The developing architecture of expressive pragmatics in preschoolers: Multimodal and structural language trumps social cognition

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Abstract

Pragmatics, defined as the ability to use language socially, matters enormously in our day-to-day life and involves both the linguistic and social aspects of human communication. The literature focusing on developmental pragmatics has explored the interplay between children's pragmatic, structural language (e.g., vocabulary), and social cognition skills (e.g., Theory of Mind, abbreviated as ToM, and emotion understanding). However, the focus of this research has largely been on receptive pragmatic domains and verbal, non-multimodal language, while much less is known about the acquisition of expressive pragmatics and its relationship with multimodal language, that is, language expressed through prosody and gesture. The overarching aim of this thesis is to investigate expressive pragmatic abilities during early preschool years (ages 3–4), in relation to language—both structural and multimodal—and social cognition, and to explore ways to promote these abilities in classroom context. In doing so, we seek to provide insight into the developing architecture of expressive pragmatics and to integrate multimodal abilities into developmental pragmatic research.

The four studies comprising this thesis analyze a cohort of more than 100 Catalan-speaking 3- to 4-year-old children. In order to comprehensively assess expressive pragmatic competence, we first created and validated a new tool (the Audiovisual Pragmatic Test, APT) which was employed in all four studies and which tests the child's ability to use language in a variety of common social contexts. Study 1 analyzes the pragmatic and prosodic skills of a group of 3- to 4-year-olds in relation to structural language (vocabulary and syntax) and social cognition (ToM, emotion understanding, and metacognitive vocabulary). Results show that pragmatics and prosody are more closely related to linguistic skills than to social cognition. Building on the results of Study 1, the following two studies explore the link between pragmatics and multimodal language. While also taking into account children's ToM development, Study 2 examines the status of prosody as a pragmatic marker and answers the question of how 3- to 4-year-olds develop the ability to use prosody to express pragmatic meanings The results allow us to assess the pragmatic prosody profile of

children of this age and show that ToM alone is not sufficient to explain children's prosodic performance. Study 3 explores whether gesture frequency (via the APT) and gesture accuracy (via a multimodal imitation task) are related to narrative skills in children aged 3 to 4. The main finding is that gesture accuracy is a positive predictor of narrative structure scores, suggesting that gesture and narrative skills are intertwined. Finally, Study 4 assesses whether multimodal and non-multimodal conversational interventions can promote pragmatic and socio-cognitive abilities in preschoolers. Results show enhanced performance for pragmatics (but not social cognition) in the posttest, demonstrating the value of language-based interventions focused on socio-cognitive aspects, both multimodal and non-multimodal, in improving pragmatic abilities.

Altogether, this thesis expands our knowledge of the acquisition of expressive pragmatics in the early preschool years. The four studies show that expressive pragmatic abilities at this age are tightly linked to language, both structural and multimodal, and less so to social cognition. Specifically, the thesis has provided evidence that components of both non-multimodal and multimodal language are associated with pragmatic competence and can help foster pragmatic development. These findings place expressive pragmatic abilities of preschoolers within the linguistic—rather than the socio-cognitive—domain and highlight the importance of taking multimodal abilities into account when investigating pragmatic development. Beyond furthering our understanding of the architecture of expressive pragmatics in the preschool years, these results are relevant for educational and clinical practices, as they lay both practical and theoretical foundations for pragmatic assessment and intervention with typically and, potentially, atypically developing children.

Resum

La pragmàtica, definida com la capacitat d'utilitzar el llenguatge socialment, té una enorme importància en la nostra vida quotidiana i comprèn tant aspectes lingüístics com socials de la comunicació humana. Estudis previs sobre el desenvolupament de la pragmàtica han explorat la relació entre les habilitats pragmàtiques dels nens, altres habilitats lingüístiques (com ara el vocabulari) i de cognició social (com ara la teoria de la ment, ToM en anglès, i la comprensió de les emocions). Tanmateix, mentre que aquesta recerca s'ha centrat en gran mesura en les habilitats de pragmàtica receptiva (la que afecta la comprensió) i en com els nens entenen la part proposicional del llenguatge, se sap molt menys sobre les habilitats de pragmàtica expressiva (la que afecta la producció) i la seva relació amb el llenguatge multimodal (el llenguatge expressat a través de la prosòdia i dels gestos de la parla). Per tal de proporcionar una visió més àmplia del desenvolupament de la pragmàtica expressiva i d'integrar de forma més clara les habilitats multimodals del llenguatge a l'estudi del desenvolupament de l'habilitat pragmàtica, l'objectiu d'aquesta tesi doctoral és investigar les habilitats pragmàtiques expressives dels nens de 3 a 4 anys en relació amb el llenguatge (tant multimodal com estructural) i la cognició social, i com es poden millorar aquestes habilitats pragmàtiques en un context d'aula.

Els quatre estudis que composen aquesta tesi doctoral analitzen les capacitats pragmàtiques expressives d'un grup de més de 100 nens catalanoparlants de 3 a 4 anys. Per tal d'avaluar la competència pragmàtica expressiva de manera exhaustiva, primer de tot, vam crear i validar un nou instrument d'elicitació pragmàtica (*Audiovisual Pragmatic Test*, APT) que s'ha emprat en tots quatre estudis i que avalua l'habilitat del nen d'utilitzar el llenguatge en diferents contextos socials quotidians. L'estudi 1 analitza les habilitats pragmàtiques i prosòdiques d'aquest grup de nens de 3 a 4 anys en relació amb el llenguatge estructural (vocabulari) i la cognició social (ToM, comprensió d'emocions i vocabulari metacognitiu). Els resultats mostren que és el llenguatge estructural, i no pas la cognició social, el factor que prediu el nivell pragmàtic i prosòdic dels nens. Basant-nos en els resultats de l'estudi 1, els dos estudis següents exploren el vincle entre la pragmàtica expressiva i

el llenguatge multimodal dels nens. L'estudi 2 analitza la prosòdia com a marcador pragmàtic i respon a la pregunta de com els nens de 3 a 4 anys desenvolupen la capacitat d'utilitzar la prosòdia per expressar significats pragmàtics, tenint en compte el nivell de ToM dels nens. Els resultats ens permeten avaluar el perfil prosòdic dels nens en aquesta franja d'edat i mostren que el nivell de ToM per si sol no és suficient per explicar l'habilitat prosòdica dels nens. L'estudi 3 investiga si la freqüència d'ús dels gestos (mesurada amb l'APT) i la precisió gestual (mesurada amb una tasca d'imitació multimodal) estan relacionades amb les habilitats narratives dels nens de 3 a 4 anys. Els resultats mostren que la precisió gestual en la tasca d'imitació està relacionada positivament amb les puntuacions de l'estructura narrativa, la qual cosa suggereix que les habilitats gestuals i narratives estan entrellaçades. Per acabar, l'estudi 4 avalua si una intervenció conversacional multimodal i no multimodal sobre creences i emocions pot millorar les habilitats pragmàtiques i sociocognitives dels nens d'aquesta edat. Els resultats mostren que, després de la intervenció, els nens milloren el seu nivell de pragmàtica expressiva però no milloren el seu nivell de cognició social, fet que demostra el valor d'una intervenció educativa basada en el llenguatge (tant multimodal com no multimodal) per promoure les habilitats pragmàtiques dels nens.

En conjunt, aquesta tesi doctoral amplia el nostre coneixement actual sobre l'adquisició de la pragmàtica expressiva dels nens en l'etapa d'educació infantil. Els quatre estudis mostren que la pragmàtica expressiva a aquesta edat està estretament vinculada a les habilitats de llenguatge (estructural i multimodal) i molt menys a les habilitats de cognició social. En concret, la tesi ha demostrat que tant els components de llenguatge no multimodal com multimodal estan relacionats amb la competència pragmàtica i poden fomentar el desenvolupament pragmàtic. Aquests resultats situen la capacitat pragmàtica els nens en l'etapa d'educació infantil en l'àmbit lingüístic més que no pas en l'àmbit sociocognitiu i destaquen la importància de tenir en compte les habilitats multimodals a l'hora d'investigar el desenvolupament pragmàtic. Més enllà d'ampliar la nostra comprensió de la pragmàtica expressiva durant l'etapa inicial de l'educació infantil, els resultats obtinguts en aquesta tesi són rellevants per a la millora de les pràctiques educatives i clíniques, ja que estableixen les bases pràctiques i teòriques per a l'avaluació i la intervenció de la pragmàtica amb nens de desenvolupament típic i potencialment atípic.

Resumen

La pragmática, definida como la capacidad de utilizar el lenguaje socialmente, tiene una enorme importancia en nuestra vida cotidiana y abarca tanto aspectos lingüísticos como sociales de la comunicación humana. La literatura centrada en el desarrollo de la pragmática ha explorado la relación entre las habilidades pragmáticas de los niños, otras habilidades lingüísticas (como el vocabulario) y habilidades de cognición social (como la teoría de la mente, ToM en inglés, y la comprensión de las emociones). Sin embargo, mientras que este tipo de investigaciones se han centrado en su mayor parte en las habilidades de pragmática receptiva (la que afecta a la comprensión) y en cómo los niños entienden la parte proposicional del lenguaje, se sabe mucho menos sobre las habilidades de pragmática expresiva (la que afecta a la producción) y su relación con el lenguaje multimodal (el lenguaje expresado a través de la prosodia y los gestos del habla). Con la finalidad de proporcionar una visión más completa del desarrollo de la pragmática expresiva e integrar de forma más clara las habilidades pragmáticas multimodales del lenguaje en el estudio del desarrollo de la habilidad pragmática, esta tesis doctoral pretende investigar las habilidades pragmáticas expresivas de los niños de 3 a 4 años en relación con el lenguaje (tanto multimodal como estructural) y la cognición social, y cómo se pueden mejorar estas habilidades pragmáticas en un contexto de aula.

Los cuatro estudios que componen esta tesis doctoral analizan las capacidades pragmáticas expresivas de un grupo de más de 100 niños catalanohablantes de 3 a 4 años. Para evaluar la competencia pragmática expresiva de manera exhaustiva creamos y validamos un nuevo instrumento de elicitación pragmática (*Audiovisual Pragmatic Test*, APT) que se ha utilizado en los cuatro estudios y que evalúa la habilidad del niño para utilizar el lenguaje en una variedad de contextos sociales cotidianos. El estudio 1 analiza las habilidades pragmáticas y prosódicas de este grupo de niños de 3 a 4 años en relación con el lenguaje estructural (vocabulario y sintaxis) y la cognición social (ToM, comprensión de emociones y vocabulario metacognitivo). Los resultados muestran que es el lenguaje estructural y no la cognición social el factor que predice el nivel pragmático y prosódico de los niños. Basándonos en los

resultados del estudio 1, los dos estudios siguientes exploran el vínculo entre la pragmática y el lenguaje multimodal de los niños. El estudio 2 analiza la prosodia como marcador pragmático y responde a la pregunta de cómo los niños de 3 a 4 años desarrollan la capacidad de utilizar la prosodia para expresar significados pragmáticos, teniendo en cuenta su nivel de ToM. Los resultados nos permiten evaluar el perfil prosódico de los niños en esta franja de edad y nos muestran que el nivel de ToM por sí solo no es suficiente para explicar la habilidad prosódica de éstos. El estudio 3 investiga si la frecuencia de uso gestual (medida con la APT) junto con la precisión gestual (medida con una tarea de imitación multimodal) están relacionadas con las habilidades narrativas de los niños de 3 a 4 años de edad. Los resultados muestran que la precisión gestual en la imitación está relacionada positivamente con las puntuaciones obtenidas en la producción de narraciones, lo que sugiere que las habilidades gestuales y narrativas están entrelazadas. Por último, el estudio 4 evalúa si una intervención conversacional multimodal y no multimodal sobre creencias y emociones puede mejorar las habilidades pragmáticas y sociocognitivas de los niños de esta edad. Los resultados muestran que, después de la intervención, los niños mejoran su nivel de pragmática expresiva pero no mejoran su nivel de cognición social, lo que pone de manifiesto el valor de intervenciones educativas basada en el lenguaje (tanto multimodal como no multimodal) para promover las habilidades pragmáticas de los niños.

En conjunto, esta tesis doctoral amplía nuestros conocimientos actuales sobre la adquisición de la pragmática expresiva en la etapa de la educación infantil. Los cuatro estudios evidencian que la habilidad pragmática expresiva a esta edad está estrechamente vinculada al nivel de lenguaje (estructural y multimodal) de los niños y menos a sus habilidades de cognición social. En concreto, la tesis ha demostrado que los componentes del lenguaje tanto multimodal como no multimodal están relacionados con la competencia pragmática y pueden fomentar el desarrollo pragmático en la etapa de la educación infantil. Estos resultados sitúan la capacidad pragmática de los niños en la etapa de la educación infantil en el ámbito lingüístico más que en el ámbito sociocognitivo y destacan la importancia de tener en cuenta las habilidades multimodales al investigar el desarrollo pragmático. Más allá de ampliar nuestra comprensión de la pragmática expresiva durante la etapa inicial de la educación infantil, los resultados obtenidos en esta tesis son reveladores para la mejora de las prácticas educativas y clínicas, ya que establecen bases prácticas y teóricas para la evaluación e intervención de la pragmática con niños de desarrollo típico y de desarrollo potencialmente atípico.

List of original publications

CHAPTER 2

Pronina, M., Prieto, P., Bischetti, L., & Bambini, V. (under review). Expressive pragmatics and prosody in preschoolers are more related to language skills than to social cognition. *Language Learning and Development.*

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CHAPTER 3

Pronina, M., Hübscher, I., Vilà-Giménez, I., & Prieto, P. (2021). Bridging the gap between prosody and pragmatics: The acquisition of pragmatic prosody in the preschool years and its relation with Theory of Mind. *Frontiers in Psychology*, *12*, 2962. https://doi.org/10.3389/fpsyg.2021.662124.

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CHAPTER 4

Pronina, M., Castillo, E., Grofulovic, J., Prieto, P., & Igualada, A. (under review). Narrative abilities at age 3 are associated positively with gesture accuracy but negatively with gesture rate. *Journal of Speech, Language, and Hearing Research*.

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CHAPTER 5

Pronina, M., Hübscher, I., Holler, J., & Prieto, P. (2021). Interactional training interventions boost children's expressive pragmatic abilities: evidence from a novel multidimensional testing approach. *Cognitive Development*, *57*, 101003. https://doi.org/10.1016/j.cogdev.2020.101003.

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Table of contexts

1

CHAPTER 1: GENERAL INTRODUCTION

1.1 Why developmental pragmatics?

Behind the common everyday and seemingly effortless acts of talking to others, whether asking questions, greeting, apologizing, contradicting, or thanking, lies the **pragmatic ability to use language** to engage socially. This ability to communicate and cooperate socially is celebrated as uniquely human and considered the pinnacle of human cognition (Tomasello, 2019). It is an ability of enormous importance in our day-to-day interactions over the course of our whole life. Communicating successfully using the right linguistic means accompanied with appropriate multimodal cues—expressed through the voice and the body, such as prosody and gestures—, while also taking into account others' emotions, desires, intentions, and thoughts, is an immensely challenging endeavour. How do children manage to navigate it? This thesis intends to address this question by investigating a range of skills on which children's pragmatic competence can draw (multimodal language, structural language, and social cognition). Looking at pragmatic skills in development provides a window into understanding the status of pragmatics in relation to other human abilities and offers insights into how to support and even improve them. We focus on the early preschool years (ages 3–4), which is a critical period for acquiring pragmatic and other developing skills needed to interact successfully and build social relationships.

Pragmatics is the ability to use language appropriately according to communicative situations (Airenti, 2017; although definitions of pragmatics vary considerably, for a review, see Ariel, 2010). It has been argued that pragmatic skills play a key role in development, as they are at the basis of early **language** and **socio-cognitive development** (Baldwin, 1995; Mundy & Newell, 2007; Tomasello, 2003; Tomasello et al., 2005, 2007; see section 1.4 for findings of empirical studies). In this sense, it has been claimed that people learn languages through interaction with other people, which means that language structure is learned through language use (Tomasello, 2003; Tomasello et al., 2005, 2007). Therefore, infants' first communicative interactions play a fundamental role in the process of acquiring language skills (Tomasello et al., 2007).

Likewise, it has been proposed that early pragmatic skills such as joint attention are foundational for later socio-cognitive abilities

(Mundy & Newell, 2007; Tomasello et al., 2005). Joint attention refers to an early developing set of behaviors in which children demonstrate the capacity to coordinate attention with a social partner (e.g., parent or caregiver) in relation to the same object or event (Carpenter, 2012). The aptitude for coordinating attention socially is one of the first building blocks for the human capacity for learning social competencies. Experimental and clinical research has shown that since joint attention is a key context for children and caregivers to share social experiences, it facilitates social learning (for a review see Mundy & Newell, 2007). Thus, in the first years of life, patterns of joint attention underpin the development of other abilities, such as structural language and social cognition.

As we have highlighted above, pragmatic skills lay the foundation for **fully functional communication** in day-to-day life and are essential for everyday wellbeing in children across different ages. There is mounting evidence that pragmatic ability has an effect on social and mental facets of children's lives. Pragmatic ability affects how children make friends, attain peer acceptance, succeed at school and regulate their emotions and behavior. **Individual differences** in children's pragmatic competence are positively associated with social skills and negatively with social difficulties (Gottman et al., 1975; Helland et al., 2014; Kemple et al., 1992; Murphy et al., 2014; Stangeland, 2017). For instance, pragmatic competence correlates with peer popularity – classroom observations indicate that popular children have better pragmatic skills than unpopular children and interact with their peers differently (Gottman et al., 1975). While investigating differences in the behavior and communication in children with average-to-high- and low-pragmatic competence, Murphy et al. (2014) found that pragmatically competent children show a more supportive attitude during collaborative problem-solving. In addition, one such area of pragmatic development—narrative skills—has long been known to be predictive of academic development including literacy (Dickinson & McCabe, 2001; Hedberg & Westby, 1993; Paris & Paris, 2003). In contrast, poor pragmatic abilities are related to behavioral, social, and emotional difficulties. In toddlers, low pragmatic skills account for play difficulties (Stangeland, 2017). Later on in development, pragmatic ability is negatively associated with inattention and hyperactivity (Leonard et al., 2011). From a longitudinal perspective, some studies have shown that low pragmatic competence at ages 3–4 may contribute to low social acceptance in later preschool years, at ages 4–5 (Kemple et al., 1992). Likewise, Helland et al. (2014) found that emotional and peer problems in middle school strongly correlate with pragmatic difficulties in adolescence.

Evidence coming from **clinical research** confirms that when pragmatic abilities develop atypically, long-term social outcomes may be adversely affected. Studies on various clinical populations characterized by pragmatic impairments, including Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and sometimes[1] Developmental Language Disorder[2] (DLD), show that children and adults with pragmatic difficulties display elevated symptoms of behavioral, social, and emotional difficulties (for ADHD: Camarata & Gibson, 1999; Green et al., 2014; for children with behavioral problems: Helland & Helland, 2017; for DLD: St Clair et al., 2011; for DLD and ASD: Whitehouse et al., 2009; see also Im-Bolter & Cohen, 2007). Children with pragmatic impairments also suffer long-term consequences in their academic and professional success. For instance, adults with a history of pragmatic deficits have persistent difficulties with literacy (e.g., Whitehouse et al., 2009) and employment (see Scott et al., 2019, for a review). Another important impact of pragmatic difficulties is that it affects overall quality of life. Diagnoses presenting pragmatic impairments such as ASD correlate with lower wellbeing, fewer positive emotions, and poorer mental health (Lord et al., 2020).

Given that pragmatic skills can set a course leading to certain developmental and social outcomes (positive in the case of well-developed pragmatic competence and negative in the case of pragmatic difficulties), a more thorough understanding of the **developmental trajectory** of **pragmatic abilities** is essential for

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[1] Note that unlike ASD, DLD is not characterized by primary social difficulties, so any pragmatic difficulties reported for this population are likely to be due to difficulties acquiring language.

[2] The term Developmental Language Disorder has recently come into use (Bishop et al., 2016, 2017). The same language impairment received different names before, for example, Specific Language Impairment (SLI), language impairment (LI), or language delay (LD).

theoretic and practical purposes. In the present thesis, we aim to take a step further in this understanding by investigating expressive pragmatic skills in children of preschool age. Given the emergence of differences in pragmatic abilities and their rapid acquisition that takes place in the preschool years, it is worthwhile investigating this developmental stage in order to pinpoint pragmatics on the developmental map of abilities and explore possible ways to promote pragmatic skills. The present PhD thesis focuses on young **preschool children aged 3 and 4** for several reasons. Firstly, at this age clear individual differences predictive of psychological wellbeing and school achievements emerge (Dickinson & McCabe, 2001; Kemple et al., 1992; Ramsook et al., 2020). It is at 3 years of age when developmental impairments involving pragmatic deficits such as ASD are often diagnosed (Daniels & Mandell, 2013). Secondly, important pragmatic changes are taking place during the preschool years. Preschoolers' pragmatic abilities rapidly become more honed (Clark, 2003). Concretely, previous research has shown that this age is especially relevant with regard to such pragmatic competences as speech act development, politeness-related meanings, referential communication, and narrative production, among others (Adamson & Dimitrova, 2014; Zufferey, 2020, see also next section for the detailed review). Thirdly and more generally, in preschool years pragmatic demands on children's social life increase as children enter school and become involved in the world beyond their families (Hartup, 1989; Parker et al., 2006). The new environment, alongside socialization with peers and teachers, enables children to acquire new pragmatic skills and attitudes (Rubin et al., 2006).

The following sections of the Introduction provide a review of research on the acquisition of pragmatics, as well as related developmental areas such as structural language, social cognition, and multimodal cues in the preschool years. First, we present an overview of pragmatic competencies that develop in the preschool years to delineate how children's pragmatic abilities have been studied and assessed previously (1.2). Then, we consider a global picture of the pragmatic development profile of preschoolers by discussing the link between pragmatics and other developmental domains such as structural language and social cognition (1.3). Next, we tackle the issue of how children's pragmatic and socio-cognitive abilities can be improved through training interventions

(1.4). This is followed by a section that argues for a multimodal approach to studying pragmatics: it explains the role of prosody and gesture in human communication in general and in pragmatic development in particular, and it discusses the multimodal pragmatic foundations for language acquisition and the emergence of social cognition. In this section, we also introduce a new tool, the Audiovisual Pragmatic Test (APT), that was specifically created for the joint assessment of expressive pragmatic and prosodic skills and is used across all studies of the thesis (1.5). Finally, the Introduction closes with a section that presents the aims, the research questions, the hypotheses, and the outline of the thesis (1.6).

1.2. What is developmental pragmatics?

1.2.1. The development of pragmatic abilities

As mentioned in the previous section, pragmatics is not easily delineated and, as a result, many definitions have been suggested in the literature (for a review, see Ariel, 2010; see also Levinson, 1983). In this thesis we follow the definition adopted by some recent developmental studies, for example, Nilsen et al. (2021), Tonini (2021) and Zajęczkowska et al. (2020) in which pragmatics is understood as the ability to use language appropriately in accordance with communicative context (Airenti, 2017). Therefore, **pragmatic ability** is viewed as a **multifaceted phenomenon** that encompasses a wide range of interdependent skills. This range of pragmatic competences includes but is not limited to the ability to understand and produce speech acts (Casillas & Hilbrink, 2020, for a recent review); to understand and mark information structure (Dimroth & Narasimhan, 2012, for a review) and to understand and produce referring expressions (Graf & Davies, 2014, for a review); to understand and mark epistemicity (Matsui, 2014, for a review); to understand and make use of politeness (Gleason et al., 1984; Talwar et al., 2007); to derive scalar implicatures (see Katsos, 2014, for a review); to comprehend non-literal language including metaphors (Pouscoulous, 2014, for a review), indirect speech and idioms (Bernicot et al., 2007), and irony (Filippova, 2014; Harris & Pexman, 2003, for reviews); to narrate a story (Carmiol & Sparks, 2014, for a review); as well as to understand and make use of conversational rules (Clark, 2003); to use discourse markers (see Zufferey, 2020); and to take turns in conversations (Casillas, 2014, for a review). This wide array of pragmatic skills, all of which add to the child's ability to use and comprehend language appropriately in social settings, falls under the umbrella term of pragmatics and has been a lively area of research in recent decades.

Before delving into the review of the acquisition of these skills, we shall remark upon the **age of the acquisition** of different pragmatic skills. In general, the acquisition of pragmatic abilities starts from birth (Stephens & Matthews, 2014) and develops over a long period, spanning most of childhood. Therefore, there is no easy answer to the question of when children acquire certain pragmatic skills. Different pragmatic skills are acquired at different ages and different aspects of the same pragmatic skill can be acquired at different developmental time points. In some cases, the divergent findings on the age children acquire particular pragmatic competences can be accounted for by the use of different methodologies and elicitation tasks to investigate the mastery of pragmatic skills (for details, see also a review by Zufferey, 2020; for a review of methods used to assess pragmatic skills, see 1.2.2). This is exemplified by children's acquisition of metaphors. Classic studies on metaphor comprehension such as Winner et al. (1976) showed that metaphors are understood literally until 6–7 years of age, while more recent research, such as that of Pouscoulous and Tomasello (2020), has suggested that 3-year-old children can already understand metaphors. The early developmental studies on metaphors tested children's comprehension via verbal explanation tasks: participants were asked to explain the meaning of a metaphor, which requires a high level of both linguistic and metalinguistic skills, as well as executive functions. Not surprisingly, preschool children failed at this task. On the other hand, the study by Pouscoulous and Tomasello (2020) focused on the child's capacity to understand metaphors rather than explain or paraphrase them and assessed this ability via behavioural choice task, which could be more suited for this aim. Thus, the differences found in the literature regarding the onset of metaphor acquisition can stem from different demands of the task (see also a review by Kalandadze et al., 2019 on metaphor comprehension in children with ASD).

Previous developmental work on the pragmatic acquisition of preschoolers aged 3–5 years (and also that of school-aged children) has traditionally included the acquisition of speech acts, information structure, referential communication, epistemicity, and politeness, together with the understanding of non-literal language such as metaphors, irony, and scalar implicatures, as well as narrative skills (e.g., see Matthews, 2014; see also Zufferey, 2020). These abilities are generally thought to develop or emerge during the preschool years. Below we present a brief overview of their developmental timelines.

We will start with **speech acts**. Children begin to develop skills for producing and understanding speech acts in early infancy (see Casillas & Hilbrink, 2020, for a review). For example, during early episodes of joint attention, infants already produce what are known as proto speech acts through the use of manual pointing gestures (e.g., E. Bates et al., 1975; see also section 1.5.2 for details). Soon after children begin to talk, the number of speech acts produced per minute rapidly increases (Snow et al., 1996). Snow et al. (1996) demonstrated that at 14 months of age, infants primarily produce assertions; by 20 months assertions remain the most frequent category but commands emerge; by 32 months infants begin to produce requests. While children produce basic speech acts such as assertions and requests first, other speech acts emerge later and speech act development continues for a number of years (see Cameron-Faulkner, 2014, for a review). For example, in the preschool years, children learn to handle indirect speech acts (e.g., Bucciarelli et al., 2003; Verbuk & Shultz, 2010) and only at the age of 5 do children acquire speech acts associated with promises (Astington, 1988). Moreover, while assertions with a declarative illocutionary force are produced very early in development, assertions conveying additional pragmatic biases that add complementary pragmatic meanings to them (see Krifka, 2015, 2017, 2019, for details on pragmatic biases) are acquired much later. For example, as we discuss in the following paragraphs, biases marking information structure within a given speech act are acquired over the course of childhood and epistemic (i.e., knowledge) biases start to emerge reliably only in the preschool years (Dimroth & Narasimhan, 2012).

As for information structure marking, children gradually acquire the conventions of adult language. Research suggests that infants have an early sensitivity to discourse novelty. For instance, infants' capacity to detect discourse novelty has been demonstrated in the context of word learning (Akhtar et al., 1996). Moreover, infants as young as 17 months are able to deal with new/changing vs. old/known information as they verbalize the novel but not the static element in a given context (Baker & Greenfield, 1988). Later in development, children acquire the specific linguistic means necessary for information structure. They start making use of lexical devices such as pronouns and particles, and different syntactic strategies such as word order and ellipses (Dimroth & Narasimhan, 2012). Peterson and Dodsworth (1991) showed that 3-year-old children do not yet display a good command of the use of pronouns and zero anaphora. The same applies to the employment of syntactic means. For instance, Narasimhan and Dimroth (2008) found that word ordering preference in 3- to 5-year-old children is the opposite of adults: while adults typically introduce new information at the end, children prefer the "new-given" pattern. Similarly, Hendriks (2000) showed that 5-year-olds use topic markers differently from adults: children organize their discourse around temporal and spatial topics, while adults organize their discourse around agentive topics. Overall, these studies demonstrate that, although young infants already possess some understanding of information structure and preschoolers begin to use linguistic strategies to express it, this pragmatic skill is still under development in the preschool years (Dimroth & Narasimhan, 2012).

With regard to **referential communication**, pragmatic competence in preschoolers is often evaluated by examining how children use words to designate a referent and whether they take into account the informational needs of their communicative partners. Studies have yielded mixed findings regarding how preschool-aged children use and understand referential communication. While some studies demonstrate that preschool children between ages 3 and 5 are sensitive to a speaker's perspective and can adjust their communicative behavior according to the knowledge of the listener (e.g., Matthews et al., 2007; Nilsen & Graham, 2009), other studies do not confirm these findings (e.g., Davies & Katsos, 2010; Perner & Leekam, 1986). For instance, Nilsen and Graham (2009) observed that 5-year-old children can generate referential descriptions to identify an object for an adult. That is, children would use a specific adjective to ask for an object when such an adjective would disambiguate between two similar objects that the listener could see (e.g., “Pick up the big duck.”). But when the children could see both objects but the listener could see only one object and therefore the adjective was not adding relevant information, children would not provide an adjective (e.g., “Pick up the duck.”). Other studies, however, have concluded that young children’s descriptions are often not informative enough to identify a referent for the listener or do not match the listener’s informational needs (e.g., Davies & Katsos, 2010; Perner & Leekam, 1986). For example, Perner and Leekam (1986) found that 3-year-old children often provide insufficient information when communicating with ignorant partners. A recent study by Grigoroglou and Papafragou (2019) indicated that in more naturalistic tasks, such as a guessing game with a naïve listener, children become more informative and at the age of 4 they are already able to give appropriate referent descriptions. These findings suggest that children’s referential communication in the preschool years is context-dependent and age-related progression can be observed in the school years.

Moving on to **epistemic** or **knowledge states**, previous research has investigated children’s understanding of whether speakers are trustworthy or knowledgeable. Within this line of developmental research, the acquisition of two main domains—namely, epistemicity and evidentiality—are considered. Epistemicity refers to the relationship between a speaker’s belief and a given propositional content (e.g., how certain the speaker is about some information), while evidentiality refers to source of evidence (e.g., direct vs. indirect evidence). Research on infancy indicates that children show an initial understanding of some of the epistemic states between ages 1 and 3 (e.g., reliable vs. unreliable speakers, see Koenig & Harris, 2005; knowledgeable vs. ignorant partners, see Liszkowski et al., 2008). However, it is only at around 4 years of age that children begin to understand lexical and grammatical markers that cue the speaker’s knowledge state, for example, particles, adverbs (e.g., “maybe”, “probably”), mental verbs (e.g., “believe”, “think”), or modal verbs (e.g., “must”, “might”) (see Matsui, 2014, for a review; see also Matsui et al., 2009; Moore et al., 1989, 1990; Papafragou, 1998). In general, the full mastery of epistemic and evidential markers develops slowly and even school-aged children of 6 years of age or older are yet to complete the acquisition of these pragmatic meanings (e.g., Papafragou et al., 2007).

Next, **politeness** is one of the important pragmatic aspects of communication. It is defined as an awareness of another person's face, or public self-image (Brown & Levinson, 1987). To use politeness strategies appropriately, the child must be able to evaluate the social relationship between the speaker and the listener in a given context and to take into account such factors as social distance and power among interlocutors, as well as the cost of the action. Across cultures, children are often explicitly taught to use appropriate polite forms by adults who provide them with a model (Küntay et al., 2014). However, it is not clear when the awareness of politeness starts to emerge in children. In general, the developmental literature states that the process of acquisition of politeness signaling takes place over the first five years of life (e.g., Axia & Baroni, 1985; Baroni & Axia, 1989; E. Bates, 1976; James, 1978). For example, Baroni and Axia (1989) reported that the ability to use target polite forms is acquired around 5 years of age or older. According to Bates (1976), Italian children primarily use direct questions and imperatives to request something until 4 years of age; they then start using proper syntactic forms between ages 5 and 6; but the ability to use appropriate requesting forms arrives later, at around age 7.

As for the understanding of **non-literal language**, such as metaphors, irony, and scalar implicatures (e.g., "some" meaning "not all"), studies have shown that preschool children have only a light grasp of it and that they keep on improving this skill throughout childhood. Within the case of **metaphors**, prior developmental research has considered the metaphor comprehension test as a typical measure of receptive pragmatic ability (Grigoroglou & Papafragou, 2017). We have already described some divergences among findings on metaphor comprehension that might be related to task demands. As mentioned, some studies indicate that when using a simplified task and age-appropriate metaphors, even 3-year-olds show some understanding of metaphors (Pouscoulous & Tomasello, 2020). Although metaphor comprehension arises in the preschool years, its acquisition continues into middle childhood and the majority of studies have assessed the understanding of metaphors in older, school-aged children using explanatory tasks of classic nominal metaphors, such as “Dancers are butterflies” (e.g., Del Sette et al., 2020; Lecce et al., 2019). Studies using this testing paradigm have shown that fully-fledged metaphor comprehension is not reached until adolescence. For example, while 9-year-old children may be as good as 10- to 12-year-old children in interpreting physical metaphors (e.g., “Dancers are butterflies”), they are still worse than older children in the interpretation of mental metaphors (e.g., “Daddy is a volcano”).

Another lively research area of non-literal language comprehension is the understanding of **irony** in children (Demorest et al., 1984; Filippova & Astington, 2010; Harris & Pexman, 2003). On the whole, it is agreed that between ages 5 and 8 children start showing signs of comprehension of irony by detecting ironic statements (e.g., Dews et al., 1996; Harris & Pexman, 2003). Although able to understand that the speaker who made an ironic remark believes something different from what was said, at this age children fail to explain the reason for producing ironic statements (Hancock et al., 2000). It is between ages 6 and 8, or even later if the cues to irony are not salient, that children begin to recognize the intention behind the speaker’s use of irony.

Turning our attention to **scalar implicatures**, it has been shown that preschoolers do not use contextual information to interpret the quantity of information expressed in utterances in the same way that adults do (Snedeker & Trueswell, 2004). In scalar implicatures, a weaker term of a scale is used while a stronger alternative is excluded. An example would be the use of the quantifier “some” instead of “not all” in a sentence like “Some of the animals are sleeping.” (example from Barner et al., 2011). Thus, “some” pragmatically implies “not all” (“Not all the animals are sleeping.”) and the listener needs to generate an enriched meaning and conclude what the speaker did not say but could have said. Research has shown that children younger than 5 years fail to draw scalar implicatures at the same rate as adults (Barner et al., 2011; Katsos & Bishop, 2011; Noveck, 2001). However, some authors propose that preschool children do start to gain the necessary pragmatic competence to derive implicatures. They argue that difficulties can be explained by the lack of processing resources (Pouscoulous et al., 2007) or vocabulary size (Barner et al., 2011) but if tasks seeking implicatures and linguistic material are simplified, preschool children perform better on scalar implicatures. These findings indicate that, actually, preschoolers may already have some ability to understand scalar implicatures, though their skills clearly have room for development and are not yet adult-like.

