*Power version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) and showed a sample size of 45 participants with a small- to medium-sized effect

198

(α = 0.05, power = 0.42 for narrative structure; α = 0.05, power = 0.56 for narrative fluency). Before the experiment, parents gave their consent to having their children participate in the experiment and be video-recorded.[11] Parents also filled out a family language questionnaire (Bosch & Sebastián-Gallés, 2001) which revealed on the one hand that all the participants were typically developing children with no prior history of communication disorders in themselves or within their families, and on the other that, even though all children were functional Catalan–Spanish bilinguals, these children were exposed to Catalan on a daily basis 88.74% of the time (SD = 10.68) as this is also the main language of instruction in the school.

4.2.2 Materials

The pretest, training and posttest materials used in this experiment were the same as those used in Vilà-Giménez et al. (2019). The pretest and posttest task consisted of the children retelling what they had seen in four short (~41–50 s) online animated cartoons about a small mouse and his friends (Westdeutscher Rundfunk Köln, http://www.wdrma us.de), with which they were previously unfamiliar (see summaries of the four cartoons in Appendix B). These materials were also used for narrative retelling tasks in Demir

---

[11] This study obtained ethics approval from the Ethics Committee at the Universitat Pompeu Fabra (Internal Committee for the Ethical Review of Projects, CIREP-UPF) as part of gaining approval for funding from the Spanish Ministry of Science, Innovation and Universities (MCIU), Agencia Estatal de Investigación (AEI), and Fondo Europeo de Desarrollo Regional (FEDER) for Project PGC2018-097007-B-100 'Multimodal Language Learning (MLL): Prosodic and Gestural Integration in Pragmatic and Phonological Development.'

et al. (2014) and Alibali, Evans, Hostetter, Ryan, and Mainela-Arnold (2009). The cartoon soundtracks contained only background music, not speech. Two of these cartoons were shown in the pretest whereas the other two were shown in the posttest. However, in both pretest and posttest, the first cartoon featured one character (the mouse—see cartoon summaries A and C in Appendix B) and the second featured two (summaries B and D). The stories in the four cartoons followed the same goal-based structure, which included the following main features of a narrative: (a) temporal and causal structure, (b) animate protagonists, (c) an initiating event, (d) a goal, (e) an attempt to achieve the goal and (f) an outcome or resolution (Demir et al., 2014; Demir, Levine, et al., 2015).

The training materials consisted of 12 video-recorded short narratives performed in Catalan by two adult female storytellers (6 stories × 2 storytellers). The narratives' main characters were a set of animals that lived on a farm. The structure of the six narratives followed that of the stories featured in the animated cartoons (English translations of the six stories are provided in Appendix C). In order to simulate real-world storytelling situations, the two storytellers were asked to use child-directed speech and smile throughout the recording session as if they were speaking to a group of children. The audio–visual stimuli were created after conducting a preliminary study in which the two female preschool teachers were recorded performing a child-directed expressive reading task (see Vilà-Giménez et al., 2019, for further details). The results of this analysis showed that storytellers associated beat gestures with

200

discourse markers and focal content words. Discourse markers (e.g. *once upon a time, before, but, because, therefore, otherwise*, etc.) are 'sequentially dependent elements which bracket units of talk' (Schiffrin, 1987, p. 31; classification based on Portolés, 1998). Focal content words (*a duck, rain, umbrella*, etc.) are considered as words with lexical meaning, typically nouns, verbs, adjectives or adverbs, which receive semantic and prosodic prominence within discourse. Regarding the form of the gesture, the results showed that the open-palm outward gesture occurred either with discourse markers or focal content words, whereas the inward gesture only accompanied focal content words.[12] Moreover, both hand movements were also associated with a head nod, a widening of the eyes, and a raising of the eyebrows. Therefore, following these findings, the audio–visual stimuli for the training phase were recorded by the two storytellers who were trained to perform the open-palm outward gesture to emphasize discourse markers and the inward hand movements to emphasize focal content words (see Figure 1). Both storytellers were monitored for to make sure that they consistently synchronized beat gestures and the corresponding target verbalizations. After recordings were completed, the first author also checked the results to ensure that the use of gestures appeared to be natural (the videos were the same as the ones used in the beat gesture condition in Vilà-Giménez et al., 2019).

---

[12] Following the MIT Gesture Studies Coding Manual. Retrieved from http://web.mit.edu/pelir e/www/manual/ (Shattuck-Hufnagel et al., 2016).

201

Figure 1. Still images showing one of the two storytellers performing an outward beat gesture hand movement (left panel) and an inward beat gesture hand movement (right panel) in one of the training videos.

Eight different versions of a PowerPoint presentation were prepared in which the order of the pretest and posttest cartoons, the six training stories and the two storytellers were counterbalanced. In each PPT presentation, before showing the six training stories (three performed by each storyteller), two slides introduced the farm and all the animals featured in the narratives.

4.2.3 Procedure

The experiment followed the same pretest–training–posttest procedure as in Vilà-Giménez et al. (2019) (see Figure 2). Each participant was randomly assigned to one of two conditions, *beat non-encouraging* (*n* = 25; mean age = 5.96, *SD* = 0.57) or *beat encouraging* (*n* = 22; mean age = 5.88, *SD* = 0.51) (see Training session below). Children were tested individually in a quiet classroom at their school and were video-recorded in all phases of the task. Each child was seated wearing headphones while watching the video presentations in the pretest, training and posttest parts; after watching each video, the child removed the headphones and

stood in front of the experimenter to retell the story. The whole session lasted approximately 30 min.
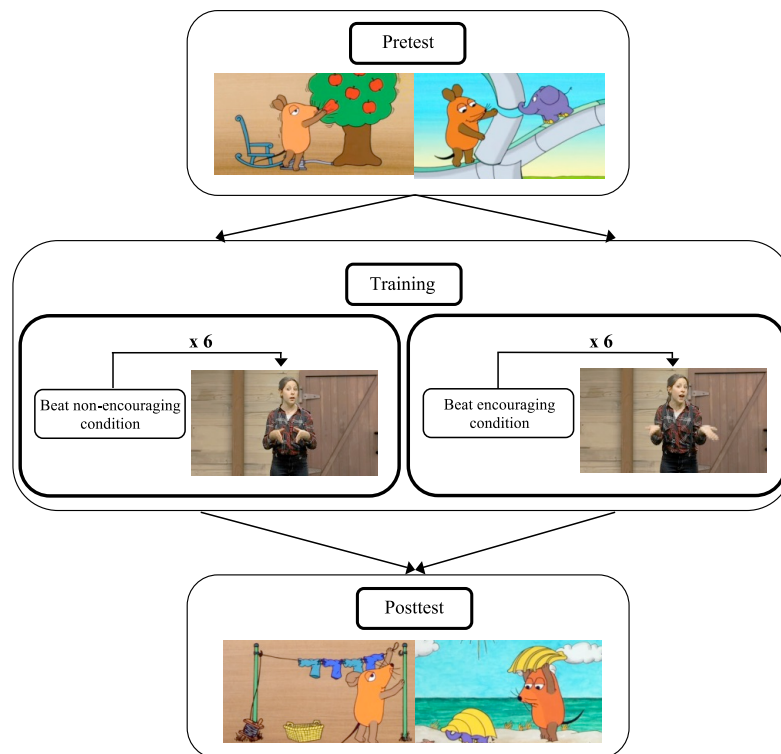
Figure 2. Experimental procedure.

4.2.3.1 Pretest and Posttest

The pretest and posttest phases consisted of a narrative retelling task. The child first watched a cartoon (containing only one character; see Cartoons A and C in Appendix B) using a laptop equipped with headphones and was then asked to stand up and retell what s/he had seen to the experimenter, who, although present in the room, pretended not to have watched the video clip. To provide

motivation, the narrative task was carried out like a game, as the experimenter had to guess the story that the child was telling through a variety of pictures extracted from the original video and from other videos. As the child attempted to retell the story, the experimenter provided positive feedback in the form of comments like 'I like the way you told the story very much, so I can easily guess which picture it is!' If the narrative was not immediately forthcoming, the experimenter said 'Can you tell me the story?' and if the child seemed to be losing focus, the experimenter prompted her/him by means of comments like 'Anything else?' The story finished when the child stopped or had nothing more to say. This procedure was then repeated using a different cartoon, this time containing two characters (see Cartoons B and D in Appendix B). The two cartoons shown in the pretest were different from the two shown in the posttest. The prompting procedure for pretest and posttest were identical across conditions.

4.2.3.2 Training session

The training session took place between the pretest and the posttest phases and the materials used were embedded in the same PowerPoint presentation between the pretest and posttest materials. Training consisted of two tasks, watching a video clip of a person telling story, and then retelling the story to the researcher, this procedure being followed for six separate video clips. The same six videos were used for both experimental conditions, although the order of stories and storyteller varied from one participant to the

next. In each of the videos a storyteller told a story while using beat gestures to emphasize discourse markers and focal content words. Prior to viewing, each child in the two conditions was instructed to pay close attention to how the storyteller was going to move her hands (e.g. 'Look at the farmer [the storyteller] and watch how she moves her hands when she's telling you the story'). After viewing, however, the child was given different instructions depending on the experimental group to which s/he had been assigned. While children assigned to the control *beat non-encouraging* condition were merely asked to retell the story they had just heard without receiving any gesture instructions, children assigned to the experimental *beat encouraging* condition were asked to retell the story while producing hand movements like those they had seen the storyteller use, with instructions along the lines of 'Did you notice that the farmer [the storyteller] moved her hands a lot as she told the story?' So now tell me the story just like the farmer did, moving your hands a lot the entire time. 'Do you remember how she did it? Do you remember when she said, "Once upon a time, there was a duck..."?' While giving these instructions, the experimenter modeled the beat gestures as used by the storyteller, performing an outward beat gesture hand movement while saying discourse markers like 'once upon a time' and an inward beat gesture hand movement for key content words like 'duck.' In this way the experimenter stressed the fact that the storyteller had been moving her hands during the entire narrative. The child then either simply retold the story (if they were in the control group) or retold it with beat gestures (if they were in the experimental group) (see Figure

3). If the child did not respond immediately to the instructions, the same neutral prompts used in the pretest and posttest parts were provided (e.g. 'Can you tell me the story?' or 'Anything else?'). The story went on until the child stopped or had nothing else to add.
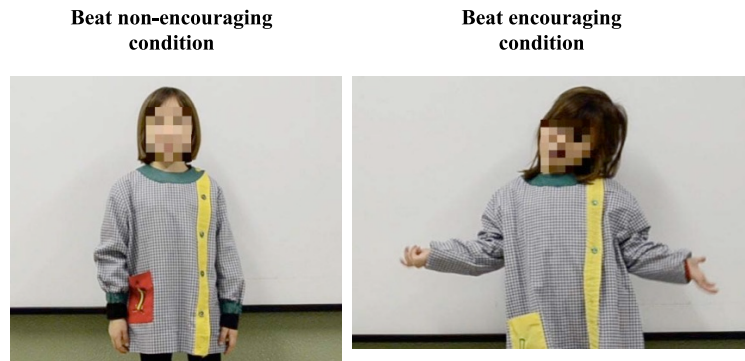
Figure 3. Still images of children performing posttest narratives after being exposed to the beat non-encouraging condition (left panel) and the beat encouraging condition (right panel).

In order to check that children correctly understood the training instructions and performed the gestures as in the model narrative, the first author of the study conducted an initial inspection of all the six short narratives produced by the children in the *beat encouraging* condition during the training sessions in which she verified the children's gestural behaviour during the narrative training sessions across conditions. All the children understood the training instructions and followed them properly by imitating the beat gestures performed in the narrative in at least in some parts of their retelling task. Therefore, none of the participants were excluded from the dataset due to a lack of understanding of the training instructions. After the first author systematically counted

all kind of gestures in the training narratives in the two conditions, an independent-samples *t* test was then conducted to compare the number of gestures produced during the training session in both the *beat encouraging* and the *beat non-encouraging* conditions. As expected, there was a significant difference in the mean number of gestures produced per group in the *beat encouraging* condition ($n = 581$; $M = 26.41$, $SD = 10.52$) and the *beat non-encouraging* condition ($n = 55$; $M = 2.2$, $SD = 7.13$); $t(45) = 9.33$, $p < .001$). These results show that the experimental condition was successful in boosting the number of gestures produced by the children during training.

4.2.4 Coding

Children's pretest and posttest narratives (47 children × 4 stories (2 pretest + 2 posttest) = 188 stories) from the full audio–video recordings were analysed and scored by the first author (a native speaker of Catalan) for narrative structure and narrative fluency. She was blind to the experimental conditions. All children's scores were averaged for both pretest and posttest.

4.2.4.1 Narrative structure

For the overall narrative structure scores of the pretest and posttest narratives, we used the same narrative assessment-coding scheme as in Vilà-Giménez et al. (2019), which was adapted from Demir et al. (2014) and Demir, Levine, et al. (2015). Four main features were

considered when analysing the structure of each story, yielding a score between 0 and 6: (a) the presence of an animate protagonist, (b) its temporal structure, (c) its causal structure and (d) the presence of a goal-directed action (i.e. an action including an initiating event, the goal, the attempt to achieve the goal and the outcome of that attempt). Specifically, the instructions for coding narrative structure from 0 to 6 were as follows.

> (0) A *narrative with no structure*. No protagonist. It does not even contain a descriptive sequence; the story is not remembered.
>
> (1) A *descriptive sequence*. Protagonist but no temporal structure. This is a narrative that includes the physical and personality characteristics of an animate protagonist with no mention of a sequence of actions (i.e. no temporal structure).
>
> (2) An *action sequence*. Protagonist and temporal structure but no causal structure. This is a narrative with actions described in a temporal order (actions follow one another in time) but in which the actions are not causally organized.
>
> (3) A *reactive sequence*. Protagonist, temporal and causal structure, but no goal. This contains actions that are temporally and causally organized but omits either the protagonist's goal or the attempt to achieve that goal, or omits both. The outcome is always mentioned here.
>
> (4) An *incomplete goal-based narrative*. This includes temporal and causal structure, a goal statement and/or description of an attempt to achieve the goal, but no information about the outcome.
>
> (5) A *goal-based narrative*. This includes not only temporal and causal structure as well as a goal statement, description of an attempt to achieve the goal and the final outcome.
>
> (6) A *complete goal-based narrative*. This contains not only temporal and causal structure but also all the main features noted above. Moreover, the story is fleshed out with details including the initiating event.

A maximum score of 6 thus corresponded to a complex complete goal-based narrative which contained all four narrative features. (For a more detailed rubric and example for scoring child-produced retelling narratives, see Vilà-Giménez et al., 2019).

4.2.4.2 Fluency

To rate the children's oral fluency, we followed the lead of many other studies (O'Brien, 2014; and see Isaacs & Trofimovich, 2011; Kennedy & Trofimovich, 2008, for examples) and had a native listener listen to the children's productions and then assign a holistic perceived fluency score using a 7-point Likert scale, with 1 = extremely disfluent and 7 = extremely fluent. Perceived fluency, according to Segalowitz (2016) refers to the 'subjective judgments of L2 speakers' oral fluency' based on their perceptions of how fluent the speaker is (p. 86).

4.2.5 Inter-rater reliability

Inter-rater reliability for narrative structure and fluency coding was established by checking the agreement between three raters (one of them the first author of the study), on a random subset of 20% of the data (44 cases). The three raters were blind to the two conditions of the study. Before conducting the reliability test, the two coders were trained in a 1-hr session in which they had to analyse and blindly rate the narrative structure and fluency of a set of random audio–visual narratives. At the beginning of the session they were

provided with an explanation of each of the scores of narrative structure and the fluency. Then, they were asked to rate a total of 10 stories and to compare the results with the first author of the study.

Cronbach's alpha coefficients, as measures of inter-rater reliability, were calculated. As for the narrative structure, overall agreement between the two coders and the author of the study indicated a high level of internal consistency (Cronbach's $\alpha = 0.815$). For the fluency scores, overall agreement between the two coders and the author of the study was satisfactory (Cronbach's $\alpha = 0.781$).

4.2.6 Statistical analysis

Two GLMM analyses (West, Welch, & Galecki, 2007) were run using SPSS Statistics 23.0 (SPSS Inc.) with overall narrative structure scores and overall fluency scores as dependent variables. In both GLMMs, Training Condition (two levels: beat non-encouraging and beat encouraging) and Test (two levels: pretest and posttest), and the interaction Condition × Test were set as fixed factors. Subject and Item (i.e. the four stories used in the pretest and posttest) were set as random factors. Bonferroni pairwise comparison post hoc tests were carried out to detect significant main effects and interactions in each of the analyses. Furthermore, in the GLMM analysis of the fluency scores, duration was included as a random factor, following the assumption that the duration in time of the narrative (e.g. how long a child speaks) correlates with her/his fluency. Finally, descriptive statistics (range, mean, *SD*) for

210

both narrative structure and fluency scores in the pretest and posttest parts and in both conditions are provided in Appendix E.