Finally, during the preschool years, children take their first steps in **narrative development**. Narrative skills refer to the ability to string sentences together to convey extended discourse (Applebee, 1980). While children's earliest speech is about events that occur here and now, later on children gradually acquire the ability to produce language without relying on the immediate context. The narrative ability to use decontextualized language and form longer discourse about thoughts or past events requires a number of grammatical and pragmatic skills, as well as cognitive resources (Aparici Aznar et al., 2018). In this PhD thesis, narratives will be regarded as a comprehensive measure of children's oral abilities reflecting both grammatical and pragmatic skills, mirroring the complexity of real-world language use. First, being a competent narrator entails a strong command of structural language domains such as vocabulary and syntax. That is why narrative abilities are often included in children's language assessment and are considered an ecological measure of linguistic abilities (e.g., grammatical measures, fluency, story structure) (Botting, 2002). Moreover, narratives are proven to be a valid measure for detecting language disorders (Duinmeijer et al., 2012). Second, narratives are considered to be a key domain in the assessment of pragmatic development (Matthews, 2014; Matthews et al., 2018). Being a competent narrator entails also having a strong command of pragmatic domains such as the ability to structure the narratives in a way that is informative for the listeners (e.g., management of common ground), providing necessary contextualizing information about the events (e.g., introduction of the setting and the characters), commenting on the narrative to create an engaging story, and ensuring cohesion and coherence of the story (e.g., the appropriate use of conjunctions, pronouns, ellipsis, the order of elements, the relationship between time tenses) (Aparici Aznar et al., 2018; Carmiol & Sparks, 2014). Understanding this set of pragmatic challenges is important to children's developing narrative abilities. In short, narrative competence constitutes a rich context within which we can assess a number of different developing aspects of language.

From a developmental perspective, narratives are a paramount component of children's daily life, as children are first exposed to narratives through stories and tales told by their caregivers or presented in books and movies (Demir & Küntay, 2014). At the age of around 3 years of age they start producing their own narratives and continue to hone these skills up to adolescence (Demir & Küntay, 2014). Although children start to produce narratives from the age of 3, preschoolers' narratives still lack some of the important features of 'true narratives' (Applebee, 1978). Three- to four-year-olds do not yet structure their narratives in a consistent informative way; for example, their narratives are characterized by the lack of a goal-based structure. Specifically, preschool children may fail to include crucial structural elements of a story line such as resolution or omit characters' goals. In addition, at this age children do not use discourse markers, which emerge only around the ages of 5 or 6 (Applebee, 1978). With time, thematic coherence, syntactic complexity, and the complexity of the information structure of children's narratives increase (Berman & Slobin, 1994; Diessel & Tomasello, 2005; McCabe & Peterson, 1991).

Overall, as it is clear from this outline of pragmatic developmental research, crucial changes in pragmatic competence take place in the early preschool years. Although full proficiency in pragmatic skills is achieved later in development, sometimes not until adolescence, important advances occur between 3 and 4 years of age, when some pragmatic skills emerge and others continue to develop. Therefore, this is a key period for the development of a number of expressive pragmatic skills, such as the production of speech acts, narratives, and the development of the pragmatic biases of epistemicity, information structure, and politeness.

1.2.2. How to assess children's expressive pragmatic abilities?

Turning to the question of how to assess children's pragmatic abilities, different methodologies have been used in previous research, including corpus-based analyses of children's interactions and elicited behavioral responses to pragmatic tasks, as well as standardized assessment tools. The corpus-based approach is an ecologically valid way to assess early pragmatic abilities in infants and toddlers. It is often focused on joint attention skills in interaction with caregivers (see Carpenter, Nagell, et al., 1998; Mundy & Newell, 2007). To measure them, the following behavioral observations are used: initiating joint attention episodes such as asking for help, asking for an object of interest, or establishing shared visual attention with the caregiver to communicate interest in an object or activity, and responding to joint attention such as following gestures or following the direction of gaze of the social partner. Over time, joint attention increases and changes its form and focus, and notably develops in the third year of life and beyond as children acquire more complex pragmatic skills and become able to sustain conversations and produce narratives (Adamson & Dimitrova, 2014).

In the preschool years and beyond, a popular ecological way to assess pragmatic abilities in children is to set **narrative tasks**. Narrative tasks are set which involve the child retelling a story, while the child may or may not be provided with language support. In some tasks, children are first presented with verbal input, that is, first the experimenter tells the story and then the child is asked to retell it. One of the most widely used tests for this assessment of narrative speech is the Renfrew Bus Story Test (Renfrew, 2006), which is very popular with preschoolers and is suitable for children between 3 and 8 years of age. In other narrative tasks, children are not provided with verbal input and are asked to retell the story on the basis of wordless cartoons or picture books (e.g., Maus cartoon used with 5- to 10-year-old children in Alibali et al., 2009; Demir et al., 2014; Vilà-Giménez, 2020). Another common way to assess pragmatic abilities in preschool and school-age children is to ask them to undertake experimental pragmatic tasks. **Experimental pragmatic tasks** in preschool and school-aged children tend to tap a specific pragmatic skill, such as the understanding of irony (e.g., Angeleri & Airenti, 2014; Filippova & Astington, 2010) or metaphors (e.g., Lecce et al., 2019; Pouscoulous & Tomasello, 2020), the comprehension and production of referential expressions (Nilsen & Graham, 2009, 2012) or scalar implicatures (Katsos et al., 2011; Pouscoulous et al., 2007). Experimental tasks to measure these abilities are very diverse and oftentimes they are specifically designed for a particular study and provide a framework to assess a specific pragmatic skill. The previously mentioned study by Nilsen and Graham (2009) that measured children's ability to adapt their language to their partner's perspective offers an illustrative example of an experimental pragmatic task. In this study, a "guessing game" was used. The general experimental procedure was as follows: the child and an experimenter were sat at a table in front of the display case and another experimenter was sat behind the display case. Several objects were placed in the boxes of the display for each trial; on each trial, a wooden sliding door blocked the view of one of the objects from the experimenter that was behind the display case but the object was still visible to the child and the first experimenter, seated in front of the display case. In different conditions (i.e., baseline, common ground, and privileged ground conditions), presented objects differed in referential ambiguity and the child and the first experimenter were prompted to generate clues for the other experimenter so that (s)he could guess the object. As is clear from this description, this task is highly specific and the whole experimental design was employed to elicit referential expressions in children and investigate referential communication in preschoolers.

Hence, the experimental approach is often narrow-focused and examines a specific type of pragmatic skill, rather than pragmatic abilities in their totality, and focuses on only verbal expressive means, rather than also considering multimodal forms of pragmatic expression. A remarkable exception to this tendency is the study by Bosco et al. (2013) that examined in a unified way the abilities of 5- to 8-year-old children to both understand and produce different kinds of pragmatic phenomena, namely, communication acts, deceit, and irony, and investigated both verbal and multimodal (referred to as extralinguistic and paralinguistic) pragmatic means. Nevertheless, the majority of the existing studies tend to focus on one pragmatic phenomenon at a time. In contrast, more comprehensive **pragmatic assessment tools** are usually designed to globally assess pragmatic competence. These tools have a broad focus and cover a set of pragmatic skills. Some of the currently existing pragmatic tools in preschool and school-aged children assessing global pragmatic skills are the following: *Children's Communication Checklist-2* (CCC-2; Bishop, 2003), *Clinical Evaluation of Language Fundamentals-5* (CELF-5, the Pragmatics Profile subscale; Wiig et al., 2013), *Clinical Evaluation of Language Fundamentals-Preschool 2* (CELF-Preschool 2, Pragmatics Profile and Pragmatics Activity Checklist subtests; Wiig et al., 2009), *The MacArthur-Bates Communicative Development Inventories* (MB-CDIs; López-Ornat et al., 2005), *Test of Pragmatic Language-2* (TOPL-2, the Pragmatic Language Usage Index; Phelps-Terasaki & Phelps-Gunn, 2007a), *Comprehensive assessment of spoken language-2* (CASL-2, the Pragmatic Language subscale; Carrow-Woolfolk, 2017), *Assessment Battery for Communication* adapted for children (ABaCO; Bosco et al., 2012; Sacco et al., 2008), *Social Skills Improvement System Rating Scales* (SSIS; Gresham & Elliott, 2008), *Pragmatic Language Skills Inventory* (PLSI; Gilliam & Miller, 2006), *Conversation Effectiveness Profile* (CEP; Kowalski, 2005), *Pragmatic Profile of Everyday Communication Skills* (PPECS; Dewart & Summers, 1995), *Functional Communication Profile Revised* (FCP-R; Kleiman, 2003), *Assessment in Speech-Language Pathology* (ASLP; Shipley & McAfee, 2015), *Pragmatic Protocol* (Prutting & Kirchner, 1987), *Assessment of Comprehension and Expression* (ACE 6-11; C. Adams et al., 2001), *Test of Language Competence* (TLC; Wiig & Secord, 1985), *Social Responsiveness Scale–Second Edition* (SRS-2; Constantino & Gruber, 2012), *Behavior Assessment System for Children–Second Edition* (BASC-2; Reynolds & Kamphaus, 2004), *Social Communication Questionnaire* (SCQ; Rutter et al., 2003). We briefly review these pragmatic tests below. For complete reviews of pragmatic assessment instruments, see Adams (2002), Russell and Grizzle (2008) and more recently O'Neill (2014) and Hyter (2017).

A considerable number of norm-referenced pragmatic assessment tools take the form of questionnaires to be completed by parent, teacher or therapist (e.g., CCC-2, pragmatic subscales from CELF-5, as well as SSIS, PLSI). These tools usually focus on the child's conversational and social skills, for example, caregivers can be asked to evaluate the child's ability to initiate a conversation, ask, give and respond to information, take turns, etc. On the one hand, these questionnaires provide valuable information about the child's performance in natural contexts, such as school or home, by a person who regularly observes the child. On the other hand, assessing pragmatic skills via questionnaires means that such tests do not provide a direct evidence-based assessment of the children's pragmatic performance.

Another type of global pragmatic assessment is the observational pragmatic checklist (e.g., PPECS, ASLP, CEP, FCP-R, SRS-2, BASC-2, SCQ). It is primarily focused on children with atypical language development—most often, children with ASD—but it can also be applicable to a wide variety of child profiles with pragmatic impairments, for example, children with ADHD (e.g., Papazoglou et al., 2013). These checklists are originally designed to measure social deficits, emotional and behavioral disorders and to screen for and eventually diagnose atypically developing children. These assessments are also based on caregiver questioning. They are intended to offer insights into children's social skills, and are popular with practitioners as they support the planning and carrying out of interventions (Adams, 2002).

Another set of tests involve interaction with the child and therefore directly assess pragmatics behavior (e.g., ABaCO, ACE 6-11, CASL-2, Pragmatic Protocol, TLC, TOPL-2). Some tests focus on pragmatic comprehension only, for example, on pragmatic skills such as making inferences (e.g., TLC). Other tests center on expressive pragmatic abilities but their target population is atypically developing children (e.g., ACE 6-11, Pragmatic Protocol). One of the most comprehensive tests to assess pragmatics is ABaCO, originally developed in Italian as a clinical instrument for the evaluation of pragmatic abilities in patients with neuropsychological and psychiatric disorders and later adapted for children. ABaCO focuses on both receptive and expressive pragmatic abilities and assesses a wide range of pragmatic phenomena by using five evaluation scales: (1) comprehension and production of linguistic acts, (2) comprehension and production of extralinguistic acts, (3) paralinguistic expressions, (4) appropriateness in context, and (5) conversation management. Some pragmatic tests (e.g., CASL-2, TOPL-2) evaluate children's communication in contexts similar to a real-life situation. These instruments assess a number of pragmatic skills, such as the ability to use language in different situations, to effectively resolve social problems and to modify language according to the social context simulating everyday scenarios.

To sum up, while there is a long list of pragmatic assessment tools, the majority of them (i) do not provide a direct assessment of children's expressive pragmatic abilities since they are based on a caregiver's report, (ii) are primarily designed to identify pragmatic deficits in atypically developing children, (iii) focus on the comprehension of pragmatics only. All in all, only two pragmatic assessment tools to date (i.e., CASL-2, TOPL-2) are suitable for directly assessing expressive pragmatic skills in typically developing children in a comprehensive and global manner. Another important factor to take into account is the specific language used in the assessment tool. While the two above-mentioned tools for assessing expressive pragmatics are available in English, there is still a need to develop and validate a pragmatic instrument to be applied to other languages. As for Romance languages, there are some tools available for Spanish-speaking children. For example, some tests originally developed in English were adapted for Spanish (the Spanish version of CCC, Crespo-Eguílaz et al., 2016; CCC-2, Mendoza & Garzón, 2012) and others were directly designed in Spanish (PleaseApp, Andrés-Roqueta et al., 2020; PREP-R, Fernández et al., 2015; PEP-L, Romero Romero et al., 2014). For example, the recently developed PleaseApp pragmatic assessment tool is an app designed to evaluate and treat pragmatic and socio-cognitive skills in both typically and atypically developing children aged 3 to 12. However, fewer instruments have been developed for Catalan.

1.3. How is pragmatics related to structural language and social cognition?

By definition, pragmatics is the ability to use language socially. It therefore lies at the intersection of language and the social world and thus deals with both the linguistic and social aspects of communication. The developmental literature suggests that **structural language** and **social cognition**[3] play a key role in explaining children's pragmatic development (for a recent detailed

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[3] It should be noted that there is a third element that has received wide attention too, namely, executive functions such as working memory, inhibition control, and cognitive flexibility. For reviews, see Bosco (2006), Filipe et al. (2020), Matthews et al. (2018). However, executive functions are outside the scope of the current work.

review see Matthews et al., 2018). Firstly, pragmatic abilities are strongly related to structural language competence, since we communicate and express ourselves socially via linguistic means (Levinson, 1983). Structural language skills, also known as formal language skills and core language skills, refer to specific knowledge in any level of grammatical linguistic structure, ranging from phonology to semantics. The levels of grammatical knowledge that are typically assessed in children include areas of lexical/vocabulary knowledge and morphosyntactic knowledge. Thus, measures of structural language evaluate the child's ability to understand and produce linguistic forms. However, as pointed out by Matthews et al. (2018), it is difficult to separate linguistic forms (e.g., grammatical structures) from linguistic functions (e.g., pragmatics) because in understanding words and sentences, we rely on pragmatic factors, while pragmatics, in turn, requires grammatical knowledge. Nevertheless, previous research has found it practical to consider structural language and pragmatics separately, since some children show difficulties using language for social purposes (e.g., Adams et al., 2002). Secondly, pragmatics is linked to the social dimension of communication and appears as a social phenomenon occurring during human interaction. The set of abilities that allows us to interact with others is known as social cognition (see Frith & Frith, 2007, for the classic definition of this term in the developmental field). Although social cognition is made up of various components, this thesis will focus on the socio-cognitive aspects that are concerned with the understanding of others' mental states. One such component of social cognition is **Theory of Mind** (ToM). The term Theory of Mind was coined by Premack and Woodruff (1978), and in the developmental literature ToM is also sometimes referred to as mindreading, perspective-taking, belief-desire reasoning, and mentalizing. ToM has received wide attention in the field and it is defined as the ability to attribute mental states to others and to use this knowledge to predict and explain their behavior (see Perner, 1991; Wellman, 2014, 2018, for reviews). Alongside ToM, another main construct of social cognition is **emotion understanding**, defined as the ability to determine the affective state of others (see Happé et al., 2017; Harris, 2006, for reviews). Therefore, social cognition includes both cognitive and affective aspects of human communication. Another construct related to both ToM and emotion understanding, which also forms part of social cognition, is the understanding of **mental state**

language, referred to as **metacognitive vocabulary**. In order to understand people's minds there must be an understanding of their cognitive and emotional mental states (e.g., what they think, know, believe, wonder, remember, when they are happy, sad, scared, surprised, angry, etc.). Even though it is well-known that social cognition and language support one another in their development during childhood (Astington & Baird, 2005), it is important to assess their role within and their relation to pragmatic abilities.

In the field of social cognition, mentalizing refers to the ability to infer others' mental states, including both cognitive and emotional states (see Frith & Frith, 2003; Hooker et al., 2008). Mentalizing is considered a part of wider social cognition. Within this thesis, the term 'mentalizing' is applied in Study 1 in order to highlight that the socio-cognitive abilities, including false belief, emotion understanding, and metacognitive vocabulary (all three of which make up mentalizing and which form part of wider set of abilities comprising social cognition), are analyzed in an integrated manner. In the other studies of this thesis, however, there is a greater focus on particular components of social cognition (e.g., ToM in Study 2), and we therefore use specific terms to refer to them: the term 'ToM' (to refer to ability to infer others' cognitive mental states), the term 'emotional understanding' (to refer to the ability to infer others' emotional states), and the term 'metacognitive vocabulary' (to refer to the understanding of mental state language), with all three elements (ToM, emotional understanding, metacognitive vocabulary) together referred to as social cognition.

The two-fold nature of pragmatics—as an ability that straddles both language competence and social cognition skills—has brought about a wide debate on the relationship between pragmatics, other language skills, and social cognition. In the following three sections, we review prior literature on this relationship. The review is divided into three parts. In the first section we describe how theoretical approaches address this issue (1.3.1). In the second section we outline the milestones in the development of social cognition (1.3.2). Finally, the third section analyzes the existing empirical evidence of the link between pragmatic abilities, structural language, and socio-cognitive skills in children (1.3.3).

1.3.1. Pragmatics, structural language, and social cognition: Theoretical approaches

Within theoretical pragmatics, the **linguistic tradition** views the pragmatic component as largely concerned with language. For example, some approaches consider pragmatics to be a level of linguistic representation that accounts for phenomena that cannot be accounted for by linguistic convention (see Ariel, 2010). In other words, pragmatics is understood as everything that is not grammatical but has to do with language use. As a consequence, much effort has been dedicated to defining which tasks fall under pragmatics and which ones are to be considered grammar (structural language). A more flexible view of pragmatics, such as the one proposed by Akmajian et al. (2010), considers pragmatics as language used in relation to language structure and context of use and argues that the picture is more complex. Specifically, the authors suggest that the dividing line between pragmatics and other aspects of language structure—for example, semantics—is difficult to draw and it is not as simple as just that pragmatics beginning where semantics leaves off. Rather, they claim that since pragmatics interferes with semantics and other linguistic levels, they cannot be separated and should be considered jointly. In the same vein, other linguistic oriented approaches define pragmatics as a specific perspective on language that affects any aspect of linguistic structuring, from phonology to semantics. Verschueren (2012) proposed that pragmatics does not deal with language as such, but rather with language use and the relationship between language form and language use. When we use language communicatively, we constantly make linguistic choices, consciously and unconsciously. These choices are made at all linguistic levels, including phonological, morphological, lexical, syntactic, semantic, etc. Therefore, refining a theory of language use (i.e., pragmatics) is a wide-ranging task that affects all language levels and that deals with the exploration of the motivations behind linguistic choices in social contexts. All in all, within the linguistic tradition, pragmatics is primarily considered to be part of the linguistic system.

By contrast, other scholars of pragmatics, inspired by the work by Grice (e.g., Grice, 1975), adopted a more **cognitively oriented perspective of pragmatics**. This approach is sometimes referred to as cognitive pragmatics (see Bosco, 2006, for a review). Cognitive pragmatics is mainly concerned with the mental processes of intentional communication, and focuses on the cognitive mechanisms that underlie language comprehension in social contexts, while it generally overlooks linguistic production. Thus, according to this approach, pragmatics is not regarded as a linguistic ability but is rather viewed as the socio-cognitive capacity for human communication (Sperber & Wilson, 1985; see also Bara, 2010). The central theoretical framework for cognitive pragmatics was first put forward by Sperber and Wilson and is known as Relevance Theory. This theory maintains that human language comprehension is guided by expectations of relevance and thus mental processes such as cognitive inferencing play a key role in comprehension. Pragmatics is defined as the ability to inferentially attribute intentions in communication and derive the speaker's meaning. Sperber and Wilson argued that there is a specific module dedicated to pragmatic interpretations, which is, in fact, a submodule of the human capacity for "mind reading" (see Scott-Phillips, 2017; Sperber & Wilson, 2002). Another theory focusing on cognitive processes underlying human communication is the framework proposed by Bara (2010). The author investigates communication from within the mind of the individual and argues that communication is essentially a cooperative activity in which the meanings are constructed by speakers, highlighting the role of intentionality and cooperation in linguistic interactions. In the analysis of communicative acts, this framework focuses on the inferential chains necessary to derive the speaker's communicative intention. Thus, both Relevance Theory and the cognitive pragmatics framework developed by Bara focus on cognitive process of communication and, therefore, take a socio-cognitive perspective on pragmatics (Bosco, 2006). On the whole, within cognitively oriented approaches, pragmatics is primarily concerned with social cognition.

Although the relationship between pragmatics, structural language, and social cognition has been a matter of long theoretical debate, lately, the issue of the status of pragmatic abilities has been increasingly addressed from a **developmental and clinical perspective**. Nowadays, scholars in developmental and clinical psychology acknowledge the complex interplay between pragmatics and both other linguistic abilities and social cognition. According to recent models of pragmatic competence proposed in the developmental and clinical fields, although pragmatics, structural language, and social cognition are closely interrelated in the process of social communication, all three elements represent theoretically distinct constructs (Hyter, 2017; Snow & Douglas, 2017). From this perspective, pragmatics cannot be reduced to structural language alone or social cognition alone but rather structural language and social cognition foster pragmatic acquisition. Pragmatic competence emerges on the back of socio-cognitive and linguistic skills and is continually refined throughout childhood and more generally over a lifetime. Snow and Douglas's model (2017) proposed thinking about pragmatics as "**a cup of competences**", in doing so highlighting that pragmatic ability is composed of various functions such as language functions and social cognition functions, among others. These functions are positioned in the context of individual psychological characteristics (e.g., temperament, self-esteem, coping styles) and social and environmental contexts in which to use and learn language (e.g., home and family, school, community, culture). This model illustrates the complexity of pragmatic competence, such is the range of inputs and factors shaping it. In addition, in the clinical field, researchers claim that it is impossible to assess and treat children and adults with pragmatics disorders in isolation from other linguistic and cognitive concerns. In the model of social communication presented in Hyter (2017), pragmatic competence is grounded in several components including ToM, affective (emotional) states, and executive functions, while it also requires comprehension and production of language. All in all, these recent psychological models suggest that both linguistic and cognitive skills theoretically underpin pragmatic ability.

1.3.2. The development of social cognition

In this section, we review the main findings in relation to the development of social cognition (see also Brizio et al., 2015), a component of human cognition that, as illustrated in previous paragraphs, is thought to be closely related to pragmatic abilities. We first summarize findings concerning children's developing understanding of mental cognitive states (intentions, desires, and beliefs); then we discuss the acquisition of lexical cues denoting mental states; the following paragraphs deal with the development of false belief, and we end the section by reviewing the development of the affective aspects of social cognition.

Mental cognitive states include intentions, desires, and beliefs. All three of these are attitudes toward propositions (Astington, 2001). Unlike beliefs, the satisfaction of intentions and desires depends on whether the world comes to match their propositional content. In the case of **intentions**, the propositional content is the intended outcome, and in the case of **desires**, the propositional content is the desired outcome. The difference between intentions and desires lies in how the outcome is fulfilled. Whereas the fulfilment of desires occurs irrespective of the manner in which their content is satisfied, in the case of the fulfilment of intentions, their content is satisfied only if the intention itself brings about the target outcome. Intentions are considered "the simplest and most obvious mental states" (Astington, 2001), and they are the first to be acquired by infants, constituting the main foundation of social cognition (Malle et al., 2001b). Intentionality helps children to organize the perception of other humans' behavior by enabling them to recognize structure (i.e., intentions and actions) in the dynamic stream of social movements and supports coordinated social interaction by helping to explain their own and others' behavior in terms of its mental causes. Although infants have some grasp of intentions and a rudimentary appreciation of intentional and unintentional actions (Behne, Carpenter, Call, et al., 2005, see also 1.5.4 below), it has been argued that infants do not yet have an explicit understanding of the concept of intention. Astington (2001) claims that by the end of the first year of life infants understand intentions as simply attitudes tied to actions and speech acts. Only later, in the preschool years, do they begin to understand intentions as representations, independent of one's actions in the world. In other words, preschoolers begin to have a metarepresentational understanding of intentions. This eventually allows children to develop the understanding of intentional causation and master the distinction between intentions and desires. In sum, the complex metarepresentational understanding of intentionality is acquired gradually and it is not until the preschool years that children begin to reliably distinguish intentions and desires.

As for the understanding of people's **beliefs**—the attitudes toward propositions whose satisfaction does not depend on events matching their propositional content—, it is widely thought that they are acquired later, in the preschool period (Malle et al., 2001a). It should be noted that beliefs can be of different kinds and that they follow different developmental paths. For example, a correct or true belief is held by someone in the case of knowledge; no belief is held in the case of ignorance; uncertain belief is held in the case of ambiguity; and a mistaken or, in other words, false belief is present in the case of having misleading evidence about something. A meta-analytic review conducted by Wellman and Liu (2004) comparing different types of mental state understandings (i.e., desire vs. belief, belief vs. false belief) confirmed that children can accurately judge others' desires before they can accurately judge others' beliefs and they can accurately judge people's true beliefs before they can accurately judge people's false beliefs. As for the understanding of true belief, although infants have some grasp of them (e.g., Liszkowski et al., 2008), it is not until the preschool years that children start to reliably distinguish between such mental states as knowledge and ignorance (Malle et al., 2001a). For instance, Koenig and Harris (2005) and Sabbagh and Baldwin (2001) found that preschoolers managed to differentiate between the person who knows something and the person who does not; moreover, children pay more attention to knowledgeable speakers and mistrust ignorant speakers.

As for the acquisition of **lexical cues to mental states** such as beliefs and desires, some theoretical models have proposed that this process is pragmatic in nature (Montgomery, 2002, 2005; Nelson, 2005, 2007). Children experience some mental states and they gradually build up the understanding of mental state verbs expressing them, like "believe", "think", "know", "remember", "want", "wish" ("I remember you did it" vs. "I believe you did it" vs. "I know you did it", for example). Montgomery (2005) maintains that they acquire mental language through the contextualized uses of these mental verbs by adults. In other words, children derive the meaning of mental verbs from social interactions with their caregivers. Hence, mental concepts are learned through early communicative exchanges. Nelson (2007) also proposed that conversations allow children to reflect on their experiences and to represent other people's mental states about the same situation and it constitutes the way in which children come to understand others' minds. In this way, conversation is the context that helps children to develop socio-cognitive abilities. Indeed, previous empirical research has established that children's exposure to conversation about mentalistic concepts (thoughts and feelings) with family members predicts understanding of the mind of others (see Harris et al., 2005; Slaughter & Peterson, 2012, for reviews; see Tompkins et al., 2018, for a recent meta-analysis). Mothers increase their mentalistic talk about desires and intentions with time: they label and contextualize the child's inner states (Slaughter et al., 2009). Children begin to use some mental terms between 18 and 36 months (Bartsch & Wellman, 1995). However, as Nelson (2005) maintains, experiencing beliefs and talking about them does not automatically entail their understanding. At the age of 3 years, children talk about the mind and can spontaneously produce such cognitive terms as "think" and "know" in everyday conversations. At the age of 4, children can better differentiate between specific mental states, for example, they begin to distinguish "think" and "know" as expressions of different degrees of certainty. But it is not until the early school years that they master mental language knowledge and are able to clearly distinguish between various mental terms (e.g., "think", "know", "guess") (see also Grazzani & Ornaghi, 2011). In short, even though preschool children are attentive to the language of the mind and start employing it, the mastery of the distinctive comprehension and use of mental state verbs is spread across various years in preschool and school.

In the field of social cognition, it is believed that genuine understanding of intentions, desires, and beliefs is possible only after the emergence of **metarepresentational understanding** (Perner, 1991). Metarepresentational ability is part and parcel of social cognition. It implies the understanding that humans' desires and beliefs are mental representations of the world and that they govern our actions in the real world (Bartsch & Wellman, 1995). This idea illustrates that people perceive themselves and others in terms of mental states (e.g., emotions, intentions, desires, beliefs, and other unseen inner states), which are manifested in people's actions. One of the most compelling ways to test whether the child possesses an appreciation of the distinction between mind and world is to test a child's understanding that a person has a false belief.

False belief understanding is undoubtedly the main ToM developmental milestone achieved in the preschool years, as demonstrated by a large body of literature (e.g., Perner & Roessler, 2012; Wellman, 2018; Wellman et al., 2001; Wellman & Liu, 2004, among others). The case of false belief is a nifty example of somebody's actions being determined by their representations of the world rather than by the real world itself. Classic tests used to measure false belief understanding assess the child's ability to predict the actions of a person who holds a false belief. False belief tasks come in many forms, but by far the most popular are the unexpected location task and the unexpected content task. The unexpected location task is known as the "Sally and Anne" task (Baron-Cohen et al., 1985). In this task paradigm, there is a change of location unknown for one of the characters: a character Sally is bound to mistakenly look for an object in the place where she has left it rather than in the place it really is because she does not know that during her absence another character Anne has moved the object to a new place. The child is asked to predict Sally's actions. The unexpected content task is the so-called "Smarties" task (Gopnik & Astington, 1988; Perner et al., 1987). In this paradigm, the focus is on the child's ability to reconstruct their own previous false belief. The task involves a change of content initially unknown to the child: the child is shown a familiar candy Smarties tube where, unbeknownst to the child, the candies have been replaced with pencils, and is asked about the contents of the tube; after the child gives the expected answer that it contains candies, the experimenter reveals to the child that it contains pencils. The child is asked to recall their initial false belief about the contents of the candy tube. It has been consistently demonstrated that children start to reliably succeed in various versions of these tasks around the age of 5 (Milligan et al., 2007; Sodian, 2006; Wellman, 2018). Specifically, most 3-year-old children fail to predict the character's actions or reconstruct their own false beliefs, 4-year-old children show a mixed performance, some of them fail and some of them succeed, and most 5-year-old children succeed in false belief tasks. This suggests that a big conceptual change in ToM occurs during the preschool period (Perner, 1991; Perner & Roessler, 2012; Wellman, 2018).

It has been shown that ToM development is gradual, as it goes beyond the preschool age and some higher-level developmental shifts in ToM take place during the school years (Bosco et al., 2014; Devine & Lecce, 2021). The above-mentioned false belief tasks involve the understanding of what individuals think about real events, that is, they test **first-order beliefs**. There are also second-order false beliefs that involve the understanding of what an individual thinks about other individuals' thoughts (Perner & Wimmer, 1985). In this way, **second-order false belief** tasks require a recursive understanding of other people's beliefs about another's beliefs such as "John *thinks* that Mary *thinks*...". The understanding of mistaken beliefs about others' beliefs emerges later in development, between 5 and 7 years of age (see Wimmer & Perner, 1983). Preschool children have very little success in these higher-level tasks but school-aged children begin to show second-order false belief understanding. Apart from achievements in second-order false belief tasks, school-aged children develop the ability to apply the ToM skills in different social contexts. For example, Banerjee et al. (2011) reported that 9-year-olds begin to use their ToM skills to explain social behavior *in faux pas* situations where one person unintentionally insults another or says something socially inadequate. ToM abilities keeps maturing during adolescence, between 11 and 17 years of age, specifically in the mastery of skills related to first- and third-person ToM reasoning, egocentric (i.e., in relation to the self) and allocentric (i.e., independently from the self) (Bosco et al., 2014).

Advances in social cognition during the preschool period also include children's developing awareness and **understanding of emotions** (see Harris, 2000, for a review). The preschool period is characterized by the understanding of such aspects of emotions as their external expression via facial expressions and their external prompts (Pons et al., 2004). While even preverbal infants show recognition of some emotions, preschool children become able to not only recognize but also name emotions based on expressive facial cues. For instance, by about 3–4 years of age, children begin to recognize and name basic emotions such as happiness, sadness, fear, anger, and neutral emotion. Moreover, during preschool years, children develop an understanding of the external causes of the emotions of others. For example, they can anticipate that somebody who is chased by a monster feels scared and somebody who got a present feels happy (Pons et al., 2004). Emotional comprehension develops gradually and during the school years, children become more sophisticated in understanding emotions and applying their emotional skills to complex social situations. In the preschool years, children only begin to appreciate cognitive aspects of emotions. For example, the understanding that emotions are connected to desires and beliefs, that is, the fact that emotions can have a mentalistic nature is only acquired at around 7 years of age. Around the same age children start to understand that there may be a distinction between expressed and felt feelings. Later on, between 9 and 11 years of age, children become able to reflect on a social situation from various perspectives and thus analyze conflicting feelings and cognitively regulate emotions.

All in all, cognitive and affective aspects of social cognition are progressively acquired from infancy to middle childhood and some important changes take place during the preschool years. Preschool children acquire mental state language, develop first-order false belief understanding, and start to attain the understanding of expressions and causes of emotions. This suggests that the age window between 3 and 4 years is an especially fruitful locus for assessing socio-cognitive development.

1.3.3. Pragmatics, structural language, and social cognition in development: Empirical evidence

We now turn to a key question regarding what we know about the **empirical relationship** between pragmatics and both structural language and social cognition in development: how is children's developing pragmatic competence influenced by their other linguistic and socio-cognitive skills? In the following paragraphs, we describe the empirical evidence that has been gathered to show how preschool and school-aged children's structural linguistic skills and social cognition skills are related to pragmatic competence.

The relationship between pragmatics, structural language, and social cognition has been examined in both typically and **atypically developing children**. The relationship in children with communication impairments has been a topic of special interest. The studies investigating this issue have tried to pin down whether pragmatic difficulties are attributable to the linguistic deficit or rather to deficits in ToM. While both structural language and social cognition are broadly implicated in pragmatic functions (Matthews et al., 2018), some authors have highlighted the role of social cognition and specifically ToM (e.g., Baron-Cohen, 1988; Baron-Cohen et al., 2000; Happé, 1993), and others have emphasized the importance of structural language skills (Norbury, 2004, 2005). Early studies by Baron-Cohen (1988) and Happé (1993) argued for a primarily cognitive explanation for the pragmatic impairment in autism. For instance, Happé (1993) suggested that due to the deficits in ToM, autistic children would have greater difficulty during pragmatic tasks in which the attribution of intentions is needed. She tested this assumption by comparing children's performances when dealing with similes (e.g., "His nose was like an icicle") and metaphors (e.g., "His nose really was an icicle") that are conceptually identical but vary in the degree to which speaker intention is recognizable, being vaguer in metaphors. The results showed that children with ToM deficits had significantly more difficulty understanding metaphors than similes, while children who successfully passed first- and second-order false belief tasks did not differ in their performance of metaphors and similes. Happé concluded that false belief understanding was necessary for understanding metaphors. Further experimental studies have supported this explanation and have reported the association between ToM and different kinds of pragmatic skills in children with ASD (Hale & Tager-Flusberg, 2005), DLD (Andrés-Roqueta et al., 2013) and ADHD (Caillies et al., 2014). In contrast, Norbury (2005) challenged the interpretation of Happé (1993) and stated that ToM is not sufficient to ensure metaphor understanding. She found that semantic ability was a stronger predictor of metaphor comprehension, while ToM performance and severity of autistic symptoms did not predict a significant amount of variance in metaphor comprehension scores. Similarly, Norbury (2004) examined idiom comprehension in children with communication disorders and found that language skills were the most important predictors of pragmatic performance. In the same vein, Davies et al. (2016) demonstrated that the production and perception of referring expressions in children with DLD correlated with their receptive vocabulary and grammar scores. Moreover, a more recent meta-analytic review conducted by Kalandadze et al. (2018) demonstrated that figurative language comprehension (e.g., metaphor and irony comprehension) in individuals with ASD, both children and adults, is strongly related to their structural language skills.