4.3 Results

4.3.1 Narrative structure scores

The results of the GLMM analysis indicated a main effect of Test ($F(1, 184) = 25.194$, $p < .001$), showing better narrative structure scores in the posttest ($\beta = 0.834$, $SE = 0.166$, $p < .001$) than in the pretest for all subjects. Regarding effect size, the β regression coefficient indicates that a child has a 0.834 probability of achieving a higher posttest than pretest narrative structure score. A significant interaction between Condition and Test was also found ($F(1, 184) = 6.167$, $p = .014$), indicating that narrative structure scores differed depending on the experimental group and whether the narrative was pretest or posttest. Further post hoc analyses showed that the two experimental groups differed significantly in posttest narrative structure scores, with children in the *beat encouraging* group ($\beta = 0.697$, $SE = 0.265$, $p = .009$) producing better narrative structures tan children in the *beat non-encouraging* condition. The β scores indicate that a child in the experimental group is 0.697 more likely to achieve a high narrative structure score than a child in the control group. Importantly, pretest scores between the two groups did not differ significantly ($\beta = 0.129$, $SE = 0.265$, $p = .628$), nor did pretest and posttest scores for the beat non-encouraging group ($\beta = 0.421$, $SE = 0.230$, $p = .069$). However,

211

significant differences were found between pretest and posttest scores in the beat encouraging condition, with better scores in the posttest (β = 1.246, *SE* = 0.240, *p* < .001) than in the pretest. In other words, a child in the experimental group is 1.246 more likely to achieve a higher posttest narrative structure score relative to pretest than a child in the control group. Therefore, children performed better in their posttest narratives when they were encouraged to gesture than when they were not (see Figure 4).
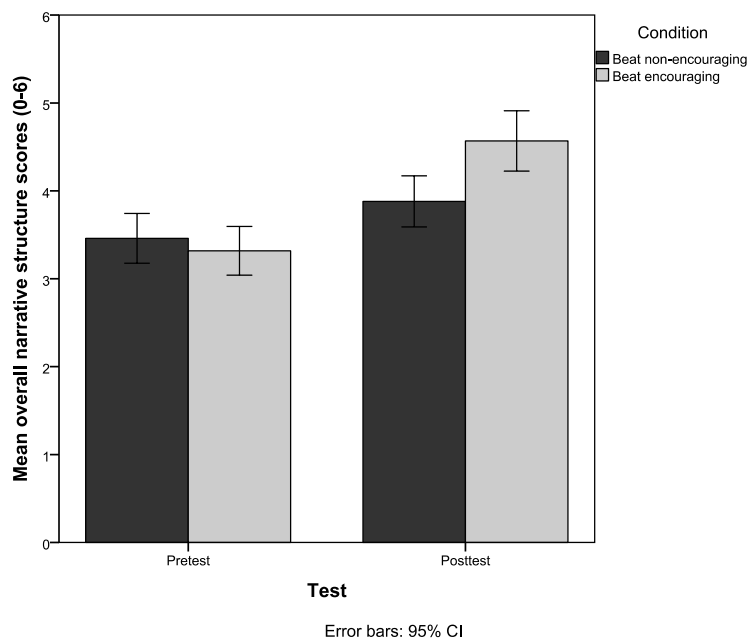
Figure 4. Mean overall narrative structure scores from 0 to 6, broken down by training condition (beat non-encouraging vs. beat encouraging) and test (pretest vs. posttest). Error bars represent 95% confidence intervals of the means.

4.3.2 Fluency scores

The results of the GLMM analysis showed a main effect of Test ($F(1, 184) = 18.277$, $p < .001$), with better fluency scores in the posttest ($\beta = 0.803$, $SE = 0.188$, $p < .001$) than in the pretest. The probability of a child's posttest narrative having a higher narrative fluency score relative to pretest is about 0.803. A significant interaction between Condition and Test was also found ($F(1, 184) = 4.649$, $p = .032$). Again, pretest scores were not significantly different across groups ($\beta = 0.214$, $SE = 0.468$, $p = .647$), and neither were posttest scores ($\beta = 0.596$, $SE = 0.533$, $p = .265$). However, whereas pretest and posttest scores for the *beat non-encouraging* condition did not significantly differ ($\beta = 0.398$, $SE = 0.249$, $p = .112$), significant differences were found between pretest and posttest scores for the *beat encouraging* condition, with better fluency scores in the posttest ($\beta = 1.208$, $SE = 0.281$, $p < .001$) than in the pretest. In other words, children in the experimental condition are 1.208 more likely to obtain better posttest than pretest narrative fluency scores than children in the control group. Therefore, children performed the posttest narratives more fluently when they were encouraged to gesture during the training session than when they were not (see Figure 5).

213
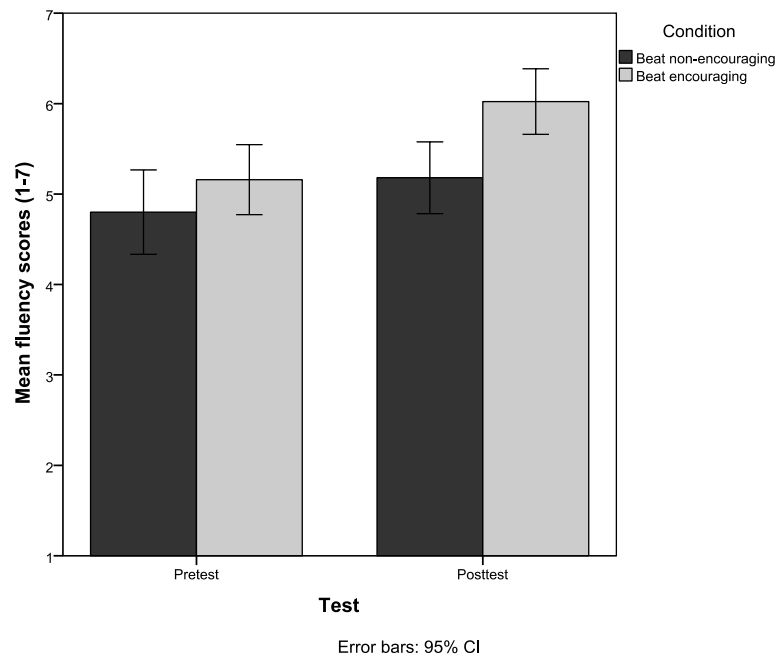
Figure 5. Mean overall fluency scores from 1 to 7, broken down by training condition (beat non-encouraging vs. beat encouraging) and test (pretest vs. posttest). Error bars represent 95% confidence intervals of the means.

4.4 Discussion and Conclusions

The current study was aimed at extending our understanding of the potential benefits of promoting the use of beat gestures in improving children's narrative performance. To our knowledge, this is the first study that investigates whether encouraging children to accompany their retelling of stories with beat gestures might lead to higher quality narratives as measured in terms of narrative structure and fluency. Our hypothesis was that it would, and our results seem to have confirmed this. A comparison of pretest and posttest scores for both narrative structure and narrative fluency showed that

214

children in the experimental group, who were encouraged to produce gestures used during training, achieved higher scores than children in the control group, who had received no such instructions, suggesting that beat gestures act as meaningful highlighters of linguistic functions in speech (e.g. information focus, discourse structure, rhythm).

These findings complement recent research showing that merely observing beat gestures as they are told a story also improves children's subsequent retelling (Vilà-Giménez et al., 2019). However, the present study goes further in that it investigates the effect of not merely observing beat gestures but also producing them.

Our findings also go beyond the previous demonstration of the positive impact of seeing beat gestures in recall tasks (Austin & Sweller, 2014; Igualada et al., 2017; Llanes-Coromina, Vilà-Giménez, et al., 2018; So et al., 2012). We argue that gestures that do not reflect representational (i.e. iconic or metaphoric) meaning, but important pragmatic and linguistic functions in discourse can boost children's narrative performance. There is previous research showing that observing iconic gestures facilitates children's memory of both nonlinguistic information (e.g. Aussems & Kita, 2019) and linguistic information (e.g., So et al., 2012). Further similar results were found in producing iconic gestures to encode aspects of events (e.g. Cook et al., 2010). Along these lines, the results of the training experiment demonstrate that, as iconic gestures do, encouraging

215

children to produce beat gestures in the training phase influences how they produce their subsequent posttest narratives, as they can be provided with visual structure that enhances the parsing and processing of narrative events in speech.

The results of the present study also expand on previous developmental work on the relationship between gestures and narrative abilities. While previous research has shown that representational gestures serve as forerunners of narrative development (Demir et al., 2014; Demir, Levine, et al., 2015; Stites & Özçalışkan, 2017), the present study suggests that beat gestures may have a similar effect. Up until recently, beat gestures had not been studied extensively in this context (see Vilà-Giménez et al., 2019, for a review). In part, this may be because beat gestures have been traditionally seen as purely rhythmic and non-meaningful (non-referential) gestures. Nonetheless, there is growing evidence that these gestures are pragmatically meaningful (Kendon, 2004, 2017; McNeill, 1992; Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016) and, in our view, the rhythmic and discourse–pragmatic cues beats have provided to children in the *beat encouraging* condition, with the visual scaffolding that highlights focal content words and discourse markers, may have actually helped boost their posttest narrative performance. The results of the present study thus add further force to the claim that beat gestures aid the language planning and learning processes underlying oral narrative discourse.

216

That said, it is clear that more research is needed to examine in greater depth how beat gesture training (together with other types of gesture training) might affect cognitive and language development. There are various issues that merit further investigation. First, further analyses of the temporal alignment between beat gestures and speech in the narratives produced by children may also extend on previous work by Mathew et al. (2017) and analyse the relevance of producing fine-grained adult's gesture–speech alignment patterns for the child's narrative success. Second, it would be of value to control the specific role of beat gestures in comparison to other types of gestures, such as representational gestures, which have already been shown to boost narrative abilities (e.g. Demir et al., 2014), or with conditions that include both representational gestures and beat gestures. Following up on previous studies describing the pragmatic and discourse functions of beat gestures (e.g. Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016) as well as their benefits on narrative performance (Vilà-Giménez et al., 2019) and speech production (Lucero et al., 2014), the present study aimed at assessing the specific role of beat gestures on their own. However, we believe that in order to contribute to the child's (or any speaker's) narrative success, the child does not need to be producing beat gestures exclusively, and using other types of gestures (just as referential gestures) would just strengthen the positive effects of gestures on narrative development. Thus, further research could examine the training value of different types of gestures in children's posttest narrative performance. We would expect that children (or any speaker) being encouraged to

produce other types of gestures (i.e. representational gestures), and not only specifically non-referential beat gestures, could benefit from gains in narrative performance. Moreover, while the present study demonstrated immediate short-term effects of a brief gesture-based training session on children's narrative performance, future research could focus more on the potential long-term effects of this sort of intervention. In other words, it would be of interest to explore whether any positive effects are sustained over time. Another question for future studies is whether beat gesture use by children has any predictive value with regard to their future narrative abilities. It may be that the onset of use of natural beat gestures by children is predictive of the superior narrative skills at different points in development. Finally, another future direction could examine how exactly the children's stories change in children who undertook the beat encouraging condition. In this sense, it could be that beats helped them with adding in a goal and perhaps with temporal sequencing.

In general terms, the results of this study are consistent with recent research showing the benefits of enacting or producing co-speech gestures while learning. Following the Gesture-for-Conceptualization Hypothesis (Kita et al., 2017, p. 258), we understand that gesture 'activates, manipulates, packages and explores spatio-motoric information for the purposes of speaking and thinking.' Gestural representation is thus shaped by online interactions with the speech formulation process, as speech and gesture production are intimately related and their relationship

underlies the cognitive processes involved. The results of this study thus have implications for embodied cognition paradigms, whereby gestural perception and production processes are integrated with speech and strongly underlie cognitive and language processing, specifically narrative development (see Kiefer & Trumpp, 2012; Wellsby & Pexman, 2014, for a review). We believe that the positive impact of storytelling incorporating bodily movement, specifically the use of beat gestures, relies on the cognitive processes involved during both the observation and performance of narratives. The ultimate value of this research, however, may lie in the potential applicability of these findings to education, because they suggest that active intervention in the form of gestural training—a technique easily adapted to the classroom context—may actually enhance the cognitive development of children. Given the evidence for links between early narrative skills and later literacy and scholastic success, anything that can boost early childhood narrative performance—as the use of beat gestures seem to do—deserves serious attention.

5

CHAPTER 5:
GENERAL DISCUSSION AND CONCLUSIONS

5.1 Summary of findings

The main goal of this dissertation was to examine the bootstrapping effects of non-referential beat gestures on children's narrative abilities. The main general hypothesis of this dissertation was based on previous studies suggesting that beat gestures help frame discourse structure, and that they highlight many other important linguistic functions in discourse, such as information structure, discourse structure, and rhythm (e.g., Dimitrova et al., 2016; Im & Baumann, 2020; McNeill, 1992; Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016). Such discourse–pragmatic functions of beat gestures would be the key to bolstering children's narrative abilities. In order to investigate the bootstrapping effects of beats on narrative development, three independent empirical studies were conducted —each one described in a different chapter. Following a longitudinal approach, the first study (Chapter 2) focused on the role that non-referential beats and flips, as well as referential iconic gestures produced by children between 14 and 58 months of age play in children's later narrative abilities at 60 months (i.e., age 5). Studies 2 and 3 (Chapters 3 and 4) used a between-subjects training with a pretest and immediate posttest design in order to investigate whether narrative training with observing beat gestures (Chapter 3) as well as encouraging children to produce these gestures (Chapter 4) contribute to improving their narrative performance at posttest.

In what follows, we summarize the main research questions from section 1.8 of the Introduction section that oriented this work in order to report the key findings of each study.

Study 1 (Chapter 2): The predictive value of non-referential beat gestures in children's later narrative abilities

1) Does the early frequency of use of non-referential beat and flip gestures (vs. referential iconic gestures) between 14 and 58 months of age predict narrative abilities at 60 months (5 years of age)?

Chapter 2 of this dissertation is a longitudinal study that focused on the analysis of speech and gesture performed by 45 children, who were visited in their homes every four months between 14 and 58 months of age. At each visit, children were videotaped spontaneously interacting with their caregivers for 90 minutes. Recordings included mealtimes, book readings, as well as play sessions. This longitudinal database is part of a larger longitudinal study of language development at the University of Chicago. At 60 months (5 years of age), children were administered a narrative production task (data from Demir et al., 2014). Results from a stepwise regression analysis showed that the early frequency of use of non-referential beat gestures from 14 to 58 months old predicted better well-structured narratives at age 5. In contrast to beat gestures, neither non-referential flips nor referential iconic gestures significantly predicted children's later narrative abilities. Therefore,

this study shows for the first time that children's early production of beat gestures in parent-child naturalistic spontaneous interactions predicts their narrative abilities later in development. These findings constitute a novel contribution to the literature which highlights the relevance of beat gesture production for children's narrative development.

Study 2 (Chapter 3): Observing rhythmic beat gestures improves children's narrative performance

2) Does a brief narrative training promoting the observation of beat gestures have an impact on 5- to 6-year-old children's narrative performance (in terms of narrative structure scores) at posttest?

Chapter 3 of this dissertation reported the results of a training experiment on the benefits of observing beat gestures by 5- to 6-year-old children when performing a narrative task. The principal aim of the study was to examine whether a brief narrative training session with 44 5- to 6-year-old children with observing storytellers' beat gestures might enhance children's subsequent narrative performance. In order to test the effects of the observation of beat gestures, children were divided into two groups and were exposed to a training phase with a total of six one-minute stories, which were presented under one of two experimental conditions. In the control condition (*no-beat condition*), children were asked to watch the narratives performed with prosodic prominence and no

beat gestures in target positions within the story. In the experimental condition (*beat condition*), children were asked to watch narratives performed with prosodic prominence and beats in target positions within the story. Pretest and posttest consisted of a narrative task in which children had to retell short animated wordless cartoons, which were analyzed for narrative structure. Results revealed that children who were exposed to the beat condition showed more gains in the quality of their posttest narratives of wordless cartoons (i.e., better narrative structure scores) than children who were exposed to the no-beat condition. Overall, the findings of this study are the first to demonstrate the positive effects of observing beat gestures on short-term children's narrative performance, in terms of narrative structure scores.

Study 3 (Chapter 4): Encouraging the use of rhythmic beat gestures boosts children's narrative performance

3) Does a brief narrative training encouraging 5- to 6-year-old children to produce beat gestures have an impact on their narrative performance (in terms of narrative structure and fluency scores) at posttest?

Chapter 4 of this thesis complemented the results obtained in the previous study (Study 2, Chapter 3), by investigating whether encouraging 5- to 6-year-old children to produce beat gestures while retelling narratives in the training phase —as opposed to solely observing them— also could trigger positive effects on their

225

narrative performance at posttest. In this experiment, 47 5- to 6-year-old children participated in a between-subjects training study with a pretest–posttest design, similar to that in the second study. Children were divided into two groups and were exposed to a training phase with a total of six one-minute stories, presented under one of two experimental conditions (*beat non-encouraging condition* or *beat encouraging condition*). In both conditions, children were asked to watch narratives performed with prosodic prominence and beat gestures in target positions within the story. However, after watching each story, children received different instructions depending on which condition was assigned to them. In the control condition (i.e., beat non-encouraging condition), children did not receive any gesture instructions and were just asked to retell the six stories to the experimenter. In the experimental condition (i.e., beat encouraging condition), children were asked to retell the stories while using their hands in the same way the storyteller did. Pretest and posttest narratives were analyzed for narrative structure and fluency. Results showed that children who were encouraged to use beats showed significant increases in their posttest narratives, both in terms of narrative structure and fluency scores, compared to the group of children who were simply asked to retell the story with no gesture instructions during training. These findings extend for the first time our understanding of the potential impact of promoting the use of beat gestures in scaffolding children's narrative performance.

This final chapter is divided into seven sections. Although each study (Chapters 2, 3, and 4) includes its own discussion and conclusions section highlighting the key findings, as well as its theoretical and methodological implications in relation to previous literature, the first two sections (5.2 and 5.3) will provide with further discussions of the main issues addressed in these studies in the light of the current literature. In the next sections, possible explanations of the mechanisms underlying the positive boosting effects of beat gestures reported in this thesis are provided (5.4), also concerning their important discourse–pragmatic and prosodic properties in narrative speech (5.5). The final section concerns the practical and methodological implications, as well as limitations and directions for future research (5.6), and a general conclusion (5.7).

5.2 Using non-referential gestures from early childhood: Beat gestures predict narrative abilities at later ages

Research concerning the multimodal communicative repertoire in infancy has provided evidence that referential gestures, such as deictic (or pointing) and iconic gestures, are both precursors (e.g., Butcher & Goldin-Meadow, 2000; Esteve-Gibert & Prieto, 2014, Iverson & Goldin-Meadow, 2005, among many others) and predictors of children's onset of linguistic milestones (e.g., Goldin-Meadow & Butcher, 2003; Igualada et al., 2015; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009, among many others). While deictics are the first documented gestures to appear (at around 9–12 months of age), the first iconic gestures emerge soon after (Acredolo & Goodwyn, 1985; Bates, 1976; Bates et al., 1979, among others). However, it is not until approximately 26 months of age that children's use of iconic gestures increases, at the same time that children become more linguistically and cognitively advanced (Özçalışkan, & Goldin-Meadow, 2011). These gestures provide children with the ability to produce a great range of communicative meanings (Özçalışkan et al., 2014; Özçalışkan, & Goldin-Meadow, 2011). Interestingly, flip gestures are among the earliest gestures children start to produce, at around 15 months of age (Acredolo & Goodwyn, 1985; see also Bartz, 2017; see Harris et al., 2017, for a review); while beat gestures, in contrast, are the last gestures that emerge ontogenetically (after 2 years of age; Levy & McNeill,

2013; Nicoladis et al., 1999). Nevertheless, little is known on the relevance of the different types of gestures in children's gestural repertoire, such as non-referential gestures, in forecasting changes at later stages of development, e.g., in the later production of linguistically complex discourses, such as oral narrative discourses.

One of the main contributions of this thesis relates to the relevance of non-referential gestures in the prediction of narrative development. There is evidence that iconic gestures serve as forerunners of linguistic change, suggesting that they are at the cutting edge of language learning (e.g., Özçalışkan & Goldin-Meadow, 2005; Rowe et al., 2008, among others). Crucially, further along development, iconic gestures still continue to positively affect (Demir et al., 2014; Parrill et al., 2018; Stites & Özçalışkan, 2017) and predict (Demir, Levine, et al., 2015) oncoming changes in children's more complex language abilities, such as narrative abilities. Nevertheless, to our knowledge, no research to date has dealt with the predictive patterns of both non-referential flip and beat gestures in children's later narrative abilities. Even though previous research demonstrated that the development of non-referential gestures is tightly connected to the emergence of complex discourse (Nicoladis et al., 1999), no previous research had assessed its predictive status. This was the main objective of Study 1 and constitutes a novel contribution to the literature (Chapter 2).

The results of the first study first expand our knowledge on the predictive relevance of referential and non-referential gestures in

the context of language development by comparing them directly in a longitudinal study. The results from Chapter 2 contribute to this line of research by demonstrating the importance of non-referential gestures in forecasting oncoming changes in the development of narrative abilities at later ages. Our study found that the children's early frequency of use of non-referential beats, in contrast to non-referential flip and referential iconic gestures, produced in the developmental window from 14 to 58 months significantly predicted the structure of children's narratives at age 5. In contrast, neither flips nor iconic gestures were found to be predictors of children's later narrative abilities.

The results from this chapter also contrast with those of previous investigations on the predictive role that referential gestures play in children's later narrative abilities. First, the non-significant predictive role of iconics in children's later narrative productions is not in accordance with previous findings by Demir, Levine, et al. (2015), who found that children who expressed CVPT gestures in narratives at age 5 got better structured narratives later in development. However, it is worth noting that while Demir, Levine, et al.'s (2015) study focused on a specific type of referential gesture, i.e., character-viewpoint, our findings are related to iconic gestures in general. Another important remark is that while our study deals with the production of gestures since 14 months of age, Demir, Levine et al. analyzed CVPT gestures since age 5. Second, results obtained in Study 1 for iconics also contrast with findings by Nicoladis and colleagues (1999) revealing that iconic gestures (but

also beats) (vs. deictic gestures, gives or emblems) were associated with more linguistically complex spoken utterances (i.e., MLU, mean length of utterances) in early stages of language development (2 to 3.6 years of age). Concerning the different functions that iconic and beat gestures serve in early discourse, these functions (i.e., representational gestures visually illustrating a referent or an abstract idea, and beat gestures aiding in structuring speech and marking discourse cohesion) may be more accentuated when related to more complex multimodal discourses (i.e., narrative speech) at later stages in development (e.g., 5–6 years) (e.g., Colletta et al., 2010). Therefore, it is likely be that due to the differential relationship these two types of gestures show in discourse, the properties of non-referential beat gestures were more relevant than iconics in children's later narratives. However, more research will be needed to assess the developmental relevance of gesture types across age spans in predicting linguistic milestones.

The results of Chapter 2 also showed that, in contrast with beat gestures, flip gestures did not signal oncoming changes in children's later discourse construction. A potential explanation for the null results obtained by flips is in line with their developmental and pragmatic role in children's speech. Children use flips, often accompanied by a shrug of the shoulders (Ferré, 2011), in order to convey a range of epistemic meanings in discourse, such as ignorance (e.g., "I don't know") when they are approximately in their second year of life (see Harris et al., 2017, for a review). It can be argued that since flip gestures tend to express epistemic modality

in a conventional way early in development, this function is not comparable to the structuring and focusing role of beat gestures in discourse (see section 5.5). This explanation is in line with the interpretation offered by Nicoladis et al. (1999) on the fact that deictic gestures, gives (i.e., empty-handed, palm-up gestures that occur either with the fingers curling back and forth or still) or emblems were not associated with more linguistically complex spoken utterances (i.e., MLU) in 5 French-English bilingual children. The authors claimed that these gestures types follow distinct developmental patterns, as they appear in children before they begin to speak. In line with this explanation, the fact that flip gestures appear very early in the children's communicative repertoire (and with a specific pragmatic function) can probably explain the fact that the use of flips by children does not relate to the acquisition of complex linguistic skills.

Concerning co-speech gesture production in children's narrative, our findings fundamentally agree with the claims made by previous literature pointing out that gesture and speech go hand in hand in development (e.g., Colletta et al., 2015), and that the children's gestures related to narrative organization (i.e., beat gestures) become relevant at the time their narratives start to become more complex.

In summary, the findings from Chapter 2 make an important contribution to the theoretical field of child language development, suggesting the existence of a strong association between the

children's early production of beat gestures and their later stages of narrative production outcomes, in contrast with other types of gestures. Crucially we argue that the pragmatic role and structuring function that non-referential beat gestures play in emerging discourse patterns may be key for children's early discourse and narrative development (see section 5.5 below).

The Studies 2 and 3 of this dissertation did manipulate the gestures children observed and produced in a gesture-based narrative training task with beat gestures and therefore address whether beats pave the way for narrative abilities, by immediately improving their subsequent posttest narrative productions.

5.3 Narrative training with observing and producing beat gestures: A helping hand for narrative discourse performance

Once children have made their first steps in language and they eventually become fluent language users, they benefit from both speaker's use of hands and from their own gesture performance in a variety of complex learning settings. There is broad evidence of a strong relationship between co-speech gestures and learning processes related to communication and thinking. In this sense, it is well-established that gesture reflects thoughts that learners cannot yet express in speech and this may help them uptake new cognitive strategies and subsequently improve their learning development (see Goldin-Meadow, 2014, 2018, and Novack & Goldin-Meadow, 2015, for reviews). Nevertheless, the research to date has generally focused on the potential role of referential gestures (e.g., iconic and pointing gestures) rather than of non-referential gestures, such as beat gestures, in boosting learning.

The results of the two training studies presented in this thesis support and expand previous investigations which have reported that the speaker's gestures can facilitate learning output. Results obtained in Study 2 of this dissertation are consistent with studies that have demonstrated that listeners can learn from observing other people's gestures, specifically referential gestures, in both cognitive (e.g., Aussems & Kita, 2019; So et al., 2012) and linguistic tasks (e.g., McGregor et al., 2009; Theakston et al., 2014). From the

production side (Study 3 of this thesis), many studies related to problem-solving strategies have shown that manipulating gesture (i.e., instructing or encouraging children to gesture) can be of help in both cognitive (e.g., Broaders et al., 2007; Cook et al., 2008, 2010) and linguistic processes (e.g., Kidd & Holler, 2009; Kirk & Lewis, 2017).

More specifically, in the context of the causal role of learning of narrative skills after manipulating gestures in a task, the results of Studies 2 and 3 (Chapters 3 and 4) of the present dissertation also expand on the previous results about the positive effects on boosting narrative performance through both observing (Demir et al., 2014) and encouraging the production (Parrill et al., 2018) of referential gestures. Our results showed that both asking children to observe beat gestures (Study 2) and encouraging them to produce beat gestures (Study 3) with no referential meaning in the training phase can also have a positive impact in boosting children's narrative productions, both in terms of narrative structure and oral fluency.

Taken together, the main findings from the three studies in this thesis expand our knowledge about the bootstrapping role of gestures in narrative development. Results clearly indicate that the additional highlighting role that beat gestures have in marking linguistic functions such as focus information and discourse structure may lead children to perform more detailed, better organized and more complete goal-based narratives. It seems that beat gestures can help children focus on critical parts of a story, by

providing them with visual structure that facilitates the parsing and processing of narrative discourse.

More particularly, the training results obtained in the two studies can be understood as an expansion of the facilitative role of gestures on basic cognitive skills like recall and comprehension of information. Positive effects of referential gestures were obtained for the recall of linguistic (e.g., So et al., 2012) and nonlinguistic information (e.g., Aussems & Kita, 2019; Cook et al., 2010). And both the observation (e.g., Dargue & Sweller, 2020a; Macoun & Sweller, 2016) and production (Cameron & Xu, 2011) of referential gestures have been found to facilitate narrative recall and comprehension in children. Findings also broadly support the positive results of the use of beat gestures on recall and comprehension, both in adults and children. The results of the two training studies also support and expand previous investigations which have highlighted the positive effects of observing beat gestures on the recall of information by adults (e.g., Morett & Fraundorf, 2019; So et al., 2012) and preschoolers (Austin & Sweller, 2014; Igualada et al., 2017; Llanes-Coromina, Vilà-Giménez, et al., 2018), as well as on children's narrative discourse comprehension (Llanes-Coromina, Vilà-Giménez, et al., 2018). Taking together the results of these studies, it seems clear that gestures that do not visually depict a referent in speech but highlight important linguistic functions in discourse can guide children in framing narrative discourse (see section 5.5), both in terms of narrative structure and fluency scores.

As for the positive effects on narrative structure scores obtained in Studies 2 and 3, the two studies showed that beat gestures can act as meaningful prominent visual cues in speech, revealing that non-referential gestures can take the same important role as referential gestures in helping children to get higher well-structured narrative productions (Demir et al., 2014; Parrill et al., 2018). In Demir et al.'s (2014) study both children with early brain injury and typically developing children benefited from audio-visual gesture elicitation in their narratives. According to the authors, it may be that gestures have specifically drawn children's attention to the story's goal (and they specifically mention the use of beats near the character's goal). In Parrill et al.'s (2018) training, it could be that encouraging children to gesture from the point of view of a character (i.e., character-viewpoint gesture) might have boosted better narrative structure, because taking this perspective may have led them to focus more on the character's goals and attempts.

Furthermore, results of Study 3 importantly revealed positive effects of training narratives with beats not only in terms of narrative structure but also in terms of oral fluency. This is the first time that a brief training session with beat gestures reveals a causal link between beat gestures and oral fluency gains in the production of narratives at posttest. The results on oral fluency complement previous investigations (see section 1.6.2.2). Although previous training studies have shown that the rhythmic properties of beat gestures enhance L2 pronunciation (Gluhareva & Prieto, 2017; Llanes-Coromina, Prieto, et al., 2018), to our knowledge, to date,

only Lucero et al.'s (2014) study has tested the effects of producing beat gestures in a first language, showing that producing beat gestures facilitated lexical access in adults.

The results of both chapters have shown the benefits of both observing beat gestures and encouraging children to produce beat gestures in promoting more complex linguistic abilities. Even though previous investigations have compared the role of either producing or observing referential gestures within the same study dealing with other learning tasks, with contradictory results (e.g., Cherdieu et al. 2017; Dargue & Sweller, 2020b; Goldin-Meadow et al., 2012; Wakefield et al., 2018), unfortunately the results obtained in the two current training experiments cannot be directly compared due to the different procedures used in the different experimental conditions. In fact, we can just strictly compare conditions performed within each experiment, but not across experiments. Even though it may seem that both the experimental condition in Study 2 (i.e., beat condition) and the control condition in Study 3 (i.e., beat non-encouraging condition) are similar, they differed in the instructions children received and the exact tasks they had to perform after watching each one of the six narrations during training. On the one hand, in the *beat* condition in Study 2, children were just asked to watch the narratives performed by storytellers who accompanied their discourses with beat gestures. After each video, children were not administered any other task. However, in the *beat non-encouraging* condition in Study 3, children were asked to do the same as in the beat condition in Study 2, but after

watching each narrative they were also asked to retell the story they had just listened to, and were encouraged to move the hands in the same way the storytellers did.

In conclusion, the empirical findings in Studies 2 and 3 (Chapters 3 and 4) provide a new understanding of the benefits that beat gesture observation and beat gesture production can have in improving children's narrative performance, in terms of both narrative structure and fluency scores. Therefore, these findings also lend support to the hypothesis that beat gestures develop in parallel with narrative development (Colletta et al., 2015; Colletta et al., 2010). We conclude that non-referential beat gestures, also considered as multimodal markers of prominence, may serve as important visual highlighters of information in discourse that help frame children's narrative production and thus can promote learning (see section 5.5). However, what are the mechanisms that are responsible for the observing and producing beneficial effects of beat gestures? The following section focuses on the cognitive hypotheses of gesture-speech integration models that may underpin them.

5.4 Embodied storytelling: The mechanisms underlying the learning effects of non-referential beat gestures

An important question that arises from the main results of this dissertation is what are the mechanisms that underlie the immediate positive effects of both observing and producing non-referential beat gestures in children's narrative abilities. Over the last decade, previous investigations have shown that co-speech gestures and speech are intimately related in learning processes. Building upon these findings, many gesture-speech production models have assumed that there is a cognitive process underpinning the spontaneous gestures that people produce; thus gesture production influences cognitive and linguistic processes. Gesture serves a unique role in learning processes as "it is an action and can exploit the effects that action has on cognition" (Goldin-Meadow, 2018, p. 164); thereby, gestures may provide learners with an embodied way of representing the knowledge.

As mentioned in section 1.2.4 of the Introduction, the theoretical frameworks on gesture-speech integration reviewed have limited their discussions to the role of representational (i.e., referential) co-speech gestures (*Lexical Retrieval hypothesis* by Krauss et al., 2000; *Information Packaging hypothesis* by Kita, 2000; *Interface hypothesis* by Kita & Özyürek, 2003; *Gesture-As-Simulated Action* by Hostetter & Alibali, 2019; *Gesture-for-Conceptualization hypothesis*, by Kita et al., 2017). Although the studies in the current

240

dissertation were not aimed at taking a particular position with regard to these production models, we believe that our results provide empirical evidence for defending that non-referential gestures can have a similar status as referential gestures in these models. Taking into account that representational gestures can act as meaningful semantically social cues that facilitate learning, beat gestures —together with their concomitant prominence— can also act as visually prominent meaningful cues that help frame discourse.

Importantly, the beneficial role of both observing and producing beat gestures in narrative production processes reported in Studies 2 and 3 of this thesis appears to be supported by the basic tenets of the *Gesture-for-Conceptualization hypothesis* (Kita et al., 2017), which takes a unified view concerning all the previous abovementioned approaches. First, as stated by the authors, "gesture's influence is not limited to speakers; speakers' schematization of information in gesture influences listener's thinking as well. In these ways, gesture plays a central role in human cognition." (p. 262). Therefore, observing speaker's beat gestures may influence the children's language processing, as gestures performed by the storytellers influence how information is packaged for both thinking and speaking. This also may trigger the children's capacity for framing the discourse, which subsequently leads them to produce better goal-structured narratives. Therefore, a theoretically plausible possibility is that observing storytellers' rhythmic beat gestures during the training phase (Study 2) may have helped children to

better parse and process the discourse, which led them to improve their narrative performance at posttest (in terms of narrative structure scores).

The positive effects on children's narrative performance obtained by encouraging beat gesture production (Study 3) are also in line with the *Gesture-for-Conceptualization hypothesis* (Kita et al., 2017), and put forward evidence for incorporating non-referential beat gestures to this model. Encouraging children to produce beat gestures during the training phase boosts children's narrative performance because gesture "activates, manipulates, packages and explores spatio-motoric representations for the purposes of speaking and thinking" (p. 262). Importantly, non-referential gestures (together with referential gestures) can help both speakers and listeners to conceptualize information in both thinking and speaking processes and crucially "this schematization process shapes these four functions" (p. 262).

Findings obtained from embodied storytelling (i.e., accompanying a narrative retelling with bodily movement) in Study 3 also support the approaches by Hostetter and Alibali (2008, 2010, 2019) as well as the embodied cognition paradigms (see section 1.2.5; see Kiefer & Trumpp, 2012, and Wellsby & Pexman, 2014, for reviews). Along with our proposal, a recent review of the *Gesture-As-Simulated Action* framework (Hostetter & Alibali, 2019) stated that the mechanisms underlying representational gestures can also be applied to non-representational gestures. In our context, using beat

gestures during narrative retellings might have acted as a strong activation of the motor system (i.e., embodied cognition). By assuming that what makes gesture such an effective learning tool is its embodiment in language, as gesture can affect both thinking and learning, we can claim that the positive impact of storytelling incorporating bodily movement, specifically the use of beats, depends on the cognitive processes involved during the observation and production of narratives. Specifically, encouraging children to produce gestures will make them involve their own motor system, leading them to better learning (see Hostetter & Mainela-Arnold, 2015, for a review).

In conclusion, the findings of our training studies support and broaden the approaches based on the important role that representational gestures play in human cognition (Kita et al., 2017) and that claim that these gestures relate to the embodiment of the mind affecting speech production processes (Hostetter & Alibali, 2008, 2010, 2019). By broadening this vision, we raise the possibility that non-referential beat gestures can equally function as referential gestures in gesture-speech multimodal integration processes. Thereby, the same mechanisms can also underpin those benefits of non-referential beat gestures in cognitive and linguistic processing. Like referential gestures, these mechanisms are based on the fact that the properties of beat gestures —and their accompanying prosody— can impact both observation and production processes. First, gestures can influence how the observer processes and schematizes narrative information. Second, gestures

as forms of embodiment in language can provide external support to accompanying speech by changing the course of speaking and also cognitive processes, as they "influence thoughts about spatio-motoric information, based on our bodily experiences in perceiving and interacting with the world" (Kita et al., 2017, p. 258). All in all, gestures contribute to improving communication in many different ways and the positive assessment of a gesture-based training with beats in improving children's narrative performance has provided additional support for it.