As for **typical development**, different patterns of results can be traced in younger, preschool, and older, school-aged, children. The link between pragmatic abilities and ToM has not been systematically reported in studies that included **preschoolers**, presenting a rather mixed picture (Angeleri & Airenti, 2014; Banasik, 2013; Bernard & Deleau, 2007; Bosco & Gabbatore, 2017a, 2017b). For example, Angeleri and Airenti (2014) focused on 3- to 6-year-old children and reported a positive correlation between various first and second-order false belief tasks, and irony comprehension but more complex path analyses suggested that a composite measure of false belief had no independent effect on irony performance. This pattern of results was confirmed by Bernard and Deleau (2007), who observed a correlation between first-order false belief understanding and a pragmatic measure of communicative perspective-taking in 3- to 4-year-old children but regression analyses failed to prove ToM as a significant predictor. Similarly, a series of studies by Bosco and Gabbatore investigated the relationship between ToM and different measures of pragmatic performance (communicative failures: Bosco & Gabbatore, 2017a, irony comprehension: 2017b) in 3- to 8-year-old children and revealed that ToM played only a partial role in explaining differences in pragmatic performance. For example, Bosco and Gabbatore (2017a) found a correlation between first-order false belief and the ability to recognize and repair communicative failure in the 3–4 age group but hierarchical regression analysis controlling for age showed that ToM (first and second-order) was not the best predictor of the difficulty in managing the communicative failures. Likewise, Bosco and Gabbatore (2017b) showed that first-order false belief correlated with irony understanding in the youngest age group (3–4 years) but it had no impact on irony understanding in hierarchical regression analysis when other factors such as age were controlled for. No specific role for second-order ToM was detected either. Finally, mixed results on the link between ToM and pragmatics also come from Banasik (2013), who found no correlation between ToM and recognition of irony in 4- to 6-year-olds but did find a relationship between the justification of the ToM responses and recognition of irony. In short, the evidence on the relationship between pragmatics and ToM is not consistent since, once other variables (e.g., age, language) are taken into account, ToM has no demonstrable, independent effect on pragmatics. In contrast, the few studies that assessed the relationship between pragmatics and structural language reported a consistent association between the two (Angeleri & Airenti, 2014; Bernard & Deleau, 2007). In both studies, receptive language measures (receptive vocabulary: Angeleri & Airenti, 2014; receptive vocabulary and receptive syntax: Bernard & Deleau, 2007) significantly correlated with pragmatic scores and predicted them in the more complex statistical models.

A greater number of studies on **school-age** children indicated that the relation between pragmatics and ToM becomes more robust later in development (De Rosnay et al., 2014; Filippova & Astington, 2008; Massaro et al., 2013, 2014; Nilsen et al., 2011; Winner & Leekam, 1991). For instance, the studies by Winner and Leekam (1991) with children aged 5–7 years and by Nilsen et al. (2011) with children aged 8–10 years both found a significant positive correlation between second-order false belief understanding and irony comprehension. By the same token, De Rosnay et al. (2014) focusing on 5- to 8-year-old children showed that the measure of first- and second-order false belief understanding correlated with the conversational competence even after age and language ability were statistically controlled, and ToM independently predicted pragmatics after controlling for the influence of other variables. Likewise, Filippova and Astington (2008) reported that advanced ToM (i.e., second-order false belief tasks, alongside the Strange Stories task and the Faux Pas task that are often used with older children and adults) made a unique contribution to irony understanding in 5- to 9-year-old children. In the same vein, Massaro et al. (2013) demonstrated that second-order false belief understanding had an effect on irony comprehension in 6- to 10-year-old children. Taken together, these studies showed good evidence for the role of ToM in explaining pragmatic competence in school-age children and, especially, irony-understanding skills. There is one study, however, that reported mixed findings. Lecce et al. (2019) explored individual differences in interpreting metaphors in 9- to 12-year-old children and found that ToM performance measured through the Strange Stories task correlated with the ability to interpret mental metaphors only in 9-year-olds but not in older age groups. This association remained significant for this age group even after controlling for verbal ability, working memory, and socioeconomic status. The authors suggested that the link between metaphor understanding and ToM is more evident in early middle childhood (9 years of age) rather than later middle childhood (10–12 years of age).

With the respect to language, a consistent association between pragmatics and other language skills has been found in school-age children, as reported by various studies (De Rosnay et al., 2014; Filippova & Astington, 2008; Massaro et al., 2014; Nilsen et al., 2011). Specifically, Nilsen et al. (2011) found a correlation between irony understanding and receptive vocabulary and Massaro et al. (2014) found a correlation between irony comprehensive and both receptive vocabulary, and metacognitive vocabulary. Moreover, De Rosnay et al. (2014) and Filippova and Astington (2008) showed that vocabulary measures, apart from being correlated with pragmatic ability, are also reliable and independent predictors of pragmatics.

All in all, previous studies in typically developing preschool and school-aged children support the idea that pragmatic ability is likely to be linked to other language skills. However, the results on the relationship with social cognition are more mixed. While studies in preschoolers did not provide systematic evidence of the link between pragmatics and ToM, the majority of the studies focusing on school children (starting from the age of 5) largely suggested the link with ToM. It is worth bearing in mind that most of this literature has explored **receptive pragmatic abilities**: above all, irony understanding (Angeleri & Airenti, 2014; Banasik, 2013; Bosco & Gabbatore, 2017b; Filippova & Astington, 2008; Massaro et al., 2013, 2014; Nilsen et al., 2011; Winner & Leekam, 1991), but also metaphor understanding (Lecce et al., 2019), communicative failure recognition and repair (Bosco & Gabbatore, 2017a), and communicative perspective-taking (Bernard & Deleau, 2007). Due to the previous research's bias towards inferential receptive pragmatic abilities, the overall picture of the cognitive architecture of children's pragmatic ability is somewhat blurred. Clearly, more investigations focusing on expressive pragmatic aspects and assessing pragmatic competence more globally are needed in order to obtain a more comprehensive picture of the relationship between pragmatics, structural language and social cognition. **Study 1** within the present thesis undertakes this task and will be the first study to explore the relationship between expressive pragmatic abilities, structural language, and social cognition in young preschoolers. Likewise, the focus of **Studies 2 and 3** is on expressive pragmatic abilities and their relationship with multimodal language. Specifically, Study 2 assesses the child's pragmatic abilities when communicating socially in everyday situations and the prosodic forms of their expression, while Study 3 investigates the link between narrative abilities and gesture use.

While previously described studies examining the link between pragmatics and social cognition focused on ToM, fewer studies have examined the developmental relationship between pragmatics and affective aspects of social cognition. Relatively few empirical studies have assessed the link with emotion understanding. For instance, Losh and Capps (2003) showed an association between narrative abilities and emotional understanding in children with ASD or Asperger's Syndrome. Studies on typically developing children reported mixed results. In particular, Coplan and Weeks (2009) observed a link between pragmatic ability and emotional adjustment in typically developing 6-year-old children. Farina et al. (2007) also reported positive results showing that global pragmatic ability and the ability to make inferences are both correlated with emotion understanding in children between the ages of 4 and 7 years. However, another study by De Rosnay et al. (2014) found no correlation between pragmatic competence and emotion understanding. Though the studies on emotional development and pragmatic abilities are scarce, more studies have investigated the relationship between emotional development and more general aspects of social functioning (rather than pragmatic ability narrowly), such as prosocial behavior. For example, Eisenberg et al. (2006) stated that emotion understanding increases concurrently with prosocial behavior during the first years of life (see also Denham, 1986). In the same vein, Ensor et al. (2011) showed a strong association between emotion understanding at the age of 3 and prosocial behavior at the age of 4 and Farrant et al. (2012) confirmed a link between emotion understanding and prosocial behavior in 3- to 6-year-old children. Overall, there is much less empirical evidence on the link between pragmatic competence and emotion understanding in children and the few existing studies do not suggest a clear picture of this link. Since social cognition is made up of various components, in assessing the relationship between pragmatics and social cognition, **Study 1** within this thesis will focus on the socio-cognitive skills governing the understanding of others' mental states, both cognitive and emotional, by means of two false belief tasks, an emotion understanding test, and a test of metacognitive vocabulary.

The evidence on the relationship between pragmatics, structural language, and social cognition as discussed in the previous paragraphs comes from correlational and regression analyses and therefore it examines naturally occurring variations in children (i.e., individual differences in language ability and social cognition) as possible contributors to pragmatic abilities. Another possible source of evidence of this relationship is the use of a training paradigm. Through the manipulation and use of specific techniques we can better understand the mechanisms involved in the relationship between pragmatics and other developing linguistic and socio-cognitive skills. No less strikingly, training studies help us to broaden our knowledge about whether and how pragmatic ability can be enhanced in children. In the next section, we review the existing interventions developed for training pragmatic and socio-cognitive skills in children.

1.4. How to train pragmatics and social cognition?

Given the importance of children's pragmatic competence for social, emotional, behavioral, and academic outcomes (Gottman et al., 1975; Kemple et al., 1992; Lord et al., 2020; Murphy et al., 2014; Whitehouse et al., 2009, see also section 1.1 above), in our view, it is worthwhile to devote efforts to developing pragmatic **training interventions** for children. However, very few studies have undertaken this task. The general focus of the developmental training studies has been on promoting socio-cognitive skills and, specifically, a large body of research has emerged on how to effectively train ToM and emotion understanding and investigated how they might boost their development. In what follows, we review the empirical results obtained by training studies that have been conducted to improve children's pragmatic (1.4.1) and socio-cognitive abilities (1.4.2).

1.4.1. Training children's pragmatic abilities

Most prior developmental research on pragmatic training has been concentrated on intervention programs designed to improve the pragmatic abilities of atypically developing children, specifically children with ASD (see Binns & Oram Cardy, 2019; Parsons et al., 2017, for reviews) and children with Pragmatic Language Impairment (e.g., Adams et al., 2012). To our knowledge, only a handful of training interventions have been conducted targeting pragmatic abilities in typically developing children. Echoing the situation with tasks to assess pragmatic abilities, existing pragmatic interventions in the preschool and school-aged typically developing children have focused on fairly specific pragmatic skills and especially on **receptive pragmatic language**. For example, several studies have targeted the training of metaphor understanding in 4- to 9-year-olds (Białecka-Pikul, 2010; Cortés et al., 2018; and more recently Tonini, 2021), with mixed results. While Białecka-Pikul (2010) found the training conducted with 4 and 5-year-olds ineffective, Cortés et al. (2018) showed an improvement in 6-year-old children's metaphor production. Also a study within the PhD thesis of Tonini (2021) demonstrated a post-training improvement in 9-year-old children's ability to explain metaphors. Moreover, a few studies have explored the effect of training on irony understanding (Lee et al., 2021; see Pexman et al., 2019, for a review; Szücs & Babarczy, 2017). Overall, positive training effects were reported: Szücs and Babarczy (2017) observed an improvement in irony comprehension in children aged 4–7 years at posttest compared to the control group and Lee et al. (2021) provided evidence that 5- to 6-year-old children's understanding of sarcasm could be improved through training. Other studies have focused on such receptive pragmatic skills as inferencing, which is the ability to construct a full and accurate representation of discourse by relating events and figuring out causes and consequences of actions. The evidence coming from studies on school-aged children confirms that pragmatic inferencing can be trained using explicit methods, that is, by guiding children's attention explicitly to the pieces of information needed to make an inference and to the process of integrating them together (Bos et al., 2016; Clarke et al., 2010). However, more recently, Davies et al. (2020) found that training involving more implicit activities such as shared book reading with preschool children had no effect on inferencing.

Although the above-mentioned studies are useful and theoretically sound, they are still limited in that they focus on specific receptive pragmatic skills. So far, very little attention has been paid to training expressive pragmatic abilities. This lack of research is particularly surprising given the importance of expressive conversational skills in the child's day-to-day life. **Study 4** presented within this thesis is the first to develop a language-based training intervention designed to improve expressive pragmatic abilities in young preschool typically developing children.

1.4.2. Training children's social cognition

Training studies on ToM

In recent decades, training research on ToM has resulted in a rich and extensive body of literature. The first studies in this area examined whether first-order false belief understanding could be promoted by exposing **preschool children** to mental state language, reporting positive results (Appleton & Reddy, 1996; Clements et al., 2000; Melot & Angeard, 2003; Slaughter, 1998; Slaughter & Gopnik, 1996). These studies used a task-specific approach, that is, they trained children on false-belief tasks and provided children with feedback on their responses to specifically developed **false-belief sequences**. For instance, Appleton and Reddy (1996) trained 3-year-olds to pass unexpected location false-belief tasks and reported a significant improvement in false belief understanding at posttest. Likewise, individual training on unexpected location tasks involving detailed feedback about why the correct answer is correct and the incorrect answer is incorrect led to an increase in false belief understanding in 3- to 5-year-olds (Clements et al., 2000). Another study that demonstrated that training in unexpected location and appearance-reality distinction false belief tasks is beneficial is Melot and Angeard (2003). Similarly, studies by Slaughter and colleagues concluded that 3- to 4-year-olds who were individually trained on unexpected content false-belief tasks improved their false belief performance (Slaughter, 1998), as did 3- to 4-year-olds who were trained on appearance-reality distinction false belief tasks (Slaughter & Gopnik, 1996). In general, these early studies strongly confirm that training involving false-belief tasks and feedback can lead to an increase in performance of the very same or very similar tasks at posttest. In this sense, a study by Lecce, Bianco, Demicheli, et al. (2014) stands out because it not only demonstrated that 4- to 5-year-olds improved their performance on first-order false belief tasks after first-order false belief training but also that children performed better on advanced ToM tasks such as second-order false belief, jokes and lies for which they had received no training.

Another line of research focused on identifying mechanisms that foster the development of ToM through training. The studies by Hale and Tager-Flusberg (2003) and Lohmann and Tomasello (2003) tested whether **training linguistic skills** can improve false belief understanding. The rationale behind these studies is based on the empirical evidence of the close relationship between language and ToM in development (Astington & Jenkins, 1999; de Villiers, 1995; see Milligan et al., 2007 for a review) and specifically a strong link between syntactic skills and false-belief understanding (de Villiers & Pyers, 2002; Slade & Ruffman, 2005). As suggested by de Villiers (de Villiers, 1995; de Villiers & De Villiers, 2000), the acquisition of sentential complements, whose syntactic structure allows a clause containing a falsehood to be embedded in the main clause that is true (e.g., "Sally thinks that the ball is the purple box"), provides children with a format to represent false beliefs and, therefore, facilitates ToM development. In order to explore the potential causal role of the acquisition of sentential complements in false belief understanding, the two above-mentioned training studies carried out syntax-based interventions and showed that the groups that received language training in these structures improved their false-belief understanding, while the control groups did not.

Another set of training investigations explored the role of conversation about mental states in acquiring ToM (Astington & Peskin, 2004; Esteban et al., 2010; Guajardo & Watson, 2002; Ornaghi et al., 2011). These studies are based on the evidence of the link between individual differences in ToM and the exposure to mental state discourse, for example, family talk about feelings (e.g., Brown et al., 1996; Dunn et al., 1991; Hughes et al., 2005; Tompkins et al., 2018, for a review; see also 1.3.2). In order to explore the role of **conversational activities** in promoting ToM development, these studies designed interventions that involved a teacher reading a storybook enriched with cognitive and emotional mental states to children and then explaining and discussing mental states. Overall, mixed results were obtained. For example, one of the first studies by Guajardo and Watson (2002) which applied this approach to 3- to 4-year-old children found that training with the experimenter reading children's storybooks in class and a subsequent discussion of the mental state concepts did not lead to improvement in false belief understanding in any of the false belief posttest tasks (Study 1). In the follow-up study, Study 2, after changing the procedure (individual training, instead of the group training applied in Study 1) and choosing younger children (almost a half-year younger than in Study 1), positive results were obtained. Next, a training study by Astington and Peskin (2004) also reported negative findings. In this study, children were read stories both at school, as a group activity, and at home, individually. The stories read to the training group contained explicit mental state terms, while the same stories read to the control group did not have any explicit mental state language. Unexpectedly, the results showed that the control group improved more in false belief understanding than the training group. A similar training study by Esteban et al. (2010) in which children participated in conversational reflective interactions about the stories previously read to them found improvements only in some false belief tasks (unexpected location) but not in others (unexpected content). In general, it seems that conversational training on mental state concepts through reading stories and discussing them with the teacher has the potential to improve ToM development. Yet its beneficial effects are not stable, since many times the improvements depend on such factors as specific tasks used at posttests (unexpected content vs. unexpected location false belief tasks), or the specific age under investigation (3 vs. 4 years of age) and specific training procedure (individual vs. group training).

Although the majority of the training studies on ToM have been carried out with preschoolers, recent research has started to explore the role of conversations about mental states in the development of ToM during the **school years**. One of the first studies of this kind by Lecce, Bianco, Devine, et al. (2014) conducted a conversational intervention about mental states based on stories with 9- and 10-

year-old children and reported positive results. Specifically, children in the experimental group performed significantly better on ToM, measured via the Strange Stories task, at posttest and delayed posttest than children in the control group, demonstrating that the training program had an enduring impact on ToM understanding. The training program developed by Lecce and colleagues has been adapted in the following training studies. For example, Bianco et al. (2016) used Lecce et al.'s ToM conversational training with 9- to 10-year-old children and corroborated previous findings by showing that the children in the training condition improved their ToM performance compared to the children in the control condition. Moreover, this study explored the mechanisms underpinning the training effects and found that it was the accuracy of mental state attributions rather than mere frequency of use of mental state terms that mediated the beneficial effect of the intervention. Furthermore, a follow-up study tested the efficacy of the above-mentioned training program when it is implemented in the school context by primary school teachers (Bianco & Lecce, 2016). It was found that the training was suitable for school-world conditions and could be delivered by primary school teachers as the 8- to 9-year-old pupils in the training group performed better than the pupils in the control group both in posttest and delayed posttest. Another study by Lecce and Bianco (2018) whose main aim was to examine the role of working memory in ToM, also implemented in Lecce et al.'s training. It was administered by regular class teachers with pupils aged between 9 and 11 years and, again, the children in the ToM training group improved their ToM more than the children in the control group.

Further research into middle childhood also informed about the positive effects of ToM conversation training. For instance, Bianco et al. (2019) successfully tested the efficacy of the adapted training program on ToM understanding with children between 7 and 8 years of age. In addition, a recently published study by Bianco et al. (2021) using an adapted version of Lecce et al's training supported these results by showing a positive effect on 7- to 8-year-old children's performance in the advanced ToM tasks (e.g., the Strange Stories task). In addition, it evaluated the effect of a new training program focused on second-order mental state scenarios for promoting ToM in children aged 7 and 8 years. It was also found to be effective since the children in this experimental group enhanced their performance of both second-order false belief tasks and advanced ToM tasks. Together, these studies demonstrated that story-based conversations about mental states are effective in enhancing ToM understanding during middle childhood.

Training studies on emotion understanding

Other studies have assessed the beneficial effects of **conversational interventions** involving target emotions to bolster children's understanding of emotions. Some early studies targeted a relatively complex component of emotion understanding: the understanding of ambivalent emotions (Bennett & Hiscock, 1993; Peng et al., 1992; Tenenbaum et al., 2008). In Bennett and Hiscock (1993), 6-year-old children watched videos and then participated in the discussion about mixed feelings (e.g., be happy and sad at the same time), the results showed that the children in the experimental group became better at identifying conflicting emotions at posttest. Peng et al. (1992) found that 6- to 7-year-olds children showed more understanding of mixed feelings after training sessions, whereas 4- to 5-year-olds did not demonstrate improvement. Another study by Tenenbaum et al. (2008) with 5- to 8-year-old children also observed an improvement in emotion understanding after training that involved explanatory conversations about ambivalent emotions. Other studies targeted more general emotion understanding skills. The study by Pons et al. (2002) implemented a teaching program about emotions with 9-year-old children and reported an increase in overall comprehension of emotion. Furthermore, Ornaghi et al. (2014) adopted a conversational approach focused on the nature, causes, and regulation of emotions in order to assess the effect of emotion understanding training on different areas of social cognition in 6- to 7-year-olds. The results showed positive training effects on emotion understanding and, additionally, on ToM and empathy. Another training study by Ornaghi and colleagues focused on preschool children (ages 4–5). In this study, children were presented with scenarios based on emotional scripts and the training group participated in conversations about emotions, their nature, causes and regulation (Ornaghi et al., 2015). The results indicated that training had a beneficial effect on children's emotion understanding and prosocial behavior but not on their ToM. Thus, the training studies on emotion understanding have, broadly-speaking, demonstrated positive outcomes, such as the development of various aspects of emotion understanding and other socio-cognitive skills.

Moreover, in recent years, there has been a growing number of preschool intervention programs developed to prevent emotional, cognitive, and social problems and promote gains in socio-emotional competence (for a meta-analytic review see Murano et al., 2020). In this way, their scope is wider than training emotion understanding and it includes skills such as enhanced academic achievement, self-regulation, decreased problematic behavior, and increased school completion. In general, these training programs have been found to be efficient. However, it should be borne in mind that they are not always easily applicable in real school contexts as they require a lot of time and effort. Specifically, this line of interventions tests programs spanning a considerably long period of time and forming part of the school curriculum. For example, an intervention "PATHS" developed by Domitrovich et al. (2007) lasts 9 months and the Emotion Course by Izard et al. (2004) requires implementation throughout the whole school year. These programs are usually conducted by specifically trained teachers and are often designed for children who have been identified as needing additional support, for example, children from disadvantaged backgrounds or children that demonstrate high levels of externalizing behaviors (Murano et al., 2020).

All in all, the training studies on pragmatic and socio-cognitive skills reviewed in this section have shown that there is a considerable bias towards interventions targeting ToM abilities. Some authors have criticized the exclusive use of the ToM paradigm to assess and train the profound ability to attribute mental states to others (Wellman, 2018). A **multidimensional test battery** that includes both cognitive and affective aspects of social cognition, as well as pragmatics, would provide a more comprehensive picture of the child's communicative development. To our knowledge, only Ornaghi and colleagues have assessed the learning outcomes of conversational training about mental states on several aspects of development. For example, one the studies carried out by Ornaghi et al. (2011) with children of 3 and 4 years of age analyzed the effect of training on false belief, emotion understanding, and receptive pragmatic ability. In this study, children engaged in conversations about the mental states of both themselves and the protagonists of the stories read by the teacher. Mixed results were reported. Specifically, an increase in false belief performance was observed only in the older group of 4-year-olds but not in the younger group of 3-year-olds. Next, a positive effect on emotion understanding was found only in 3-year-old children, while no specific effect of the training was detected in 4-year-olds since both control and experimental groups improved their performance. Similarly, in the case of pragmatics—measured through a short pragmatic judgment test—a significant training effect was observed only in 3-year-olds, while both the experimental and control groups of 4-year-old children improved. However, no study so far has assessed the potential effects of the training intervention on the children's expressive pragmatic abilities using a comprehensive pragmatic test battery. We highlight the importance of the assessment of training effects at different levels of the child's social development and in the aforementioned training, Study 4, we adopt a multidimensional approach to testing by incorporating false belief, emotion understanding, metacognitive vocabulary, and expressive pragmatics tasks.

Overall, the studies reviewed in this section have shown that both pragmatics and social cognition (ToM and emotion understanding) are amenable to intervention. Although for some areas mixed or negative results were reported, overall positive training effects were found for receptive pragmatic skills, ToM and emotion understanding, suggesting that these developing abilities can be supported and promoted during preschool and school years. Moreover, as will be discussed in the next section, a growing body of research has demonstrated that pragmatic development in children goes hand-in-hand with their use and understanding of multimodal gestural and prosodic cues. However, little is known about whether the use of **multimodal training intervention** may be beneficial for fostering social cognition and pragmatics, the research question that will be also tested in **Study 4** of the thesis.

1.5. Why multimodal pragmatics?

1.5.1. The role of prosody and gesture in human communication

Human communication is much more than words. It involves a dynamic information exchange using verbal resources but also multimodal ones – prosody and gesture. It is not just *what* we say but *how* we express it. In terms of non-verbal communication, **prosodic cues** are among the most salient, and they play an important role in encoding and decoding pragmatic information (Culpeper, 2011). Prosodic dimensions include pitch variation (intonation), intensity (loudness), duration characteristics (speech rate, pauses) and voice quality (e.g., nasalized or creaky voice). Pitch is an intrinsic component of spoken language, indispensable for understanding and producing pragmatic meanings (Cutler et al., 1997; Hirschberg, 2017; Pierrehumbert & Hirschberg, 1990; Prieto, 2015). Pitch, however, is never used in isolation from other prosodic parameters: all prosodic dimensions work together to convey a message (Ladefoged & Johnson, 2011). For instance, such prosodic parameters as intensity and speech rate, together with pitch, are important means for communicating emotional content (Scherer, 1986, 2003). In particular, increased speech rate, high intensity, and increased pitch range are typically employed to express joy while reduced pitch range, lower intensity and slower speech rate is used to communicate sadness (Banse & Scherer, 1996).

Alongside voice signals, people use the hands (manual referential pointing, iconic, and metaphoric gestures, as well as non-referential or beat gestures; McNeill, 1992)[4], the head (nods and tilts), and the face (eyebrow movements, facial expressions) in order to express and perceive pragmatic meanings (see Wagner et al., 2014, for an

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[4] According to McNeill's (1992) gesture classification, there are 4 types of gesture. *Deictic* gestures are pointing gestures with referential or abstract content. *Iconic* gestures are gestures that depict aspects of objects, entities or events. *Metaphoric* gestures are gestures that represent abstract concepts. Finally, *beat* gestures are prosodically aligned gestures which typically reinforce a message.

overview on gesture articulators). Speakers of all ages from all around the world produce spontaneous co-speech **gestures** while communicating. We accompany most clauses (McNeill, 1992) and idea units (Kendon, 1980) with gesture(s) and we rely on gesture in comprehension (Goldin-Meadow & Alibali, 2013; Hostetter, 2011). In short, co-speech gestures are an integral and prominent part of communication which is strongly integrated with speech. In the last few decades, research has started to embrace the study of gesture and to explore the interplay between gestures and speech. It has been argued that gesture and speech are closely connected and constitute one communicative system that is integrated at the pragmatic, semantic, and temporal levels (Levinson & Holler, 2014; McNeill, 1992). On the temporal level, early observations showed that gestures tend to temporally align with prosodically prominent units in speech (Kendon, 1980; McNeill, 1992). An increasing number of studies has found that the prominent phases of gestures (i.e., gestural strokes) are synchronized with prosodically prominent syllables showing that prosodic structure acts as an anchoring point for the production of gestures (e.g., Esteve-Gibert et al., 2014; Esteve-Gibert & Prieto, 2013; Loehr, 2012).

Multimodal cues, both prosodic and gestural, are used for **a wide range of communicative functions**. In many languages, pragmatic meanings encoded in prosody go far beyond the traditionally proposed distinction of sentence type (falling intonation for affirmation vs. rising intonation for question). A recent review by Brown and Prieto (2021) has analyzed the literature on the contribution of prosodic and gestural signals to pragmatic marking and have pinpointed a set of pragmatic meanings expressed through multimodal cues, namely, information status, discourse structure and turn-taking, epistemic positioning, (im)politeness, irony, and speaker identity. Starting with information structure, oftentimes, focal information in a sentence is highlighted with prosodic prominence, for example, with a higher pitch, louder amplitude, and longer duration (Carlos Gussenhoven, 2002). Gestural cues coupling with prosodic prominence also highlight the information that the speaker considers important: they serve to mark focus, adding emphasis or further parts of discourse (Kendon, 1980; Loehr, 2012; Shattuck-Hufnagel & Prieto, 2019). Speakers associate these emphatic realizations on the visual and prosodic domain with contrastive interpretations (Ito & Speer, 2008) and the absence of the prominent accentuation leads to difficulties in processing and integration of the information into the discourse context (Dimitrova et al., 2012).

As for conversational turn-taking phenomena, different turn-yielding prosodic strategies can be employed by speakers: final falling or high-rising intonation, a lower level of intensity and pitch, voice quality and lengthening features (Gravano & Hirschberg, 2011). The use of these means allows for a smooth turn transition in conversation.

Focusing on epistemic stances, cross-linguistically prosodic patterns can convey fine-grained differences in epistemicity. Majorcan Catalan would be a good example of differences in evidentiality encoded in prosody. In this variety of Catalan, the information source can be expressed via intonation and sentence particles. A particular nuclear pitch configuration associated with sentences headed with the particle *que* express that the speaker inferred something based on direct sensory information (via one of the five senses), while another nuclear pitch contour is used to indicate that the speaker inferred something based on reported evidence (Vanrell et al., 2017). Moreover, different prosodic strategies such as fillers, delays, or sentence-final rising intonation can be used to mark an epistemic state of uncertainty (Krahmer & Swerts, 2005). Gesture also serves to signal epistemic positioning. For example, marked facial expressions often express uncertainty (Krahmer & Swerts, 2005), eyebrow furrowing – incredulity (e.g., Crespo Sendra et al., 2013), and pointing gestures can reinforce first person and third person evidentials (Roseano et al., 2016).

Regarding politeness, the classic work by Brown and Levinson (1987) claimed that politeness is realized by means of various linguistic strategies, including intonational ones, and proposed that high pitch is universally associated with politeness. Other studies suggested that in situations like addressing a status superior, politeness can be expressed via slower speech rhythm, a quieter voice, and slower gestures (Brown et al., 2014; Brown & Winter, 2019; see the recent meta-analytic review by Winter et al., 2021 regarding the crosslinguistic use of pitch for polite marking). Other works in this area showed that intonation choices can be affected by such factors as social distance and cost of the action: Catalan speakers use rising intonation patterns in requesting situations of high-level distance and for high-level cost offers and requests (Astruc et al., 2016).

Overall, the aforementioned research has shown the important role of prosody and gesture in human communication and exemplified that speakers employ prosodic, facial, manual, and other body means to express and understand a wide variety of pragmatic meanings. Multimodal cues are thus important for communication in adults, but they are even more so in children. In what follows, we take a developmental perspective and review the role of prosody and gesture in pragmatic development. As is the case with verbal means, the ability to interpret and express pragmatic meanings through prosody and gesture develops over a long period of time. We discuss the multimodal foundations of infants' pragmatic development and present the existing evidence on the role of multimodal cues within children's acquisition of different pragmatic skills.

1.5.2. The role of prosody and gesture in pragmatic development

Immediately after birth, neonates already show an exceptional sensitivity to social stimuli and display social attunement (Rochat & Striano, 1999). Well before infants begin to speak, they start to share experiences with others and communicate in a bidirectional way (the so-called '2-month revolution', when children start to engage in dyadic interactions, e.g., Nwokah, 2014; Trevarthen, 1979) and then to participate in triadic interactions (the so-called '9-month revolution', when children start to engage in attentional triads, e.g., Meltzoff, 2002; Tomasello, 1995; Tomasello et al., 2005). In other words, infants show interest for communicative involvement and begin to interact socially before having fully developed verbal skills. What makes it possible? Research on early pragmatic development has demonstrated that in preverbal stages infants rely heavily on multimodal cues to communication (for reviews, see Esteve-Gibert & Guellaï, 2018; Hübscher & Prieto, 2019).

The role of **early multimodal behavior** in communicative development has been assessed in numerous studies on infants

(Bates et al., 1975; Brooks & Meltzoff, 2005; Carpenter, Nagell, et al., 1998; Caselli et al., 2012; Fernald, 1989, 1993; Goldin-Meadow, 2007; Iverson & Goldin-Meadow, 2005; Liszkowski et al., 2008; Meltzoff & Moore, 1989; Rowe & Goldin-Meadow, 2009; Tomasello et al., 2005, 2007, among many others). These studies provide overwhelming evidence of the crucial role played by multimodal means —prosody, facial expression, eye gaze, manual gestures— in early pragmatic development. From birth, infants begin to engage in social interactions and, in doing so, use multimodal signals. Early patterns of face perception and imitation, alongside the understanding that faces and voices convey important communicative information, start paving the way for pragmatic development. For instance, just after birth infants orient to face-like stimuli (Farroni et al., 2005) and during the first year of their life, infants continue to show a preference for looking at human faces (Johnson et al., 1991; Turati et al., 2005). In addition, infants are able to detect eye-like stimuli and orient their attention towards them (Batki et al., 2000). They also display sensitivity to eye contact from birth: infants not only prefer to look at faces and eyes but also prefer to look at faces that engage them in mutual gaze rather than faces with averted gaze (Farroni et al., 2002). Moreover, some hours after birth newborns already imitate certain facial gestures (e.g., tongue protrusions and mouth opening, Meltzoff & Moore, 1989) and some weeks later infants are able to reproduce facial expressions that they saw a day ago (Meltzoff & Moore, 1994). This exceptional early sensitivity to multimodal cues of communication constitutes the foundation for pragmatic development (for a review of research on the role of multimodal cues on linguistic and socio-cognitive development, see sections 1.5.3 and 1.5.4 below). The following paragraphs will assess studies on infancy and childhood that delve into this topic, particularly those regarding such aspects of pragmatic development as (i) the acquisition of speech acts, (ii) the acquisition of information focus, (iii) the development of epistemic stances, and (iv) the development of politeness.

The development of **speech acts** is one of the first pragmatic milestones and multimodal cues pave its way (see Casillas & Hilbrink, 2020 for a review). In regard to perception, infants are able to distinguish between the communicative intentions of others by associating specific prosodic and gestural means with specific speech acts (see Liszkowski, 2014, for a review). The studies by Behne and colleagues have found that infants begin to recognize the pragmatic function of pointing gestures (Behne et al., 2012; Behne, Carpenter, & Tomasello, 2005), and Camaioni et al. (2004) demonstrated that infants differentiate between imperative and declarative speech acts, as they react differently to imperative and declarative pointing. Other studies have shown that infants are acutely sensitive to prosodic information expressing pragmatic intents (see studies using action imitation paradigm, e.g., Carpenter, Akhtar, et al., 1998; Sakkalou & Gattis, 2012). Likewise, a more recent study by Esteve-Gibert et al. (2017) demonstrated that 12-month-old infants use specific multimodal act-accompanying cues, in particular prosody and manual gestures with different hand configurations in order to distinguish the expressive, imperative, and informative intents behind their caregiver's pointing gestures.