The following section discusses the communicative value that beat gestures can serve in discourse.

5.5 The communicative value of non-referential beat gestures: Important discourse–pragmatic functions

The results of the work presented in this thesis highlight the positive effects that non-referential beat gestures have in bootstrapping children's narrative abilities. In the previous section, we have discussed the mechanisms that may underlie the potential beneficial role of beat gestures in cognitive and linguistic processing by suggesting that both gestures (regardless of referentiality) and the mind are influenced by each other in cognitive processes. One explanation as to why referential gestures are so effective in language learning and narrative development (e.g., Demir et al., 2014; Goldin-Meadow, Levine, Zinchenko, et al. 2014; Mumford & Kita, 2014) is that these hand movements depict the core semantic properties of a referent in speech and thus add additional details of the information expressed by speech. By definition, beat gestures are different from iconic gestures in that they do not encode referential properties of entities in discourse. In contrast to these referential gestures (i.e. iconic, deictic, metaphoric gestures), beat gestures do not reflect contextual meaning of the spoken message. So, why is it that non-referential beats have this unique property of bootstrapping discourse abilities? This section will further discuss the communicative and linguistic value of beat gestures that might be at the core of their beneficial effects on children's narrative discourse performance.

We claim that the significant role of beat gestures in narrative bootstrapping is related to the pragmatic, discursive, and prosodic functions they perform in discourse (see section 1.6 for a summary). Beat gestures highlight important linguistic functions associated with information structure marking, rhythmic marking, and discourse structure marking (Dimitrova et al., 2016; Im & Baumann, 2020; McNeill, 1992; Prieto et al., 2018; Shattuck-Hufnagel & Prieto, 2019; Shattuck-Hufnagel et al., 2016, among others). Importantly, these functions have been typically associated with prosody (Im & Baumann, 2020; Loehr, 2012, among others; see Wagner et al., 2014, for a review). Along the same lines, previous studies have examined the effect of other visual highlighters in comparison to beat gestures (e.g., Biau & Soto-Faraco, 2013; Holle et al., 2012; Wang & Chu, 2013). Results obtained from these studies add support to the claim that beat gestures act as attentional markers that are tightly linked to language-related areas of the brain, instead to the visual-perception areas. In sum, as beat gestures typically appear in prosodically prominent positions in the discourse, they serve to highlight important components of the discourse (Kendon, 2004, 2017; McNeill, 1992).

By performing beat gestures, it is reasonable to conjecture then that children are building up their narrative skills (e.g., narrative structure and fluency), since they mark out the important information and the organization of discourse. As McNeill (1992) previously noted, beat gestures "mark information that does not

advance the plot line but provides the structure within which the plot line unfolds" (p. 15) (see also McNeill & Levy, 1993). Thus the use of beat gestures may help children in organizing and framing discourse.

Practice taking on the bodily perspective of discourse structure may enable children to better produce narrative structure. McNeill (1992) also stated that beats are linked to the pragmatic structure and tend to emerge later in development, at around 5–6 years of age. And other studies seem to also corroborate this hypothesis (e.g., Blake et al., 2008; Mathew et al., 2017) by showing that children at this age start performing beat gestures and keep using them as their discourse develops and gets more complex.

Importantly, children use beat gestures to mark important information in speech and mark cohesive and discourse relationships (e.g., Colletta et al., 2015; Colletta et al., 2010).

Interestingly, the discursive role of beat gestures in children's narratives is currently being analyzed in an ongoing longitudinal study with a total of 83 children recorded at two points in development; 5- to 6-year-old children and 7- to 9-year-old children. While narratives at Time 1 consisted of children's pretest retellings in both Study 2 and Study 3 of the present thesis, narratives from the same children were collected two years later (Time 2) by the author of this dissertation. This study is being conducted together with other colleagues in our group (Júlia Florit-

Pons, Patrick Louis Rohrer, and the advisor of this thesis, Dr. Pilar Prieto). Results demonstrate that children increased the use of beat gestures from Time 1 ($n = 90$) to Time 2 ($n = 276$), while they used less iconics at Time 2 ($n = 205$; iconics at Time 1, $n = 117$). Descriptive analyses of the functions children perform in narrative speech reveal that they have both structuring and emphasizing functions in discourse. For example, the top panel in Figure 4 shows a beat gesture performed on a focal content word such as "cotxet" ("stroller"), in order to emphasize the newness of this object. The bottom panel in Figure 4 shows a beat gesture performed on a discourse marker, such as "al final" ("at the end"), to order and sequence the discourse. These examples show that children themselves use both functions (i.e., highlighting new information in discourse and framing discourse functions) in their own narrative discourses. Nevertheless, further research should be conducted to further analyze the development of the pragmatic functions of beat gestures in children's oral narrative speech.

Figure 4. Top panel: example of a beat performed on a focal content word with a focus marking function ("hi havia un **cotxet** [there was a **stroller**]") (**bold** indicates the word associated with the beat). Bottom panel: example of a beat performed on a discourse marker with a discourse marking function ("i **al final** [and **at the end**]"). The points mark position of the hand with the stroke of the gesture being shown in the middle image.

In conclusion, our findings offer important insights to our present knowledge about the role of non-referential beat gestures in discourse. The fact that beat gestures act as important linguistic and

pragmatic anchoring cues within discourse may be at the core of their scaffolding role in helping children frame complex narrative discourses.

5.6 Practical and methodological implications. Limitations and future directions

Research presented in this thesis can yield valuable practical and methodological implications that are important in our understanding of the relationship between gestures, specifically beat gestures, and children's acquisition patterns of complex linguistic skills, such as oral narrative discourse abilities.

Firstly, we would like to emphasize the importance of promoting multimodal narrative abilities not only to teachers and clinicians, but also to families. At school, narrative is a primary genre inside and outside the classroom and it covers all the linguistic skills in one nice package. Given the fact that narratives have academic and social importance, it is important to focus our attention on the development of children's oral language skills, and more specifically on the development of their multimodal narrative skills. While classroom training studies with narratives have been successfully developed with preschool children (e.g., Nicolopoulou, Cortina, Ilgaz, Cates, & de Sá, 2015; Spencer & Slocum, 2010), we claim that more effective intervention should target not only children's speech, but also their gestures and their multimodal behavior. For example, Nicolopoulou et al. (2015) observed that activities combining voluntary storytelling with group story-acting carried out as a regular part of the preschool curriculum can promote the abilities of preschool children from low-income and otherwise disadvantaged backgrounds in three major areas that

contribute to their readiness for success in formal education: narrative and other oral language skills, emergent literacy, and social competence. Spencer and Slocum (2010) also demonstrated that narrative interventions are a promising and effective strategy to teach oral narration to children with risk factors and narrative language delays, who may benefit from it in their short-term and long-term narrative retelling skills.

Second, in educational settings teachers can increasingly use multimodal techniques to help children refine their oral abilities. Building on the results of our training studies and on those of previous studies that have shown that teacher's gestures (i.e., observation) as well as children's own performance (i.e., production) can have positive effects on children's learning processes (e.g., Goldin-Meadow et al., 1999; Goldin-Meadow & Singer, 2003; Singer & Goldin-Meadow, 2005; Valenzano et al., 2003), the use of storytelling abilities which include the use of beat gestures (and also other types of naturalistic gestures) can greatly contribute to building up children's language development. Teachers can think about how they can transmit specific content to their students in the lesson, in order to consciously move their hands and body to reflect key messages. They can also encourage learners to produce gestures during the lesson, as this can help them activate new knowledge and frame discourse structure in the narrative task. Future studies could explore whether classroom narrative interventions, which exploit the potential of gesture-based training with beat gestures (as well as with other gestures), can also have

strong and long-lasting effects on language development. All in all, nonverbal communication expressed in hand movements can be of interest to pedagogical education, as it can reveal the attitudes and motivations of both the teacher and the student, as well as it can also sway students to go deeper to the content of the given message during lessons (e.g., Goldin-Meadow et al., 1999).

Parting from this background, it is worth noting that gesture is an early marker of change and can provide a magnificent tool for both teachers and learners. Specifically, we claim that the findings presented in this dissertation may offer clinicians and speech therapists some guidance, by suggesting the importance of including gestures in their linguistic assessment tasks. Our first study demonstrated that children's early production of beat gestures at early stages in life can predict their narrative abilities when they are older. In this sense, both narrative production and gesture can serve as an index for individual differences in typical development profiles. Paying attention to the gestures learners produce can help professionals determine any existing underlying delays in acquiring more complex linguistic or cognitive skills in populations with atypical development. As gestures are likely to illustrate learner's understanding of the task, not yet evident in their speech, this can help professionals figure out if learners are ready to learn. Also, gestures can help diagnose any existing language or cognitive difficulties (see Cartmill, Demir, & Goldin-Meadow, 2012; Goldin-Meadow, 2015, 2018; Goldin-Meadow & Alibali, 2013, and Goldin-Meadow & Iverson, 2010, for reviews) that result in an

atypical language profile (e.g., children with early brain injury, autism, Down syndrome, etc.) (e.g., Sauer, Levine, & Goldin-Meadow, 2010). In this sense, a better understanding of gesture-speech development could help improve clinical practices regarding children's language assessment and intervention.

A first limitation mentioned in Study 1 was the lack of temporal gesture-speech alignment information in children's naturalistic discourse, as the analysis of the pragmatic functions of children's speech offered no information about the specific parts of the utterances these gestures —beats, flips and iconics— were associated with. Future research on gesture-speech alignment analyses should address in more detail the pragmatic functions that beat, flip and iconic gestures perform in discourse, and how they develop over time. Specifically, it would be interesting to examine the temporal association between co-speech gestures and specific content in speech. Moreover, in general, further analyses regarding children's ability to temporally integrate gesture and speech should be performed.

This thesis also opens the path for future research on the multimodal integration of children's narrative development and co-speech gestures. In order to complement the gesture-speech alignment research, an ongoing project previously mentioned (see section 5.5; together with Júlia Florit-Pons, Patrick Louis Rohrer, and Dr. Pilar Prieto) is currently analyzing children's narrative productions at two time points in development. The main goals of

this study are to deepen our knowledge regarding (a) how the use of beat gestures (along with other types of gestures) evolves over time in children's narrative discourse; and (b) how the temporal integration between gestures and prosodic prominence in speech develops as discourse abilities develop (Mathew et al., 2017).

Likewise, another ongoing longitudinal study using the same data aims at determining whether the gesture rate (and the use of beats) produced in narratives when children are 5–6 years of age can predict better narratives (in terms of narrative structure and fluency scores) when children are 7–9 years old. This study differs from Study 1 of this thesis primarily in the type of data and time frame being analyzed. While gesture production in Study 1 was collected from spontaneous interactions with caregivers, this ongoing study recorded a controlled narrative task at an older age. Similarly, another ongoing study will also test whether the ability to temporally integrate gestures (e.g., beats and iconics) in narrative speech in an adult-fashion at 5–6 years of age is related to children's narrative abilities at the same point in development or later in development (when children are 7 to 9 years old).

Along the same lines for results obtained in Studies 2 and 3, another direction for future research could assess whether children produce more gestures after being asked to observe beat gestures and also after being encouraged to produce them, and their effects on discourse production. A number of studies already provide evidence, for example, that children who were encouraged to

produce gestures in creating novel uses of a word produce more gestures on their own (Kirk & Lewis, 2017; see also Parrill et al., 2018).

To sum up, further research on the abovementioned topics will expand our understanding of the multimodal development of narratives and will provide further insight on the relationship between these abilities and gesture use.

5.7 General conclusion

The present dissertation represents one step forward in the broad goal of understanding the link between the multimodal gesture-speech integration and children's narrative development, specifically focusing on the role of a less-studied gesture, i.e., non-referential beat gesture. One of the main contributions of this work is that non-referential beat gestures can be used to bootstrap children's narrative abilities; thereby they can represent an important tool for learning by building up and framing children's more complex linguistic skills, such as oral language skills. The three studies reported in this thesis contribute in many ways to previous literature by highlighting the communicative role of beat gestures and their important discourse–pragmatic functions in speech. First, results give clear evidence of the predictive value of beat gestures in children's later narrative abilities. Second, results also demonstrate that by incorporating beat gestures in a brief narrative training task with a pretest and an immediate posttest design, children can be provided with higher significant gains in the quality of their subsequent narrative performance. Studying the hand movements that spontaneously accompany narrative speech, as well as examining their contribution through storytelling tasks are necessary steps in yielding a better understanding of how children develop multimodal narrative discourse. Considering that gesture is a powerful embodied form of communication and that beat gestures visually highlight important structuring cues in

discourse, we strongly believe that these gestures can foster the learning of narrative speech by children.

In conclusion, the results of the present thesis provide valuable knowledge to linguists, neuroscientists, developmental psychologists, as well as to prosody and gesture researchers who are interested in how gesture-speech multimodal integration abilities can be of help in developing language. Moreover, the findings can also have methodological and practical implications for teachers interested in how multimodal approaches can contribute to improving children's oral language skills by performing multimodal teaching strategies, as well as for professionals working on the needs of individuals with social or language communication disorders.

References

ABNER, N., COOPERRIDER, K., & GOLDIN-MEADOW, S. (2015). Gesture for Linguists: A Handy Primer. *Language and Linguistics Compass, 9*(11), 437–451. doi: 10.1111/lnc3.12168

ACREDOLO, L. P., & GOODWYN, S. W. (1985). Symbolic gesturing in language development: A case study. *Human Development, 28*(1)*,* 40–49. doi:10.1159/000272934

ACREDOLO, L. P., & GOODWYN, S.W (1988). Symbolic gesturing in normal infants. Child Development, *59*(2), 450–466. doi:10.2307/1130324

ALAMILLO, A. R., COLLETTA, J. M., & GUIDETTI, M. (2013). Gesture and language in narratives and explanations: The effects of age and communicative activity on late multimodal discourse development. *Journal of Child Language, 40*(3), 511–538. doi: 10.1017/S0305000912000062

ALIBALI, M. W., EVANS, J. L., HOSTETTER, A. B., RYAN, K., & MAINELA-ARNOLD, E. (2009). Gesture-speech integration in narrative: Are children less redundant than adults? *Gesture, 9*(3), 290–311. doi:10.1075/gest.9.3.02ali

ALIBALI M. W., HEATH D. C., & MYERS H. J. (2001). Effects of visibility between speaker and listener on gesture production: Some gestures are meant to be seen. *Journal of Memory and Language, 44*(2), 169–188. doi:10.1006/jmla.2000.2752

ALIBALI, M. W., & KITA, S. (2010). Gesture highlights perceptually present information for speakers. *Gesture, 10*(1), 3–28. doi: 10.1075/gest.10.1.02ali

ALIBALI, M. W., KITA, S., & YOUNG, A. J. (2000). Gesture and the process of speech production: We think, therefore we gesture. *Language and Cognitive Processes, 15*(6), 593–613. doi: 10.1080/016909600750040571

ALIBALI, M. W., SPENCER, R. C., KNOX, L., & KITA, S. (2011). Spontaneous gestures influence strategy choices in problem solving. *Psychological Science, 22(*9), 1138–1144. doi: 10.1177/0956797611417722

APARICI, M. (2019). Desarrollo del discurso. In M. Aparici & A. Igualada (Eds.), *El desarrollo del lenguaje y la comunicación en la infancia* (pp. 167–186). Barcelona: Editorial UOC.

APPLEBEE, A. (1978). *The child's concept of story*. Chicago, IL: Chicago Press.

APPLEBEE, A. N. (1980). Children's narratives: New directions. *Reading Teacher, 34*(2), 137–142.

AUSSEMS, S., & KITA. S. (2019). Seeing Iconic Gestures While Encoding Events Facilitates Children's Memory of These Events. *Child Development, 90*(4), 1123–1137. doi: 10.1111/cdev.12988

AUSTIN, E., & SWELLER, N. (2014). Presentation and production: The role of gesture in spatial communication. *Journal of*

262

Experimental Child Psychology, 122(1), 92–103. doi: 10.1016/j.jecp.2013.12.008

AUSTIN, E., & SWELLER, N. (2017). Getting to the elephants: Gesture and preschoolers' comprehension of route direction information. *Journal of Experimental Child Psychology, 163,* 1–14. doi: 10.1016/j.jecp.2017.05.016

Avid Technology, Inc. (2016). Pro Tools 11 [Computer software]. Retrieved from https://www.avid.com/pro-tools

BAILLS, F., ZHANG, Y., & PRIETO, P. (2018). Hand-clapping to the rhythm of newly learned words improves L2 pronunciation: Evidence from Catalan and Chinese learners of French. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 853–857). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-172

BAMBERG, M. (1987). *The acquisition of narratives: Learning to use language*. Berlin: De Gruyter Mouton.

BARSALOU, L. W. (2008) Grounded cognition. *Annual Review of Psychology*, *59*(1), 617–645. doi: 10.1146/annurev.psych.59.103006.093639

BARSALOU, L.W. (2010). Grounded cognition: Past, Present, and Future. *Topics in Cognitive Science, 2*(4)*,* 716–724. doi: 10.1111/j.1756-8765.2010.01115.x

BARSALOU, L. W., NIEDENTHAL, P. M., BARBEY, A. K., & RUPPERT, J. A. (2003). Social embodiment. In B. H. Ross (Ed.), *The*

psychology of learning and motivation: Advances in research and theory (Vol. 43, pp. 43–92). Elsevier Science.

BARTZ, D. T. (2017). *Young children's meta-ignorance*. EdD thesis (Harvard University, Cambridge, MA).

BATES, E. (1976). *Language and context*. New York: Academic Press.

BATES, E., BENIGNI, L., BRETHERTON, I., CAMAIONI, L., & VOLTERRA, V. (1979). *The emergence of symbols: Cognition and communication in infancy*. New York: Academic Press.

BAVELAS, J. B., CHOVIL, N., LAWRIE, D. A., & WADE, A. (1992). Interactive gestures. *Discourse Processes, 15*(4)*,* 469–489. doi: 10.1080/01638539209544823

BAVIN, E. (2014). Gestures in Communicative Development (Overview). In P. Brooks & V. Kampe (Eds.), *Encyclopedia of Language Development* (pp. 248–252). Thousand Oaks, CA: SAGE.

BEATTIE, G., & COUGHLAN, J. (1999). An experimental investigation of the role of iconic gestures in lexical access using the tip-of-the-tongue phenomenon. *British Journal of Psychology*, *90*(1), 35–56. doi: 10.1348/000712699161251

BEAUPOIL-HOURDEL, P., MORGENSTERN, A., & BOUTET, D. (2015). A child's multimodal negations from 1 to 4: The interplay between modalities. In P. Larrivée & C. Lee (Eds.), *Negation and Polarity: Experimental Perspectives. Language, Cognition, and Mind* (Vol. 1, pp. 95–123).

Springer, Cham. doi: 10.1007/978-3-319-17464-8_5

BEHNE, T., LISZKOWSKI, U., CARPENTER, M., & TOMASELLO, M. (2012). Twelve-month-olds' comprehension and production of pointing. *British Journal of Developmental Psychology*, *30*(3), 359–375. doi:10.1111/j.2044-835X.2011.02043.x

BEILOCK, S. L., & GOLDIN-MEADOW, S. (2010). Gesture changes thought by grounding it in action. *Psychological Science, 21*(11), 1605–1610. doi: 10.1177/0956797610385353

BERMAN, R.A. (1988). On the ability to relate events in narrative. *Discourse Processes*, *11*(4), 469–497. doi: 10.1080/01638538809544714

BERMAN, R. (1998). Typological perspectives on connectivity. In N. Dittmar & Z. Penner (Eds.), *Issues in the Theory of Language Acquisition* (pp. 203–224). Bern: Peter Lang.

BERMAN, R. A., & SLOBIN, D. I. (1994). *Relating events in narrative: A crosslinguistic developmental study*. Hillsdale: Lawrence Erlbaum Associates.

BERNARDIS, P., & GENTILUCCI, M. (2006). Speech and gesture share the same communication system. *Neuropsychologia, 44*(2), 178–190. doi: 10.1016/j.neuropsychologia.2005.05.007

BIAU, E., FERNÁNDEZ, L. M., HOLLE, H., AVILA, C., & SOTO-FARACO, S. (2016). Hand gestures as visual prosody: BOLD responses to audio–visual alignment are modulated by the communicative nature of the stimuli. *Neuroimage, 132*, 129–137. doi: 10.1016/j.neuroimage.2016.02.018

BIAU, E., & SOTO-FARACO, S. (2013). Beat gestures modulate auditory integration in speech perception. *Brain & Language, 124*(2), 143–152. doi : 10.1016/j.bandl.2012.10.008

BLAKE, J., MYSZCZYSZYN, D., JOKEL, A., & BEBIROGLU, N. (2008). Gestures accompanying speech in specifically language-impaired children and their timing with speech. *First Language, 28*(2), 237–253. doi: 10.1177/0142723707087583

BLONDER, L. X., BURNS, A. F., BOWERS, D., MOORE, R. W., & HEILMAN, K. M. (1995). Spontaneous gestures following right hemisphere infarct. *Neuropsychologia, 33*(2), 203–213. doi: 10.1016/0028-3932(94)00099-B

BOERSMA, P., & WEENINK, D. (2016). Praat: Doing phonetics by computer (Version 6.0.23) [Computer Software]. Retrieved from http://www.praat.org/

BONACINA, S., CANCER, A., LANZI, P. L., LORUSSO, M. L., & ANTONIETTI, A. (2015). Improving reading skills in students with dyslexia : the efficacy of a sublexical training with rhythmic background. *Frontiers in Psychology, 6*(1510)*,* 1–8. doi: 1 0.3389/fpsyg.2015.01510

BORGHI, A. M., & CARUANA, F. (2015). Embodiment Theory. In J. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 420–426). Amsterdam: Elsevier. doi: 10.1016/B978-0-08-097086-8.56025-5

BOSCH, L., & SEBASTIÁN-GALLÉS, N. (2001). Evidence of early language discrimination abilities in infants from bilingual environments. *Infancy*, *2*(1), 29–49. doi: 10.1207/S15327078IN0201_3

BRANDOM, R. B. (1983). Asserting. *Noûs, 17*, 637–650. doi: 10.2307/2215086.

BROADERS, S. C., COOK, S. W., MITCHELL, Z., & GOLDIN-MEADOW, S. (2007). Making children gesture brings out implicit knowledge and leads to learning. *Journal of Experimental Psychology: General*, *136*(4), 539–550. doi: 10.1037/0096-3445.136.4.539

BRODSKY, W., & SULKIN, I. (2011). Handclapping songs: A spontaneous platform for child development among 5-10-year-old children. *Early Child Development and Care, 181*(8), 1111–1136. doi: 10.1080/03004430.2010.517837

BROOKS, N., & GOLDIN-MEADOW, S. (2016). Moving to Learn: How Guiding the Hands Can Set the Stage for Learning. *Cognitive Science, 40*(7), 1831–1849. doi: 10.1111/cogs.12292

BUTCHER, C., & GOLDIN-MEADOW, S. (2000). Gesture and the transition from one- to two-word speech: When hand and mouth come together. In D. McNeill (Ed.), *Language and gesture* (pp. 235– 258). Cambridge: Cambridge University Press.

BUTTERWORTH, B. L., & BEATTIE, G. W. (1978). Gesture and

Silence as Indicators of Planning in Speech. In R. N. Campbell & P. T. Smith (Eds.), *Recent Advances in the Psychology of Language: Formal and Experimental Approaches* (pp. 347–360). New York: Plenum.

BUTTERWORTH, B., & HADAR, U. (1989). Gesture, speech, and computational stages: A reply to McNeill. *Psychological Review, 96*(1), 168–174. doi: 10.1037/0033-295X.96.1.168

BUTTERWORTH, B., SWALLOW, J., & GRIMSTON, M. (1981). Gestures and Lexical Processes in Jargonaphasia. In J.W. Brown (Ed.), *Jargonaphasia* (p. 113–124). New York, Academic Press. doi: 10.1016/C2013-0-07219-2

BYRD, C. E., MCNEIL, N. M., D'MELLO, S. K., & COOK, S. W. (2014). Gesturing may not always make learning last. In P. Bello, M. Guarini, M. McShane, & B. Scassellati (Eds.), *Proceedings of the 36th Annual Conference of the Cognitive Science Society* (pp. 1982–1987). Austin, TX: Cognitive Science Society.

CAIN, K., & OAKHILL, J. (2003). Reading Comprehension Difficulties. In T. Nunes & P. Bryant (Eds.), *Handbook of Children's Literacy* (pp. 313–338). The Netherlands: Kluwer Academic Publishers.

CAMERON, H., & XU, X. (2011). Representational gesture, pointing gesture, and memory recall of preschool children. *Journal of Nonverbal Behavior, 35*(2), 155–171. doi: 10.1007/s10919-010-0101-2.

CARTMILL, E. A., DEMIR, Ö. E., & GOLDIN-MEADOW, S. (2012). Studying gesture. In E. Hoff (Ed.), *Research methods in child language: a practical guide* (pp. 208–225). Blackwell Publishing.

CASASANTO, D. (2009). Embodiment of abstract concepts: good and bad in right- and lest-handers. *Journal of Experimental Psychology: General, 138*(3), 351–367. doi: 10.1037/a0015854

CASASANTO, D. (2011). Different Bodies, Different Minds: The Body Specificity of Language and Thought. *Current Directions in Psychological Science*, *20*(6), 378–383. doi:10.1177/0963721411422058

CHERDIEU, M., PALOMBI, O., GERBER, S., TOCCAZ, J., & ROCHET-CAPELLAN, A. (2017). Make Gestures to Learn: Reproducing Gestures Improves the Learning of Anatomical Knowledge More than Just Seeing Gestures. *Frontiers in Psychology, 8*(1689), 1–15. doi: 10.3389/fpsyg.2017.01689

CHU, M., & KITA, S. (2011). The Nature of Gestures' Beneficial Role in Spatial Problem Solving. *Journal of Experimental Psychology, 140*(1), 102–116. doi: 10.1037/a0021790

CIENKI, A., & MÜLLER, C. (2008). Metaphor, gesture, and thought. In R. W. Gibbs, Jr. (Ed.), *The Cambridge handbook of metaphor and thought* (pp. 483–501). Cambridge: Cambridge University Press. doi: 10.1017&CBO9780511816802.029

CLARK, H. H. (1996). *Using language*. Cambridge, UK: Cambridge University Press.

COCKS, N., MORGAN, G., & KITA, S. (2011). Iconic gesture and speech integration in younger adults and older adults. *Gesture, 11*(1), 24–39. doi: 10.1075/gest.11.1.02coc

COLE, J. (2015). Prosody in context: a review. *Language, Cognition and Neuroscience*, *30*(1–2), 1–31. doi: 10.1080/23273798.2014.963130

COLLETTA, J. M. (2009). Comparative analysis of children's narratives at different ages: A multimodal approach. *Gesture*, *9*(1), 61–69. doi: 10.1075/gest.9.1.03col

COLLETTA, J. M., GUIDETTI, M., CAPIRCI, O., CRISTILLI, C., DEMIR, Ö. E., KUNENE-NICOLAS, R. N., & LEVINE, S. (2015). Effects of age and language on co-speech gesture production: an investigation of French, American, and Italian children's narratives. *Journal of Child Language*, *42*(1), 122–145. doi: 10.1017/S0305000913000585

COLLETTA, J. M., PELLENQ, C., & GUIDETTI, M. (2010). Age-related changes in co-speech gesture and narrative: evidence from French children and adults. *Speech Communication*, *52*(6), 565–576. doi: 10.1016/j.specom.2010.02.009

COLONNESI, C., STAMS, G. J. J. M., KOSTER, I., & NOOM, M. J. (2010). The relation between pointing and language development: A meta-analysis. *Developmental Review, 30*(4), 352–366. doi: 10.1016/j.dr.2010.10.001

CONGDON, E. L., NOVACK, M. A., BROOKS, N., HEMANI-LOPEZ, N., O'KEEFE, L., & GOLDIN-MEADOW, S. (2017). Better together: Simultaneous presentation of speech and gesture in math instruction supports generalization and retention. *Learning and Instruction, 50,* 65–74. doi: 10.1016/j.learninstruc.2017.03.005

COOK, S. W., & GOLDIN-MEADOW, S. (2006). The Role of Gesture in Learning: Do Children Use Their Hands to Change Their Minds? *Journal of Cognition and Development, 7*(2), 211–232. doi: 10.1207/s15327647jcd0702_4

COOK, S. W., MITCHELL, Z., & GOLDIN-MEADOW, S. (2008). Gesturing makes learning last. *Cognition, 106*(2), 1047–1058. doi: 10.1016/j.cognition.2007.04.010

COOK, S. W., YIP, T. K., & GOLDIN-MEADOW, S. (2010). Gesturing makes memories that last. *Journal of Memory and Language, 63*(4), 465–475. doi: 10.1016/j.jml.201.07.002

COOK, S. W., YIP, T. K., & GOLDIN-MEADOW, S. (2012). Gestures, but not meaningless movements, lighten working memory load when explaining math. *Language and Cognitive Processes, 27*(4), 594–610. doi: 10.1080/01690965.2011.567074

COOPERRIDER, K., ABNER, N., & GOLDIN-MEADOW, S. (2018). The Palm-Up Puzzle: Meanings and Origins of a Widespread Form in Gesture and Sign. *Frontiers in Communication, 3*(23), 1–16. doi: 10.3389/fcomm.2018.00023

CRAVOTTA, A., BUSÀ, M. G., & PRIETO, P. (2019). Effects of Encouraging the Use of Gestures on Speech. *Journal of Speech, Language, and Hearing Research*, *62*(9), 3204–3219. doi: 10.1044/2019_JSLHR-S-18-0493

DARGUE, N., & SWELLER, N. (2018a). Donald Duck's garden: the effects of observing iconic reinforcing and contradictory gestures on narrative comprehension. *Journal of Experimental Child Psychology*, *175*, 96–107. doi: 10.1016/j.jecp.2018.06.004.

DARGUE, N., & SWELLER, N. (2018b). Not all gestures are created equal: the effects of typical and atypical iconic gestures on narrative comprehension. *Journal of Nonverbal Behavior*, *42*(3), 327–345. doi: 10.1007/s10919-018-0278-3.

DARGUE, N., & SWELLER, N. (2020a). Learning Stories Through Gesture: Gesture's Effects on Child and Adult Narrative Comprehension. *Educational Psychology Review*, *32*(1), 249–276. doi: 10.1007/s10648-019-09505-0

DARGUE, N., & SWELLER, N. (2020b). Two hand and a tale: When gestures benefit adult narrative comprehension. *Learning and Instruction*, *68*, 101331. doi: 10.1016/j.learninstruc.2020.101331

DAVIES, P., SHANKS, B., & DAVIES, K. (2004). Improving narrative skills in young children with delayed language development. *Educational Review, 56*(3), 271–286. doi: 10.1080/0013191042000201181

DEMIR, Ö. E., FISHER, J. A., GOLDIN-MEADOW, S., & LEVINE, S. C. (2014). Narrative processing in typically developing children and children with early unilateral brain injury: Seeing gesture matters. *Developmental Psychology, 50*(3), 815–828. doi: 10.1037/a0034322

DEMIR, Ö. E., & KÜNTAY, A. (2014). Narrative Development. In P. Brooks & V. Kampe (Eds.), *Encyclopedia of Language Development* (pp. 393–397). Thousand Oaks, CA: SAGE.

DEMIR, Ö. E., LEVINE, S. C., & GOLDIN-MEADOW, S. (2010). Narrative skill in children with early unilateral brain injury: a possible limit to functional plasticity. *Developmental Science, 13*(4), 636–647. doi:10.1111/j.1467-7687.2009.00920.x

DEMIR, Ö. E., LEVINE, S. C., & GOLDIN-MEADOW, S. (2012). Getting on track early for school success: The STEP assessment system to support effective instruction (PreK-3rd). Creating an assessment of literacy skills for three and four year olds. *Foundation for Child Development*. Retrieved from http://fcd-us.org/sites/default/files/Lit%20Tech%20Report.pdf

DEMIR, Ö. E., LEVINE, S. C., & GOLDIN-MEADOW, S. (2015). A tale of two hands: children's early gesture use in narrative production predicts later narrative structure in speech. *Journal of Child Language, 42*(3), 662–681. doi: 10.1017/S0305000914000415

DEMIR, Ö. E., ROWE, M. L., HELLER, G., GOLDIN-MEADOW, S., & LEVINE, S. C. (2015). Vocabulary, syntax, and narrative development in typically developing children and children with early unilateral brain injury: early parental talk about the "there-and-then" matters. *Developmental Psychology*, *51*(2), 161–175. doi: 10.1037/a0038476

DIMITROVA, D., CHU, M., WANG, L., ÖZYÜREK, A., & HAGOORT, P. (2016). Beat that word: how listeners integrate beat gesture and focus in multimodal speech discourse. *Journal of Cognitive Neuroscience, 28*(9), 1255–1269. doi: 10.1162/jocn_a_00963

DUINMEIJER, I., DE JONG, J., & SCHEPER, A. (2012). Narrative abilities, memory and attention in children with a specific language impairment. *International Journal of Language & Communication Disorders, 47*(5), 542–555. doi: 10.1111/j.1460-6984.2012.00164.x

EFRON, D. (1941). *Gesture and environment*. Morningside Heights, NY: King's Crown Press.

EKMAN, P., & FRIESEN, W. V. (1969). The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica*, *1*(1), 49–98. doi: 10.1515/semi.1969.1.1.49

ESTEVE-GIBERT, N., BORRÀS-COMES, J., ASOR, E., SWERTS, M., & PRIETO, P. (2017). The timing of head movements: The role of prosodic heads and edges. *The Journal of the Acoustical Society of America, 141*(6), 4727–4739. doi: 10.1121/1.49866649

ESTEVE-GIBERT, N., & PRIETO, P. (2013). Prosodic structure shapes the temporal realization of intonation and manual gesture movements. *Journal of Speech, Language, and Hearing Research*, *56*(3), 850–864. doi: 10.1044/1092-4388(2012/12-0049)

ESTEVE-GIBERT, N., & PRIETO, P. (2014). Infants temporally coordinate gesture-speech combinations before they produce their first words. *Speech Communication*, *57*, 301–316. doi: 10.1016/j.specom.2013.06.006

FAUL, F., ERDFELDER, E., BUCHNER, A., & LANG, A.-G. (2009). Statistical power analyses using G_Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods, *41*(4), 1149–1160. doi: 10.3758/BRM.41.4.1149

FAZIO, B. B., NAREMORE, R. C., & CONNELL, P. J. (1996). Tracking children from poverty at risk for specific language impairment: A 3-year longitudinal study. *Journal of Speech and Hearing Research*, *39*(3), 611–624. doi: doi:10.1044/jshr.3903.611

FEAGANS, L., & APPELBAUM, M. I. (1986). Validation of language subtypes in learning disabled children. *Journal of Educational Psychology*, *78*(5), 358–364. doi: 10.1037/0022-0663.78.5.358

FERRÉ, G. (2009). Gesture catchments and density in narratives of personal experience. *GESPIN* (pp. 1–7). Poznan: Poland. hal-00488990

FERRÉ, G. (2011). Functions of three open-palm hand gestures. *Journal Multimodal Communication*, *1*(1), 5–20. doi: 10.1515/mc-2012.0002

FERRÉ, G. (2018). Gesture/speech integration in the perception of prosodic emphasis. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 35–39). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-7

FEYEREISEN, P. (2006). Further investigation on the mnemonic effect of gestures: Their meaning matters. *European Journal of Cognitive Psychology*, *18*(2), 185–205. doi: 10.1080/09541440540000158

FRANÇOIS, C., GRAU-SÁNCHEZ, J., DUARTE, E., & RODRÍGUEZ-FORNELLS, A. (2015). Musical training as an alternative and effective method for neuro-education and neuro-rehabilitation. *Frontiers in Psychology*, *6*(475), 1–15. doi: 10.3389/fpsyg.2015.00475

FREEDMAN, N., & HOFFMAN, S. P. (1967). Kinetic behaviour in altered clinical states: approach to objective analysis of motor behaviour during clinical interviews. *Perceptual and Motor Skills, 24*(2), 527–539. doi: 10.2466/pms.1967.24.2.527

GLUHAREVA, D., & PRIETO, P. (2017). Training with rhythmic beat gestures benefits L2 pronunciation in discourse-demanding situations. *Language Teaching Research, 21*(5), 609–631. doi: 10.1177/1362168816651463

GOLDIN-MEADOW, S. (2003). *Hearing gesture: how our hands help us think*. Cambridge, MA: Beknap Press of Harvard University Press.