As for production, studies have shown evidence that infants can also express speech acts in gesture and prosody. The seminal work by Bates et al. (1975) established that proto speech acts appear at around 10 months of age and are first expressed through gesture. This study provided a detailed analysis of early speech act development and differentiated between two types of communicative pointing gestures carrying different pragmatic meanings: proto imperatives and proto declaratives. For example, children can produce proto imperative pointing gestures to request that the adult fetch an object and proto declarative ones (e.g., showing an object to the adult) to engage the adult in communication and share a social experience. In a further investigation of gesturally expressed speech acts, Tomasello et al. (2007) proposed dividing proto declarative gestures into expressive gestures, that are used to share an attitude towards an object, and informative gestures, that are used to provide the missing information to the adult. Similarly, Kovács et al. (2014) suggested that in addition to pointing to an event to share the appreciation of it with others, infants can point to something in order to exhibit the information about it from the adult, that is, pointing serves as a request. With regard to prosodic productions marking speech act information, research on the early use of prosodic cues has shown that in the second half of the first year of life, children start using prosodic patterns to signal different speech acts (Esteve-Gibert et al., 2017; Esteve-Gibert & Prieto, 2013; Papaeliou et al., 2002;

Papaeliou & Trevarthen, 2006). Papaeliou et al. (2002) showed that 7- to 11-month-old infants use distinct prosodic cues (duration, F0) to produce emotional vocalization and vocalizations with other pragmatic functions. Another study by Papaeliou and Trevarthen (2006) complemented these findings by identifying different prosodic patterns used by babbling infants to produce communicative versus investigative vocalizations. Further, Esteve-Gibert and Prieto (2013) analyzed a longitudinal corpus of Catalan infants aged from 7 to 11 months and found that infants can express specific pragmatic meanings in their intentional vocalizations by using distinct prosodic patterns. Specifically, vocalizations expressing requests and discontent displayed a wider pitch range and longer duration than statements and responses that were shorter and had a narrower pitch range.

Moreover, infants jointly use pointing gestures and intentional vocalizations to signal speech acts, as it has been shown that pointing gestures with specific pragmatic functions are accompanied by specific prosodic patterns (Aureli et al., 2017; Grünloh & Liszkowski, 2015; Murillo et al., 2018; Murillo & Capilla, 2016). For instance, Murillo and Capilla (2016) showed that 9- to 15-month-old Spanish infants produced a flat intonation with declarative pointing and a rising intonation with requestive pointing. Relatedly, Aureli et al. (2017) demonstrated that the match between prosody and pointing intentions starts to emerge in Italian-learning infants between 12 and 18 months of age. In addition, Grünloh and Liszkowski (2015) found that prosodic characteristics of Dutch 14-month-old infants' vocalizations signal a distinction between requestive acts and expressive and informative ones, in the same way pointing hand shapes do.

As infants grow older, they acquire more vocabulary and grammar of the ambient language and move into a verbal stage of development. By the age of 2 years, when infants begin to produce two-word combinations, they have a full repertoire of intonational means, that is, pitch accents and boundary tones, to express basic speech acts such as assertions and requests (Rusiewicz & Esteve-Gibert, 2018). For example, longitudinal studies in 1-to 2-year-old children acquiring Catalan, Spanish, and Portuguese showed that children use a variety of phonologically distinct intonation contours for specific pragmatic meanings from the onset of speech and they master the prosodic properties of the nuclear configurations over time (Frota et al., 2016; Prieto et al., 2012). Importantly, while children's early intonation patterns are adult-like and tend to use target-like intonation to express the corresponding pragmatic intentions (e.g., a request, a vocative, discontent, insistence), the full control of prosodic features in the production is acquired gradually (Rusiewicz & Esteve-Gibert, 2018). Furthermore, a particularly well-controlled study by Bosco et al. (2013) accounted for both the comprehension and production of speech acts and both structural and multimodal language in an integrated fashion (the authors use terms "extralinguistic cues" for gesture and "paralinguistic cues" for prosody). They reported that 5-to 8-year-old children understood simple communication acts (e.g., direct and conventional indirect speech acts) better than complex communication acts (e.g., non-conventional indirect speech acts) which involve a longer inferential chain via both structural and multimodal language such as gestures, and tone, intonation, and rhythm conveying emotional states and propositional attitudes. These results showed that verbal and multimodal language share relevant cognitive factors in the tested pragmatic areas and the authors suggested that these findings support the idea that structural and multimodal cues are parallel modalities of pragmatic expression.

Whereas children can mark the distinction between basic speech acts such as assertions and requests quite early in development, the ability to mark **information structure** within a given speech act emerges later. Cross-linguistically, information structure and in particular the marking of focus can be manifested through morphologic, lexical, and syntactic means, as well as through multimodal cues, or a combination of these markers. Although developmental studies have primarily investigated morphosyntactic means, some studies have looked at focus-marking from a prosodic perspective (for reviews, see Chen, 2018; Ito, 2018) and from a gestural perspective (e.g., Esteve-Gibert et al., 2021; Rohrer et al., 2022; Shattuck-Hufnagel et al., 2016). Specifically, research has shown that prosodic means help children understand and mark focus. Even 18-month-old infants can map intonation to information structure to a certain extent (Thorson & Morgan, 2014), and with the aid of intonational means, preschool children can understand such a pragmatically loaded phenomenon as contrastive focus-marking (Kurumada & Clark, 2017). However, prosodic abilities related to information structure are usually mastered later in development. It is between 3 and 6 years of age when children begin to use intonational strategies to mark focus (e.g., Hornby & Hass, 1970; Romøren, 2016; Wonnacott & Watson, 2008) and after the age of 6 children can interpret contrastive intonation (Ito et al., 2012; Speer & Ito, 2009). It has been suggested that the mastery of focus intonation provides the basis for the acquisition of pragmatically complex interpretative and expressive uses of intonation (Speer & Ito, 2009). Furthermore, bodily cues also help mark focus. For example, Esteve-Gibert et al. (2021) found that French-speaking preschoolers mark corrective focus with head nods. Shattuck-Hufnagel et al. (2016) showed that non-referential gestures are used to mark emphasis together with pitch accents by children between ages 5 and 7 years. A study by Koutalidis et al. (2020) reported that German-speaking preschool children make use of non-referential gestures to introduce particles marking focus (e.g., “noch”, “auch”, “nur” meaning “even”, “also” and “only”). And a study by Rohrer et al. (2022) indicated that co-speech gestures play a key role in marking information structure in narrative speech produced by children. For example, by the age of 5 years children use both referential and non-referential gestures to update common ground, specifically, they use non-referential gestures to mark new referents more than old and accessible referents, while referential gestures do not follow this pattern. Moreover, by the age of 7, children use non-referential gestures even more to move discourse forward.

As for **epistemic states**, as we mentioned earlier in the Introduction, even though infants possess some understanding of epistemic states (Koenig & Harris, 2005; Liszkowski et al., 2008) it is only in the preschool years that children start to comprehend lexical and grammatical means to epistemicity (see Matsui, 2014). That being said, a recent surge of research on multimodal cues to various epistemic meanings has shown that they act as precursors of later acquisition of epistemic lexical markers (Armstrong, 2020; Armstrong et al., 2018; Bartz, 2017; Hübscher et al., 2017; Kim et al., 2016). Regarding the bodily cues conveying epistemic stances, a longitudinal study by Bartz (2017) reported that, while children as young as 22 months start off signaling their ignorance by flipping their palms to the side, first verbal cues to ignorance appear later (22–26 months). Furthermore, Kim et al. (2016) found that while 3-

to 4-year-olds cannot express their knowledge state verbally, they can do so through bodily signals such as shrugging shoulders, looking away and shaking the head. By the same token, Hübscher et al. (2019) showed that prosody (e.g., rising and rising-falling pitch contours), face (e.g., raised eyebrows, various lip movements, and nose wrinkles) and body cues (e.g., head tilts and shoulder shrugs) come first to express uncertain knowledge in 3- and 5-year-olds. In addition, both visual and prosodic cues facilitate children's comprehension of epistemic states. Hübscher et al. (2017) found that 3-year-old children already can make use of multimodal cues for marking uncertainty. In this study, children had to identify an uncertain speaker and the materials included lexical ("potser" meaning "maybe" vs. "segur" meaning "surely"), intonational (rising vs. falling), and body markers (head nod vs. squinted eyes, raised eyebrows, head tilt). The results showed that children detected uncertainty better when audiovisual cues were presented. In addition, younger children were found to be more sensitive to prosodic markers of speaker uncertainty than to lexical ones. Likewise, Armstrong et al. (2018) reported that preschool children better understood the speaker's incredulity when it was encoded in both prosody and gesture, suggesting that sensitivity to the two types of cues develop in parallel. Another study by Armstrong (2020) examined the ability of preschool and early school-aged children to use prosody as a resource for modulating lexically encoded modal meanings, and specifically focused on the prosodic modulations of the modal verb "might". It was found that after age 4 children rely on prosodic cues to differentiate between weak (i.e., "might" approaching "will not") and strong commitment (i.e., "might" approaching "will") and by the age 7, they performed at ceiling level. Overall, this research suggests that prosodic and gestural cues play a bootstrapping role in children's early epistemic development (see also Armstrong & Hübscher, 2018, for a review).

Finally, regarding the development of the expression of **politeness**, previous research has focused primarily on morphosyntactic (e.g., conditional verbal forms as more polite) and lexical means (e.g., "please"). Importantly, several studies have addressed the issue from the multimodal point of view. An early study by Bates (1976) reported that at around 4 years of age children identify some polite prosodic strategies, for example, question intonation. More recently, a work conducted by Hübscher and colleagues provided evidence of preschoolers' reliance on multimodal cues when inferring and expressing polite meanings. For example, in the study by Hübscher et al. (2020) children of 3 years of age participated in a comprehension task and were asked to judge the speaker's polite stance. Across all conditions, the lexical cue to polite stance "please" was the same and prosodic and facial features varied. The results of the experiment showed that preschool children are able to make use of intonation and/or facial expression exclusively to access the speaker's polite meaning. Another recent cross-sectional study by Hübscher et al. (2019) shed light on the children's ability to use multimodal cues (prosody, gesture, body posture) to express politeness. Along the same lines, the results showed that preschoolers use a wide range of prosodic mitigation strategies (e.g., rising intonation, more breathiness, slower speech rates), face and body mitigation strategies (e.g., eyebrow raises, smiles, adaptors) and body signals (e.g., raised shoulders, trunk lateral leanings) to request a high-cost object and/or asking an interlocutor with higher social distance. Further, in contrast with 3-year-olds, 5-year-old children showed a more extended use of indirect polite constructions which indicates that the ability to exploit lexical and morphosyntactic markers to communicate politeness develops in a slower way during the preschool period. Taken together, these studies demonstrate that preschool children can already detect and express politeness by multimodal means when they are still acquiring grammatical and lexical politeness markers.

All in all, the results reviewed in this section suggest that pragmatic abilities, prosody, and gesture develop in parallel, and both prosody and gesture play a key role in pragmatic development at different stages. In the preverbal period, infants strongly rely on multimodal aspects of communication reflecting pragmatic meanings such as prosody, facial expression, eye gaze, and manual gestures. Moreover, during infancy, prosodic and gestural cues constitute a bootstrapping step for acquiring pragmatics, as infants use multimodal means to access and express pragmatic meanings (e.g., speech acts). This ability continues to develop later in development. Beyond the infancy period, developmental studies traditionally tend to focus more on the morphosyntactic and lexical means of the expression of pragmatic meanings. Despite this, the reviewed research has highlighted that prosody, gesture, and pragmatics continue to go hand-in-hand and the role of prosody and gesture as scaffolds. Children are found to be sensitive to multimodal markers when inferring particular pragmatic meanings such as epistemic and polite meanings. On the production side, preschoolers have already acquired the basic intonational inventory of the ambient language and move on to acquiring specific prosodic features to express more advanced pragmatic meanings, for example: information structure, epistemic and polite stances. The studies reviewed in this section have made a significant contribution to our knowledge of the prosodic expression of pragmatics, however, they tend to focus on a specific pragmatic skill rather than provide a broad picture of the multimodal pragmatic development of children of a certain age. Overall, the role of prosody in first language acquisition is an underexplored area of research, and the question regarding the development of prosodic and social cognition skills, as well as the question regarding the development of the mapping between pragmatic meaning and prosody is yet to be answered (see Stephens & Matthews, 2014). **Study 2** within the present thesis represents the first attempt to investigate a wide range of pragmatic meanings and their expression through prosody in order to build up a more comprehensive pragmatic prosody profile of young preschool-aged children. In turn, **Study 3** focuses on another aspect of multimodal language—namely, gestures—and investigates it in relation to narrative skills.

In the following sections, the focus continues to be on the development of multimodal communicative behaviors. The next three sections will group existing studies into two broad categories, by first looking at studies that explore the foundational role of multimodal pragmatics in early language acquisition (1.5.3), before looking at studies that investigate the precursor and predictive role of multimodal cues in socio-cognitive development (1.5.4), focusing on the patterns of perception and production of emotions, intentions, and beliefs. We then summarize the main arguments for the multimodal approach to pragmatics (1.5.5) and in the last section (1.5.6), we review the existing tools to assess multimodal pragmatic abilities and introduce the new Audiovisual Pragmatic Test (APT).

1.5.3. Multimodal pragmatic foundations of language

The development of multimodal pragmatics has been increasingly recognized as a pivotal aspect of language acquisition. A wide range of empirical results indicate that early pragmatic communicative skills in preverbal infants, that is, their ability to participate in social interactions via multimodal cues, constitutes one of the pillars of language development (see Matthews, 2014). Multimodal skills involving prosodic and gestural behaviors arise very early in development and play a key role in lexical and syntactic acquisition. For instance, Brooks and Meltzoff (2005) showed that infants' gaze-following behavior at 10–11 months is strongly correlated with subsequent vocabulary comprehension at 18 months. Brooks and Meltzoff (2008) reported that infants' gaze following and pointing skills at the age of 10–11 months predict their productive vocabulary at 2 years of age. As for prosody, from birth, infants are sensitive to prosodic information that they use to acquire syntactic and lexical knowledge of the ambient language. They can perceive and exploit the prosodic structure of utterances to parse syntactic structures into clauses and phrases and to segment the speech stream into words (see de Carvalho et al., 2018, for a review; Frota et al., 2020; Gleitman, 1990; J. Morgan & Demuth, 1996). For example, prosodic information about lexical stress can be used for word recognition in infants' learning (Bhatara et al., 2018). Prosody boosts lexical learning in various ways: rhythm and stress prominence help word segmentation, intonation facilitates referent identification, and both intonation and phrasal boundaries aid with word-to-meaning mapping (see Thorson, 2018, for a review). Moreover, the way adults speak to infants also supports the process of language acquisition. Across languages, it has been found that adults use specific prosodic properties in communication with infants, what is known as **infant-directed speech** (IDS, Fernald, 1989). IDS is characterized by especially salient prosody, for example, higher pitch and intensity, exaggerated pitch contours, a slower speech rate, a longer duration. Typically, in IDS, utterances are shorter, grammatical structures are simpler, specific words are emphasized and repeated (Fernald, 1992). IDS attracts infants' attention and during the first months of life, infants show a strong preference for IDS over adult direct speech (Dunst et al., 2012; Newman & Hussain, 2006). The prosodic features of IDS present infants with prominent cues to early word segmentation and facilitate long-term word retention (Cristia, 2013; see also Teixidó et al., 2018, for a review of electrophysiological evidence for the general claim that IDS supports language acquisition).

In addition to prosody, **referential gestures** including **deictic gestures** and **iconic gestures** have been found to be predictive of language outcomes. A growing number of studies have demonstrated that referential deictic and iconic gestures are related to and can predict a child's structural language development (see Colonnesi et al., 2010, for a meta-analysis; see Rohlfing, 2019, for a review), both lexical (e.g., Igualada et al., 2015; Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009, among others) and syntactic (e.g., Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005; Özçalışkan & Goldin-Meadow, 2005, among others). Regarding lexical acquisition, for example, a study by Mumford and Kita (2016) found a positive concurrent correlation between receptive vocabulary and hand dominance in pointing gestures at 10–12 months. Specifically, the larger the receptive vocabulary, the more right-handed the pointing, suggesting that at this age language and gesture start to be generated as a single process. Relatedly, Camaioni et al. (1991) showed that the frequency of children's pointing gesture at 12 months of age correlates positively with the size of their lexicon at 20 months. Bavin et al. (2008) supported these findings, showing a significant longitudinal correlation between gestures (i.e., reported percentage of gesture use) and object use at 1 year of age and vocabulary comprehension and production at 2 years of age in a large representative sample of children. Another longitudinal study by Igualada et al. (2015) found that the ability to produce simultaneous gesture-speech combinations at 12 months is also related to later expressive vocabulary and morphosyntactic development at 18 months. In addition, Iverson and Goldin-Meadow (2005) showed that between the ages of 10 and 24 months, lexical items that children produce in gesture appear earlier in the child's verbal lexicon. Further, Rowe and Goldin-Meadow (2009) observed infants' interaction with their caregivers and found that children's gesture vocabulary at 18 months predicts verbal vocabulary size at 42 months. By the same token, children's gesture use predicts later syntactic acquisition. Gesture-plus-word pairings expressing sentence-like information (e.g., a word "drink" accompanied by a pointing gesture at a bottle) pave the way for two-word speech.

Overall, it has been reported that the age at which children start using supplementary gesture-plus-word combinations predicts the age at which children start uttering two-word combinations (Butcher & Goldin-Meadow, 2000; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005). These studies provide strong evidence that early gesture use is a strong predictor of later lexical and grammatical development.

Another multimodal skill that constitutes a developmental pillar for language acquisition is **multimodal imitation** (Carpenter, Nagell, et al., 1998; Charman et al., 2000). Imitation is the ability to intentionally replicate the behavior or actions of others and it is a fundamental mechanism for language learning. Spontaneous prosodic and gesture imitation behaviors occur naturally in interaction, especially during the first two years of life (Jones, 2007; Meltzoff & Prinz, 2002). Both natural and elicited imitation are foundational human behaviors that strongly relate to language production and comprehension abilities (Bates et al., 1979; Carpenter, Nagell, et al., 1998; Castillo et al., 2021; Hanika & Boyer, 2019; Masur & Eichorst, 2002; Snow, 1989). For example, an early study by Bates et al. (1979) found a relationship between vocal imitation (i.e., sound and word imitation) and language production and comprehension skills in 9- to 13-month-old infants. Concerning lexical development, Masur and Eichorst (2002) showed that infants who imitated more novel words at 13 months had larger lexicons later in development, at 17 months and 21 months. Gesture imitation is also related to language development: Hanika and Boyer (2019) reported that motor imitation (e.g., embodied imitation such as clapping hands and actions with objects) in 15- to 18-month-old infants is associated with later language comprehension skills. Similarly, Carpenter, Nagell, et al. (1998) found correlations between the emergence of imitative learning of arbitrary actions in naturally occurring joint attention episodes and referential language in 9- to 15-months infants. Further, Snow (1989) observed that both vocal and gestural imitation skills at 14 months are longitudinally related to the number of verbs produced at 20 months. Overall, these studies have shown that infants' multimodal imitation skills, both prosodic and gestural, are related to language skills.

As for the later development of multimodal imitation skills, only a handful of studies have assessed the relationship between multimodal imitation and language development in **preschool and school years**. For instance, a recent study by Castillo et al. (2021) with 3- to 4-year-old typically developing children investigated their multimodal imitation ability, that is, the ability to accurately imitate lexical, prosodic, and gestural content. This study found that multimodal imitation skills were positively correlated with and predicted both children's narrative structure scores and their expressive pragmatic scores, indicating that the ability to imitate multimodal cues is strongly related to pragmatic abilities. However, the majority of studies have focused on atypical development. The evidence coming from clinical studies also confirms the link between gesture imitation and language skills. For instance, Dohmen et al. (2016) administered a body and posture imitation task with 2-year-old children identified with delayed onset and progression of language. The body and posture imitation task included some pragmatically meaningful body cues, for example, conventional gestures (e.g., waving for greeting) and facial expressions of anger and happiness, but it also included other meaningless cues, for example, manual postures (e.g., pat elbow, form and open fist) and actions with objects (e.g., throw a ball). The results showed that poorer body imitation skills at the age of 2 were predictive of verbal language delay at 4 years of age. Dohmen et al. (2016)'s findings suggest that measures of body imitation (pragmatically relevant and non-relevant gestures mixed) can be used for the identification of children at risk of language developmental deficits. Similarly, another study found that 6- to 8-year-old children with DLD have poorer gesture accuracy imitation skills compared to typically developing children (Wray et al., 2017). In this study, the accuracy of gesture imitation was assessed via two tasks. The first one actually did not include imitation *per se* since the child had no model to imitate but was asked to come up with gestures conveying different objects and actions (e.g., *guitar*, *sword fight*). Gesture accuracy was evaluated in terms of how closely the gesture reproduced the depicted concepts. The second task included the imitation of sequences of meaningless gestures produced by an adult (e.g., sequence: hand in a fist, palm down, palm to the side, clap) and the performance was evaluated in terms of how closely the child replicated the adult model. Finally, Ingersoll and Lalonde (2010) demonstrated that the ability to imitate pragmatically relevant gestures is associated with language development in children with ASD and training involving gesture imitation has beneficial outcomes on language use. Altogether, the above-mentioned studies on preschool and school-aged children (most of the studies analyzing atypical development) indicate that gesture-accuracy measures assessed via gesture imitation tasks are related to structural language skills later in life. Importantly, it should be noted that the gestures analyzed in these studies often are meaningless motor sequences, rather than being pragmatically grounded gestures.

Taken together, the findings reviewed in this section show that children's early pragmatic uses of gaze-following, prosody, and pointing, as well as their multimodal imitation skills reliably predict later their linguistic outcomes. While many studies have demonstrated that gesture can predict structural language outcomes in infants, we know much less about the link between gesture and language use, that is, pragmatics, in older, preschool typically developing children (but see Vilà-Giménez et al., 2019, for beneficial effects of beat gestures on the recall of information in 5- to 6-year-old children; Vilà-Giménez & Prieto, 2020, for beneficial effects of beat gesture in narrative training with 5- to 6-year-old children), and about the predictive role of different gesture measures (e.g., gesture imitation, gesture frequency). **Study 3** presented in this thesis will expand this research by investigating the relationship between gesture and narrative skills later in development, in the early preschool years. Moreover, Study 3 will comprehensively assess gesture production. Specifically, the novelty of this study is that it will compare the effects of two different gesture measures, namely, gesture accuracy and gesture rate, in relation to pragmatics, and in contrast to previous investigations (e.g., Wray et al., 2017), it will focus on pragmatically relevant gestures that occur in socially meaningful contexts rather than on meaningless motor sequences.

1.5.4. Multimodal pragmatic foundations of social cognition

Infants' early multimodal communicative behaviors also underlie social cognition, including **emotional development**. The literature reported that early in development multimodal cues such as facial expressions map onto emotional states (Flom & Bahrick, 2007).

Infants first encounter most of the facial components of human expression shortly after birth and are already able to express some basic emotions (for example, sadness or enjoyment) at around 4 months of age. By the end of the first year they can signal more complex emotions such as surprise, fear, or interest (Sullivan & Lewis, 2003). Likewise, they are capable of discriminating emotions based on the perception of faces. By 3 months of age, infants can recognize the facial expressions of smiling and frowning (Barrera & Maurer, 1981); by 4 months of age, they can differentiate faces expressing joy, anger, and no emotion (LaBarbera et al., 1976); between 5 and 7 months of age, infants are able to discriminate a larger range of facial expressions including fear, surprise, and anger, and can recognize them in the same or different person (Bornstein & Arterberry, 2003; Nelson & Dolgin, 1985; Serrano et al., 1992).

Within the first year of life, children also gradually develop the ability to express and recognize emotions from vocal cues. Infants as young as 3 months start to control prosodic parameters of their speech in order to signal emotional meanings (Oller et al., 2013). For instance, during their first year of life (weeks 7–58) infants use variation in duration, pitch range, and pitch peak, as well as laughter and crying to distinguish basic positive and negative emotions (Scheiner et al., 2002). Moreover, the emotional load of infants' vocalizations is understood by adults who can accurately distinguish between infants' sounds expressing negative (e.g., pain, isolation) and positive emotions (e.g., play, reunion) (Lindová et al., 2015). Studies on the perception of vocal emotional expressions in infants have shown that they are sensitive to changes in prosody conveying emotional meanings. Five-month-olds discriminate affective expressions in infant-directed speech such as approval and prohibition and react to them accordingly, in particular, they smile more to positive emotional prosody (Fernald, 1993). Infants' responses to emotional prosody have also been studied in behavioral studies that showed that infants attend to voice signals expressing different emotions (e.g., infants' mothers were asked to produce happy or fearful vocalizations) to guide their behavior accordingly (e.g., Mumme et al., 1996; Vaish & Striano, 2004). Attunement in emotional vocal cues continues to develop later. For instance, 15-months-olds can differentiate positive emotional vocal cues from humorous ones and match them to intentional actions (Hoicka & Wang, 2011).

Naturalistic and ecological expressions of emotion usually involve both prosodic and visual information and infants discriminate emotions better when they are presented with synchronous voice and face information. For instance, discrimination of happy, angry, and sad expressions emerges by 4 months in synchronous multimodal speech, but in unimodal (only prosodic or only visual) modality infants begin to discriminate these expressions some months later (Flom & Bahrick, 2007). Similar results come from the studies on face-voice matching (Walker, 1982). In a series of experiments with 5- and 7-month-old infants, Walker (1982) demonstrated that infants looked more at facial expressions of emotions (happy, sad, angry, and neutral) when they were accompanied with affectively concordant vocal expressions, even if the soundtrack was asynchronous. These results demonstrated that by 7 months infants detect information expressing emotions in both audio and visual displays and perceive both modalities as conveying a single and meaningful affective expression. Interestingly, an effect of person familiarity has been found: infants match the facial and vocal expression of a familiar person (e.g., mother) earlier (i.e., at around 3.5 months of age) than that of an unfamiliar one (e.g., another woman) (Kahana-Kalman & Walker-Andrews, 2001). By 5 months of age, infants can detect, discriminate, and match the facial and vocal emotional cues of not only adults but also other infants (Vaillant-Molina et al., 2013). Overall, this research indicates that infants develop expressive and perceptive multimodal skills related to affect during the first year of life and highlights the important role of multimodal cues in the emergence of emotional competence.

As for the link between prosody and emotion understanding **later in development**, the reliance on prosodic cues to understand speakers' emotions seems to be less powerful. Although infants draw on prosodic cues to emotions, some studies showed that other than prosodic sources of information such as lexical (Friend & Bryant, 2000; Morton & Trehub, 2001; Waxer & Morton, 2011) are prioritized during childhood. Some studies have demonstrated longitudinally the relationship between structural language and emotion comprehension. Griffiths et al. (2020) showed that composite language scores including vocabulary and grammar scores (both expressive and receptive) at age 5–6 predicted emotion recognition at age 10–12. Although it appears that starting from the preschool years grammatical means take over from prosody in emotion comprehension, other studies have suggested that children use emotion prosodic cues implicitly (Berman et al., 2016; Khu et al., 2018) and rely on facial markers of emotions (Nelson & Russell, 2011; Quam & Swingley, 2012). In Berman et al. (2016), 3- to 5-year-olds were asked to match visual cues (happy- and sad-looking faces) to prosodic (happy- and sad-sounding speech) ones; both explicit (pointing) and implicit (eye gaze) measures were collected. Results indicated that it was only once the children reached the age of 5 that they could explicitly match acoustic and visual cues, and younger children at the age of 3 were successfully able to match them implicitly in the case of negative affect (sad-sounding intonation and sad-looking face). These findings were echoed by Khu et al. (2018) who found that eye gaze measures of 4-year-old children indicate that they use the interlocutor's emotional prosody to infer the interlocutor's emotional state. Furthermore, Nelson and Russell (2011) observed that preschoolers label emotions on the basis of facial and postural cues. By the same token, Quam and Swingley (2012) reported that 2- and 3-year-olds exploit facial and body-language cues to interpret a situation or an emotion and that 4- and 5-year-old children are also able to use happy or sad prosody in the same task. Together, these studies show a rather mixed picture: while some studies argued that preschool and school-age children use other linguistic means to express and understand emotions, other studies suggest that children implicitly exploit prosody and gesture to infer feelings. Children start to use multimodal skills to process emotions in an explicit way later when more complex socio-cognitive abilities are in place. Overall, while there is evidence of a bootstrapping role of prosody within language and emotion understanding in infants, the link between prosody and social cognition later in development appears to be less robust.

Turning to the cognitive aspects of social cognition, there is some empirical evidence — some of which has been discussed in the previous section when reviewing the literature on early speech act development — supporting the belief that even very young children are sensitive to **multimodal cues of mental states**. Though mental states, as intentions, are invisible, people can learn about them through multimodal signals, and the use of such signals appear early in life (C. D. Frith & Frith, 2007). Infants are highly attuned to reading intentions from eye movements, facial movements, and gestures. Lee et al. (1998) showed that infants use eye gaze information for early “mind-reading” purposes. Namely, by following eye gaze direction, infants were able to identify which object is wanted, showing that they can infer other people’s desires. Other studies found that infants distinguish intentional from non-intentional meanings by means of the production and comprehension of different prosodic patterns (e.g., Sakkalou & Gattis, 2012), the shape of pointing gestures (e.g., Behne et al., 2012; see also Rohlfing et al., 2017), and their combination (Esteve-Gibert et al., 2017). Similarly, children first express their own mental states through multimodal cues. For example, to express the inner state of desire (“want”), infants may gesture towards the object they want. Research shows that mothers increase their mentalistic talk about desires and intentions when the child starts to use imperative gestures, as they label and contextualize the child’s inner states (Slaughter et al., 2009). According to Montgomery (2005), this exposure to conversational exchanges about inner states via verbal and multimodal cues paves the way for the acquisition of mental states (see also 1.3.2, for more details). Furthermore, regarding the understanding of people’s beliefs, some multimodal studies have shown that in the early forms of social cognition (e.g., the understanding of true beliefs, as opposed to the understanding of false beliefs that develops later) children are already able to attribute such mental states as knowledge and ignorance. For instance, Liszkowski et al. (2008) found that 12-month-old infants gesture appropriately for knowledgeable versus ignorant partners and thus their use of pointing gestures is based on an understanding of the others’ knowledge. In this study, infants pointed more to an object in order to provide information if the adult did not know its location and they pointed less to an object whose location was known to the adult. Together, the studies on the infants’ acquisition of intentionality, mental state language, and beliefs point to the important role of multimodal cues such as eye gaze, facial expression, and gesture in this process.

Meanwhile, very little research has assessed the link between multimodal cues (prosody and gesture) and social cognition in the **preschool and school years**. Regarding prosody, the evidence coming from studies on adults indicates that prosody and some aspects of social cognition are related. A recent study by Esteve-Gibert et al. (2020) found that individual empathy skills determine the sensitivity to intonational cues. Developmental studies have mainly assessed the association between perceptive prosodic skills and ToM primarily in atypically developing children and adolescents and have reported overall negative results (Chevallier et al., 2011; Colich et al., 2012; Pexman et al., 2011). For example, Chevallier et al. (2011) tested the ability of 13-year-old high functioning ASD children to recognize different socio-cognitive meanings, such as emotions and second-order mental states, from the voice. Surprisingly, it was found that children with ASD were able to process all kinds of prosodic cues, including the ones that require metarepresentational skills, just as well as typically developing children matched on age. The results coming from Colich et al. (2012) supported these findings. This study compared the understanding of ironic remarks in 13-year-old children with ASD and matched-on-age typically developing children, and used a task in which children were presented with short scenarios before being asked to make a decision about whether the final remark meant what the character had said. The remarks were produced with different prosodic cues, described by the authors as sincere or ironic tone of voice. The results showed that children with ASD and their matched peers determined irony from the tone of voice equally well. Similarly, Pexman et al. (2011) manipulated the speaker's tone of voice to create conditions for ironic and literal comments and then tested them with 11-year-old high functioning ASD children and a control group. Again, their results showed that the children with ASD were as accurate as the typically developing children in recognizing the speaker's ironic criticism. On the whole, these studies suggest that a deficit in ToM, characteristic for children with ASD (see Baron-Cohen, 2001, for a review), does not necessarily lead to a deficit in the perceptive prosodic skills, namely, in the ability to read intentions in the voice. As for the relationship between social cognition and gesture in later development, few studies have directly examined this issue. For instance, Cochet et al. (2017) explored the link between pointing and ToM in children between 3 and 4 years of age and showed that ToM skills significantly correlated with the amount of declarative informative pointing produced by preschool children, supporting the results coming from research on infancy. In addition, previous literature reported imitative deficits in children with ASD of different ages (see Williams et al., 2004, for a systematic review). A study by Perra et al. (2008) demonstrated that both ToM and imitation were reliable predictors of ASD symptoms in children aged between 6 and 15 years. These findings offer a hint that gesture and ToM might be connected in preschool and school-aged typically and atypically developing children, but further research is needed to attain more conclusive results.

1.5.5. Multimodal approach to pragmatics

The research presented in the preceding sections has provided compelling evidence for the **key role of multimodal cues** in human communication. As demonstrated by a large number of studies, both prosody and gesture serve to express a broad range of pragmatic meanings in adult language (see Brown & Prieto, 2021, for a review; see section 1.5.1). In development, multimodal cues play a crucial role in the acquisition of pragmatics. Infants heavily rely on them for the comprehension and expression of pragmatic meanings at both the preverbal and verbal stages (see Esteve-Gibert & Guellaï, 2018; Hübscher & Prieto, 2019, for reviews; see section 1.5.2). Moreover, multimodal skills are considered to be foundational for the acquisition of language and social cognition (see de Carvalho et al., 2018; Frith & Frith, 2007, for reviews; see sections 1.5.3 and 1.5.4). Nevertheless, research on the interplay between pragmatics, language, and social cognition in preschool and school-aged children tends to neglect the multimodal component of language. This thesis aims to break this trend and to include multimodal language aspects into the picture when assessing the acquisition of pragmatics and other developing abilities. In this work, we adopt a multimodal approach to language and explore the role of multimodal language skills (prosody and gesture), structural language skills (vocabulary and syntax), and socio-cognitive skills (ToM, emotion understanding, and metacognitive vocabulary) in the development of expressive pragmatics. **Expressive pragmatic ability** is the key area to focus on because it deals with real-world language use and aids children in communicating successfully in everyday life. Moreover, as discussed earlier in the Introduction, expressive pragmatics develops markedly during the preschool years (e.g., the acquisition of speech acts, epistemic meanings, information focus, politeness, and narrative skills, etc.). In the next section, we review existing instruments for assessing expressive multimodal pragmatics and introduce a new Audiovisual Pragmatic Test (APT) developed with the aim of assessing expressive pragmatic skills while taking into account multimodal forms of pragmatic expression.

1.5.6. How to assess children's multimodal pragmatic abilities?

The aim of this section is to critically evaluate whether the tools currently available are adequate to comprehensively assess children's multimodal pragmatic profiles (both in prosody and gesture). We start with a brief review of the currently existing prosodic tools, then we examine gesture instruments, and at the end of the section we analyze pragmatic tests. While the assessment carried out in section 1.2.2 covered the currently available pragmatic tests for children, the review of the pragmatic tools provided in this section focuses narrowly on their assessment of multimodal components of pragmatic ability.