GOLDIN-MEADOW, S. (2009). How gesture promotes learning throughout childhood. *Child Development Perspectives, 3*(2), 106–111. doi: 10.1111/j1750-8606.2009.00088.x.

GOLDIN-MEADOW, S. (2014). How gesture works to change our minds. *Trends in Neuroscience and Education, 3*(1), 4–6. doi: 10.1016/j.tine.2014.01.002

GOLDIN-MEADOW, S. (2015). Gesture as a window onto communicative abilities: Implications for diagnosis and intervention. *Perspectives on Language Learning and Education, 22*(2), 50–60. doi: 10.1044/lle22.2.50

GOLDIN-MEADOW, S. (2018). Taking a Hands-on Approach to Learning. *Policy insights from the Behavioral and Brain Sciences, 5*(2), 163–170. doi: 10.1177/2372732218785393

GOLDIN-MEADOW, S., & ALIBALI, M. W. (2013). Gesture's role in speaking, learning, and creating language. *Annual Review of Psychology, 64*(1), 257–283. doi: 10.1146/annurev-psych-113011-143802

GOLDIN-MEADOW, S., & BUTCHER, C. (2003). *Pointing toward two-word speech in young children.* In S. Kita (Ed.), *Pointing: Where language, culture, and cognition meet* (pp. 85–107). Hillsdale, NJ: Lawrence Erlbaum Associates.

GOLDIN-MEADOW, S., COOK, S. W., & MITCHELL, Z. A. (2009). Gesturing gives children new ideas about math. *Psychological Science, 20*(3), 267–272. doi:10.1111/j.1467-9280.2009.02297.x

GOLDIN-MEADOW, S., & IVERSON, J. M. (2010) Gesturing across the life span. In W. F. Overton & R. M. Lerner (Eds.), *The handbook of life-span development. Cognition, biology, and methods* (Vol. 1, p. 754–791). John Willey & Sons Inc. doi: 10.1002/9780470880166.hlsd001021

GOLDIN-MEADOW, S., KIM, S., & SINGER, M. (1999). What the teacher's hands tell the student's mind about math. *Journal of Educational Psychology, 91*(4), 720–730. doi: 10.1037/0022-0663.91.4.720

GOLDIN-MEADOW, S., LEVINE, S. C., HEDGES, L. V., HUTTENLOCHER, J., RAUDENBUSCH, S. W, & SMALL, S. L. (2014). New evidence about language and cognitive development based on a longitudinal study: hypotheses for intervention. *American Psychologist, 69*(6), 588–599. doi: 10.1037/a0036886

GOLDIN-MEADOW, S., LEVINE, S. C., ZINCHENKO, E., YIP, T. K., HEMANI, N., & FACTOR, L. (2014). Doing gesture promoted learning a mental transformation task better than seeing gesture. *Developmental Science, 15*(6), 876–884. doi: 10.1111/j1467-7687.2012.01185.x.

GOLDIN-MEADOW, S., NUSBAUM, H., KELLY, S. D., & WAGNER, S. (2001). Explaining math: Gesture lightens the load.

278

Psychological Science, 12(6), 516–522. doi: 10.1111/1467-9280.00395

GOLDIN-MEADOW, S., & SINGER, M. (2003). From children's hands to adults' ears: Gesture's role in teaching and learning. *Developmental Psychology, 39*(3), 509–520. doi: 10.1037/0012-1649.39.4.509

GOLDIN-MEADOW, S., & WAGNER, S. (2005). How our hands help us learn. *Trends in Cognitive Sciences, 9*(5), 234–241. doi: doi:10.1016/j.tics.2005.03.006

GRAHAM, J. A., & HEYWOOD, S. (1975). The effects of elimination of hand gesture and of verbal codability on speech performance. *European Journal of Social Psychology, 5*(2), 189–195. doi: 10.1002/ejsp.2420050204

GRAZIANO, M. (2014a). The development of two pragmatic gestures of the so-called *Open Hand Supine family* in Italian children. In M. Seyfeddinipur & M. Gullberg (Eds.), *From Gesture in Conversation to Visible Action as Utterance: Essays in honor of Adam Kendon* (pp. 311–330). John Benjamins Publishing Company. doi: 10.1075/z.188.14gra

GRAZIANO, M. (2014b). Gestures in Southern Europe: Children's pragmatic gestures in Italy. In C. Müller, A. Cienki, E. Fricke, S. H. Ladewig, D. McNeill, & J. Bressem (Eds.), *Body – Language – Communication: An International Handbook on Multimodality in Human Interaction* (Vol. 2, pp. 1253–1258). Berlin: De Gruyter Mouton.

GRAZIANO, M., & GULLBERG, M. (2018). When Speech Stops, Gesture Stops: Evidence From Developmental and Crosslinguistic Comparisons. *Frontiers in Psychology, 9*(879), 1–17. doi: 10.3389/fpsyg.2018.00879

GREENFIELD, PM., & SMITH, JH. (1976). *The structure of communication in early language development*. New York: Academic Press.

GRIFFIN, T. M., HEMPHILL, L., CAMP, L., & WOLF, D. P. (2004). Oral discourse in the preschool years and later literacy skills. *First Language*, *24*(2), 123–147. doi: 10.1177/0142723704042369

GUIDETTI, M. (2002). The emergence of pragmatics: Forms and functions of conventional gestures in young French children. *First Language*, *22*(3), 265–285. doi:10.1177/014272370202206603

GUIDETTI, M. (2005). Yes or no? How young French children combine gestures and speech to agree and refuse. Journal of Child Language, *32*(4), 911–924. doi:10.1017/S0305000905007038

GULLBERG, M., VOLTERRA, V., & DE BOT, K. (2008). Gestures and some key issues in the study of language development. *Gesture, 8*(2), 149–179. doi: 10.1075/gest.8.2.03gul

HARRIS, P., L., BARTZ, D. T., & ROWE, M. L. (2017). Young children communicate their ignorance and ask questions. *Proceedings of the National Academy of Sciences of the*

United States of America, 114(30), 7884–7891. doi: 10.1073/pnas.1620745114

HIRATA, Y., & KELLY, S. D. (2010). Effects of Lips and Hands on Auditory Learning of Second-Language Speech Sounds. *Journal of Speech, Language, and Hearing Research, 53*(2), 298–310. doi: 10.1044/1092-4388(2009/08-0243)

HOLLE, H., OBERMEIER, C., SCHMIDT-KASSOW, M., FRIEDERICI, A.D., WARD, J., & GUNTER, T. C. (2012). Gesture facilitates the syntactic analysis of speech. *Frontiers in Psychology, 3*(74), 1–12. doi: 10.3389/fpsyg.2012.00074

HOSTETTER, A. B. (2011). When do gestures communicate? A meta-analysis. *Psychological Bulletin*, *137*(2), 297–315. doi: 10.1037/a0022128

HOSTETTER, A. B., & ALIBALI, M. W. (2007). Raise your hand if you're spatial: relations between verbal and spatial skills and gesture production. *Gesture, 7*(1), 73–95. doi: 101075/gest.7.1.05hos

HOSTETTER, A. B., & ALIBALI, M. W. (2008). Visible embodiment: Gestures as simulated action. *Psychonomic Bulletin & Review, 15*(3), 495–514. doi: 10.3758/PBR.15.3.495

HOSTETTER, A. B., & ALIBALI, M. W. (2010). Language, gesture, action! A test of the Gesture as Simulated Action framework. *Journal of Memory and Language, 63*(2), 145–257. doi: 10.1016/j.jml.2010.04.003

HOSTETTER, A. B., & ALIBALI, M. W. (2019). Gesture as simulated action: Revisiting the framework. *Psychonomic Bulletin & Review, 26*(3), 721–752. doi: 10.3758/s13423-018-1548-0

HOSTETTER, A., & MAINELA-ARNOLD, E. (2015). Gestures Occur With Spatial and Motoric Knowledge: It's More than Just Coincidence. *Perspectives on Language Learning and Education, 22*(2), 42–49. doi: 10.1044/lle22.2.42

HOWE, A., & JOHNSON, J. (Eds.). (1992). *Common bonds: storytelling in the classroom*. London: Hodder & Stoughton.

HUBBARD, A. L., WILSON, S. M., CALLAN, D. E., & DAPRETTO, M. (2009). Giving speech a hand: gesture modulates activity in auditory cortex during speech perception. *Human Brain Mapping*, *30*(3), 1028–1037. doi: 10.1002/hbm.20565

IGUALADA, A., BOSCH, L., & PRIETO, P. (2015). Language development at 18 months is related to multimodal communicative strategies at 12 months. *Infant Behavior and Development, 39,* 42–52. doi: 10.1016/j.infbeh.2015.02.004

IGUALADA, A., ESTEVE-GIBERT, N., & PRIETO, P. (2017). Beat gestures improve word recall in 3- to 5-year-old children. *Journal of Experimental Child Psychology*, *156,* 99–112. doi: 10.1016/j.jecp.2016.11.017

IM, S., & BAUMANN, S. (2020). Probabilistic relation between co-speech gestures, pitch accents and information status. *Proceedings of the Linguistic Society of America, 5*(1), 685–697. doi: 10.3765/plsa.v5i1.4755

IONESCU, T., & VASC, D. (2014). Embodied cognition: challenges for psychology and education. *Porcedia – Social and Behavioral Sciences, 128,* 275–280. doi: 10.1016/j.sbspro.2014.03.156

ISAACS, T., & TROFIMOVICH, P. (2011). Phonological memory, attention control, and musical ability: Effects of individual differences on rater judgments of second language speech. *Applied Psycholinguistics, 32*(1), 113–140. doi: 10.1017/S0142 71641 0000317

IVERSON, J. M., CAPIRCI, O., & CASELLI, M. C. (1994). From communication to language in two modalities. *Cognitive Development, 9*(1)*,* 23–43. doi: 10.1016/0885-2014(94)90018-3

IVERSON, J. M., CAPIRCI, O., VOLTERRA, V., & GOLDIN-MEADOW, S. (2008). Learning to talk in a gesture-rich world: early communcaton in Italian vs. American children. *First Language, 28*(2), 164–181. doi: 10.1177/0142723707087736

IVERSON, J. M., & GOLDIN-MEADOW, S. (2005). Gesture paves the way for language development. *Psychological Science, 16*(5), 368–371. doi: 10.1111/j.0956-7976.2005.01542.x

JENKINS, T., COPPOLA, M., & COELHO, C. (2017). Effects of gesture restriction on quality of narrative production. *Gesture, 16*(3), 416–431. doi: 10.1075/gest.00003.jen

KARMILOFF-SMITH, A. (1986). Some fundamental aspects of language development after age 5. In P. Fletcher & M. Garman (Eds.), *Language Acquisition* (pp. 455–474). Cambridge: CUP.

KARTALKANAT, H., & GÖKSUN, T. (2020). The effects of observing different gestures during storytelling on the recall of path and event information in 5-year-olds and adults. *Journal of Experimental Child Psychology, 189,* 104725. doi: 10.1016/j.jecp.2019.104725

KELLY, S. D. (2001). Broadening the units of analysis in communication: speech and nonverbal behaviours in pragmatic comprehension. *Journal of Child Language*, *28*(2), 325–349. doi: 10.1017/S0305000901004664

KELLY, S. D., BARR, D., CHURCH, B., & LYNCH, K. (1999). Offering a Hand to Pragmatic Understanding: The Role of Speech and Gesture in Comprehension and Memory. *Journal of Memory and Language*, *40*(4), 577–592. doi: 10.1006/jmla.1999.2634

KELLY, S. D., MANNING, S. M., & RODAK, S. (2008). Gesture Gives a Hand to Language and Learning: Perspectives from Cognitive Neuroscience, Developmental Psychology and Education. *Language and Linguistics Compass, 2*(4), 569–588. doi: 10.1111/j.1749-818x.2008.00067.x

KELLY, S. D., MCDEVITT, T., & ESCH, M. (2009). Brief training with co-speech gesture lends a hand to word learning in a foreign

language. *Language and Cognitive Processes, 24*(2), 313–334. doi: 10.1080/01690960802365567

KELLY, S. D., ÖZYÜREK, A., & MARIS, E. (2010). Two Sides of the Same Coin: Speech and Gesture Mutually Interact to Enhance Comprehension. *Psychological Science*, *21*(2), 260–267. doi: 10.1177/0956797609357327

KENDEOU, P., VAN DEN BROEK, P., WHITE, M., & LYNCH, J. (2007). Preschool and early elementary comprehension: Skill development and strategy interventions. In D. S. McNamara (Ed.), *Reading comprehension strategies: Theories, Interventions, and Technologies* (pp. 27–45). Mahwah, NJ: Erlbaum.

KENDEOU, P., VAN DEN BROEK, P., WHITE, M. J., & LYNCH, J. (2009). Predicting Reading Comprehension in Early Elementary School: The Independent Contributions of Oral Language and Decoding Skills. *Journal of Educational Psychology*, *101*(4), 765–778. doi: 10.1037/a0015956

KENDON, A. (1980). Gesticulation and speech: two aspects of the process of utterance. In M. R. Key (Ed.), *The Relationship of Verbal and Nonverbal Communication* (pp. 207–227). Berlin: De Gruyter Mouton.

KENDON, A. (1982). The study of gesture: some observations on its history. *Recherches Sémiotiques/Semiotic Inquiry, 2*(1), 45–62. doi: 10.1075/gest.16.2.01ken

KENDON, A. (1995). Gestures as illocutionary and discourse structure markers in Southern Italian conversation. *Journal of Pragmatics, 23*(3), 247–279. doi: 10.1016/0378-2166(94)00037-F

KENDON, A. (2004). *Gesture: Visible Action as Utterance.* Cambridge: Cambridge University Press.

KENDON, A. (2017). Pragmatic functions of gestures. Some observations on the history of their study and their nature. *Gesture, 16*(2), 157–175. doi: 10.1075/gest.16.2.01ken

KENNEDY, S., & TROFIMOVICH, P. (2008). Intelligibility, comprehensibility and accentedness of L2 speech: The role of listener experience and semantic context. *Canadian Modern Language Review, 64*(3), 459–489. doi: 10.3138/cmlr.64.3.459

KIDD, E., & HOLLER, J. (2009). Children's use of gesture to resolve lexical ambiguity. *Developmental Science, 12*(6), 903–913. doi: 10.1111/j.1467-7687.2009.00830.x

KIEFER, M., & TRUMPP, N. M. (2012). Embodiment theory and education: The foundations of cognition in perception and action. *Trends in Neuroscience and Education, 1*(1), 15–20. doi: http://doi.org/10.1016/j.tine.2012.07.002

KIRK, E., & LEWIS, C. (2017). Gesture Facilitates Children's Creative Thinking. *Psychological Science, 28*(2), 225–232. doi: 10.1177/0956797616679183

KITA, S. (2000). How representational gestures help speaking. In D. McNeill (Ed.), *Language and Gesture* (pp. 162–185). Cambridge, UK: Cambridge Univ. Press.

KITA, S., ALIBALI, M. W., & CHU, M. (2017). How do gestures influence thinking and speaking? The gesture-for-conceptualization hypothesis. *Psychological Review, 124*(3), 245–266. doi: 10.1037/rev0000059

KITA, S., & ÖZYÜREK, A. (2003). What does cross-linguistic variation in semantic coordination of speech and gesture reveal?: Evidence for an interface representation of spatial thinking and speaking. *Journal of Memory and Language, 48*(1)*,* 16–32. doi: 0.1016/S0749-596X(02)00505-3

KRAHMER, E., & SWERTS, M. (2007). The effects of visual beats on prosodic prominence: Acoustic analyses, auditory perception and visual perception. *Journal of Memory and Language*, *57*(3), 396–414. doi: 10.1016/j.jml.2007.06.005

KRAUSS, R. M., CHEN, Y., & GOTTESMAN, R. F. (2000). Lexical gestures and lexical access: a process model. In D. McNeill (Ed.), *Language and Gesture* (Language Culture and Cognition, pp. 261–283). Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511620850.017

KRIFKA, M. (2015). Bias in Commitment Space Semantics: Declarative questions, negated questions, and question tags. In S. D'Antonio, M. Moroney, & C. Rose Little (Eds.), *Proceedings of the 25th Semantics and Linguistic Theory Conference* (pp. 328–345). Stanford, CA. doi: 10.3765/salt

KUSHCH, O., IGUALADA, A., & PRIETO, P. (2018). Prominence in speech and gesture favour second language novel word learning. *Language, Cognition and Neuroscience, 33*(8), 992–1004. doi: 10.1080/23273798.2018.1435894

KUSHCH, O., & PRIETO, P. (2016). The effects of pitch accentuation and beat gestures on information recall in contrastive discourse. In J. Barnes, A. Brugos, S. Shattuck-Hufnagel, & N. Veilleux (Eds.), *Speech Prosody 2016* (pp. 922–925). Boston, United States of America. International Speech Communication Association. doi: 10.21437/SpeechProsody.2016-189

LEONARD, T., & CUMMINS, F. (2011). The temporal relation between beat gestures and speech. *Language and Cognitive Processes, 26*(10), 1457–1471. doi: 10.1080/01690965.2010.500218

LEVELT, W. J. M. (1989). *Speaking: From intention to articulation.* Cambridge: MIT Press.

LEVINSON, S. C., & HOLLER, J. (2014). The origin of human multimodal communication. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 369*(1651): 20130302. doi: 10.1098/rstb.2013.0302

LEVY, E. T., & MCNEILL, D. (2013). Narrative development as symbol formation: Gestures, imagery and the emergence of cohesion. *Culture and Psychology, 19*(4), 548–569. doi: 10.1177/1354067X13500328

288

LLANES-COROMINA, PRIETO, P., & ROHRER, P. (2018). Brief training with rhythmic beat gestures helps L2 pronunciation in a reading aloud task. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 498–502). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-101

LLANES-COROMINA, J., VILÀ-GIMÉNEZ, I., KUSHCH, O., BORRÀS-COMES, J., & PRIETO, P. (2018). Beat gestures help preschoolers recall and comprehend discourse information. *Journal of Experimental Child Psychology, 172*(8)*,* 168–188. doi: 10.1016/j.jecp.2018.02.004

LOEHR, D. (2004). *Gesture and Intonation*. (Unpublished Doctoral Dissertation). Georgetown University, Washington, D.C.

LOEHR, D. (2007). Aspects of rhythm in gesture and speech. *Gesture*, *7*(2), 179–214. doi: 10.1075/gest.7.2.04loe

LOEHR, D. P. (2012). Temporal, structural, and pragmatic synchrony between intonation and gesture. *Laboratory Phonology*, *3*(1), 71–89. doi: 10.1515/lp-2012-0006

LÓPEZ-ORÓS, M., & TEBEROSKY, A. (1998). La evolución de la referencia en catalán en narraciones orales y escritas. *Infancia y Aprendizaje, 21*(83), 75–92. doi: 10.1174/021037098760403488

LUCERO, C., ZAHARCHUK, H., & CASASANTO, D. (2014). Beat gestures facilitate speech production. In P. Bello, M. Guarini, M. McShane, & B. Scassellati (Eds.), *Proceedings*

of the 36th Annual Conference of the Cognitive Science Society (pp. 898–903). Austin, TX: Cognitive Science Society.

MACEDONIA, M., BERGMANN, K., & ROITHMAYR, F. (2014). Imitation of a Pedagogical Agent's Gestures Enhances Memory for Words in Second Language. *Science Journal of Education*, *2*(5), 162–169. doi: 10.11648/j.sjedu.20140205.15

MACEDONIA, M., MÜLLER, K., & FRIEDERICI, A. D. (2011). The impact of iconic gestures on foreign language word learning and its neural substrate. *Human Brain Mapping*, *32*(6), 982–998. doi: 10.1002/hbm.21084

MACOUN, A., & SWELLER, N. (2016). Listening and watching: The effects of observing gesture on preschoolers' narrative comprehension. *Cognitive Development*, *40*, 68–81. doi: 10.1016/j.cogdev.2016.08.005

MADAN, C. R., & SINGHAL, A. (2012). Using actions to enhance memory: effects of enactment, gestures, and exercise on human memory. *Frontiers in Psychology, 3*(507), 1–4. doi: 10.3389/fpsyg.2012.00507

MATHEW, M., YUEN, I., & DEMUTH, K. (2017). Talking to the beat: Six-year-olds' use of stroke-defined non-referential gestures. *First Language*, *38*(2), 1–18. doi: 10.1177/0142723717734949

MAYBERRY, R. I., & NICOLADIS, E. (2000). Gesture Reflects Language Development: Evidence from Bilingual Children. *Current Directions in Psychological Science, 9*(6), 192–196. doi: 10.1111/1467-8721.00092

MAYER, M. (1969). *Frog, where are you?* New York: The Dial Press.

MCCLAVE, E. (1994). Gestural beats: The rhythm hypothesis. *Journal of Psycholinguistic Research*, *23*(1), 45–66. doi: 10.1007/BF02143175

MCGREGOR, K.K., ROHLFING, K.J., BEAN, A., & MARSCHNER, E. (2009). Gesture as a support for word learning: The case of *under*. *Journal of Child Language, 36*(4), 807–828. doi: 10.1017/S0305000908009173

MCNEIL, N. M., ALIBALI, M. W., & EVANS, J. L. (2000). The role of gesture in children's comprehension of spoken language: Now they need it, now they don't. *Journal of Nonverbal Behavior*, *24*(2), 131–150. doi: 10.1023/A:1006657929803

MCNEILL, D. (1992). *Hand and Mind: What Gestures Reveal about Thought*. Chicago: University of Chicago Press.

MCNEILL, D. (2000). *Language and Gesture* (Language Culture and Cognition). Cambrige: Cambridge University Press. doi: 10.1017/CBO9780511620850

MCNEILL, D. (2005). *Gesture and thought*. Chicago: University of Chicago Press. doi: 10.7208/Chicago/9780226514642.001.0001

MCNEILL, D. (2012). *How language began: Gesture and speech in human evolution.* Cambridge: Cambridge University Press. doi: 10.1017/CBO9781139108669

MCNEILL, D. (2016). *Why we gesture: The Surprising Role of Hand Movements in Communication.* Cambridge University Press. doi: 10.1017/CBO9781316480526

MCNEILL, D., & DUNCAN, S. (2000). Growth points in thinking-for-speaking. In D. McNeill (Ed.), *Language and Gesture* (pp. 141–161). Cambridge, United Kingdom: Cambridge University Press.

MCNEILL, D., & LEVY, E. T. (1993). Cohesion and gesture. *Discourse Processes, 16*(4)*,* 363–386. doi: 10.1080/01638539309544845

MCNEILL, D., LEVY, E. T., & DUNCAN, S. D. (2015). Gesture in Discourse. In D. Tannen, H. E. Hamilton, & D. Schiffrin (Eds.), *The Handbook of Discourse Analysis* (Vol. 2, pp. 262–289). John Wiley & Sons, Inc.

MCNEILL, D., QUEK, F., MCCULLOUGH, K. E., DUNCAN, S. D., FURUYAMA, N., BRYLL, R., MA, X., & ANSARI, R. (2001). Catchments, prosody and discourse. *Gesture, 1*(1), 9–33. doi: 10.1075/gest.1..1.03mcn

MORETT, L. M. (2014). When Hands Speak Louder Than Words: The Role of Gesture in the Communication, Encoding, and Recall of Words in a Novel Second Language. *The Modern*

Language Journal, 98(3), 834–853. doi: 10.1111/j.1540-4781.2014.12125.x

MORETT, L. M., & FRAUNDORF, S. H. (2019). Listeners consider alternative speaker productions in discourse comprehension and memory: Evidence from beat gesture and pitch accenting. *Memory and Cognition, 47*(2)*,* 1515–1530. doi: 10.3758/s13421-019-00945-1

MORSELLA, E., & KRAUSS, R. M. (2004). The role of gestured in spatial working memory and speech. *The American Journal of Psychology, 117*(3), 411–424. doi: 10.2307/4149008

MUMFORD, K. H., & KITA, S. (2014). Children use gesture to interpret novel verb meanings. *Child Development*, *85*(3), 1181–1189. doi: 10.1111/cdev.12188

MUMFORD, K. H, & KITA, S. (2016). At 10–12 Months, Pointing Gesture Handedness Predicts the Size of Receptive Vocabularies. *Infancy, 21*(6), 751–765. doi: 10.1111/infa.12138

MUÑOZ, M. L, GILLAM, R. B., PEÑA, E. D., & GULLEY-FAEHNLE A. (2003). Measures of language development in fictional narratives of Latino children. *Language, Speech, and Hearing Services in Schools*, *34*(4), 332–342. doi: 10.1044/0161-1461(2003/027)

MURILLO, E., ORTEGA, C., OTONES, A., RUJAS, I., & CASLA, M. (2018). Changes in the synchrony of multimodal communication in early language development. *Journal of*

Speech, Language, and Hearing Research. 61(9), 2235–2245. doi: 10.1044/2018_JSLHR-L-17-0402

NAREMORE, R., DENSMORE, A.E., & HARMAN, D. (1995). *Language intervention with school age children: conversation, narrative and text*. San Diego, CA: Singular Publishing Group.

NICOLADIS, E. (2007). The effect of bilingualism on the use of manual gestures. *Applied Psycholinguistics, 28*(3), 441–454. doi: 10.1017.S0142716407070245

NICOLADIS, E., MARENTETTE, P., & NAVARRO, S. (2016). Gesture Frequency Linked Primarily to Story Length in 4-10-Year Old Children's Stories. *Journal of Psycholinguistic Research, 45*(2), 189–204. doi: 10.1007/s10936-014-9342-2

NICOLADIS, E., MAYBERRY, R. I., & GENESEE, F. (1999). Gesture and early bilingual development. *Developmental Psychology, 35*(2), 514–526. doi: 10.1037/0012-1649.35.2.514

NICOLOPOULOU, A., CORTINA, K. S., ILGAZ, H., CATES, C.B., & DE SÁ, A. B. (2015). Using a narrative- and play-based activity to promote low-income preschoolers' oral language, emergent literacy, and social competence. *Early Childhood Research Quarterly, 31,* 147–162. doi: 10.1016/j.ecresq.2015.01.006

NICOLOPOULOU, A., & RICHNER. E. S. (2007). From Actors to Agents to Persons: The Development of Character

Representation in Young Children's Narratives. *Child development, 78*(2), 412–429. doi: 10.1111/j.1467-8624.2007.01006.x

NINIO, A., SNOW, C. E., PAN, B. A., & ROLLINS, P. R. (1994). Classifying communicative acts in children's interactions. *Journal of Communication Disorders, 27*(2), 157–187. doi: 10.1016/0021-9924(94)90039-6

NOVACK, M. A., CONGDON, E. L., HEMANI-LOPEZ, N., & GOLDIN-MEADOW, S. (2014). From action to abstraction: Using the hands to learn math. *Psychological Science, 25*(4), 903–910. doi:10.1177/0956797613518351

NOVACK, M., & GOLDIN-MEADOW, S. (2015). Learning from Gesture: How Our Hands Change Our Minds. *Education Psychology Review, 27*(3), 405–412. doi: 10.1007/s10648-015-9325-4

O'BRIEN, M. G. (2014). L2 learners' assessments of accentedness, fluency, and comprehensibility of native and nonnative German speech. *Language Learning, 64*(4), 715–748. doi: 10.1111/lang.12082

O'NEILL, D. K., & HOLMES, A. C. (2002). Young preschoolers' ability to reference story characters: The contribution of gestures and character speech. *First Language, 22*(1), 73–103. doi: 10.1177/014272370202206403

ÖZÇALIŞKAN, Ş., GENTNER, D., & GOLDIN-MEADOW, F. (2014). Do iconic gestures pave the way for children's early verbs?

Applied Psycholinguistics, 35(6), 1143–1162. doi: 10.1017/S0142716412000720

ÖZÇALIŞKAN, Ş., & GOLDIN-MEADOW, S. (2005). Gesture is at the cutting edge of early language development. *Cognition, 96*(3), B101–B113. doi: 10.1016/j.cognition.2005.01.001

ÖZÇALIŞKAN, Ş., & GOLDIN-MEADOW, S. (2009). When gesture-speech combinations do and do not index linguistic change. *Language and Cognitive Processes, 24*(2), 190–217. doi: 10.1080/01690960801956911

ÖZÇALIŞKAN, Ş., & GOLDIN-MEADOW, S. (2011). Is there an iconic gesture spurt at 26 months? In G. Stam & M. Ishino (Eds.), *Gesture studies: Vol. 4. Integrating gestures: The interdisciplinary nature of gesture* (pp. 163–174). John Benjamins Publishing Company. doi: 10.1075/gs.4.14ozc

ÖZÇALIŞKAN, Ş., LUCERO, C., & GOLDIN-MEADOW, S. (2016). Is Seeing Gesture Necessary to Gesture Like a Native Speaker? *Psychological Science, 27*(5), 737–747. doi: 10.1177/0956797616629931

ÖZYUŘEK, A., & KELLY, S. D. (2007). Gesture, brain, and language. *Brain and Language, 101*(3), 181–184. doi: 10.1016/j.bandl.2007.03.006

PARRILL, F., LAVANTY, B., BENNETT, A., KLCO, A., & DEMIR, Ö. E. (2018). The relationship between character viewpoint gesture and narrative structure in children. *Language and Cognition, 10*(3), 408–434. doi: 10.1017/langcog.2018.9

PETERSON, C., & MCCABE, A. (1996). Parental Scaffolding of Context in Children's Narratives. In C. E. Johnson & J. H. V. Gilbert (Eds.), *Children's Language* (Vol. 9, pp. 183–196). Hillsdale, NJ: LEA.

PINE, K., BIRD, H., & KIRK, E. (2007). The effects of prohibiting gestures on children's lexical retrieval ability. *Developmental Science, 10*(6), 747–754. doi: 10.1111/j.1467-7687.2007.00610.x

PING, R., & GOLDIN-MEADOW, S. (2008). Hands in the Air: Using Ungrounded Iconic Gestures to Teach Children Conservation of Quantity. *Developmental Psychology, 44*(5), 1277–1287. doi: 10.1037/0012-1649.44.5.1277

PORTOLÉS, J. (1998). *Marcadores del discurso* [*Discourse markers*]. Barcelona, Spain: Ariel.

POUW, W., HARRISON, S. J., & DIXON, J. A. (2019). Gesture–speech physics: The biomechanical basis for the emergence of gesture–speech synchrony. *Journal of Experimental Psychology: General, 149*(2), 391–404. doi: 10.1037/xge0000646

PRIETO, P., BORRÀS-COMES, J., CABRÉ, T., CRESPO-SENDRA, V., MASCARÓ, I., ROSEANO, P., . . . VANRELL, M. M. (2015). Intonational phonology of Catalan and its dialectal varieties. In S. Frota & P. Prieto (Eds.), *Intonational variation in romance* (pp. 9–62). United Kingdom: Oxford University Press.

PRIETO, P., CRAVOTTA, A., KUSHCH, O., ROHRER, P., & VILÀ-GIMÉNEZ, I. (2018). Deconstructing beat gestures: a labelling proposal. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 201–205). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-41

RAUSCHER, F. H., KRAUSS, R. M., & CHEN, Y. (1996). Gesture, speech, and lexical access: The role of lexical movements in speech production. *Psychological Science*, *7*(4), 226–231. doi: 10.1111/j.1467-9280.1996.tb00364.x

RAVIZZA, S. (2003). Movement and lexical access: Do noniconic gestures aid in retrieval? *Psychonomic Bulletin & Review*, *10*(3), 610–615. doi: 10.3758/BF03196522

ROCHET-CAPELLAN, A., LABOISSIÈRE, R., GALVÁN, A., & SCHWARTZ, J. (2008). The Speech Focus Position Effect on Jaw-Finger Coordination in a Pointing Task. *Journal of Speech Language and Hearing Research*, *51*(6), 1507–1521. doi: 10.1044/1092-4388(2008/07-0173)

ROHLFING, K. (2019). Learning Language from the Use of Gestures. In J. S. Horst & J. V. Torkildsen (Eds.), *International Handbook of Language Acquisition.* Routledge Handbooks Online. doi: 10.4324/9781315110622

ROHLFING, K. J., GRIMMINGER, A., & LÜKE, C. (2017). An Interactive View on the Development of Deictic Pointing in Infancy. *Frontiers in Psychology, 8*(1319), 1–6. doi: 10.3389/fpsyg.2017.01319

Rohlfing, K. J., Longo, M. R., & Bertenthal, B. I. (2012). Dynamic pointing triggers shifts of visual attention in young infants. *Developmental Science, 15*(3), 426–435. doi: 10.1111/j.1467-7687.2012.01139.x

Rossi, F., Pontecorvo, C., López-Orós, M., & Teberosky, A. (2000). Referential Development in Storytelling and in Storywriting of Catalan and Italian Children, *Language and Education, 14*(3), 164–183. doi: 10.1080/09500780008666788

Roustan, B., & Dohen, M. (2010). Co-production of contrastive prosodic focus and manual gestures: Temporal coordination and effects on the acoustic and articulatory correlates of focus. *Speech Prosody 2010, Fifth International Conference* (pp. 100110:1–4). Chicago: IL, USA. hal-00971288

Rowe, M. L., & Goldin-Meadow, S. (2009). Early gesture selectively predicts later language development. *Developmental Science, 12*(1), 182–187. doi: 10.1111/j.1467-7687.2008.00764.x

Rowe, M. L., Özçalişkan, Ş., & Goldin-Meadow, S. (2008). Learning words by hand: Gesture's role in predicting vocabulary development. *First Language, 28*(2), 182–199. doi: 10.1177/0142723707088310

Rusiewicz, H. L., & Esteve-Gibert, N. (2018). Set in time: Temporal coordination of prosodic stress and gesture in the development of spoken language production. In P. Prieto & N. Esteve-Gibert (Eds.), *The development of prosody in first*

language acquisition (pp. 103–124). John Benjamins. doi: 10.1075/tilar.23.06rus

SAUER, E., LEVINE, S. C., & GOLDIN-MEADOW, S. (2010). Early gesture predicts language delay in children with pre- and perinatal brain lesions. *Child Development, 81*(2)*,* 528–539. doi: 10.1111/j.1467-8624.2009.01413.x

SCHIFFRIN, D. (1987). *Discourse markers (studies in interactional sociolinguistics 5)*. United Kingdom: Cambridge University Press.

SEGALOWITZ, N. (2016). Second language fluency and its underlying cognitive and social determinants. *International Review of Applied Linguistics in Language Teaching, 54*(2), 79–95. doi: 10.1515/iral-2016-9991

SEKINE, K., & KITA, S. (2015). The parallel development of the form and meaning of two-handed gestures and linguistic information packaging within a clause in narrative. *Open Linguistics*, *1*(1), 490–502. doi: 10.1515/opli-2015-0015

SHAPIRO, L., & HUDSON, J. (1991). Tell me a make-believe story: coherence and cohesion in young children's picture-elicited narratives. *Developmental Psychology*, *27*(6), 960–974. doi: 10.1037/0012-1649.27.6.960

SHAPIRO, L., & STOLZ, S. A. (2019). Embodied cognition and its significance for education. *Theory and Research in Education, 17*(1), 19–39. doi: 10.1177/1477878518822149

SHATTUCK-HUFNAGEL, S., & PRIETO, P. (2019). Dimensionalizing co-speech gestures. In S. Calhoun, P. Escudero, M. Tabain, & P. Warren (Eds.), *Proceedings of the 19th International Congress of Phonetic Sciences, Melbourne, Australia 2019* (pp. 1490–1494). Canberra, Australia: Australasian Speech Science and Technology Association Inc.