Our review of the **prosodic assessment** tools and protocols currently available for children found a total of 6 tests, namely, *Prosody Profile* (PROP; Crystal, 1992), *Prosody Voice Screening Profile* (PVSP; Shriberg et al., 1990), *Diagnostic Analysis of Nonverbal Accuracy 2* (DANVA 2; Nowicki & Duke, 1994), *Profiling Elements of Prosody in Speech-Communication* (PEPS-C; Peppé & McCann, 2003), *Perception of Prosody Assessment Tool* (PPAT; Klieve, 1998), and *Minnesota Tests of Affective Processing* (MNTAP; Lai et al., 1991). In what follows we explain why these tools are not optimal for comprehensively assessing expressive pragmatic prosody skills in children. First, all six tests primarily focus on children with atypical language development. For example, the PROP and the PVSP were designed exclusively for clinical use; the PPAT and the MNTAP were developed for research purposes in diverse clinical populations. Only two of the listed prosodic tests, the DANVA 2 and the PEPS-C, were initially developed for both clinical and research purposes in both typically and atypically developing children. Second, many of the prosodic tests focus only on receptive abilities. The PROP and the PVSP, however, do evaluate expressive prosody but neither of these tests covers a variety of pragmatic functions of prosody. For example, the PROP evaluates a sample of clinical data only in terms of the acoustic dimensions of prosody such as pitch, loudness, speed of speech, pause, and rhythm. Similarly, the PVSP uses spontaneous conversational speech samples and evaluates variables, such as pitch, tempo, stress, loudness, laryngeal quality, and resonance. On the whole, these tests seek to measure disability in several prosody-voice characteristics of children's speech. Perhaps the PEPS-C is the only one of the instruments that takes into account the pragmatic function of prosody. Yet it only assesses a few communicative aspects of prosody, namely, the ability to place contrastive stress (e.g., the child is asked to correct the commentator) and the ability to express affective stances (only two, liking and disliking, e.g., the child is asked to say the food sounding as though they like it), and statements and questions (e.g., in order to elicit a statement, the child is asked to tell something to the experiment and in order to elicit a question, the child is prompted to ask the experimenter about something).

As for the **assessment of gestures**, to our knowledge, the currently available assessment instruments include the following 5 tools, namely *Children's Communication Checklist-2* (CCC-2; Bishop, 2003), *MacArthur Communicative Development Inventories* (MB-CDIs; López-Ornat et al., 2005, for Spanish version), *Language Use Inventory* (LUI; O'Neill, 2009), *Clinical Evaluation of Language Fundamentals-Preschool 2* (CELF-Preschool 2, Pragmatics Profile and Pragmatics Activity Checklist subtests; Wiig et al., 2009), *NEPSY-II* (Korkman et al., 2007), and *Communication and Symbolic Behavior Scales Developmental Profile* (CSBS-DP, Wetherby & Prizant, 2002). The majority of these tools take the form of caretakers' questionnaires or checklists (e.g., CCC-2, MB-CDIs, LUI, the subtests within the CELF) and, thus, they do not provide the researcher with direct empirical observations of children's gesture abilities. One of the most popular tools for assessing gestures, the NEPSY-II, centers on motor movements required for gesture production: it assesses imitation of hand positions and motor sequences rather than pragmatic functions of gesture. Another tool, the CSBS-DP, involves a structured observation of the child's gesture but in analyzing gesture production, it only uses quantitative information about gesture frequency. Moreover, it is suitable only for infants and toddlers (6–24 months of age). Overall, the assessment of gesture skills is only loosely integrated into standard assessment instruments, with motor and quantitative aspects of gesture production considered primarily, while the pragmatic component of gesture use is not taken into account.

On another note, available **pragmatic tools** (see section 1.2.2) are not generally suitable for assessing multimodal components of pragmatic abilities. First, many of the norm-referenced pragmatic questionnaires (e.g., CCC-2, pragmatic subscales from CELF-5 and CELF-Preschool 3) are based on caregivers' answers, they do not provide a direct assessment of pragmatic performance, and, therefore, neither do they allow for a direct assessment of prosodic or gestural aspects of pragmatic expressions. Moreover, pragmatic multimodal abilities are generally not included in the questionnaires. Some questions may target speech abilities more generally—for example, whether the child pronounces words in a babyish way, leaves off beginnings and endings of words, mixes up words that sound similar or makes mistakes in pronouncing long words—but questions targeting prosodic abilities are rare. A case in point would be that while CELF-Preschool 2 contains a question about whether the child is able to use an angry, happy, or sad voice, overall prosodic aspects tend to be neglected. Second, observational pragmatic checklists (e.g., PPECS, ASLP, CEP, FCP-R, SRS-2, BASC-2, SCQ), either do not evaluate prosody or gesture (e.g., PPECS, ASLP) or assess it very broadly (e.g., CEP, FCP-R), for example, seeking to detect atypical prosody, such as monotonous tone of voice. Finally, pragmatic tools that directly assess pragmatic behavior (e.g., ACE 6-11, CASL-2, Pragmatic Protocol, TLC, TOPL-2), do not take multimodal dimensions of pragmatic behavior into account. This is the case with the tests focusing on pragmatic comprehension (e.g., TLC). The tests centering on expressive pragmatic abilities are designed for clinical populations and only broadly assess the adequacy of the child's prosody (e.g., ACE 6-11, Pragmatic Protocol). CASL-2 and TOPL-2 assess expressive pragmatic skills using a series of vignettes describing everyday situations. However, they are not available in Catalan and they do not specify how multimodal components of the answers should be taken into account. Furthermore, they consider only the verbal aspect of the child's answer.

To summarize, despite the close relationship between pragmatics and the multimodal cues that express it, a brief review of the existing prosodic, gesture, and pragmatic assessment tools identifies a mismatch between them: prosodic and gesture tools largely neglect pragmatic aspects, while pragmatic tests generally do not take prosody and gesture into account (see also Bosco et al., 2013). There is thus a need for a pragmatic instrument that focuses on expressive pragmatic skills and takes multimodal forms of the expression into account.

Given the current state of affairs and in order to comprehensively assess expressive pragmatics skills, we designed a novel assessment instrument that targets everyday pragmatic uses and takes multimodal forms of pragmatic expression into account: the **Audiovisual Pragmatic Test** (APT; Pronina et al., 2019). The APT is an efficient and sound instrument that can elicit reliable data in practice. Its pragmatic coverage is based on standardized and widely used pragmatic tools such as TOPL-2 and CASL-2 that focus on communicative pragmatics skills. The APT comprehensively addresses a broad range of different pragmatic skills required in everyday communication (e.g., to ask for permission, ask for some information, call someone, thank, produce a greeting, etc.), it includes different social day-to-day situations (e.g., communication with a group of peers, with a friend, with a teacher, with parents, with a shop assistant, etc.), it assesses the production of a broad range of speech acts (e.g., assertions, requests, expressive acts) and targets main pragmatic areas of development in the preschool and school years (e.g., information structure, epistemic states, and politeness). Its elicitation procedure follows the Discourse Completion Task (DCT) methodology that has long been established in the field of pragmatics and prosody and has proven powerful and efficient method of researching pragmatic uses of prosody (for review of the DCT method in the pragmatic field, see Ogiermann, 2018; in the prosodic field, see Vanrell et al., 2018).

The full version of the APT contains a total of 47 items, each depicting a pragmatic situation and targeting a specific speech act. In this thesis, a shorter 35-items version of the APT was used because it was expected that the last 12 items would be too difficult for the test-takers, 3- to 4-year-olds, as these items present pragmatic situations that preschool children would not be likely to encounter (e.g., a polite refusal to give personal information). A full 47-item version was tested with older children, 5- to 8-year-olds, who managed to successfully complete all the test (Pronina, Hübscher, et al., in prep.). The distribution of items builds on previously developed standardized pragmatic developmental tests for children (e.g., CASL-2) and is enriched with items coming from DCT questionnaires. The 35-item version includes 1 item of unbiased assertions, 7 items of biased assertions, 10 items of unbiased requests, 5 items of biased requests, 7 items of basic expressive acts and 5 items of complex expressive acts. Unbiased requests and assertions have no additional pragmatic meanings. For example, an unbiased assertion has a declarative or explanation illocutionary force and no markers of modality (e.g., declarative statement). An example of unbiased request would be command or a neutral information-seeking question. Biased speech acts (see also Krifka, 2015, 2017, 2019) convey additional pragmatic biases marking information structure, epistemic meanings or negation (e.g., a statement expressing contrastive focus, a question expressing incredulity). In total, 4 items target information structure bias, 7 items target epistemic bias and 3 items target negation bias. As for expressive acts, basic expressive acts revolve around basic social situations such as greeting, thanking or apologizing (see Norrick, 1978), while complex expressive acts correspond to more complex social acts such as expressing congratulations, condolences, compassion or praise. Full APT materials and instructions are available in both Catalan and English in the Open Science Framework (OSF) repository (Pronina, Hübscher, Vilà-Giménez, et al., 2021a).

The APT is suitable for children starting from the age of 3: the items are presented in a role-play scenario; they are coherent with a child's everyday life and accompanied by colored pictures; all this helps the child to feel immersed in the social scenarios presented throughout the testing and to minimize memory load. It is a reliable and validated tool: its psychometric properties—namely, content validity, convergent validity, interrater reliability, test-retest reliability, and internal consistency reliability—showed overall good-to-excellent results for all tests (Pronina et al., under review).

In all the studies within the present thesis, the APT was used. Since the APT was designed for the assessment of communicative pragmatic uses in context while also accounting for multimodal forms of pragmatic expression, it can be used for both pragmatic assessment and multimodal context-based assessment. In Study 1 of the thesis, we investigate pragmatic and prosodic skills by using pragmatic and prosodic scores derived from the APT. In Study 2, we focus on prosodic expressions of pragmatic meanings and analyze prosodic scores gathered via the APT. In Study 3, we analyze gestural expressions of pragmatic meanings, using a subset of APT items that are more likely to elicit gestures. In Study 4, we center on pragmatic abilities only and examine pragmatic scores collected with the APT. In other words, APT is a measure of children's multimodal pragmatic abilities: an expressive pragmatic instrument and an elicitation tool of prosodic and gestural production in children.

1.6. Scope and outline of the thesis

This thesis adopts a multimodal framework of pragmatics and aims to explore 3- to 4-year-old children's pragmatics-prosody-gesture interface during the preschool years while also accounting for other linguistic and socio-cognitive abilities under development. Building on previous proposals, the present thesis aims to explore the expressive pragmatic ability of young preschoolers by assessing the role of multimodal linguistic cues (prosody and gesture), structural language, and social cognition in expressing and fostering pragmatics, therefore pinpointing pragmatics on a developmental map of abilities.

In order to do so, we will analyze a **cohort of children** and use a **multidimensional testing battery** across all the studies of the thesis. The cohort consists of more than 100 Catalan-speaking children between ages 3 and 4 recruited in two public schools in Barcelona. The multidimensional testing battery includes two tests of structural language (expressive vocabulary and expressive syntax) and four tests of social cognition (two first-order false belief tasks, emotion understanding test, and a test of metacognitive vocabulary). In order to comprehensively assess expressive multimodal pragmatic skills targeting day-to-day communication, we will use the Audiovisual Pragmatic Test (APT, Pronina et al., 2019) that was designed for this purpose and which is available for Catalan-speaking children from the age of 3 upwards. Moreover, in assessing the interplay between pragmatics, structural language, and social cognition, we will also control for other possibly influencing factors such as age, socioeconomic status (SES), and bilingual language dominance.

The present thesis includes **four studies** that explore the expressive pragmatic skills involving discourse production in young preschoolers. The **main goals** of these studies are the following: (i) to determine how the expressive pragmatic skills of young preschoolers are related with both their structural language (vocabulary, syntax) and social cognition skills (ToM, emotion understanding, and metacognitive vocabulary) (Study 1); (ii) to examine the pragmatic prosody profile of young preschoolers and their relation to ToM skills (Study 2); (iii) to investigate the relationship between narrative skills and different measures of gesture abilities (Study 3); and (iv) to assess the role of language-based pragmatic training concerning mental states (both multimodal and non-multimodal) on the pragmatic and socio-cognitive abilities of young preschoolers (Study 4). Four **main research questions** will be addressed, each in a separate chapter:

(1) **Study 1**: How are expressive pragmatic and prosodic skills related to other developing abilities in the mental architecture of young preschoolers? What is the role of structural language and social cognition skills?

(2) **Study 2**: What is the pragmatic prosody developmental profile of young preschoolers? Which pragmatic meanings can preschoolers successfully express via prosody? Are prosodic abilities related to ToM skills at this age?

(3) **Study 3**: How are gesture abilities (measured in two different ways) related to narrative abilities? Will narrative performance relate differently to gesture rate and gesture accuracy?

(4) **Study 4**: Can expressive pragmatic (and social cognition) skills be boosted through a language-based pragmatic intervention focusing on mental states? Will the use of prosodic and gestural cues in a multimodal intervention be beneficial?

The **central underlying hypothesis** of this thesis is that expressive pragmatic abilities in the early preschool period are intimately related to language, both structural (vocabulary and syntax) and multimodal (prosody and gesture expressed through the voice and the body), and less so to social cognition. We expect that vocabulary and syntax will be related to pragmatic abilities (Study 1) and support the development of pragmatic knowledge (Study 4). In contrast, we predict that the role of socio-cognitive capacities will be less clear (Study 1), as previous findings on the link between pragmatics and ToM in preschoolers are inconclusive. The multimodal part of this hypothesis builds upon previous literature on the bootstrapping role of multimodal cues in infants' pragmatic development and the literature on the role of prosody and gesture in the expression of pragmatic meanings in childhood. We expect to assess the pragmatic prosody profile of early preschool years and their relation with ToM (Study 2), find the relationship between gesture measures and pragmatic skills (Study 3), and show a beneficial effect of multimodal training involving both prosodic and gestural cues on pragmatic skills (Study 4).

To answer the research questions outlined above, this thesis is structured into four independent research papers (Chapters 2–5), as well as the Introduction (Chapter 1) and Conclusion (Chapter 6) sections. Each paper presented in this thesis contains its own introduction, methods, results, and discussion sections. Even though each paper addresses a different aspect of multimodal pragmatics development, there might be some overlap in the reviewed literature across chapters. The full cohort consisted of 117 children; the number of children across the four studies varies according to the inclusion and exclusion criteria such as language dominance (105 children in Study 1, 102 children in Study 2). Training Study 4 includes less participants (83 children) because some of the children missed school during the intervention and dropped out, and because some of them were inattentive during pretest or posttest. Finally, only a subset of children took part in Study 3 (31 children).

Study 1 (Chapter 2) analyzes the interplay between expressive pragmatics and both social cognition (referred to as 'mentalizing' in this study) and language. Using several statistical approaches (correlations, regressions, and Structural Equation Modeling), it investigates how expressive pragmatic and expressive prosodic abilities are related to structural language and social cognition skills in preschool children. A total of 105 3-to 4-year-old children were tested individually on their expressive pragmatic and prosodic skills with the Audiovisual Pragmatic Test (APT). The children's answers in each of the APT items were evaluated perceptually in terms of the pragmatic and prosodic appropriateness of the produced answer in relation to its social context. Children were also administered two structural language measures, that is, an expressive syntax test and an expressive vocabulary test, as well as a series of social cognition measures that included ToM (measured with two false belief tasks), an emotion understanding test, and a test for metacognitive vocabulary. The hypothesis was that both expressive pragmatic and prosodic performance would be related to other language abilities. However, we expected that there would be weaker links with social cognition measures.

Study 2 (Chapter 3) takes an in-depth look at the pragmatic and prosodic development of young preschoolers. The aim of the study is to assess their ability to use prosody to express pragmatic meanings, and to analyze how this ability relates to children's developing understanding of the minds of others (ToM), as some previous studies in children and adults have suggested that ToM is linked to the receptive prosody skills, although other available evidence is inconclusive or contradictory. A total of 102 3- to 4-year-old, Catalan-speaking children participated in this study. They undertook the Audiovisual Pragmatic Test (APT). The prosodic component of their responses was evaluated perceptually in terms of the prosodic appropriateness of the produced answer. The children were additionally tested on their ToM abilities with two classic false belief tasks: the unexpected content task and the unexpected location task. The hypothesis was that children's acquisition of prosodic cues to express pragmatic meanings would vary depending on the specific pragmatic area. Specifically, we predicted that the prosody of unbiased and basic speech acts would have been acquired by this developmental point while the prosody to express biased pragmatic meanings, for example, information focus and epistemic states, would be acquired fully later, and to a lesser degree at this stage. A second hypothesis of the study was that ToM might be related to expressive prosodic skills, in line with previous research that reported a link between ToM and receptive prosody.

Study 3 (Chapter 4) further examines the relationship between young preschoolers' pragmatic skills and multimodal language, and, specifically, two measures of gesture skills. Prior research on infancy showed that the frequency of gesture use by infants is related to the development of pragmatic and structural language abilities in the initial stages of language acquisition. However, much less is known about the relationship between gesture and pragmatic language measures at later stages of language acquisition. This study explores the role of two gesture measures, namely, gesture accuracy (i.e., the accuracy with which pragmatically relevant gestures are produced or reproduced) and gesture rate (i.e., frequency). A total of 31 3- to 4-year-old children participated in a multimodal imitation task to assess gesture accuracy and in a context-based gesture elicitation task (the Audiovisual Pragmatic

Test, APT, was employed) to assess gesture rate, and in a narrative retelling task to assess their ability to structure a story. In line with some previous studies on atypical development, we hypothesized that gesture rate and gesture accuracy would differ in their relation to children's narrative skills and, specifically, that gesture accuracy would have a stronger connection with retelling abilities than gesture rate.

Study 4 (Chapter 5) explores whether pragmatic and socio-cognitive development can be enhanced through either multimodal and non-multimodal language-based pragmatic training intervention that focus on mental states. Previous studies concerning training social cognition in preschool children have mainly focused on ToM skills, while other cognitive and affective aspects of social cognition, as well as children's expressive pragmatic ability to interact socially with others, remain less studied. A total of 83 3- to 4-year-old children were assigned to the control condition (no training) or to one of the two experimental conditions: either the non-embodied (i.e., non-multimodal) conversational condition or the embodied (i.e., multimodal) conversational condition. The children underwent a 4-week intervention during which they listened to stories enriched with mental state terms, both cognitive and emotional. Then children in the control group were trained using non-conversational and non-reflective activities, whereas children in the two conversational conditions were trained through group interaction with a teacher who encouraged them to reflect on their own and others' mental states. In the non-embodied group, children were encouraged to interact verbally with the teacher, and in the embodied group, children were encouraged to interact with the teacher both verbally and multimodally. Before and after training, children from all groups were assessed on their pragmatic competence with the Audiovisual Pragmatic Test (APT) and a series of social cognition tasks (ToM, emotion understanding, and metacognitive vocabulary). The prediction was that training children in mental state concepts (both multimodally and non-multimodally) would enhance not only their ToM understanding, as found in previous research, but also their pragmatic performance.

Chapter 6 concludes the thesis by reviewing the main results obtained in the previous chapters, highlighting the overarching findings and discussing them in light of our current knowledge of developmental pragmatics. It also outlines the methodological, practical, and clinical implications of the thesis and suggests directions for future research.

The four studies presented in this thesis have either been published or are under review in peer-reviewed journals. Information about the current publication status of each article and the respective co-authors is provided at the beginning of each chapter. The author of this thesis is the first and leading author in all four co-authored papers. All studies have been directed/co-directed and co-authored by the thesis supervisor Dr. Pilar Prieto. Study 1 is the result of a collaboration with former members of the *Prosodic Studies Group*, Dr. Iris Hübscher (University of Zurich, Zurich University of Applied Sciences) and Dr. Ingrid Vilà-Giménez (Universitat Pompeu Fabra; Universitat de Girona). Study 2 is the outcome of a research collaboration established with Prof. Valentina Bambini (IUSS) and Dr. Luca Bischetti (IUSS) that started during a research stay abroad at the University School for Advanced Studies (IUSS) in Pavia, Italy. Study 3 has been conducted in collaboration with Dr. Alfonso Igualada (Universitat Oberta de Catalunya), PhD student Jelena Grofulovic (Leipzig University), and MA student Eva Castillo (Universitat Pompeu Fabra). Study 4 has been carried out in collaboration with Dr. Iris Hübscher (University of Zurich, Zurich University of Applied Sciences) and Prof. Judith Holler (Radboud University, Max Planck Institute for Psycholinguistics). Minor differences in style across the four chapters are due to the fact that the studies have been published at /submitted to different journals with varying requirements.

2

CHAPTER 2: EXPRESSIVE PRAGMATICS, STRUCTURAL LANGUAGE, AND SOCIAL COGNITION

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2.1. Introduction

Pragmatics typically refers to the ability to use language in human communication (Airenti, 2017; Jacob Mey, 1993). Given this definition, pragmatics lies at the point where language and the social world meet: on the one hand, it deals with how we communicate via linguistic means to express different speech acts (i.e., principle units of human communication, expressing speaker intentions, for example, a request, a greeting, an apology, etc., Levinson, 1983); on the other hand, pragmatics is concerned with the social dimension, as language adapts to the situational context (which includes aspects such as social conventions, rules of politeness, knowledge and believes of the interlocutors, see Brown & Levinson, 1987). The consequence of this two-fold nature of pragmatic competence is that it can be regarded as belonging both to the language competence, along with more structural language skills such as syntax, vocabulary, etc., and to a domain closely related to social cognition abilities, understood as those abilities that allow us to interact with others (Frith & Frith, 2007). Among social cognition abilities, pragmatics seems to be especially related to mentalizing, indicating the ability to infer others' mental and emotional states (Frith & Frith, 2003; Hooker et al., 2008), which is also sometimes referred to as Theory and Mind or mindreading. However, the relationship between pragmatics, other language skills, and mentalizing has been a matter of wide debate and theoretical models vary in how they address this issue. Here, we tackle the status of pragmatic ability and its relationship with the other skills from a developmental perspective, bringing novel evidence based on preschool children.

In the linguistic tradition, pragmatics is viewed as a domain of language competence, either pertaining to phenomena that cannot be resolved within grammar and other linguistic levels (Ariel, 2010) or projecting onto any aspect of language, from syntax to semantics, and specifying the condition of use of language in general (Akmajian et al., 2010; Verschueren, 2012). Conversely, Gricean-inspired approaches highlight the role of pragmatics as the social-cognitive capacity for human communication (Sperber & Wilson, 1985). According to this framework, pragmatics is the ability to inferentially attribute intentions in communication and derive the speaker's meaning. In this way, pragmatics is often regarded as a part of social cognition, rather than of language, and specifically as a communication-specific submodule of mentalizing (Scott-Phillips, 2017; Sperber & Wilson, 2002). A third view has emerged more recently from empirical research in the developmental and clinical fields. Here, authors seem to acknowledge the complexity of the relationship between pragmatics, other language skills, and the broad domain of social cognition. In this perspective, a few models of the pragmatic capacity have been proposed, which regard it as a "cup of competence" fed into by language and social cognition functions (e.g., understanding of mental and emotional states), among others (Hyter, 2017; P. Snow & Douglas, 2017). The specific relationships between these domains, however, vary considerably depending on the age and the ability being tested.

Focusing more closely on the empirical research on development, we often see that the literature adopted a correlational approach to investigating the interplay between pragmatics and other linguistic and mentalizing skills. When describing the results offered by this literature, a distinction should be made between preschool and school-aged children. The few studies on typically developing preschool children mostly indicate that pragmatic skills do not systematically correlate with ToM (Angeleri & Airenti, 2014; Banasik, 2013; Bernard & Deleau, 2007; Bosco & Gabbatore, 2017a, 2017b), whereas the correlation with structural language skills seems to be stronger and more consistent across studies (Angeleri & Airenti, 2014; Bernard & Deleau, 2007). Conversely, the more numerous studies on school-age children suggest that the relationship between pragmatics and ToM becomes more robust later in development (De Rosnay et al., 2014; Del Sette et al., 2020; Filippova & Astington, 2008; Lecce et al., 2019; Massaro et al., 2013, 2014; Nilsen et al., 2011; Winner & Leekam, 1991). It should also be noted that this literature investigated mostly receptive pragmatic skills, paying particular attention to the understanding of nonliteral language, such as metaphors and irony (e.g., Angeleri & Airenti, 2014; Banasik, 2013; Bosco & Gabbatore, 2017b), while it neglected expressive aspects of pragmatic skills, such as producing speech to express different communicative intentions (i.e., producing speech acts), while also adjusting for social context and interlocutors.

While previous work on developmental pragmatics has considered verbal pragmatic behavior above all, communication also involves the use of multimodal cues (Brown & Prieto, 2021). Multimodal cues include both auditory cues, such as prosody, and visual cues, such as gestures. Prosody is especially relevant here, since it can affect the heart of expressive pragmatics and plays an important role in encoding and decoding pragmatic meanings (Culpeper, 2011). For instance, prosodic modifications in speech are used to distinguish speech acts and signal politeness and other social aspects (Prieto, 2015). Children rely heavily on these prosodic cues when communicating (Chen, 2018; Esteve-Gibert et al., 2017; Ito, 2018). However, our understanding of children's use of prosody is far from comprehensive, with prior research mostly focusing on very early stages and not fully integrating work on preschoolers (Chen et al., 2020). Moreover, research on the development of prosody has often been restricted to the description of intonational pitch contours (see Frota & Butler, 2018 for a review), without considering the true pragmatic implications of prosodic skills, such as, for instance, how prosody supports the production of different speech acts.

To our knowledge, there is a dearth of studies systematically assessing possible associations between prosody, structural language, and mentalizing in development. When focusing on the relationship between prosody and structural language, some studies have reported positive correlations. For instance, one investigation reported that prosodic segmentation abilities are concurrently correlated with vocabulary scores in atypical development (Frota et al., 2020). Other evidence of a link between prosody and structural language comes from studies that showed the bootstrapping role of prosody in language acquisition (see de Carvalho et al., 2018; Thorson, 2018, for a review). Similarly, vocal cues are shown to be crucial for mental state, intention, and emotion comprehension (M. Armstrong & Hübscher, 2018; see also Esteve-Gibert et al., 2020; Esteve-Gibert & Prieto, 2018). Nevertheless, other studies on atypical development offer less straightforward results on the relationship between prosody and mentalizing. For instance, several studies reported that children and adolescents with Autism Spectrum Disorder (ASD) use prosodic cues to judge speaker ironic intent or speaker states as well as age-matched controls do

(Chevallier et al., 2011; Colich et al., 2012; Pexman et al., 2011). These studies concluded that impaired mentalizing skills do not necessarily cause difficulties with mindreading based on the perception of prosody, which potentially weakens the idea of a relationship between mentalizing and receptive prosodic abilities.

The present study

The present study aims to overcome the limitations of the previous developmental literature by jointly testing the role of structural language and mentalizing skills on pragmatics. First, past research rarely focused on expressive pragmatic skills; second, it neglected prosody, which is highly relevant in relation to pragmatics; third, it devoted little attention to preschoolers. Finally, the range of language and mentalizing measures is often limited to vocabulary knowledge, for language, and false belief understanding, for mentalizing, neglecting other components, such as syntax and emotion recognition. Given this scenario, this study seeks to provide fresh insight into the developmental research on pragmatic abilities by investigating the relative role of a range of structural language and mentalizing skills in communicative abilities involving (a) expressive pragmatic skills; and (b) expressive prosodic skills in young preschool children.

To achieve this, we employed a recently developed assessment tool that evaluates expressive pragmatic and prosodic abilities in children (i.e., Audiovisual Pragmatic Test, APT, Pronina et al., 2019) by looking at speech act production from the point of view of pragmatics and prosody. Moreover, we included in the assessment various components of mentalizing (i.e., false belief, metacognitive vocabulary, and emotion understanding) and structural language (i.e., vocabulary and syntax).

Although the previous literature did not comprehensively address the relationship between pragmatics, prosody, and other language and mentalizing abilities, previous research allows us to make a set of predictions. First, following Angeleri and Airenti (2014), Banasik (2013), Bernard and Deleau (2007) and Bosco and Gabbatore (2017a, 2017b), we hypothesized that expressive pragmatic skills would be related to structural language. Second, in line with Frota et al. (2020), we predicted that preschoolers' expressive prosodic abilities would be associated with their structural linguistic skills. However, we expected weaker or no correlations between pragmatic skills and mentalizing (Angeleri & Airenti, 2014; Banasik, 2013; Bernard & Deleau, 2007; Bosco & Gabbatore, 2017a, 2017b), as well as weaker or no correlations between prosodic abilities and mentalizing (Chevallier et al., 2011; Colich et al., 2012; Pexman et al., 2011).

To test these hypotheses, we used several statistical techniques, including correlations, regressions, and Structural Equation Modeling (SEM). SEM is one of the most comprehensive statistical approaches to testing hypotheses about the relationship between variables (Hoyle, 1995) and it has been used in recent studies addressing the relationship between pragmatics and Theory of Mind (Bischetti et al., 2019). SEM has the advantage of simultaneously considering the relationships between multiple independent and dependent variables in a single model. Moreover, it captures latent (unobserved) constructs and tests both direct and indirect effects (Kline, 2005), which makes this method ideal for testing the predictive power of different constructs in pragmatic and prosodic development and to map the network of unique relationships among predictors.

2.2. Methods

2.2.1. Participants

A total of 117 3-to 4-year-old children were initially enrolled in the study. All of them were typically developing children with no history of speech, language, or hearing difficulties. Children were recruited from two public schools in Barcelona, a Catalan-Spanish bilingual area, where the main language of instruction is Catalan. Parents gave written consent and filled out questionnaires concerning their occupational status (i.e., the International Socio-Economic Index, Ganzeboom et al., 1992) and their children's exposure to Catalan (Bosch & Sebastián-Gallés, 2001). The study was approved by the ethics committee of [blinded]. The sample was collected as a part of a larger developmental project and was included in previous studies analyzing prosodic development

(Pronina, Hübscher, Vilà-Giménez, et al., 2021b) and the effects of training interventions (Pronina, Hübscher, Holler, et al., 2021).
In order to ensure that the children had sufficient language skills to undertake the verbal tasks of the study, a criterion for participation was set at a minimum of 20% completion of the expressive vocabulary test taken from the standardized language battery *Evaluación de Lenguaje Infantil, ELI* (Saborit Mallol & Julián Marzá, 2005). This criterion is based on the normative data provided in the validation of the test (Saborit Mallol & Julián Marzá, 2005) and corresponds to the lowest value (6 items out of 30) obtained by typically-developing 3-year-old children. Taking into account this exclusion criterion, the final sample included 105 children[5] (47 boys and 58 girls); their ages ranged from 3;3 to 4;3 (*M* = 3;9, *SD* = 3.25 months).

2.2.2. Assessment Materials and Procedure

Children were tested individually in a quiet classroom, in two testing sessions of about 20 minutes each. The order of tests was constant across participants: emotion understanding, metacognitive vocabulary, false belief, vocabulary, syntax, and the test of expressive pragmatics and prosody. All testing was conducted in Catalan by the first author or three research assistants and was video recorded. Before the assessment, the examiners underwent training sessions in which they were provided with scoring guidelines, examples, and feedback. The scoring of each test was carried out online by the examiner; the scores of the expressive pragmatics and prosody test were checked additionally offline by the first author and corrected if necessary. The final offline-corrected APT scores were used for the analysis. In scoring the performance of Catalan-Spanish bilinguals, in line with previous research on bilingual populations (e.g., Gross et al., 2014), we accepted answers both in Catalan and Spanish, two closely related Romance languages. Moreover, in the analysis of the data, we additionally examined the

[5] Prosodic data were available for 86 participants, due to missing or poor-quality audiovisual recordings, and SES data were available for 94 children, since not all parents provided information about their occupations (89% of parents completed questionnaire responses). Data for the rest of the variables are based on the full sample of 105 participants.

effect of the child's exposure to Catalan on their performance in all the other tests.

Mentalizing measures

The three measures used here come from a commonly employed set of tests for the assessment of preschoolers' mentalizing skills (e.g., Grazzani & Ornaghi, 2011; Ornaghi et al., 2011).

Emotion understanding. We used the Catalan translation of the Spanish version of the Emotion Matching Task, which assesses emotion comprehension in preschool children (3 to 6 years) and has been shown to have good internal consistency and concurrent validity (Alonso-Alberca et al., 2012). This task measured the understanding of four main emotions (happiness, sadness, anger, fear/surprise) and consisted of two subtests. In the first subtest (12 items), children were presented with four pictures expressing different emotions and were then asked which one better matched a given situation. Each correct answer received 1 point. In the second subtest (12 items), children were presented with a picture expressing an emotion and asked to name it. Each correct answer was scored as either 1 or 2 points, depending on the child's accuracy in labeling emotions. Total scores ranged from 0 to 36.
Metacognitive vocabulary. The children's comprehension of mental state verbs was assessed using the Metacognitive Vocabulary Test (Pelletier & Astington, 1998), which was specifically developed for preschool children (3 to 7 years) and reported to have good internal consistency and interrater reliability (Lockl & Schneider, 2006; Massaro et al., 2014). The test was translated into Catalan. In line with the procedure previously applied with preschoolers (e.g., Ornaghi et al., 2011), children were read a subset of stories (n = 6) accompanied by illustrations and were then asked to select which of the two presented metacognitive verbs (e.g., "know", "guess") correctly described the mental state of the character. Children were given 1 point for each correct choice. Total scores ranged from 0 to 6.

False belief (FB). Following previous research (e.g., Atkinson et al., 2017; Mathews et al., 2003), we used two classic tasks to assess FB: the Unexpected Content Task (UCT, "Smarties" task, Gopnik & Astington, 1988) and the Unexpected Location Task (ULT, "Sally and Ann" task, Baron-Cohen et al., 1985). These tasks have been used in different languages and are demonstrated to be reliable and valid measures of FB understanding (Wellman et al., 2001), with good internal consistency (KR-21 value of .82 for UCT and of .78 for ULT, Girli & Tekin, 2010), excellent interrater reliability (Cohen's kappa of 1.00 for UCT and of .92 for ULT, Atkinson et al., 2017), moderate test-retest reliability (kappa value of .53 for UCT and of .62 for ULT, C. Hughes et al., 2000), and good convergent validity against other false belief tasks (*r* coefficient of .67 for ULT, Hiller et al., 2014; *r* coefficient ranging from .38 to .70 for UCT, Mahy et al., 2017). In the UCT, children were shown a *Lacasitos* tube (analogous to Smarties tube in Catalonia) and were asked two false belief questions about the contents of the tube. One point was awarded for each correct answer. In the ULT, children saw a video (from M. Armstrong et al., 2018) showing the transfer of a ball from one location to another and were asked one false belief and one control question. They were awarded 1 point for each correct answer. Considering UCT and ULT together, the total composite FB score ranged from 0 to 4.

Structural language measures

Vocabulary. We used the vocabulary test from the validated Catalan battery *Evaluación de Lenguaje Infantil, ELI*, which showed good internal consistency and construct validity (Saborit Mallol & Julián Marzá, 2005). The test included 30 pictures denoting common objects, such as a tree or a bridge, and the child was asked to name them. Correct answers, either in Catalan or Spanish, received 1 point. Total scores ranged from 0 to 30.

Syntax. We tested syntax with a task created along the lines of previous reliable and valid assessment tools for syntax abilities in preschoolers (e.g., the Comprehensive Assessment of Spoken Language 2, CASL-2, Carrow-Woolfolk, 2017). This task was made up of 16 items testing different syntactic structures. The child was asked to finish an incomplete sentence or formulate a novel one according to visual and verbal prompts. For example, the beginning of a sentence was read to the child and they had to complete it (e.g., "This boy is standing. This boy... [is sitting]"). In this task, children's answers were always given in Catalan, but in principle

Spanish was also accepted. Each correct answer was given 1 point. Total scores ranged from 0 to 16.

Expressive pragmatic and prosodic skills

Children's expressive pragmatic and prosodic abilities were evaluated using the Audiovisual Pragmatic Test (APT, Pronina et al., 2019). The APT assesses the production of a broad range of speech acts (e.g., requests and declaratives) that are typical of the child's day-to-day life. The speech acts are elicited through scenarios (n = 35) that represent everyday social contexts and are accompanied with illustrations. For instance, the participant is presented with a picture showing an adult cutting a cake while next to a child, and prompted with this instruction "Imagine that your aunt is cutting a cake. You are very hungry and want to ask her for a piece of cake. What would you say?", which is expected to trigger a request speech act (see Fig. 1; see OSF project[6] for full materials in Catalan and English translation).

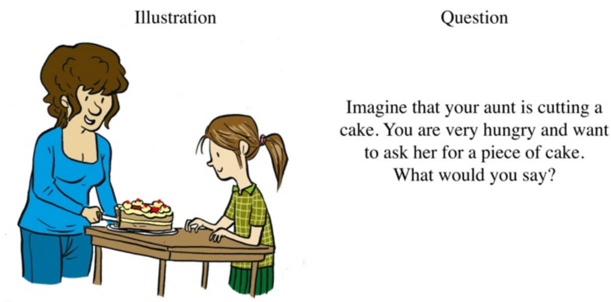

Figure 1. Example item of the Audiovisual Pragmatic Test. The item is intended to elicit a request and includes the question asked orally and the illustration shown to the child.

From this test, two scores were extracted: one referring to expressive pragmatic competence and one referring to expressive prosodic competence.

Expressive pragmatic skills. Each answer was evaluated in terms of appropriateness, that is, whether the answer appropriately

[6] https://osf.io/pyc34/?view_only=c5cfa653094a454dae1990fcbc8722c9

expressed the target speech act and the degree to which it was socially adequate in the given context. An answer was given 2 points if the produced speech act was of high pragmatic quality, meaning that the child managed to express the intended speech act and reacted to the contextual situation in a socially appropriate way; there were several possible appropriate answers for each item (e.g., “Can I have a piece of cake?”, “Can I have some cake, please?”, etc., for the situation in Fig. 1). An answer was given 1 point if the child managed to produce the intended speech act but showed some lack of social adjustment (e.g., “Give me”, “I want cake”, etc., for the situation in Fig.1). The answer was given a 0 score if the child did not give any answer or produced an answer that did not match the intended speech act (e.g., “Thank you”, “Yes”, etc., for the situation in Fig.1). Pragmatic scores were calculated as sum scores and ranged from 0 to 70. For more details on coding, see Pronina, Hübscher, Vilà-Giménez, et al. (2021).

Expressive prosodic skills. Each answer was evaluated for prosody and, in line with previous research (Papakyritsis, 2021; Rasinski, 2004), this was done on a perceptual basis, that is, based on how appropriate and natural the prosody of the answer sounded to the trained coder. The answer received 2 points for prosody if the answer was pragmatically appropriate and the child used direct speech employing natural sounding prosody consistent with the situation in the presented scenario (e.g., “Can I have a piece of cake?” with request intonation, for the situation in Fig. 1). The answer received 1 point if it was pragmatically appropriate and the child used direct speech but there was a mismatch between the intended pragmatic meaning and the prosody used, rendering the answer unnatural-sounding (e.g., “Can I have a piece of cake?” with flat intonation, for the situation in Fig. 1). Finally, the answer received 0 points if the child did not give any answer or did not use direct speech and, therefore, the answer was not eligible for prosodic evaluation (e.g., “I would say that... ”, for the situation in Fig. 1). A 0 score was given also to answers that were not pragmatically appropriate (i.e., they received a 0 in the pragmatic score). This was done because when the target speech act is not produced, it is not possible to observe the target prosody (e.g., the prosody of an inappropriate pragmatic answer such as “Thank you” for the situation in Fig.1 cannot correspond to the target prosody of request). Prosodic scores were calculated as sum scores and ranged from 0 to 70.

The APT has already been used for the assessment of pragmatic and prosodic abilities in previous research (e.g., Castillo et al., 2021; Pronina, Hübscher, Holler, et al., 2021). Here we further analyzed its internal consistency, reliability, and validity.

2.2.3. Data analysis

Prior to the main analyses, a psychometric evaluation of the APT was conducted.

Then we investigated the association between pragmatic and prosodic ability, on the one hand, and both structural language and mentalizing, on the other hand, in three different ways. First, we used a correlational approach in order to explore existing relationships between all measurements, also including age, SES, and the child's exposure to Catalan.

Second, we investigated the predictive role of structural language and mentalizing in pragmatics, as well as in prosody, by means of (separate) multiple regressions. Independent variables were standardized before being entered into the analysis, and potential collinearity across predictors was checked. The condition number *k* was 1.89, thus showing no sign of multicollinearity (Baayen, 2008). Accordingly, all predictors were included in each regression analysis. In fitting separate models onto each dependent variable (namely pragmatics and prosody), we first ran a full multiple linear regression model with all structural language and mentalizing measures, together with age, as predictors. Then, stepwise model selection based on the Akaike Information Criterion (AIC) was used to choose from among all possible predictors. In all regression models, adjusted R^2 was used as a measure of explained variance.

Third, we used Structural Equation Modeling (SEM, Bollen, 1989) to further investigate the relative role of structural language, mentalizing, and age in predicting pragmatic and prosodic scores. Consistent with the regression analyses, we built two separate SEM models: one for pragmatics and the other for prosody. When designing the SEM models, we selected measures of mentalizing and structural language on the basis of the multiple regression results; specifically, we included the measures that were kept in the stepwise models. Then, we specified the single latent variables for structural language and mentalizing, that is, the hypothetical unobservable constructs underlying observed variables. In all measurement models, the variance of all latent variables was fixed to 1, all other factor loadings were freely estimated. Standardized estimates were reported. The commonly used criteria for assessing the acceptability of structural models were adopted (Kline, 2005): comparative fit index (CFI), Tucker Lewis index (TLI), the standardized root mean square residual (SRMR), and the root-mean square error of approximation (RMSEA). In line with the literature, CFI and TLI values of .95 or higher were taken as indicative of a very good model fit, while values between .90 and .95 were considered indicative of an acceptable fit. SRMR values less than .08 were considered indicative of a good fit (Bentler, 1990; Hu & Bentler, 1999). For RMSEA, we considered values below .05 as indicative of a very good fit and values in the range of .05 and 0.08 as pointing to an acceptable model fit (Hu & Bentler, 1999). In addition, we also reported a 90% confidence interval (CI) for RMSEA values, acknowledging that for small sample sizes these values may be biased (Iacobucci, 2010; Schreiber, 2008).

All statistical analyses were performed with R, release 3.6.1 (R Core Team, 2020). The SEM analysis was conducted using the *lavaan* package, version 0.6-6 (Rosseel, 2012).

2.2.4. Data availability statement

The dataset and the code used to run the analyses in R are available in the Open Science Framework repository (https://osf.io/jy4wv/?view_only=8105a9d31fa04b4c8e055279b3e746f9).

2.3. Results

2.3.1. Psychometric properties of the APT

When analyzing the psychometric properties of the APT, we considered its internal consistency, interrater reliability, test-retest reliability, convergent validity, and content validity. The internal consistency of the whole APT was excellent (Cronbach's $\alpha = .91$). Interrater reliability of the scoring system was analyzed using 25% of the data (26 participants, 910 responses). Two additional coders who did not participate in the original coding of data were specifically trained to evaluate responses and performed the scoring offline by watching video recordings of testing sessions. The final APT scores and the scores awarded by the two additional coders were used to calculate the interrater reliability. Overall agreement in scores was 83% for pragmatic scores and 87% for prosodic scores. Interrater agreement measured with Fleiss kappa, was .79 for pragmatic scores and .81 for prosodic scores, indicating high agreement (Fleiss et al., 1981).

The test-retest reliability was conducted on a subset of 10 participants, who were administered the APT twice, with an interval of 4 weeks. The correlations between the APT scores were strong and significant for both pragmatics ($r(8) = .83$, $p = .003$) and prosody ($r(8) = .86$, $p = .001$), indicating good test-retest reliability. Additional analyses suggested the test-retest stability of the APT, as no practice effects were found for either pragmatics ($t(9) = -1.39$, $p = .199$) or prosody ($t(9) = -1.69$, $p = .129$).

Convergent validity was supported by the significant positive correlation between the APT and another task assessing narrative pragmatic abilities, namely, the Renfrew Bus Story Test[7] (Renfrew, 2006) ($r(103) = .28$, $p = .004$). Furthermore, the content validity analysis was based on the data provided by 4 experts in linguistics and psychology, who rated the test items on a 5-point Likert scale. They were presented with the test stimulus for each item, and were

[7] The Renfrew Bus Story Test is a comprehensive measure of narrative skills, and it is widely used for eliciting story retelling in preschool and young school-aged children.

then asked whether they agreed that that item was appropriate for assessing the target speech act (e.g., “This item adequately measures the child’s ability to produce a request. Do you agree with this statement?”, for the example in Fig. 1), with 5 being “I completely agree” and 1 being “I completely disagree”. For all items, the mean value was above 4.25 (for the table showing the content validity of each item, see additional analysis at the OSF repository, linked in the section Data availability statement), indicating the high content validity of the tool.

Overall, all analyses showed good results in terms of psychometric properties, demonstrating that the APT is a reliable, valid, and robust instrument for assessing pragmatic abilities in early childhood.

2.3.2. Descriptive statistics and bivariate correlations

Descriptive statistics for the APT, mentalizing and structural language tests, age, socio-economic status (SES), and Catalan language exposure are shown in Table 1.

Table 1. Means, standard deviations, and range of observed values, age, socio-economic status, and percentage of Catalan language exposure.

	M	*SD*	Range of observed scores
Audiovisual Pragmatic Test			
Pragmatics	13.90	10.16	0 – 46
Prosody	14.85	12.12	0 – 56
Age (in months)	44.90	3.25	39 – 51
Structural language			
Syntax	2.74	1.42	0 – 7
Vocabulary	11.52	2.83	6 – 22
Mentalizing			
False belief	1.59	0.96	0 – 4
Emotion understanding	16.20	6.83	0 – 27
Metacognitive vocabulary	3.01	1.19	0 – 6

Socio-economic status	61.16	12.73	27 – 85
Catalan language exposure (%)	56.27	22.93	0 – 100

Simple bivariate correlations between measures are shown in Table 2. The correlational analysis revealed moderate correlations (rs(103) = .39–.55, ps < .001) between pragmatics and structural language scores (i.e., syntax and vocabulary), as well as between prosody and structural language measures. By contrast, correlations between pragmatics and prosody, on one hand, and measures of mentalizing, on the other hand, were generally weaker. In particular, a moderate correlation was found with FB ($r(103) = .35$, $p < .001$ for pragmatics; $r(84) = .40$, $p < .001$ for prosody), but the correlations with the other mentalizing measures were smaller (rs >.20, ps < .05) or even not significant. Moreover, scores of mentalizing tests were not significantly correlated with each other. Unlike mentalizing measures, scores of structural language tests were significantly correlated ($r(103) = .27$, $p = .01$). Finally, some significant correlations (rs(103) = .24–.25, ps < .05) were found between mentalizing (FB and emotion understanding) and syntax, but not between mentalizing and vocabulary (rs(103) = .11–.19, ps > .05). Age was positively correlated with all the measures (rs >.20, ps < .04) but emotion understanding ($r(103) = .17$, $p = .09$). SES, by contrast, was not correlated with any of the other variables (rs < .11, ps > .30), and was therefore left out of further analyses.

We additionally checked whether the percentage of a child's exposure to Catalan could possibly influence their performance in language and mentalizing tests. Catalan language exposure was not correlated with any measure (rs < .18, ps > .07) and was excluded from further analyses.

Table 2. Bivariate correlations among measures (structural language and mentalizing measures, age, socio-economic status, and percentage of Catalan language exposure).

Variable	1	2	3	4	5	6	7	8	9	10
Audiovisual Pragmatic Test										
1. Pragmatics	—									
2. Prosody	.93***	—								
3. Age	.38***	.35**	—							
Structural language										
4. Syntax	.55***	.48***	.21*	—						
5. Vocabulary	.39***	.43***	.28**	.27*	—					
Mentalizing										
6. False belief	.35***	.40***	.40***	.25*	.19	—				
7. Emotion understanding	.26*	.23*	.17	.24*	.11	.15	—			
8. Metacognitive vocabulary	.20*	.10	.20*	.13	.11	.10	.18	—		
9. Socio-economic status	.07	.12	-.09	.05	.06	-.04	.04	-.11	—	
10. Catalan language exposure	.04	.05	-.13	-.11	-.08	-.00	.18	-.01	-.05	—

Note: $*p < .05$, $**p < .01$, and $***p < .001$.

2.3.3. Multiple regressions

Predicting pragmatic skills

The full model, that is, the first multiple regression model that included all structural language measures (syntax, vocabulary), all mentalizing measures (FB, metacognitive vocabulary, and emotion understanding), and age as predictors was run. In this model, only structural language measures turned out to be predictive of pragmatic skills ($b = 4.11$, $p < .001$ for syntax and $b = 1.99$, $p = .02$ for vocabulary). None of the measures of mentalizing were a significant predictor of pragmatic scores ($b = 1.27$, $p = .14$, $b = .63$, $p = .43$, and $b = .91$, $p = .26$, for FB, metacognitive vocabulary, and emotion comprehension, respectively), while neither was age ($b = 1.63$, $p = .07$). This model accounted for 40% of the variance of the dependent variable ($R^2 = .40$, $F(6,98) = 12.77$, $p < .001$). Overall, results from the full model indicated a positive relationship between the structural language scores and the pragmatic scores.

The stepwise model for pragmatics selected on the basis of the AIC included the two structural language measures, FB and age, as predictors. This model showed that syntax, vocabulary, and age were significant predictors of pragmatic scores ($b = 4.34$, $p < .001$, $b = 2.04$, $p = .01$, and $b = 1.83$, $p = .04$, respectively), while the role of FB was still limited and not significant ($b = 1.33$, $p = .12$). These factors together explained 40% of the variance ($R^2 = .40$, $F(4,100) = 18.57$, $p < .001$). The results of the two multiple regression models on pragmatic scores are reported in Fig. 2.

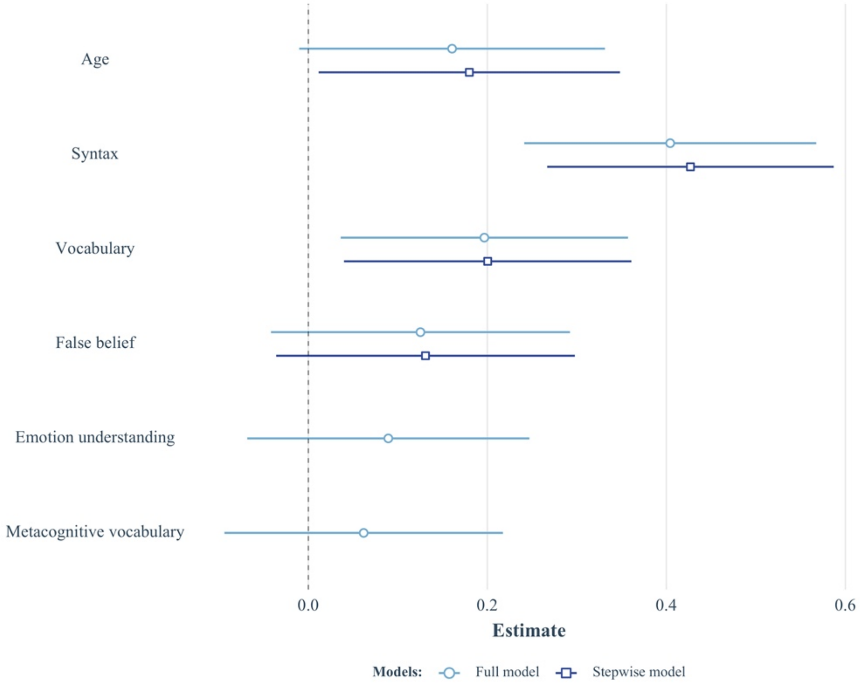

Figure 2. Forest plot showing the results of the two multiple regression analyses (full model and stepwise model) for pragmatics.

Predicting prosodic skills

The full model investigated a number of predictors (measures of structural language, mentalizing, and age) of prosodic scores. In this model, three measures were significant predictors of prosodic ability: syntax (b = .30, p < .01), vocabulary (b = .27, p = .01), and FB (b = .21, p = .04). Emotion understanding (b = .11, p = .25), metacognitive vocabulary (b = -.04, p = .65), and age (b = .11, p = .26) were not predictive. This model explained 36% of the dependent variable variance (R^2 = .36, F(6,79) = 8.85, p < .001). Results from this model indicated a positive relationship between the structural language and FB scores, on the one hand, and the prosodic scores, on the other hand.

The stepwise model for prosody selected on the basis of AIC included three scores, that is, syntax, vocabulary, and FB. All three variables were significant predictors of prosodic competence (b = 3.68, p < .001, b = 3.30, p = .00, and b = 2.51, p = .01, for syntax, vocabulary, and FB respectively). These factors together explained

36% of the variance (R^2 = .36, F(3,82) = 16.76, p < .001). The results of the two multiple regression models on prosodic scores are reported in Fig. 3.

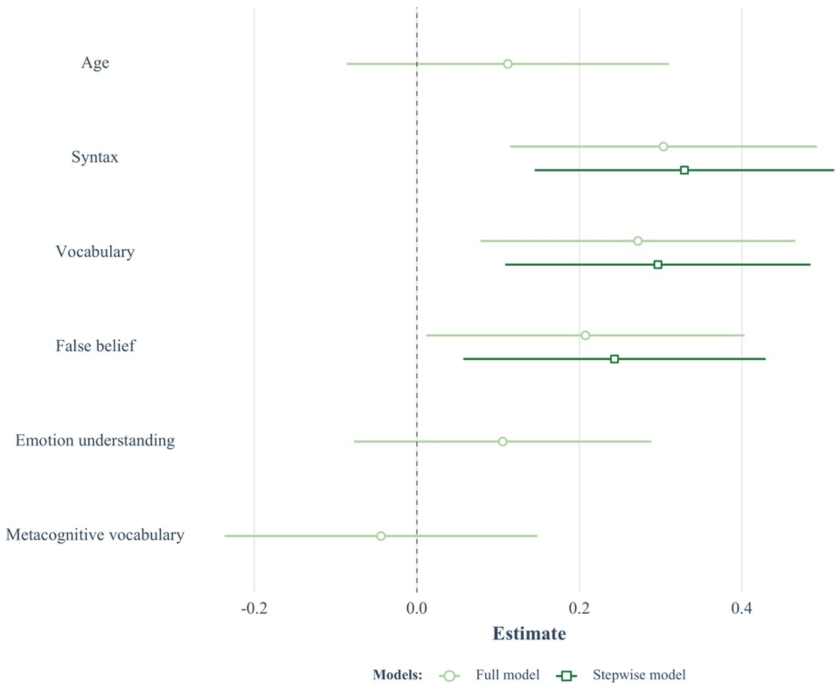

Figure 3. Forest plot showing the results of the two multiple regression analyses (full model and stepwise model) for prosody.

2.3.4. Structural equation models

Model of pragmatic skills

First, we assessed a two latent factor measurement model. Specifically, we tested whether the answers to the UCT were loaded to a FB latent factor[8] and whether syntax and vocabulary scores

[8] The other FB measure, that is, the ULT, was not included in the FB latent factor since the answers to both false belief and control questions in this task were not correlated with the results of the UCT. For the sake of rigor and completeness, we also ran complementary analyses using an SEM model with the composite FB score (based on both UCT and ULT scores). The reported SEM model with the latent FB factor based on the UCT scores only and the SEM model with the composite FB score highlighted the same pattern of results.

were loaded onto a single structural language latent factor. The results showed that both latent factors were significantly loaded (b = .90, p < .001 and b = .96, p < .001 for FB and b = .59, p < .001 and b = .44, p = .001 for structural language). Then pragmatic scores were regressed on the FB latent factor and the structural language latent factor. Also, the FB latent factor and the structural language latent factor were specified as covariates in order to control for their mutual influence. Age was included as an exogenous control variable. The structural model showed good fit indices, $\chi^2(5) = 6.16$, p = .29, CFI = .988, TLI = .977, RMSEA=.047, 90% CI [.00, .15], SRMR= .044.

Next, we examined the relationships between the variables in a structural model. Similar to the multiple regression results, the SEM model indicated that only structural language was a strong significant predictor of pragmatics (b = .90, p < .001), while FB was not (b = .01, p = .96). The covariance path between structural language and FB fell short of significance (b = .30, p = .10) after we controlled for the effect of the exogenous variable of age, which was significantly associated with both FB (b = .49, p < .001) and structural language (b = .44, p = .01). However, the direct effect of age on pragmatics was not significant (b = -.03, p = .89), and age did not exert a robust indirect effect on pragmatics through structural language (b = .40, p = .06). The specified model is presented in Fig. 4.

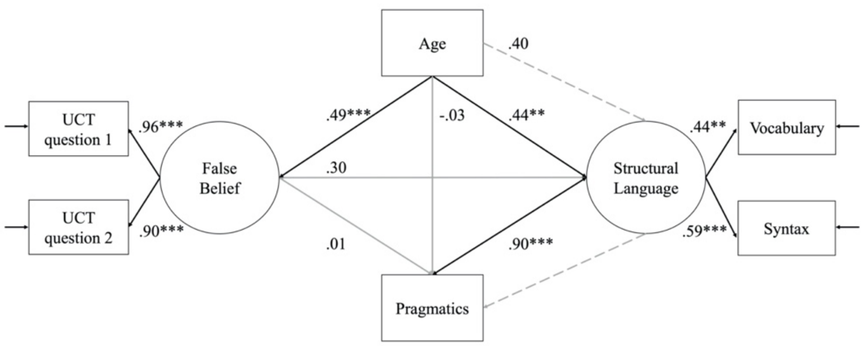

Figure 4. Structural equation modeling (SEM) predicting pragmatic ability. A solid black line represents the significant direct paths with **p < 0.01, ***p < .001. A solid grey line represents non-significant direct paths. A dashed grey line represents non-significant indirect paths. UCT, Unexpected Content Task. Standardized path coefficients are shown along their path arrows.

Model of prosodic skills

We preliminarily tested a measurement model for prosody. This model included the same latent factors as the SEM model for pragmatics (structural language and FB[9]), which were specified as predictors of prosodic ability and covariates. The control variable of age was specified as predictor of all other variables. The measurement model showed that both latent factors were significantly loaded (b = .87, p < .001 and b = .95, p < .001 for FB and b = .55, p < .001 and b = .51, p < .001 for structural language). The structural model fit indices were CFI = .953, TLI = .907, RMSEA = .083, 90% CI [.00, .19], and SRMR = .074. Although the RMSEA index is just over the recommended threshold of .08, the other fit statistics are favorable in indicating good (CFI, SRMR) and acceptable (TLI) model fit. Overall, the model provided adequate fit to the data: $\chi^2(5) = 7.95$, p = .16.

We then analyzed the relationships between the variables in a structural model. As in the case of pragmatics, only the structural language latent factor was predictive of prosodic competence (b = .91, p < .001). The FB latent factor turned out to be not significant (b = .002, p = .99); the covariation path between FB and structural language was not significant either (b = .30, p = .11). Age was a significant predictor of both FB (b = .48, p < .001) and structural language ability (b = .50, p = .01) but not of prosody (b = -.10, p = .66). The indirect effect of age on prosody mediated by structural language was not significant (b = .45, p = .07). The specified model is presented in Fig. 5.

[9] As in the case with the model for pragmatics, only the UCT answers were used to create the FB latent factor, since the results of the ULT were not correlated with the results of the UCT. We also ran a complementary analysis to support the results of the reported model. The SEM model with a latent FB factor based on the UCT scores and the SEM model with the composite FB score (based on the both UCT and ULT scores) revealed the same results.

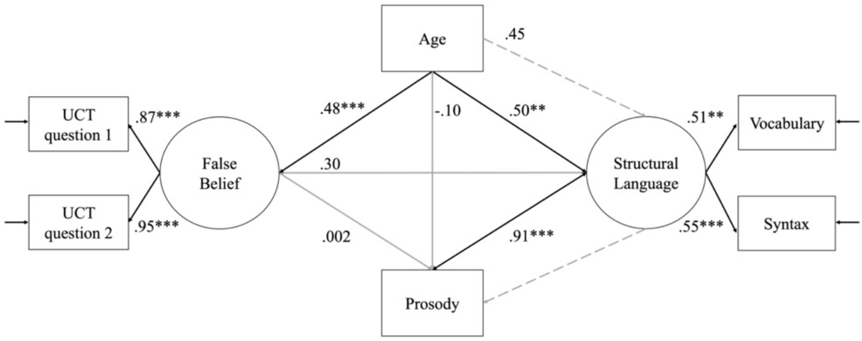

Figure 5. Structural equation modeling (SEM) predicting prosodic ability. A Solid black line represents the significant direct paths with $**p < 0.01$, $***p < .001$. A solid grey line represents non-significant direct paths. A dashed grey line represents non-significant indirect paths. UCT, Unexpected Content Task. Standardized path coefficients are shown along their path arrows.

2.4. Discussion and conclusions

The present study investigated the relative role of structural language and of aspects of social cognition, such as mentalizing, in preschoolers' communicative abilities involving (a) pragmatics and (b) prosody. Innovatively with respect to the previous literature, we addressed these issues in a comprehensive fashion by jointly examining the role of a set of structural language (i.e., syntax and vocabulary) and mentalizing skills (i.e., false belief, emotion understanding, and metacognitive vocabulary) in both expressive pragmatics and prosodic abilities through multiple statistical approaches. Our findings suggest that, at around the age of 4, both expressive pragmatic and prosodic abilities are strongly related to the other linguistic skills (especially syntax), while the role of mentalizing is statistically negligible, as demonstrated by the most complex and comprehensive modeling. These findings have important theoretical implications and are of practical interest for both educational and clinical fields.

Starting with the findings on expressive pragmatics skills, we expected the pragmatic scores obtained in the APT (Pronina et al., 2019) to be strongly related to structural language and less so to mentalizing. The results confirmed our expectations. Simple correlational analyses revealed significant correlations between pragmatic scores and both language and mentalizing skills, but correlations with language appeared numerically (and statistically) stronger. When using more sophisticated analyses, both the multiple regression and the SEM approaches highlighted that only structural language scores played a role in predicting pragmatic ability. The findings on the significant relationships between pragmatic and other language measures are fully in line with the previous literature. For instance, Norbury (2004) and a recent study by Andrés-Roqueta et al. (2021) outlined the role of structural language skills in pragmatic competence, and the link between the two has been reported by a number of studies in preschool and school-aged children (see Matthews et al., 2018). With respect to this literature, the main innovations of our study concern the kind of pragmatic skills tested and the age under investigation. Whereas the vast majority of previous studies focused on inferential pragmatic abilities (e.g., irony, see Angeleri & Airenti, 2014; conversational perspective-taking, see Bernard & Deleau, 2007), the pragmatic skills measured here are related more to verbal aspects of discourse production. In the APT, children are asked to utter a speech act as a verbal response to the prompted social interaction. One likely explanation for the role of structural linguistic skills observed here is therefore that these are necessary in order to shape the felicitous speech acts: in other words, to produce pragmatically appropriate responses the child must adequately formulate and structure sentences, which requires active lexical and syntactic planning.

In contrast to the findings of the role of structural language skills, our results indicated that pragmatic abilities were not related to mentalizing skills. As a first comment, the change in the pattern of relationships from the correlations —where pragmatics and mentalizing were significantly associated— to the other statistical approaches —where the role of mentalizing, specifically false belief, became negligible— needs some technical explanation. Unlike correlations, multiple regressions and SEM simultaneously account for several variables, and it is not uncommon to see correlations disappear when more complex statistical analyses are used (Jacob Cohen et al., 2003, pp. 6–7). In the SEM model the variance that false belief, structural language, age, and pragmatics share was taken into account, and therefore false belief was no longer a significant predictor of pragmatic scores[10]. Hints to this came also from the fact that the correlations between pragmatics and structural language measures are stronger than the correlations between pragmatics and mentalizing measures. Our findings thus highlight the importance of using statistical approaches that enable researchers to evaluate the role of several variables in a comprehensive way, making it possible to observe genuine relationships between these variables.

At the theoretical level, the finding of the missing relationship between pragmatics and mentalizing could be explained by the type of pragmatic skills under consideration. The focus on expressive aspects of pragmatic abilities adopted in this study allows us to expand the evidence that the link between pragmatics and mentalizing is not systematic, something that was previously observed mainly in relation to receptive pragmatics (Angeleri & Airenti, 2014; Banasik, 2013; Bernard & Deleau, 2007; Bosco & Gabbatore, 2017a, 2017b). We believe that, when trying to ascertain the role of socio-cognitive skills in pragmatic competence, it is key to distinguish between different pragmatic aspects. Specifically, results might change depending on the pragmatic skills under consideration. Non-literal language skills (e.g., irony detection) largely capitalize on the ability to derive the speaker's intended meaning and mental state, while some other pragmatic skills might be closer to the interface with structural language (e.g., scalar implicatures), and some tasks selectively involve mentalizing, depending on the content to infer, as in the case of psychological metaphors (Lecce et al., 2019). The importance of distinguishing between linguistic pragmatic (e.g., scalar implicatures) and social pragmatic (e.g., irony comprehension) tasks has recently been highlighted by Andrés-Roqueta and Katsos (2017, 2020), though with examples related mainly to the receptive domain. In the expressive domain, it is likely that the task of producing pragmatically appropriate speech acts, as requested in the APT,

[10] See also graphics illustrating the dissapearing relationship between false belief and pragmatic scores on the OSF repository linked in the section Data availability statement.

does not fully exploit mentalizing skills but rather engages the linguistic tools available to the child.

Similarly, results might change depending on the specific aspects of social cognition under consideration. Pragmatic behavior is deeply connected with the social dimension; it is shaped by the social context (Brown & Levinson, 1987) and impacts social relationships (Agostoni et al., 2021; e.g., Del Sette et al., 2021). Mentalizing is a fundamental aspect of social cognition, but there are several other socio-cognitive skills that allow us to interact socially, such as affiliation, agent recognition, biological motion perception, empathy, social attention, and social learning, among others (see Happé et al., 2017, for a review). Whereas our data point to a weak relationship between expressive pragmatics and mentalizing (including false belief), we cannot exclude the possibility that a stronger relationship might be found when considering other socio-cognitive skills underlying social ability. It is also important to point out that our findings in the SEM model refer specifically to the role of a particular mentalizing skill (Theory of Mind as measured with false belief). False belief tasks used in this study, despite being standard and by far the most popular in developmental research, are sometimes criticized for focusing narrowly on only one aspect of belief understanding and measuring it in a rather categorical way (Wellman, 2018). We have tried to overcome the last limitation of the false belief task by using two different false belief sequences. However, it might be the case that other measures that test the understanding of belief more comprehensively, such as Theory of Mind scales (e.g., Wellman & Liu, 2004), could provide different insights into the pattern of associations between pragmatic and mentalizing skills.

Another possible explanation for the lack of a significant association between pragmatic abilities and mentalizing may be related to the specific developmental stage under investigation. Pragmatic skills develop throughout childhood (Matthews, 2014), and while the relationship between pragmatics and mentalizing is not robust in young preschoolers (3-4 years of age), it becomes stronger in older children (5- to 9-year-olds in Filippova & Astington, 2008; 8- to 9-year-olds in Lecce et al., 2019 and Del Sette et al., 2020; 6- to 10-year-olds in Massaro et al., 2013; 8- to 10-year-olds in Nilsen et al., 2011; 5- to 7-year-olds in Winner &

Leekam, 1991). We believe that it is plausible that the relationship between pragmatics and mentalizing may vary throughout development and is not yet strong in early developmental stages, such as the one investigated here (3- to 4-year age range). It might well be the case that expressive pragmatics in the early preschool age is still very simple and involves mindreading aspects only to a limited extent. It is only in the later stages that conversation becomes more implicit and more complex discursive abilities requiring reading the mind are involved, with mentalizing playing a greater role and contributing to explaining expressive pragmatic skills.

Since pragmatics and prosody are strongly interrelated, in this study we also analyzed the prosodic component of children's pragmatic responses. Based on previous developmental research (e.g., de Carvalho et al., 2018; Frota et al., 2020), we hypothesized that expressive prosodic skills would be related to and predicted by other language abilities, while the role of mentalizing was expected to be trivial. Our results confirmed this hypothesis. Pairwise correlations showed a relationship between prosody and structural language scores, as well as between prosody and some measures of mentalizing; similarly, multiple regression analyses pointed to a significant role of both structural language and false belief skills. However, when, in the SEM model, we controlled for measurement errors and for both direct and indirect relationships, only language turned out to be a significant predictor of prosodic performance. Similar to what we observed in the model of pragmatics, when the common variance among false belief, age, structural language, and prosody is accounted for, false belief is no longer a significant predictor of prosodic skills.

Elaborating further, these findings extend previous results in early infancy that revealed prosody's bootstrapping role in language acquisition and infants' use of prosodic cues to build their knowledge of syntactic structures and to infer word meaning (de Carvalho et al., 2018). Specifically, our results show that prosody also continues to be related to structural language later in development, that is, during the preschool years.

As for the lack of evidence supporting a relationship between mentalizing and prosody, while, on the one hand, it goes against previous research highlighting the role of intonation for comprehension of mental and emotional states (e.g., M. Armstrong & Hübscher, 2018), on the other hand, the lack of evidence resonates with studies on atypical populations. For example, children and adolescents with ASD were as accurate in processing vocal cues that require mentalizing and in detecting irony from prosodic cues as control participants were (Chevallier et al., 2011; Colich et al., 2012; Pexman et al., 2011; see Golan et al., 2006, for similar evidence in adults with Asperger Syndrome). Taken together, these studies suggest that difficulties in mentalizing do not necessarily entail difficulties in reading the mind in the voice. Our findings support this observation and extend it to expressive prosodic skills in typically developing preschoolers, as individual differences in prosodic expression abilities were not found to be related with mentalizing abilities.

It is important to highlight the parallelism in findings for pragmatics and prosody. The pattern of results reported for prosody is highly similar to the one observed for pragmatics. The most comprehensive SEM analyses for the two dimensions depicted models where structural language was a strong predictor of pragmatic and prosodic skills, while false belief was not; the associations with other variables confirm the similarity. The remarkable resemblance in the map of associations that emerged from the SEM models for pragmatic and prosodic abilities strengthens the idea that the two develop in parallel and highlights the importance of accounting for prosodic expressions of pragmatic ability is key.

Our results also raise a question about the independent role of the different structural language components (syntax and vocabulary) in the prediction of expressive pragmatic and prosodic skills. In studies on pragmatics in typically developing children, the choice of other language variables is often limited to receptive vocabulary (e.g., Angeleri & Airenti, 2014; Nilsen et al., 2011), while a syntax measure is rarely included. However, research on atypical populations specifically emphasized the role of syntax in pragmatic-related domains. For instance, once syntactic abilities were accounted for, the performance in idiom comprehension by children with ASD and controls was comparable (Whyte et al., 2014), while semantic skills did not predict additional variance in performance

(Norbury, 2004). In line with this literature, the results of our study suggest that even though both vocabulary and syntax are important variables contributing to pragmatic and prosodic performance, syntax is a stronger predictor. More generally, our findings highlight the importance of considering a number of language aspects, from syntax to pragmatics, when evaluating the linguistic profile of a child.