SHATTUCK-HUFNAGEL, S., & REN, A. (2018). The Prosodic Characteristics of Non-referential Co-speech Gestures in a Sample of Academic-Lecture-Style Speech. *Frontiers in Psychology, 9*(1514), 1–13. doi: 10.3389/fpsyg.2018.01514

SHATTUCK-HUFNAGEL, S., REN, A., MATHEW, M., YUEN, I., & DEMUTH, K. (2016). Non-referential gestures in adult and child speech: Are they prosodic? In J. Barnes, A. Brugos, S. Shattuck-Hufnagel, & N. Veilleux (Eds.), *Speech Prosody 2016* (pp. 836–839)*. Boston, United States of America*. International Speech Communication Association. doi: 10.21437/SpeechProsody.2016-171

SHATTUCK-HUFNAGEL, S., YASINNIK, Y., VEILLEUX, N., & RENWICK, M. (2007). A method for studying the time alignment of gestures and prosody in American English: 'Hits' and pitch accents in academic-lecture-style speech. In A. Esposito, M. Bratanic, E. Keller, & M. Marinaro (Eds.), *Fundamentals of Verbal and Nonverbal Communication and the Biometric Issue* (pp. 34–44). Brussels: NATO

SINGER, M. A., & GOLDIN-MEADOW, S. (2005). Children Learn When Their Teacher's Gestures and Speech Differ.

Psychological Science, 16(2), 85–89. doi: 10.1111/j.0956-7976.2005.00786.x

So, W. C., CHEN-HUI, C. S., & WEI-SHAN, J. L. (2012). Mnemonic effect of iconic gesture and beat gesture in adults and children: Is meaning in gesture important for memory recall? *Language and Cognitive Processes, 27*(5)*,* 665–681. doi: 10.1080/01690965.2011.573220

SPENCER, T. D., & SLOCUM, T. A. (2010). The Effect of Narrative Intervention on Story Retelling and Personal Story Generation Skills of Preschoolers With Risk Factors and Narrative Language Delays. *Journal of Early Intervention, 32*(3), 178–199. doi: 10.1177/1053815110379124

STEIN, N. L. (1988). The development of children's storytelling skill. In M. B. Franklin & S. S. Barten (Eds.), *Child Language: A reader* (pp. 282–297). New York, NY: Oxford University Press.

STEIN, N. L., & ALBRO, E. R. (1997). Building complexity and coherence: Children's use of goal-structured knowledge in telling stories. In M. Bamberg (Ed.), *Narrative development: Six approaches* (pp. 5–44). Mahwah, NJ: Erlbaum.

STEIN, N. L., & GLENN, C. G. (1979). *An analysis of story comprehension in elementary children* (Vol. 2). Norwood, NJ: Ablex.

STITES, L. J., & ÖZÇALIŞKAN, Ş., (2017). Who Did What to Whom? Children Track Story Referents First in Gesture. *Journal of*

Psycholinguistic Research, 46(4)*,* 1019–1032. doi: 10.1007/s10936-017-9476-0

STRADLER, M. A., & WARD, G. C. (2005). Supporting the narrative development of young children. *Early Childhood Education Journal*, *33*(2), 73–80. doi: 10.1007/s10643-005-0024-4

TABORS, P. O., SNOW, C. E., & DICKINSON, D. K. (2001). Homes and schools together: Supporting language and literacy development. In D. K. Dickinson & P. O. Tabors (Eds.), *Beginning literacy with language* (pp. 313–334). Baltimore: Brookes Publishing.

TELLIER, M. (2008). The effect of gestures on second language memorisation by young children. *Gesture*, *8*(2), 219–235. doi: 10.1075/gest.8.2.06tel

THEAKSTON, A., COATES, A., & HOLLER, J. (2014). Handling agents and patients: Representational cospeech gestures help children comprehend complex syntactic constructions. *Developmental Psychology, 50*(7), 1973–1984. doi: 10.1037/a0036694

THOMPSON, L. A. (1995). Encoding and memory for visible speech and gestures: A comparison between young and older adults. *Psychology and Aging*, *10*(2), 215–228. doi: 10.1037/0882-7974.10.2.215

TIERNEY, A., & KRAUS, N. (2013). Music training for the development of reading skills. *Progress in Brain Research, 207,* 209–241. doi: 10.1016/B978-0-444-63327-9.00008-4

Trabasso, T., Stein, N., & Johnson, L. (1981). Children's knowledge of events: a causal analysis of story structure. In G. Bower (Ed.), *Learning and motivation* (Vol. 15, pp. 237–282). San Diego, CA: Academic Press. doi: 10.1016/S0079-7421(08)60177-2

Trabasso, T., Stein, N. L., Rodkin, P. C., Munger, M. P., & Baughn, C. R. (1992). Knowledge of goals and plans in the on-line narration of events. *Cognitive Development*, *7*(2), 133–170. doi: 10.1016/0885-2014(92)90009-G

Valenzeno, L., Alibali, M. W., & Klatzky, R. L. (2003). Teachers' gestures facilitate students' learning: A lesson in symmetry. *Contemporary Educational Psychology*, *28*(2), 187–204. doi: 10.1016/S0361-476X(02)00007-3

Vilà-Giménez, I., Igualada, A., & Prieto, P. (2019). Observing Storytellers Who Use Rhythmic Beat Gestures Improves Children's Narrative Discourse Performance. *Developmental Psychology*, *55*(2), 250–262. doi:10.1037/dev0000604

Vilà-Giménez, I., & Prieto, P. (in press, 2020). Encouraging kids to beat: Children's beat gesture production boosts their narrative performance. *Developmental Science*. doi:10.1111/desc.12967

Vion, M., & Colas, A. (2005). Using connectives in oral French narratives: Cognitive constraints and development of narrative skills. *First Language, 25*(1), 39–66. doi: 10.1177/0142723705046899

VOLTERRA, V., & IVERSON, J. M. (1995). When do modality factors affect the course of language acquisition? In K. Emmorey & J. Reilly (Eds.), *Language, gesture, and space* (pp. 371–390). Hillsdale, NJ: Lawrence Erlbaum Associates.

WAGNER, P., MALISZ, Z., & KOPP, S. (2014). Gesture and speech in interaction: An overview. *Speech Communication, 57,* 209–232. doi: 10.1016/j.specom.2013.09.008

WAGNER, S. M., NUSBAUM, H., & GOLDIN-MEADOW, S. (2004). Probing the mental representation of gesture: Is handwaving spatial? *Journal of Memory and Language*, *50*(4), 395–407. doi: 10.1016/j.jml.2004.01.002

WAKEFIELD, E. M., HALL, C., JAMES, K. H., & GOLDIN-MEADOW, S. (2018). Gesture for generalization: gesture facilitates flexible learning of words for actions on objects. *Developmental Science, 21*(5):e12656 doi: 10.1111/desc.12656

WANG, L., & CHU, M. (2013). The role of beat gesture in pitch accent in semantic processing: An ERP study. *Neuropsychologia, 51*(13), 2847–2855. doi: 10.1016/j.neuropsychologia.2013.09.027

WELLSBY, M., & PEXMAN, P. M. (2014). Developing embodied cognition: insights from children's concepts and language processing. *Frontiers in Psychology, 5*(506), 1–10. doi: 10.3389/fpsyg.2014.00506

WEST, B., WELCH, K. B., & GALECKI, A. T. (2007). *Linear mixed*

models: A practical guide using statistical software. New York, NY: Chapman & Hall/CRC.

WILLEMS, R. M., & HAGOORT, P. (2007). Neural evidence for the interplay between language, gesture, and action: A review. *Brain and Language, 101*(3). 278–289. doi: 10.1016/j.bandl.2007.03.004

YASINNIK, Y., RENWICK, M., & SHATTUCK-HUFNAGEL, S. (2004). The timing of speech-accompanying gestures with respect to prosody. *Proceedings from the International Conference: From Sound to Sense: +50 years of Discoveries in Speech Communication* (pp. C97–C102). Cambridge, MA: MIT.

YEO, A., LEDESMA, I., NATHAN, M. J., ALIBALI, M. W., & CHURCH, R. B. (2017). Teachers' gestures and students' learning: sometimes "hands off" is better. *Cognitive Research: Principles and Implications, 2*(1), 41. doi: 10.1186/s41235-017-0077-0

ZHANG, T., BAILLS, F., & PRIETO, P. (in press). Hand-clapping to the rhythm of newly learned words improves L2 pronunciation: Evidence from training Chinese adolescents with French words. *Language Teaching Research*. doi: 10.1177/1362168818806531

Appendices

Appendix A: Chapter 2

Pragmatic functions of speech associated to beats, flips and iconic gestures

Table 3. Pragmatic functions of speech related to the children's flip gesture production.

Pragmatic functions of speech associated to flip gestures		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unbiased assertions	123	36,7	36,7	90,7
	Biased assertions or questions	136	40,6	40,6	46,3
	Requesting speech act	31	9,3	9,3	100,0
	Expressive speech act	26	7,8	7,8	54,0
	Unclear	19	5,7	5,7	5,7
	Total	335	100,0	100,0	

Table 4. Pragmatic functions of speech related to the children's beat gesture production.

Pragmatic functions of speech associated to beat gestures		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unbiased assertions	155	69,8	69,8	91,4
	Biased assertions or questions	42	18,9	18,9	19,8
	Requesting speech act	19	8,6	8,6	100,0
	Expressive speech act	4	1,8	1,8	21,6
	Unclear	2	,9	,9	,9
	Total	222	100,0	100,0	

Table 5. Pragmatic functions of speech related to the children's iconic gesture production.

Pragmatic functions of speech associated to iconic gestures		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unbiased assertions	412	74,5	74,5	89,2
	Biased assertions or questions	67	12,1	12,1	13,2
	Requesting speech act	60	10,8	10,8	100,0
	Expressive speech act	8	1,4	1,4	14,6
	Unclear	6	1,1	1,1	1,1
	Total	553	100,0	100,0	

Appendix B: Chapters 3 & 4

Narrative Structure of All the Stories in the Animated Cartoons
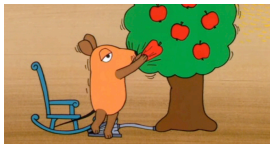
CARTOON A

Initiating event: After the mouse has inflated the inflatable apple tree, he sniffs an apple.

Goal: The mouse wants to take an apple from the tree.

Attempt: The mouse picks an apple from the tree.

Outcome: The tree deflates automatically so the mouse cannot eat the apple.

CARTOON B

Initiating event: The mouse and elephant find a sculpture but the elephant accidentally knocks it over with his trunk.

Goal: The mouse and elephant want to repair the sculpture.

Attempt: The mouse and elephant turn the sculpture into a slide.

Outcome The mouse and elephant slide down the slide.

CARTOON C

Initiating event: The wind keeps blowing the socks off the clothesline.

Goal: The mouse wants to hang up the socks (so they will not get blown off the line).

Attempt: The mouse unties the clothesline, passes it through the socks, and reties it.

Outcome: When the wind blows again, the socks no longer blow off the line.

CARTOON D

Initiating event: The mouse and elephant are walking on the beach and find a large clamshell. The mouse tries unsuccessfully to open the clamshell.

Goal: The mouse wants to open up the clamshell.

Attempt: The mouse tries unsuccessfully to open the clamshell with his foot so the elephant helps him with his trunk.

Outcome: The mouse and elephant each use one half of the clamshell as a hat.

Appendix C: Chapters 3 & 4

English Translations of the Six Training Stories

First story	**Once upon a time**, **a duck** was walking to school. **Suddenly**, it started to **rain**, and the duck didn't have an **umbrella**. **In the end**, he came up with a **solution**: he put his hood on his **head** to protect himself from the rain.
Second story	**Once upon a time**, **a rabbit** went for walk in the mountains. **Suddenly**, some **cows** started to walk towards him and he was scared. **In the end**, he found a **solution**: he stood **still** behind a tree **until** the cows left.
Third story	**Once upon a time**, there was **a horse** that was hungry. **Suddenly**, he realized that there were no **biscuits** in the cupboard, **because** he had eaten them all. **In the end**, he thought of a **solution**: he made biscuits in the **oven**.
Fourth story	**Once upon a time**, there was **a hen** that was sleepy. **Suddenly**, she fell asleep on the **sofa**, **but** her **alarm clock** woke her up. She had forgotten that the following day was her **birthday** and that she was planning to buy **candles** to celebrate it. **In the end**, she found a **solution**: she bought some **enormous** candles and was **therefore** able to celebrate her birthday.

Fifth story	**Once upon a time, a pig** was playing football in the park. **Suddenly**, he realized that it was **late** and he had to go back **home**, because **otherwise** his **mother** would get angry. **In the end**, he thought of a **solution**: he took a **shortcut** to get home. **That way**, he managed to not arrive late and his mother did not get angry.
Sixth story	**Once upon a time**, **a cat** was staying at his grandparents' house in summer. **Suddenly**, he remembered that he had to do his **homework**, because **otherwise** his **grandparents** wouldn't wait for him to go to the beach. **In the end**, he came up with a **solution**: he did the homework **before** his grandparents arrived, and **that way** he was able to go to the **beach**.

Appendix D: Chapter 3

Example of a Child-Produced Narrative

Below is a transcript of a child retelling one of the cartoon stories from the posttest task. The English translation that follows is marked-up to illustrate scoring in terms of narrative structure.

Child: *Hi havia una vegada, un esquirol que volia penjar la roba, però feia tant de vent que no podia penjar els seus mitjons, i a sobre estaven tots trencats. I va trobar una solució. Va desfer un fil i va començar a posar els mitjons, i després ho va tornar a enganxar al fil, i ja va poder que s'assequessin els mitjons.*

English translation: *[Once upon a time, a squirrel wanted to hang up the clothes **GOAL**], [but it was windy and he couldn't hang up his socks, and they were all worn out. **INITIATING EVENT**] [And he found a solution. He untied the clothesline, passed the socks through it, and then retied it. **ATTEMPT TO ACHIEVE THE GOAL**] [And he got the socks to dry. **OUTCOME**]*

Here the child tells a complete, temporally, and causally structured story, as all the linguistic elements are well linked. Regarding the narrative structure items that constituted scoring points, the child mentioned the initiating event, the goal of the protagonist, the attempt to achieve this goal, and the outcome of this attempt (these items have been separated by square brackets). Moreover, the

316

retelling includes significant detail. Thus, this particular retelling received the maximum score of 6.

Appendix E: Chapter 4

Descriptive statistics for narrative structure and fluency scores

Descriptive statistics for narrative structure and fluency scores in the pretest part of the beat non-encouraging condition

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Narrative structure scores	50	5	0	5	3.46	.994
Fluency scores	50	6	1	7	4.80	1.641
Valid N (listwise)	50					

Descriptive statistics for narrative structure and fluency scores in the pretest part of the beat encouraging condition

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Narrative structure scores	44	3	2	5	3.32	.909
Fluency scores	44	5	2	7	5.16	1.275
Valid N (listwise)	44					

Descriptive statistics for narrative structure and fluency scores in the posttest part of the beat non-encouraging condition

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Narrative structure scores	50	3	3	6	3.88	1.023
Fluency scores	50	5	2	7	5.18	1.395
Valid N (listwise)	50					

Descriptive statistics for narrative structure and fluency scores in the posttest part of the beat encouraging condition

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Narrative structure scores	44	3	3	6	4.57	1.129
Fluency scores	44	6	1	7	6.02	1.191
Valid N (listwise)	44					

Appendix F: Publication list

The following publications are associated with this thesis.

Publications in peer-review (JCR) journals:

LLANES-COROMINA, J., VILÀ-GIMÉNEZ, I., KUSHCH, O., BORRÀS-COMES, J., & PRIETO, P. (2018). Beat gestures help preschoolers recall and comprehend discourse information. *Journal of Experimental Child Psychology*, *172*(8), 168–188. doi: 10.1016/j.jecp.2018.02.004

VILÀ-GIMÉNEZ, I., IGUALADA, A., & PRIETO, P. (2019). Observing Storytellers Who Use Rhythmic Beat Gestures Improves Children's Narrative Discourse Performance. *Developmental Psychology*, *55*(2), 250–262. doi: 10.1037/dev0000604

VILÀ-GIMÉNEZ, I., & PRIETO, P. (in press, 2020). Encouraging kids to beat: Children's beat gesture production boosts children's narrative performance. *Developmental Science*. doi: 10.1111/deesc.12967

Conference proceedings:

PRIETO, P., CRAVOTTA, A., KUSHCH, O., ROHRER, P., & VILÀ-GIMÉNEZ, I. (2018). Deconstructing beat gestures: a labelling proposal. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 201–205). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-41

PRONINA, M., HÜBSCHER, I., VILÀ-GIMÉNEZ, I., & PRIETO, P. (2019). A new tool to assess pragmatic prosody in children: Evidence from 3- to 4-year-olds. In S. Calhoun, P. Escudero, M. Tabain, & P. Warren (Eds.), *Proceedings of the 19th International Congress of Phonetic Sciences, Melbourne, Australia 2019*. Canberra, Australia: Australasian Speech Science and Technology Association Inc.

VILÀ-GIMÉNEZ, I., & PRIETO, P. (2018). Encouraging children to produce rhythmic beat gestures leads to better narrative discourse performances. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, & D. Śledziński (Eds.), *Proceedings of the 9th International Conference on Speech Prosody* (pp. 704–708). Poznań, Poland. doi: 10.21437/SpeechProsody.2018-143

Manuscripts submitted or in preparation:

PRONINA, M., HÜBSCHER, I., VILÀ-GIMÉNEZ, I., & PRIETO, P. (in preparation). The acquisition of prosody in the preschool years: Bridging the gap between prosody and pragmatics.

VILÀ-GIMÉNEZ, I., DOWLING, N., DEMIR-LIRA, Ö. E., PRIETO, P., & GOLDIN-MEADOW, S. (submitted). The predictive value of beat gestures: Early use predicts narrative abilities at 5 years of age. *Child Development*.