A possible limitation of the present study is that we did not consider other socio-cognitive aspects. As discussed above, there are several components of social cognition which were not considered here. Evidence shows that some of them —for example, empathy— are related to pragmatic competence. Specifically, Esteve-Gibert et al. (2020) reported that more empathic individuals can disambiguate pragmatically ambiguous sentences better than less empathic individuals and Ornaghi et al. (2020) found correlations between 2- to 3-year-old children's empathic skills and language abilities (including pragmatics). Future research investigating the relationship between pragmatics and social cognition would benefit from a broader consideration of socio-cognitive aspects. Furthermore, executive functions were not considered in this study. The previous literature offers evidence that the domain of executive function is associated with pragmatic proficiency and that specific executive functions, such as working memory and inhibition, can explain variance in different kinds of pragmatic tasks (e.g., Filipe et al., 2020; see Matthews et al., 2018 for a review). Some authors have suggested the importance of executive functions, specifically for expressive pragmatic skills in typically developing preschoolers (Blain-Brière et al., 2014). Executive functions might also be important for prosody, as suggested in another study in older, 6- to 9-year-old, children (Filipe et al., 2018). We suggest that further research also include measures of executive function in order to control for this factor and to investigate its possible specific role in the map of associations between pragmatic, prosodic, and general cognitive skills.

Taken collectively, our study shed new light on the literature on pragmatic development in preschoolers with important findings on the relationship between expressive pragmatics and other skills, accounting also for prosodic aspects. Specifically, our study shows that in the early preschool ages, pragmatics and prosody are closely intertwined with the development of other language skills and relate less strongly to mentalizing. The implications of these results are both theoretical and practical. Theoretically, the present results contribute to the wide debate on the relationship between pragmatics and social cognition, specifically mentalizing (Bambini, Arcara, Martinelli, et al., 2016; Bambini, Bischetti, et al., 2020; Fairchild & Papafragou, 2021; Lecce et al., 2019). In line with the recent view that pragmatics and mentalizing do not overlap (Bosco, Tirassa, et al., 2018), we offer fresh evidence that expressive pragmatic skills, including prosody, are to some extent separate from mentalizing skills, especially false belief, in early development. Practically, the present findings may be of relevance for educational and clinical applications. Pragmatics is associated with far-reaching educational outcomes (MacWhinney & Bornstein, 2003). In particular, individual differences in pragmatic competence are associated negatively with academic literacy difficulties (Whitehouse et al., 2009) and positively with successful academic development, including math (Ramsook et al., 2020), reading comprehension (Elleman, 2017; Tonini et al., 2022), writing skills (Troia, 2011), and literacy at large (Dickinson & McCabe, 2001; Paris & Paris, 2003). Since pragmatics affects educational achievements, it seems paramount to develop training interventions in order to promote pragmatic abilities in children. The findings of the present study offer a promising strategy for improving pragmatic skills, starting from preschool ages. Because expressive pragmatic abilities are strongly related to other language skills in young children, promoting structural linguistic abilities can be of help in interventions targeting pragmatic improvements. We suggest that practicing educators and speech-language therapists designing pragmatic interventions should incorporate strategies for improving structural aspects of language, especially in early developmental stages. We believe that the implementation of training of this kind in educational settings could be beneficial for fostering pragmatic development and improving children's academic performance as well as social relationships.

3

CHAPTER 3: EXPRESSIVE PRAGMATICS AND PROSODY

Pronina, M., Hübscher, I., Vilà-Giménez, I., & Prieto, P. (2021). Bridging the gap between prosody and pragmatics: The acquisition of pragmatic prosody in the preschool years and its relation with Theory of Mind. *Frontiers in Psychology*, *12*, 2962. https://doi.org/10.3389/fpsyg.2021.662124

3.1. Introduction

Prosody is an essential part of spoken language, and refers to suprasegmental features of speech at the word and sentence levels, such as changes in pitch, duration, and intensity. In this way, speakers typically produce utterances faster or slower, louder or quieter, and mark them with different pitch contours (intonation). Prosodic changes are well-known to encode different pragmatic meanings across languages, helping speakers to reflect intended meanings in context (Gussenhoven, 2004; Ladd, 2008). For example, a speaker can intend to focalize some information, convey uncertainty or express positive appreciation (see also examples below). Despite a growing body of literature on the prosody-pragmatics interface, relatively little of it has explored how children learn to use prosody to convey pragmatic meanings (Chen et al., 2020; Prieto & Esteve-Gibert, 2018). Although previous research has investigated early prosodic abilities in very young infants, studies on speech prosody in older children that bring prosody and pragmatics together are still rare and tend to focus on fairly specific aspects of the pragmatics-prosody interface such as the prosody of focus (Chen, 2018; Ito, 2018; see also Esteve-Gibert & Prieto, 2018 for a review) rather than providing a complete picture of children's developmental profile. We are thus faced with a gap in our understanding of the acquisition of pragmatic uses of prosody during the preschool years and beyond. In order to address this issue, we aim here to comprehensively explore the acquisition of pragmatic prosody, that is, the ability to convey a set of pragmatic dimensions through prosody, in children aged 3–4, while taking cognitive abilities such as Theory of Mind (ToM) into account as a potential influencing factor. We next highlight the importance of considering pragmatics and prosody together, briefly review research on prosodic development, and outline what is known about the potential role of ToM in this respect.

3.1.1. Prosody-pragmatics interface in adult language and in development

It has been amply demonstrated that, across languages, prosodic cues such as intonational patterns or speech rate are central in the conveyance of pragmatic meaning (Pierrehumbert & Hirschberg, 1990). This is not surprising because prosody is never produced in isolation, dissociated from a specific pragmatic situation. Cross-linguistically, prosodic features convey a wide range of pragmatic dimensions, ranging from unbiased speech acts (for example, information-seeking questions) to biased speech acts (for example, statements encoding speakers' beliefs) (see L. Brown & Prieto, 2021; Prieto, 2015, for an overview of the pragmatic meanings encoded by prosody).

For example, languages typically use distinct prosodic patterns such as falling or rising intonation to differentiate between an unbiased assertion and an unbiased request. By the same token, the information status of an element in discourse (e.g., whether it is new information or previously known) is encoded by many languages through the use of prosodic focus (see Kügler & Calhoun, 2020, for a typological review). If a person mishears, "back yard" and asks "Did you say 'pack of cards'?", the response will be "*No*, I said '*back yard'*", with prosodic stress (in italics) expressing contrastive/corrective focus. Prosodic patterns are also involved in the marking of expressive speech acts conveying social affect; in other words, to sound socially appropriate, speakers need to produce an utterance using an appropriate tone of voice (e.g., Culpeper, 2011). For example, the appropriate prosody for the basic expressive speech act such as English greeting "Good morning" typically includes slow tempo and a wide pitch range, and the absence of these prosodic cues may have the effect of conveying indifference or rudeness. Similarly, when one is presented with a piece of freshly baked homemade pie (complex expressive acts), the comment "Mmm! It smells delicious!" will best convey positive affect if the utterance is delivered with higher pitch than usual or a temporal lengthening of the stressed syllables. Finally, epistemic states which denote knowledge and beliefs of the speaker about the propositional content of the target utterance, such as ignorance, obviousness, surprise, degree of certainty, incredulity or confirmation, can also be expressed by prosodic means across languages (e.g., Roseano et al., 2016). For example, *wh*- questions conveying surprise and curiosity, such as "*What*'s in the bag?!", are typically realized through wider pitch excursions. In short, across languages, a broad panoply of pragmatic meanings are conveyed by means of a wide variety of prosodic and intonational strategies—what we will refer to in this paper as "pragmatic prosody".

3.1.2. An overview of research on children's prosodic development

Previous research on the development of prosody in children has tended to focus on early infancy (see Chen et al., 2020; Frota & Butler, 2018, for reviews). Several of these studies have investigated the essential role played by prosodic cues in very young infants for their language development. For example, it has been established that infants exploit prosodic structure to segment speech and access syntactic information (e.g., Christophe et al., 2003; Mehler et al., 1988; Morgan & Demuth, 1996; Wellmann et al., 2012; see de Carvalho et al., 2018, for a detailed review). Other studies have shown that the ability to discriminate lexical stress influences language-specific preference patterns, an ability that is important for the acquisition of language-specific prosodic properties (Bhatara et al., 2018). It has also been demonstrated that prosodic signals help infants not only with word segmentation but also with word-semantic mapping (e.g., Friedrich & Friederici, 2004; Jusczyk et al., 1993; Jusczyk & Aslin, 1995; Kooijman et al., 2013; see Teixidó et al., 2018; Thorson, 2018, for reviews). As Frota and Butler (2018) argue, these early perception abilities pave the way for the infants' emerging abilities related to the production of intonation.

Research has demonstrated that towards the end of their first year of life infants start to master some basic pragmatic uses of prosody, such as to make requests (Esteve-Gibert & Prieto, 2018), and during the second year of life they begin to use some intonational pitch contours in an adult-like way. Specifically, in this period children's intonational output produced in naturalistic settings tends to reflect the basic target inventory of nuclear pitch accents and boundary tones of the ambient language, and, importantly, the form-meaning relationships of some tunes are adult-like too. In a longitudinal study with four Catalan- and two Spanish-learning toddlers, Prieto et al. (2012) showed that from the first onset of speech these toddlers have a small repertoire of intonational contours that express distinct speech acts, such as requests, questions, vocatives, statements or commands (and see Frota et al., 2016, for a similar analysis involving European Portuguese-speaking children). Thus, by age 3 children are already skilled at expressing basic speech acts prosodically.

Thereafter children continue to acquire pragmatic prosody skills, albeit gradually. Different methods have been used to explore the development of prosody in the preschool and school ages, ranging from corpus-based (e.g., the CHILDES project Macwhinney, 2000) to experimental task-oriented behavioral approaches (e.g., a picture-matching task in Chen, 2009, 2011; a guessing game in Hübscher, Vincze, et al., 2019). However, these methods have been applied to assess a small number of pragmatic prosody aspects. For example, elicited production experiments have examined a limited range of pragmatic uses of prosody, mostly including the prosodic contrast between assertions and requests (e.g., Patel & Brayton, 2009; Patel & Grigos, 2006) or the use of prosody to encode focus (Chen & Höhle, 2018; Hornby & Hass, 1970). From the point of view of clinical evaluation, assessment tools have also tended to include a narrow list of pragmatic functions of prosody. Such tools are primarily designed for clinical use or for research in diverse clinical populations (see Peppé, 2018) and mainly focus either on receptive prosodic skills, or on basic expressive prosodic skills. The PEPS-C (Peppé & McCann, 2003) is the only instrument that takes into account some pragmatic functions of prosody, as it assesses the production of questions and statements, the ability to place contrastive stress and the ability to express affective stances (two feelings: liking and disliking) (see Filipe et al., 2017, for European Portuguese, and 2018, for children with autism; Martínez-Castilla & Peppé, 2008, for Spanish; Wells et al., 2004, for British English). To our knowledge, no previous study has comprehensively integrated the pragmatic functions of prosody through a context-based elicitation method. Below we provide a brief overview of what is known about the development of pragmatic prosody from preschool years onwards, focusing on the marking of informational structure, social affect and epistemic meanings.

The ability to prosodically mark the informational structure of an utterance (i.e., focus) through intonational means has been shown to have a slow developmental trajectory in some languages. While it has been reported that children start to use intonational prominence to mark focus between 3 and 6 years of age (Hornby & Hass, 1970; Romøren, 2016; Wonnacott & Watson, 2008), typological differences between languages have been shown to affect the respective developmental trajectories for this skill (Chen, 2018). At the same time, although even preverbal children can to a certain extent both comprehend and express informational structure (Thorson & Morgan, 2014), early onset in the detection of focus does not translate into immediate mastery in production (Ito, 2018). Ito (2018) argued that the use of prosodic cues to express and comprehend focus can be affected by language-specific constraints, that is, by the language-specific repertoire of focus expressions and the availability of alternative means of focus marking such as syntactic strategies. The acquisition of focus prosody can also be affected by individual variability related to grammatical and cognitive skills, above all executive functions (see also Filipe et al., 2018, for a broader link between prosodic skills and executive functions). In fact, prior evidence of the role of executive function in various aspects of oral communication skills in both typically and atypically developing children led Ito (2018) to suggest that the growth of cognitive resources such as attention span and memory must affect, to some degree, children's ability to map prosodic cues to informational structures. The author also warned that the methodology employed in a particular study (e.g., the experimental task performed, the type of focus under investigation, such as narrow focus vs. contrastive focus) must be carefully borne in mind when that study's results are evaluated. This is because focus intonation is a complex skill that is in the process of development in the preschool years, and its use requires the integration of advanced semantic and pragmatic knowledge in combination with certain cognitive abilities.

Another important skill undergoing development in the preschool years (ages 3–5) is the expression and comprehension of social affect, that is, the ability to produce and comprehend basic expressive social acts such as greeting or thanking, as well as more complex expressive social acts such as congratulating or voicing concern. As children grow up and as the social world around them becomes more complex, emotional and social competencies become closely interconnected (Denham et al., 2011). By preschool, children's social tasks include identifying a speaker's emotion and being able to convey their own emotions appropriately in keeping with the ongoing context. Though recent research has pointed to the importance of prosodic cues in signaling and inferring social meanings such as politeness and assessed its development in 3- to 5-year-old children (Hübscher et al., 2020; Hübscher, Garufi, et al., 2019), relatively little attention has been paid to the prosodic strategies employed by preschoolers in social interactions to perform expressive social acts, whether basic or complex.

Similarly, the ability to prosodically express epistemic states such as uncertainty, disbelief, obviousness or surprise develops over a long period and full adult-like competence is achieved only gradually. Awareness of a speaker's epistemic state (e.g., a knowledgeable vs. an ignorant speaker) based on contextual evidence (not prosodic cues) is present even in 12-month-old infants (Liszkowski et al., 2008). However, various cross-sectional studies have demonstrated that it is in the time window between 3 and 5 years of age that children start to employ prosodic signals to comprehend and express epistemic meanings (M. Armstrong, 2018; M. Armstrong et al., 2018; Hübscher et al., 2017; Hübscher, Vincze, et al., 2019). In a study investigating the expression of (dis)belief in 1- to 3-year-olds, Armstrong (2018) found that around 3 years of age the children began to be able to express their belief about propositional content through polar questions (e.g., they could convey a belief that there was going to be a party the next day by asking a question like "Is there a party tomorrow?"). However, the children were not able to express disbelief, incredulity or doubt about the propositional content (e.g., they could not produce the counter-expectational question "There's a party tomorrow?!").

The ability to use prosodic cues to comprehend and convey epistemic states continues to develop over the preschool period (M. Armstrong et al., 2018; Hübscher et al., 2017). For example, 4- and 5-year-old children are better at comprehending disbelief through prosody than 3-year-old children (M. Armstrong et al., 2018). As for production, likewise, children start to signal the epistemic meaning of uncertainty through prosodic and gestural markers between the ages of 3 and 5, and this ability develops as they get older (Hübscher, Vincze, et al., 2019). Interestingly, young preschool children do not use prosody to express epistemic meanings in exactly the same way as adults do. For instance, 3- to 4-year-olds are able to use rising pitch contours expressing uncertainty, but other strategies typically employed by adults (e.g., fillers and vowel lengthening) only begin to emerge later, starting around age 5 (Hübscher, Vincze, et al., 2019). Armstrong (2018) tentatively proposed to explain her findings about the late developmental window for the acquisition of epistemic markers in terms of cognitive developmental constraints. That is, in order to be able to utter a disbelief contour the child must be able to hold in mind simultaneously a previous belief and new information that has become available in the discourse in order to compare them. In this view, non-felicitous uses by children of contours expressing speaker disbelief can be attributed to their immature conceptual understanding of epistemic states.

3.1.3. Relationship between prosodic development and Theory of Mind

As proposed in a recent overview on the development of mental state prosody by Armstrong and Hübscher (2018), the acquisition of epistemic intonation could be related to factors such as belief understanding. In order to comprehend epistemic states expressed through prosody, the child must have developed the capacity to understand the mental states of others, known as ToM (Premack & Woodruff, 1978). Children's ToM understanding is a crucial cognitive competence that develops gradually during childhood and undergoes great changes during the preschool period (Wellman, 2018). Research investigating ToM abilities in preschoolers has mostly focused on one key aspect of ToM, namely, explicit false-belief understanding (see Wellman & Liu, 2004, for a review). The test most frequently used to assess ToM development in this period is the so-called false belief task which focuses on a child's ability to predict the actions of a person holding a mistaken (false) belief. Since it is not until around the age of 4 that typically developing children succeed in false-belief tasks (Sodian, 2006; Wellman, 2018), its use is ideal for the present investigation involving young preschoolers (i.e., 3-4-year-olds).

With respect to the relationship between the acquisition of epistemic meanings and ToM, previous research has suggested that ToM understanding can be linked to epistemic vocabulary (see De Rosnay & Hughes, 2006; Ebert et al., 2017; Slaughter & Peterson, 2012, for the acquisition of mental state lexicon) and morphosyntax (e.g., see Matsui et al., 2009 for the acquisition of grammaticalized means , for evidential and certainty marking in Japanese). However, studies on the relationship with epistemic prosody are few in number (e.g., M. Armstrong et al., 2018; Esteve-Gibert et al., 2020). Empirical evidence for such a relationship comes from the study on the comprehension of disbelief conducted by Armstrong and colleagues (2018). The results revealed that the ability to perceive disbelief through intonation in 3- to 5-year-old children was predicted by the stage they had reached in the development of their ToM. To our knowledge Armstrong et al.'s (2018) experiment is the only one that includes ToM measures in relation to the development of epistemic prosody. One study involving adult participants found that empathy skills (sometimes understood as 'affective' ToM, see Harwood & Farrar, 2006; Hughes et al., 2007, for details) are linked to individual variation in receptive prosodic skills (Esteve-Gibert et al., 2020). Specifically, it was shown that more empathetic individuals are more sensitive to intonational cues, while less empathetic individuals have trouble disambiguating a speaker's intentions on the basis of their intonation.

However, some contradictory evidence for the relationship between prosody and ToM comes from studies on atypical development. For instance, some studies have failed to detect any relationship between receptive prosodic skills and ToM (Chevallier et al., 2011; Colich et al., 2012). For example, Chevallier et al. (2011) found that children with Autism Spectrum Disorder (ASD) were as good as typically developing children in processing prosody, suggesting that impaired ToM does not entail difficulty in reading other people's minds from vocal cues. As for expressive prosody, it is widely known that individuals with ASD and other disabilities often present unusual prosody (see Loveall et al., 2021; McCann & Peppé, 2003, for a detailed review) but research still is lacking on the association between prosodic impairments and ToM. Summarizing, past research on the relationship between children's prosody and ToM is admittedly limited and has mainly focused on epistemic prosody and receptive prosodic skills, which suggests that more research should be undertaken to assess this complex issue.

3.1.4. Main goals and hypotheses

All in all, the state of the art on prosodic development reveals a rather fragmentary picture of the development of pragmatic prosody, with studies mainly focusing only on the early stages of the detection or comprehension of pragmatic meanings conveyed by prosodic means, with much less being known about the subsequent stages of development between ages 3 and 4. The main aim of the present study is thus to explore the development of pragmatic prosody skills in typically developing young preschool children in that period. The range between 3 and 4 years of age was selected as a focus for this study for several reasons. First, previous research has demonstrated that children's production of epistemic- and politeness-related meanings starts in the early preschool age, thus, this age range is especially relevant with regard to different pragmatic competences (Hübscher, Garufi, et al., 2019; Hübscher, Vincze, et al., 2019). Second, interestingly, numerous studies have consistently shown that critical development of ToM takes place in this period (Wellman, 2018).

Crucially, as noted above, prior research has tended to focus on specific pragmatic functions of prosody, such as the conveyance of information focus and belief states. Here we will attempt to take a more holistic, comprehensive measure of children's communicative uses of prosody by using the Audiovisual Pragmatic Test (APT; Pronina et al., 2019). The APT has been specifically designed to track the acquisition of pragmatic prosody skills in children starting from the preschool age. We hypothesize that the route taken in the acquisition of pragmatic prosody will vary depending on the nature of the specific pragmatic area, with the prosody of unbiased and basic speech acts being acquired first and the prosody of biased pragmatic dimensions such as information focus and epistemic state being acquired later and to a lesser degree in this period.

Finally, a further goal of the study is to assess whether the acquisition of pragmatic prosody skills in children is linked in any way with their development of ToM abilities. Here we hypothesize that, in line with previous research that suggested the link between ToM and receptive prosodic skills in children and adults (e.g., M. Armstrong et al., 2018; Esteve-Gibert et al., 2020), ToM will be related to expressive prosodic skills across various pragmatic areas.

3.2. Methods

3.2.1. Participants

A total of 117 3- to 4-year-old children were initially enrolled in this study, all of them preschoolers at two Catalan public schools located in the middle-income district of Sant Martí within the metropolitan area of Barcelona, where the population is largely Catalan-Spanish bilingual and the main language of instruction is Catalan. Prior to the experiment, the children's caregivers signed a participation consent form and filled out a language questionnaire (Bosch & Sebastián-Gallés, 2001) regarding the daily exposure of their child to Catalan. They also completed an occupational status questionnaire that was used to assess socio-economic status (SES). Caregivers' responses on their occupation were coded according to the International Socio-Economic Index (ISEI; Ganzeboom et al., 1992), a continuous occupational index that categorizes occupations into job categories, with higher job category score indicating higher occupation status. According to caregivers' reports, all enrolled participants were typically developing children and had no history of speech, language or hearing difficulties.

Prior to initiation of the study proper, participating children were given a Catalan language test (Saborit Mallol et al., 2005) that is specially designed to evaluate expressive vocabulary skills in children aged 2 to 9. This was done to ensure that participants' command of Catalan would be sufficient to allow them to perform the tasks they would be asked to do. The mean vocabulary score for the 117 participants was 31.23 out of 100 (SD = 12.77, ranging from 0 to 70). A score of 20 was set as the eligibility threshold for participation. Of the 117 children who had been initially enrolled in the study, 15 failed to reach this threshold. This left a final study population of 102 children (45 males, 57 females), with ages ranging from 39 to 51 months (M_{age} = 44.92 months, SD = 3.29 months). The mean overall Catalan exposure time of these children was 57% (SD = 23). The children came from middle socioeconomic status families (M_{SES} = 61.16, SD = 12.73).

3.2.2. Materials

ToM. ToM was assessed using two classic false belief tasks that measure a child's ability to understand others' mental states. The first one was Gopnik and Astington's (1988) unexpected content task. In this task, each child was shown a plastic tube, the usual packaging for *Lacasitos* colored chocolate disks (the local analog to the Smarties tube used in the original task described in Gopnik & Astington, 1988), and was then asked what it contained. This consistently produced the expected answer "Caramels" ("Candies"). The tube was then opened to reveal that it contained bits of chalk. After seeing these contents, the child was asked what they had thought was in the box before it was opened and what a friend of theirs would think was inside the box before it was opened.

The second was a version of the unexpected location task described in Baron-Cohen et al. (1985) adapted to Catalan (M. Armstrong et al., 2018). In this task, each child was shown a video in which a princess puts a ball in a container and leaves the scene. A lion then appears, moves the ball from the container where the princess left it to a second container, and leaves the scene. Finally, the princess returns to the scene. At this point, the child was asked where the princess would look for the ball and where the ball really was.

Audiovisual Pragmatic Test (APT). The Audiovisual Pragmatic Test (APT) was developed to jointly test pragmatic and prosodic abilities from early childhood, starting from the age of 3, until late childhood in typically developing children (see Pronina et al., 2019, for a detailed explanation of the task; materials are available from the Open Science Framework online repository – https://osf.io/pyc34). First, its pragmatic coverage is appropriate for children starting from age three as it takes into account widely-used standardized pragmatic tests designed to assess communicative behavior in children such as the *Test of Pragmatic Language* (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007a) and the *Comprehensive Assessment of Spoken Language–2* tool (CASL–2; Carrow-Woolfolk, 2017). Second, it uses a carefully controlled picture-supported set of contextual prompts, allowing the user to assess children's prosody in relation to pragmatic social contexts (i.e., pragmatic prosody). The elicitation procedure follows the Discourse Completion Task methodology, in which the participants are asked to imagine a pragmatic scenario and then to respond to it using their own words. This procedure has been widely used to research both pragmatics and prosody and has been proven to be an effective, reliable and validated method in the field of prosody (M. D. M. Vanrell et al., 2018). The procedure is suitable for children as the everyday situations presented in the items are adapted for a child's everyday life and are presented to children on a role-play basis, which allows them to immerse in the social situations. Moreover, all items are supported with colored pictures, which help children to imagine the situations and minimize memory load. Children are asked to respond as naturally as possible and can freely utter any response. The APT was tested with 3- to 8-year-old children and it was found that children of all ages engage in the activity (42% of 3-4-year-olds, 94% of 5-6-year-olds and 100% of 7-8 year-olds respond all the items) and are able to produce (semi-) spontaneous speech in response to the APT items (Pronina, Hübscher, et al., in preparation).

The full version of the APT includes 47 items which depict a specific pragmatic situation. Test administration involves the examiner picturing the social situation in a lively child-directed fashion while the child looks at the illustration displayed on the computer screen. The examiner asks the child to respond appropriately as if (s)he was an actual participant in the situation. If the child shows any difficulty understanding a situation or does not behave as expected, the examiner tries to clarify the situation further by replacing the fictional characters in the prompt with the names of people who were likely to be important to the child (such as a friend, parent or teacher). For example, if the child seems to have trouble imagining a friend offering to share half of his muffin, the experimenter would ask the child to name one of their friends in real life and then would frame the situation as if that friend was the main character in the social sharing situation.

Each item is intended to elicit a pragmatically appropriate verbal response which corresponds to one of four speech acts, namely *assertions*, *requests*, *basic expressive acts* and *complex expressive acts,* with assertions and requests being either *unbiased* or *biased*. Unbiased requests and assertions have no additional pragmatic meanings. An unbiased assertion has a declarative or explanation illocutionary force and no markers of modality, as exemplified by an unmarked declarative statement (example 1 in Table 1). An example of an unbiased request would be a command (example 2), a neutral information-seeking question (example 3), or a request for permission (example 4). Biased requests and assertions convey additional pragmatic biases that add complementary meanings to them (see Krifka, 2015, 2017, 2019). In line with Krifka's account, we differentiate between negation and epistemic biases, but we also add focus bias. For example, a request or an assertion can have marked informational structure, that is, focus (example 5), express different types of epistemic meanings (example 6) or negation (example 7). *Basic expressive acts* correspond to basic social acts such as greeting, bidding farewells, thanking or apologizing (examples 8 and 9; see Norrick, 1978). *Complex expressive acts* revolve around complex social situations like expressing compassion, condolences, congratulations or praise towards a peer, a parent or a teacher (examples 10 and 11). These items typically require the child to produce a positive exclamation or to communicate a positive stance conveying appreciation of or emotional support for the person to whom they are speaking.

For the purposes of the study, given that the test-takers were 3- to 4-year-old children, only the first 35 items out of a total of 47 were used. We predicted that the last 12 items would not be appropriate for this age range since they were tied to social contexts that preschool children would not be likely to encounter (for example, having to politely refuse to give personal information).

Table 1. Speech acts tested by the APT, with sample prompt context descriptions and corresponding illustrations.

	Speech act	Pragmatic biases	Context description (read by experimenter to child)	Illustration (viewed by child)
1	**Assertion**	**Unbiased**	*Imagine that you're eating a piece of cake and when you finish, your aunt asks you, "Do you want more?". What would you say?*	

2	**Request**	**Unbiased**	*Imagine that you're in a park with your family and your parents ask you to look after your little sister. But suddenly she runs out of the park. You're worried because there's a lot of traffic and you're afraid she'll step into the street. What would you tell her?*	
3	**Request**	**Unbiased**	*Imagine that there is there's a new girl in your grade at school. You like music class very much. One day you start talking with her and you want to know if she's also taking music class. How would you ask her?*	
4	**Request**	**Unbiased**	*Imagine that you want to watch TV and you know that usually your parents don't allow you to. How would you ask permission from your parents?*	
5	**Assertion**	**Biased (focus)**	*Imagine that you are in your grandmother's house and she can't hear well. You just told her that you want a snack because you are hungry but she did not hear you and asks, "Do you want to go for a walk?" How would you tell her that that's not what you want, you want a snack instead?*	

6	**Request**	**Biased** **(epistemic bias of surprise)**	*Imagine that one day your mother comes home carrying a very big bag. You're very curious about what's in the bag. What would you say to your mother?*	
7	**Assertion**	**Biased** **(negation)**	*Imagine that you do not like bananas but your mother gives you one. She is very sure you like them. You want to tell her that you do not like bananas. What would say?*	
8	**Basic expressive act**		*Imagine that you walked into your classroom in the morning. What would you say to your teacher?*	
9	**Basic expressive act**		*Imagine that you just entered the classroom in the morning. What would you say to your teacher?*	
10	**Complex expressive act**		*Imagine that you come home and when you enter the kitchen you see your mother baking and smell a delicious pie. What would you tell her?*	
11	**Complex expressive act**		*Your friend just tripped and fell down. What would you say?*	

3.2.3. Procedure

During their regular class time, the children were accompanied individually to a quiet room at their respective preschools by the examiner (the first author) or one of three trained research assistants, and then underwent the assessment procedures. Assessment took place in two separate sessions of a total duration of 30 minutes, though each child was supervised by the same experimenter in both sessions.[11] In the first session the child performed the two ToM assessment tasks while in the second session the APT was carried out. All four experimenters were fluent Catalan speakers and all testing was conducted in Catalan. The duration of the APT was between 15 and 20 minutes (this variability is explained below). The total duration of the two ToM tasks together was approximately 5 minutes, all participants were able to provide answers to the questions and complete both ToM tasks. All assessment sessions were video-recorded.

For the APT, the child was asked to sit in front of the computer screen where the pictures illustrated the social situation serving as prompts would be presented. The experimenter first engaged in a warm-up conversation with the child, took them through two sample items to make them familiar with the test procedure and then proceeded with the test itself. Although the version of the APT used here consisted of 35 items, the test was stopped before if the child showed signs of lack of collaboration or fatigue. The experimenter could interrupt the session for little breaks. However, the test was stopped if the child was unwilling to continue. For example, if the child answered "I don't know" or remained silent over several items, the test was discontinued. This procedure is in line with the guidelines of similar developmental batteries (e.g., CASL-2, CELF-2 Preschool). In total, this occurred in the case of 59 out of the 102 participating children. Two children explicitly asked to stop the task or return to his/her class; 36 children ceased to collaborate over several items, either by saying “I don’t know” in response to the prompts, providing inappropriate responses like

[11] The two tests presented in this article form part of a bigger project on the development of pragmatic skills and their relation to other linguistic and socio-cognitive abilities (Pronina et al., submitted, 2021).

"Please" or "Yes" to all prompts, or failed to respond verbally at all; 15 children became too restless to remain on task; and 6 children became excessively distracted and/or tired.

3.2.4. Scoring

Before testing, all experimenters were trained for scoring of the ToM tasks and the APT in a one-hour session. Then they carried out the scoring online while administering the tests using previously prepared answer sheets. Scores were then carefully checked by the first author on the basis of the session video-recordings.

ToM. As described above, in the unexpected content task, each child was asked what they originally thought was in the Lacasitos tube, and if they answered "Candies" they were awarded one point. If, when asked what a friend of theirs would think was in the tube, they answered "Candies", they were awarded a second point, for a possible total of two on this task. In the unexpected location task, each child was asked where the princess would think the ball was and the ball actually was. If they answered "In the first container" to the first question they received one point, and if they answered "In the second container" to the second question they received a second point, for a possible total of two. Thus the total ToM score ranged from 0 to 4.

Audiovisual Pragmatic Test. For the APT, two complementary scores were given, one for pragmatic appropriateness and the other for prosodic appropriateness. The pragmatic score was used only for screening purposes, since pragmatically inappropriate responses were excluded from the prosodic analysis.

Pragmatic appropriateness score. The pragmatic component of each response was given a score from 0 to 2. The scores were based on the examiner's perception of whether a given response expressed the intended speech act and was socially and contextually appropriate. A score of 2 was recorded if the child's answer was of high pragmatic quality, that is, the child managed to produce the intended speech act and did so in a socially appropriate way, such as if when asking for a piece of cake, the child used a polite question like "Can I have a piece?". A score of 1 was given if the child managed to utter the expected speech act but showed a lack of social appropriateness, which usually meant, depending on the scenario that the child either said too little or too much or answered too directly. For example, in the context of asking for a cake, if the child bluntly said “Give me” or “I want cake” this response was scored as 1 since the child was able to express the request but failed to mitigate it politely as would be appropriate for the situation. A score of 0 was given if the child either produced a response that did not match the relevant speech act or failed to provide any response whatsoever[12]. In the context of asking for more cake, for example, a response like “I like cake” would receive a score of 0.

Prosodic appropriateness score. As noted, the prosodic component of a child’s response was only assessed if it had first received a score of 1 or 2 for pragmatic appropriateness. Prosodic appropriateness was scored in a similar fashion, that is, by perceptually assessing the prosodic felicitousness of the response relative to the particular context. Given the fact that specific pitch contours and prosodic patterns encode a set of pragmatic meanings, in the assessment of prosodic felicitousness, we did not carry out an intonational analysis of pitch contours and prosody was assessed holistically by simultaneously considering the effect that different dimensions of prosody (e.g., intonation, amplitude and duration) produce on the listener. This which is in line with previous clinical and developmental research (Papakyritsis, 2021; Rasinski, 2004).

The prosodic component of the response was perceptually assessed as felicitous prosody, infelicitous prosody, or indirect speech. Prosody was scored as felicitous if the child used direct speech in first-person and answered with the prosody that would be appropriate if the situation was really happening at that moment. Because various prosodic strategies may be employed by a speaker

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[12] We subjected a 50% sample of our data to examine these zero scores. This analysis showed that in the majority of cases (88%) items were scored zero because the child made no attempt to answer the item, either by saying “I don’t know” or by simply remaining silent, or they commented on the pictures and situations without paying attention to the item in question. Only in 12% of cases did the children respond to the prompt but in a way that was pragmatically inappropriate (for example, this was the case if, for the item intended to elicit a farewell, the child responded by saying “Hola!” (“Hello!”)).

to encode a certain particular pragmatic meaning, no single prosodic pattern was regarded as uniquely appropriate for an item, and the prosodic means used by the child were evaluated in terms of perceived felicitousness in each particular instance. For example, consider a context in which the child was prompted to ask a peer whether she was also taking music class. If the child answered “Are you taking music class?” with the corresponding interrogative intonation contour (Figure 1, left panel), prosody was scored as felicitous. If in another context the child was prompted to produce an affectionate farewell to the mother and (s)he said “Bye!” with a naturally-sounding rising-falling pitch contour, the answer was also scored as felicitous (Figure 2, left panel).

In contrast, prosody was scored as infelicitous if there was a mismatch between the pragmatic meaning that should have been communicated by the response and the prosody used. For example, if in asking whether a peer was also taking music class the child produced a pragmatically appropriate response such as “Are you taking music class?” but the intonational contour was not interrogative but assertive (see Figure 1, right panel), infelicitous prosody was recorded. Prosody was also scored as infelicitous if the child’s response conveyed very low prosodic expressiveness. These answers were typically characterized by very narrow pitch range variation or reduced intensity and therefore sounded unnatural. For example, if the child was prompted to produce an affectionate farewell to his/her mother, and the child said “Bye” using non-expressive flat intonation, the answer was scored as infelicitous (see Figure 2, right panel), as it was deemed not to correspond with the target pragmatic meaning. It is important to note that a lack of expressiveness did not render the answer non-appropriate: the child still managed to produce a pragmatically appropriate response.

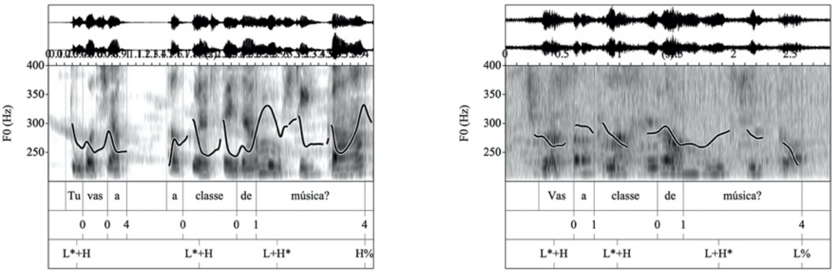

Figure 1. Left panel: Waveform, spectrogram and F0 trace for the question *Tu vas a classe de música?* Are you taking music class?' scored 2 for prosody and produced with two prenuclear L*+H pitch accents and a L+H*H% nuclear configuration. **Right panel**: Waveform, spectrogram and F0 trace for the same question, this time scored 1 for prosody and produced with two prenuclear L*+H pitch accents and a L+H*L% nuclear configuration, which is typical for statements.

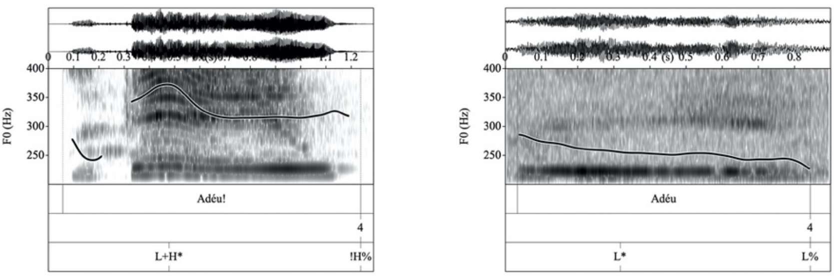

Figure 2. Left panel: Waveform, spectrogram and F0 trace for the prosodically appropriate expressive farewell "Adéu!" "Bye!" scored 2 for prosody and produced with a L+H* nuclear configuration and followed by a !H% boundary tone. **Right panel**: Waveform, spectrogram and F0 trace for the same utterance with inappropriately unexpressive prosody in the form of a L* nuclear accent and followed by a L% boundary tone. This utterance would receive a score for prosodic appropriateness of 1.

Finally, prosody was scored as indirect speech if the answer was pragmatically appropriate but the child did not enact the scenario; that is, if (s)he did not take the perspective of the situation's character. For example, if, to the experimenter's question "What would you say?" in the situation where a piece of cake is offered, the child answered "That I want some cake" or "I would say that I want some cake", using indirect speech to describe his/her actions instead of enacting the direct response, the pragmatic prosody of the answer cannot be evaluated as the target sentence is embedded. It should be noted that the answers produced in indirect speech cannot be classified into prosodically felicitous or infelicitous for the provided pragmatic situation, and thus are rendered as non-eligible for the prosodic scoring.

At this point, it is important to highlight that pragmatic and prosodic components of the answer were assessed separately. The reason behind this separation is because we do not wish to penalize children's prosodic scores on the basis of pragmatic adequacy. Thus, an answer deemed as highly pragmatically appropriate (a score of 2) could be scored either as prosodically felicitous, infelicitous, or indirect, depending on the prosody used by the child. Likewise, an answer that lacks some pragmatic adjustment (a score of 1, e.g., a request produced as an imperative) could be scored either as prosodically felicitous, infelicitous or use of indirect speech. In this way, a child's prosody score is not penalized based on the pragmatics score.

Inter-rater reliability. The APT results were double checked and rescored if needed by the first author of this study. The reliability of her scoring on the APT was confirmed by checking her scoring of a subset of the APT results from this study (910 responses representing 26 participants, 25% of the collected data) against scores awarded to the same items by two independent, previously trained scorers, each working separately. Using the R package *irr*, version 0.84 (Gamer et al., 2012), the scores awarded to these responses by each rater were checked against the scores awarded by each of the other two raters to determine the inter-rater reliability. Since more than two raters were involved, the inter-rater agreement was measured using Fleiss multi-rater kappa. According to Fleiss et al. (1981) benchmarks for interpreting the values of kappa, results ranging from .75 to 1.00 are considered "excellent" and results between .40 and .75 indicate "good agreement beyond chance". Overall agreement between the two independent raters and the original coder was 83% for pragmatic scores and 87% for prosodic scores. Fleiss Kappa was .79 ($p < .001$) and .81 ($p < .001$) for pragmatic scores and prosodic scores correspondingly. These results suggest a high degree of inter-rater reliability among raters for both pragmatic and prosodic scores.

3.2.5. Data analyses

Two sets of analyses were performed on this dataset, all of them using R, release 4.0.2 (R Core Team, 2020). All missing data was excluded from the analysis; that is, we excluded all missing answers to the items that were not administered to the children due to the discontinuation of the APT (see also section 2.3 for details for the interruption of testing), as they do not provide any information about a child's prosodic abilities. Thus, we focus only on the items that were presented to the children.

Our first analysis was limited to the data obtained by means of the APT (Analysis 1, section 3.1). The goal was to assess the role of speech act type on the production of pragmatically and prosodically appropriate cues. For this purpose, the 35 APT items were grouped into one of six broad categories of speech act type (namely, unbiased assertions, biased assertions, unbiased requests, biased requests, basic expressive acts, complex expressive acts). Linear mixed-effect models using the *lme4* software package, version 1.1-23 (D. Bates et al., 2015) were run to compare children's performance on different speech act categories. A first linear mixed-effect model tested whether there was a significant difference in the children's prosodic performance on unbiased and biased speech acts. We fit the model for the data on unbiased assertion, biased assertions, unbiased requests and biased requests. Prosodic Score (felicitous vs. infelicitous vs. indirect) was set as the dependent variable; Bias (unbiased vs. biased speech act) was set as predictor; Participant and Item were entered as random factors. In the second linear mixed-effect model, we tested whether the difference between the children's prosodic performance on basic and complex expressive speech acts was significant. This model was fitted for the data on the basic and complex expressive acts with Prosodic Score (felicitous vs. infelicitous vs. indirect) as the dependent variable, Speech Act (basic vs. complex expressive speech act) as the fixed effect and Participant and Item as random factors. We further run additional models that compared the prosodic performance in (a) different types of biases and (b) different types of epistemic biases. Again, Prosodic Score was entered as dependent variable and Participant and Item were set as random factors, but in one model Bias Type was used as independent variable (unbiased vs. negation vs. focus vs. epistemicity) and in another one Epistemic Bias (surprise vs. confirmation vs. incredulity vs. obviousness vs. uncertainty) was set to be independent variable.

Second, we analyzed the relationship between pragmatic prosody, ToM and age in months (Analysis 2, section 3.2). Here we conducted a series of linear mixed-effect models, also using the *lme4* software package, version 1.1-23 (D. Bates et al., 2015). The first model included all pragmatic prosody areas. Prosodic Score (felicitous vs. infelicitous vs. indirect) was set as the dependent variable. Nested models were compared using Akaike's information criterion (AIC), and the best-fitting model included both Age in months, ToM and their interaction as fixed effects. Participant and Item were set as random factors. The predictors were centered at their mean before they were entered in the analysis. Finally, a series of linear mixed-effect models were run for different speech acts (i.e., expressive, unbiased and biased speech acts). The same model specification as in the first model (i.e., Prosodic Score as the dependent variable, Age in months, ToM and their interaction as fixed effects, Participant and Item as random factors) was used in all the models that were conducted for speech acts.

Let us keep in mind that though the original APT consists of 47 items, only 35 were used in this study (as the remaining 12 items described complex social situations that preschoolers would be unlikely to have faced in real life). After administration of the APT, this was found to also be true of one of the items that had been included, as indicated by the fact that none of our participants proved able to understand the context or provide a pragmatically felicitous response to it. Therefore, our analyses are based on data taken from only 34 APT items.

3.3. Results

3.3.1. Analysis 1. Pragmatic prosody

Our intention was to use the results of the first analysis to build a kind of collective profile for the pragmatic prosody skills of this population (i.e., Catalan-speaking children aged 3 to 4). Our analyses centered around the set of speech acts which this age group is able to successfully perform using prosody. As explained, the prosodic component of the APT answers was assessed perceptually. This is consistent with previous research (e.g., perceptual assessment is considered a gold standard in clinical contexts, Papakyritsis, 2021; Rasinski, 2004, for perceptual assessment of speech prosody in retelling and reading tasks).

As noted in section 2.2.2, the 34 items tested in the APT each fell within one of six broad categories of speech act, namely unbiased assertions, biased assertions, unbiased requests, biased requests, basic expressive acts and complex expressive acts. Also recall that the APT prosodic appropriateness scoring system distinguishes between three degrees of appropriateness, as follows: lowest degree—pragmatically felicitous answers produced as indirect speech (i.e., the child was not able to answer from the perspective of the character, that is, was not able to enact the answer); intermediate degree—pragmatically felicitous answers enacted but prosodically infelicitous (e.g., non-expressive or produced with non-adequate prosody); and highest degree—answers that are felicitous both pragmatically and prosodically. The responses by 102 children were then broken down by speech act category and prosodic appropriateness level. This was then converted to a percentage by dividing each total by the total number of items within the speech act category administered to the children (missing answers were excluded). The results are shown in Figure 3.

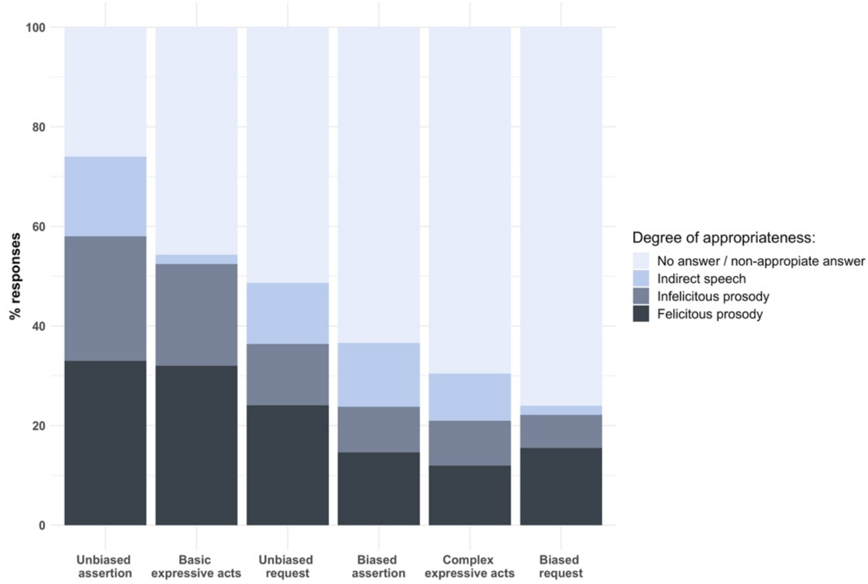

Figure 3. Percentage of prosodically felicitous responses by children, broken down by speech act category and degree of appropriateness.

In this figure, speech act categories are ordered from left to right according to their success in retrieving appropriate responses (and appropriate prosodic responses) from children. Overall, it can be seen that preschoolers are able to produce appropriate responses to all speech act categories, although there are clear differences in the route of their acquisition. While a majority of children managed to successfully produce appropriate unbiased assertions, basic expressive acts and unbiased requests—albeit not necessarily with expressive prosody—biased speech acts, either assertions or requests, and complex expressive acts proved more difficult. By the same token, the highest proportions of prosodically felicitous answers are concentrated around APT items eliciting unbiased assertions (33%), basic expressive acts (32%) and unbiased requests (24%), while APT items eliciting biased assertions, complex expressive acts, and biased requests yielded prosodically felicitous responses 16% of the time at most.

These results suggest that biased pragmatic meanings are more challenging than unbiased meanings for young preschoolers. This difference was proven to be statistically significant. The first linear mixed-effect model showed that the preschoolers performed significantly better on unbiased pragmatic meanings items than on biased pragmatic meaning items (β = -0.358, t = -2.820, p = .010). The second linear mixed-effect model showed that preschoolers also performed significantly better on basic expressive acts compared to complex expressive acts (β = -0.559, t = -3.389, p = .007). The full estimates are given in Table 2.

Table 2. Model specification and estimates for the models exploring the differences in the prosodic performance for different speech act types.

Fixed effects	β	*SE*	t	p
Pragmatic bias (biased items vs. unbiased items)				
Intercept	.63	.10	6.459	<.001***
Bias	-0.36	.12	-2.820	.010**
Expressive speech acts (basic expressive vs. complex expressive)				
Intercept	.83	.12	6.811	<.001***
Expressive speech act type	-0.56	.17	-3.389	.007**

** $p < .01$, *** $p < .001$

The same data is shown in Figure 4, though there the results for expressive acts are excluded and biased assertions are further broken by type of bias. This allows us to see that preschoolers seem to be more successful at conveying some degree of negative bias (51%) relative to other types of bias, most notably epistemic bias (12%). Additionally, we broke this effect down by conducting contrast analyses between bias types. The only contrast that achieved significance level was the contrast between unbiased speech acts and speech acts conveying epistemic biases (β = .629, t = 6.532, p = .006).

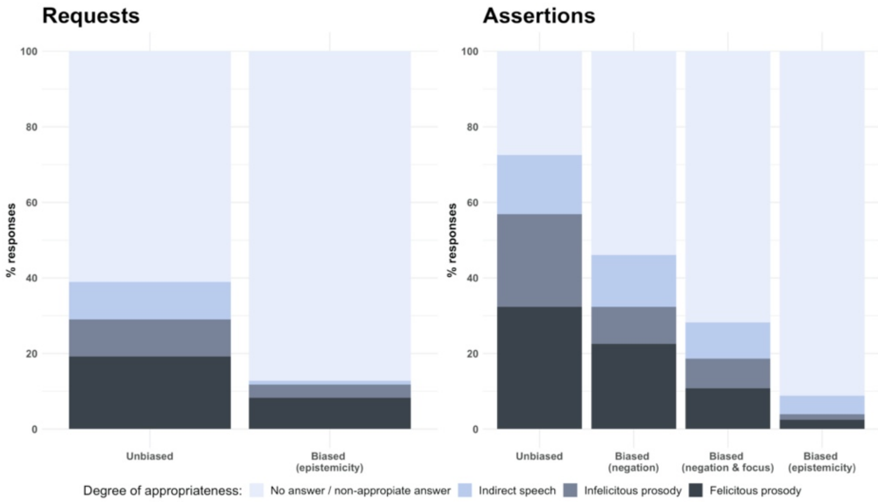

Figure 4. Percentage of prosodically felicitous responses to unbiased versus biased requests and assertions.

Figure 5 focuses more narrowly on the data related to biased epistemic meanings. Here we find clear differences between the children's ability to convey epistemic stance in request and assertion speech acts. While participants were able to express surprise about an object of interest (49%) or utter a confirmation-seeking request (21%), they tended to struggle with other epistemic meanings such as obviousness (16%), uncertainty (7%) and incredulity (1%). The contrast between surprise bias and uncertainty bias turned out to be significant (β = .770, t = 10.784, p = <.001).

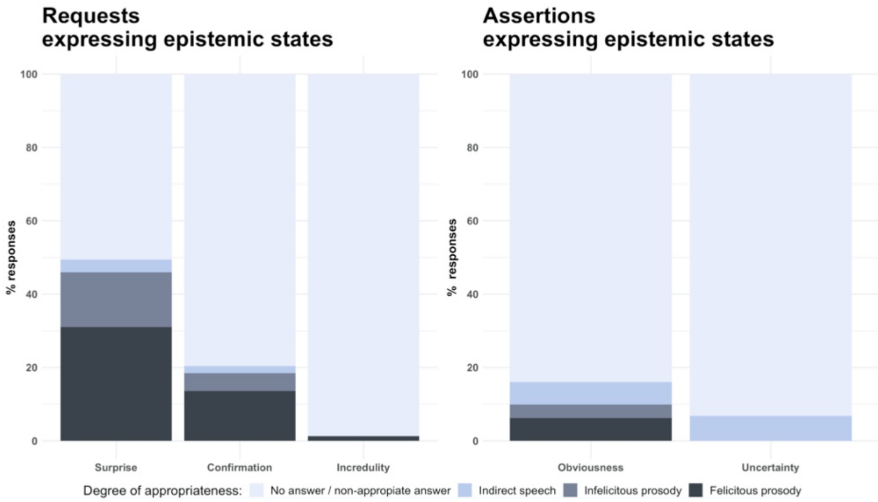

Figure 5. Percentage of prosodically felicitous responses by children for requests and assertions expressing epistemic stances.

3.3.2. Analysis 2. Relationship between pragmatic prosody, ToM and age

Since previous research has suggested that the acquisition of prosody is related to ToM development, in this section we report on the results of the linear mixed-effect models that were intended to assess the relevance of ToM on the children's overall prosodic performance, on the one hand, and their prosodic performance for specific speech act categories, on the other.

The first linear mixed-effect model was fit for the Prosodic Score involving all pragmatic areas (i.e., all items were entered in the model) and showed that Age, ToM and their interaction were not significant predictors of the Prosodic Score. Table 3 shows the full estimates for the fixed effects.

Table 3. Model specification and estimates for the models exploring the relationship between ToM and prosodic abilities (children's overall prosodic performance and their prosodic performance for specific speech act categories).

Fixed effects	*β*	*SE*	*t*	*p*
Overall prosodic performance				
Intercept	.44	.07	6.302	<.001***

Age	.06	.04	1.747	.084
ToM	.05	.04	1.225	.224
Age: ToM	.06	.03	1.865	.065
Basic expressive acts				
Intercept	.81	.15	5.539	.001**
Age	.12	.05	2.243	.027*
ToM	.01	.06	0.093	.926
Age: ToM	.03	.05	0.631	.530
Unbiased meanings				
Intercept	.57	.09	6.598	<.001***
Age	.06	.05	1.236	.219
ToM	.03	.05	0.474	.637
Age: ToM	.13	.04	2.917	.004**
Complex expressive acts				
Intercept	.26	.09	2.770	.032*
Age	.04	.04	0.906	.367
ToM	.07	.04	1.664	.100
Age: ToM	.07	0.04	1.840	.069
Biased meanings (epistemic)				
Intercept	.25	.14	1.808	.118
Age	.04	.04	1.137	.259
ToM	.03	.04	.870	.387
Age: ToM	-0.03	.03	-0.873	.385
Biased meanings (focus)				
Intercept	.40	.15	2.665	.069
Age	.00	.06	.033	974
ToM	.10	.06	1.675	.099
Age: ToM	.08	.05	1.608	.113

* $p < .05$, ** $p < .01$, *** $p < .001$

Given that previous research has highlighted the role of ToM for the acquisition of prosodic patterns expressing epistemic states (M. Armstrong & Hübscher, 2018), we carried out a set of analyses of the relation between ToM and children's performance across different speech act categories. Results showed that both Age, ToM and their interaction could affect the children's prosodic performance differently depending on the speech act category. The full estimates of all models are also provided in Table 3. Age was a significant predictor of performance for basic expressive acts (β = .122, t = 2.243, p = .027), suggesting that there is a gradual improvement in the expression of basic expressive acts of young preschoolers. ToM was not found to be a significant predictor of prosodic performance for any speech act, which suggests that ToM alone is not sufficient to explain the variation in prosodic scores. The interaction between Age and ToM was only significant for unbiased speech acts (β = .128, t = 2.917, p = .004). It turned out that higher ToM scores were positively related to better prosodic performance for unbiased items only in older children (β = .009, t = 3.832, $p < .001$). Yet within the younger group, children with higher ToM scores did not perform significantly better on prosody than children with lower ToM scores.

3.4. Discussion and conclusions

The main aim of the present study was to investigate the use of prosody by Catalan-speaking 3- to 4-year-old children for the expression of diverse pragmatic meanings. Results from the APT administered to 102 Catalan preschoolers have allowed us to sketch out a pragmatic prosody profile of children at this point in development by identifying the pragmatic uses of prosody according to speech act type that they have begun to acquire in an adult way and those that are still to be developed. Finally, by combining APT-derived data with ToM assessments, we have been able to assess the potential links between the development of pragmatic prosody skills and ToM at this age.

First, the results of the perceptive prosodic ratings (i.e., prosodic appropriateness scores given to children's APT responses) showed that Catalan-speaking preschoolers deal well with the prosodic expression of basic pragmatic meanings such as basic expressive (e.g., greetings, calling) and unbiased speech acts, that is, unbiased requests (e.g., commands) and unbiased assertions (e.g., declarative statements with no biased meanings). However, they have more trouble in adequately producing prosodic cues related to the expression of pragmatic biases such as information structure (e.g., corrective/contrastive focus), belief states (e.g., incredulity, uncertainty, obviousness) and negation. All in all, these results corroborate previous findings on intonational development. For instance, previous work has shown that by 3 years of age children can use pragmatically appropriate prosody for basic speech acts. As mentioned above, Frota et al. (2016, for Portuguese) and Prieto et al. (2012, for Catalan and Spanish), showed that by the age of two children use an adult-like basic phonological inventory of nuclear pitch accents and boundary tones. This paper has shown that preschoolers employ a wide range of intonational contours and, more broadly, prosodic strategies, in order to express different types of pragmatic meanings, and that they do this with different degrees of competence depending on the specific pragmatic area involved.

As for the ability to express more complex pragmatic meanings, our findings confirm and expand the results from previous studies. For example, we found that 3- to 4-year-old children start to successfully express focus in biased assertions, producing appropriate pragmatic answers 37% of the time and 15% of appropriate prosodic answers. This rate contrasts with the results on unbiased assertions, where 74% of responses were pragmatically appropriate (33% of appropriate prosodic answers). This is consistent with Chen's (2018) typological study suggesting that at 3 to 6 years of age children only begin to use intonational means for focus marking. As for the acquisition of epistemic prosody, our results showed that requests conveying epistemic meanings only obtained 24% of appropriate pragmatic responses (16% of appropriate prosodic answers). Even fewer appropriate responses (12%) were obtained for assertions expressing epistemic meanings (3% of appropriate prosodic answers). These results confirm previous studies on Catalan language indicating that young preschoolers already start to comprehend and express certain epistemic states through prosody (see, for example, Armstrong et al., 2018 and Hübscher, Vincze, et al., 2019, on the comprehension of disbelief and the expression of uncertainty respectively) and that this ability improves with age. Focusing now on the production of a specific epistemic stance like uncertainty, Hübscher, Vincze, et al. (2019) described different prosodic and gestural markers used by preschoolers to express uncertainty. For example, they reported that 3- to 4-year-old children extensively used rising uncertainty pitch contours. In our corpus, however, no felicitous examples of prosodic contours conveying uncertainty were obtained. A possible explanation for the differences between these findings could lie in the tasks used to elicit uncertainty expressions in preschoolers. While Hübscher, Vincze, et al.'s (2019) user-friendly guessing game was probably cognitively easier for children, the APT required children to understand a set of diverse situational prompts, which is possibly a more challenging task for children.

In general, it is relevant to draw a parallel between the timeline in the acquisition of pragmatic prosody and the development of other pragmatic cues like morphosyntactic or lexical markers. For example, it has been shown that even though 4-year-olds start to change word order to mark focus (A. Sauermann et al., 2011), the ability to express information structure through syntactic cues is not yet acquired in the preschool years and it is not until middle childhood that children use syntactic strategies in an adult-like manner (Arnhold et al., 2016; Dimroth & Narasimhan, 2012; Narasimhan & Dimroth, 2008). Similarly, previous research has shown that children begin to express epistemic states through lexical markers (e.g., verbs "know", "think") at around the age of 3 (Diessel & Tomasello, 2001) and around the age of 4 they learn modal auxiliaries (e.g., "might", "may") (Papafragou, 1998; see also Matsui, 2014, for a review). Further research is needed to develop a full picture of the route of acquisition of different means that mark these pragmatic meanings and to establish the time window in which different focus and epistemic markers appear in children's production, as well as to evaluate a potential precursor role of prosody in this respect. In order to gain a deeper understanding of the relationship between pragmatic and prosodic abilities, future studies investigating the two abilities through two separate tasks would be needed. In this view, it is of interest to compare our results with a recent study by Castillo et al. (in press) that reported a positive correlation between expressive pragmatic and prosodic abilities, where the latter were measured through an independent prosodic imitation task.

Second, our study also contributes to the relatively underexplored research area that investigates the link between ToM and prosodic skills. Though previous research has suggested that the development of receptive prosody is linked and constrained by ToM (for results in children, see Armstrong et al., 2018, and Armstrong & Hübscher, 2018; for results in adults, see Esteve-Gibert et al., 2020), as well as by other cognitive factors such as executive functions (Filipe et al., 2018; Ito, 2018), it should be noted that ToM measures are not usually included in studies on prosodic development. The present study examined the production side of pragmatic prosody and its link with ToM abilities. Our results suggest that ToM is not sufficient to explain and predict pragmatic prosody performance in preschool aged children, nor is the interaction between ToM and age. These results are in line with previous studies on prosodic skills in children with ASD (Chevallier et al., 2011; Colich et al., 2012) that showed that ToM impairment does not affect receptive prosodic abilities and extend them to expressive prosodic skills in typically developing children. Future research will need to gain a more in-depth understanding of how pragmatic prosody is acquired and determine the role of linguistic, socio-cognitive and age factors in that process. It might well be that a complementary set of individual variables may explain the development of pragmatic prosody skills. For instance, children's core language skills such as vocabulary and syntax abilities, as well as their general socio-cognitive development as manifested, for example, in their ability to understand emotions and their comprehension of metacognitive vocabulary.

In relation to ToM effects, the pattern of results was also affected if different pragmatic skills were considered separately. Interestingly, our study found that the children's performance on unbiased meanings was explained by the interaction between their age and ToM. These results indicate that the level of ToM does not equally affect children's prosodic performance across ages. Specifically, higher ToM scores were positively related to better prosodic performance in older children (i.e., one standard deviation above the mean), while higher ToM scores were not associated with better prosodic performance in younger children (i.e., one standard deviation below the mean). This is most likely due to the floor effect observed for ToM in the younger group since younger children’s scores clustered toward the bottom end of the spectrum, and therefore their ToM scores did not vary much. By contrast, more variability was found in their prosodic performance, as the APT includes a variety of items targeting unbiased pragmatic meanings. It could be that older preschoolers’ (M_{age} = 45.12 months, *SD* = 3.27 months) developing understanding of others is manifested in the way they act in social environments and react to it using appropriate prosodic strategies (see also C. Hughes & Leekam, 2004). Unbiased pragmatic meanings presented in the APT embrace a wide range of common social situations that preschool children are likely to experience in their day-to-day life (e.g., answer an adult’s request, request some information, ask for a permission, produce a command, etc.). Thus, the explanation behind the finding of the role of ToM and age for children’s prosodic performance in unbiased pragmatic meaning relates to the claims of the literature that states the importance of social interactions for the children’s development of ToM (Carpendale & Lewis, 2004).

While the number of prosodically appropriate answers given to the items containing unbiased pragmatic meanings was predicted by the interaction between ToM and age, this was not the case with other pragmatic types. In particular, no link was found between epistemic prosody skills and ToM. This result contrasts with past research on prosodic aspects of the understanding of epistemic states showing that children’s comprehension of prosodically-encoded disbelief is predicted by their ToM level (M. Armstrong et al., 2018). Yet our results go in line with previous studies on the more general relationship between the acquisition of epistemic meanings and ToM that found that children’s ability to understand and reason about epistemic concepts is not related to ToM (e.g., Perner et al., 2003; Tardif et al., 2004; Tardif & Wellman, 2000). As for focus, this study did not point to the role of ToM in the development of prosodic focus marking. Focus expression requires some cognitive flexibility, which is crucial for ToM (Jacques & Zelazo, 2005) as it relies on the ability to flexibly shift between conflicting perspectives. However, it could be that other (socio) cognitive factors can better explain the gradual acquisition of focus prosody. For example, focus prosody could be linked more to such cognitive resources as memory and attention span, since focus structures represent complex discourse structure and require children to switch attention between different referential elements. Therefore, in line with what has been previously suggested by Ito (2018), the ability to process and express complex information structure may be related to executive functions rather than to the ability to embed one's perspective within other perspectives.

Overall, this is the first study that provides a comprehensive pragmatic prosody profile of 3- to 4-year-old Catalan speaking children. This prosodic profile could be established by using the APT test, which has been designed from children aged 3 until late childhood (see Pronina et al., 2019). In general, the children of the lower end of the age spectrum of the APT (3- to 4-year-olds) showed interest and engagement in the activity, successfully passed the familiarity items and understood the format of the task. Forty-two percent of the children were able to finish the test, which allowed us to gather a considerable amount of data on the prosodic patterns produced by preschool children while controlling for pragmatic contexts (i.e., a total of 905 prosodically appropriate responses). We believe that the APT has the potential to be a very useful tool in the field of developmental research because it allows researchers to elicit comparable semi-spontaneous speech data across individual children and child populations. Future studies might use the APT to build comprehensive profiles of developmental patterns in pragmatic prosody including older children and track the pragmatic prosody profile throughout childhood.

This study has several limitations. First, even though the use of the APT with 3-year-old children was successful, it revealed some shortcomings. As we have noted, 58% of the children were not able to fully complete the task (35 items). This might be explained by the fact that the APT is quite long and requires concentration on the part of the children. We should bear in mind that the APT was designed for a wide age span of children allowing researchers to track the acquisition of different pragmatic areas across development, that is why it could be possible that the youngest group (3-4 years) does not necessarily respond to all items of the test. While older children can successfully complete all the test (e.g., specifically, 94% of the 5- to 6-year-olds and 100% of the 7- to 8-year-olds finished the whole APT with 47 items, Pronina, Hübscher, et al., the paper is in preparation), this was not the case with 3-year-olds. In line with the guidelines for developmental test batteries (e.g., see Carrow-Woolfolk, 2017; Semel et al., 2004), if during the administration of the APT it becomes clear that the test is too difficult or demanding for the child, the testing should be stopped and this does not mean a failure in the test (in our case, the child managed to pass familiarization items, engaged in the activity and answered as many items as (s)he could). Yet perhaps in order to increase the number of 3-year-old children fully completing the test it could have been better to shorten it or present the items in two separate sessions. Second, different speech acts were not represented equally in the APT (only first the 35 items were administered); it included 1 item of unbiased assertions, 7 items of biased assertions, 10 items of unbiased requests, 5 items of biased requests, 7 items of basic expressive acts and 5 items of complex expressive acts. Though the distribution strongly builds on previous research, specifically, as a whole, it is based on widely-used standardized pragmatic developmental tests for children (e.g., Carrow-Woolfolk, 2017) and some pragmatic areas were enriched with additional items adapted for children from adult Discourse Completion Task questionnaires on Catalan prosody, this still entails that some pragmatic areas had more coverage more within the APT. Third, the use of the Discourse Completion Task (as opposed to more ecologically-valid tasks) might have affected the results, which will need to be compared in the future with studies using other tasks. In this regard, the fact that some age discrepancies appear between our results and Hübscher, Vincze, et al.'s (2019) study on the production of uncertainty prosody suggests that the choice of situational prompts for every pragmatic area may have affected the specific results on the developmental path. Future studies using more ecological tasks are therefore needed to help broaden our understanding of the acquisition of pragmatic uses of prosody across languages. Finally, in the present study prosodic abilities were estimated by perceptual judgments of Catalan raters. Future analyses of the data could perform more complete acoustic and prosodic analyses and focus on the typology of child-produced intonational pitch contours, as well as on their developmental patterns. Further analyses could also assess the development of the target intonational pitch contours produced by Catalan children by means of the ToBI coding system (see Prieto, 2014, for Cat_ToBI) and complementary acoustic analyses.

In conclusion, the comprehensive assessment of the acquisition of pragmatic prosody by young preschoolers (3- to 4-years of age) reported in this article demonstrates the importance of bridging the gap between prosody and pragmatics when accounting for prosodic developmental profiles, as well as of the relation of the acquisition of prosody to other developing abilities such as ToM. Our results shed light on the pragmatic prosody profile of young preschoolers, who are able to perform prosodic patterns of unbiased speech acts and have more trouble with prosodic expressions of pragmatic biases. Along these lines, we suggest that clinical prosodic instruments should include a more exhaustive assessment of speech prosody and look to integrate a wider range of its pragmatic functions. Moreover, the present findings also help elucidate the relationship between the acquisition of pragmatic prosody and cognitive capacities such as ToM. In general terms, by exemplifying the value of incorporating pragmatic abilities in prosodic assessment, this study underlies the importance of considering other linguistic and socio-cognitive dimensions in order to gain a more fine-grained picture of the acquisition of pragmatic prosody. At the same time, on a more practical plane, it suggests that a thorough evaluation of children's pragmatic prosody profile could have diagnostic relevance in detecting pragmatic deficits.

4

CHAPTER 4: NARRATIVES AND GESTURE

Pronina, M., Castillo, E., Grofulovic, J., Prieto, P., & Igualada, A. (under review). Narrative abilities at age 3 are associated positively with gesture accuracy but negatively with gesture rate. *Journal of Speech, Language, and Hearing Research*.

4.1. Introduction

Co-speech gestures form an integral part of human communication and are present in the linguistic repertoire of speakers of all ages. Indeed, the current general consensus is that language and gesture form an integrated system (e.g., among many others, Butterworth & Hadar, 1989; Levinson & Holler, 2014; McNeill, 1992). Furthermore, gestures can have both abstract and concrete referential meanings, and perform both a complementary and supplementary role in relation to the information conveyed by speech (Kendon, 1980; Levinson & Holler, 2014; McNeill, 1992).[13]

Gestures in Typically Developing Children

In the context of language acquisition, the use of communicative gestures precedes and serves as a precursor to verbal communication, and can predict the future development of a variety of linguistic skills across languages in both monolingual (Camaioni et al., 1991, for Italian; Cameron-Faulkner et al., 2021, for Bengali, Chinese and English; Lüke et al., 2017, 2020, for German; Igualada et al., 2015, Murillo & Belinchón, 2012, for Spanish; Rowe & Goldin-Meadow, 2009, for English) and bilingual children (Esteve-Gibert et al., 2016, for Catalan-Spanish; Nicoladis et al., 1999, for French-English). On average, typically developing (TD) infants start using gestures, typically pointing gestures, communicatively at 11–12 months of age (e.g., Camaioni et al., 2004; Carpenter et al., 1998), and various studies have shown a predictive link between pointing and children's subsequent lexical and syntactic development. For example, the frequency with which children produce pointing gestures at 12 months of age positively correlates with the size of their lexicon at 20 months (Camaioni et al., 1991; see also Colonnesi et al., 2010, for a meta-analysis). Evidence also shows that gesture and speech are temporally connected to one another from early on. For instance, already at the babbling stage,

[13] According to McNeill's (1992) classification, there are four types of gesture: *deictic* gestures (pointing gestures with referential or abstract content), *iconic* gestures (gestures that depict aspects of objects, entities or events), *metaphoric* gestures (gestures that represent abstract concepts) and *beat* gestures (prosodically aligned gestures which typically reinforce a message).

infants not only combine deictic gestures with vocalizations but also align them temporally, marking the transition to the one-word language stage (Esteve-Gibert & Prieto, 2014). By the same token, children using supplementary gesture-plus-word pairings are the first to switch from one-word to more syntactically complex two-word combinations (Butcher & Goldin-Meadow, 2000; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005).

While pointing gestures are the first to emerge, other types of gestures develop later in the process of language acquisition. Representation iconic gestures depicting objects or actions start to appear frequently between ages 2 and 3, when children have already begun to produce their first words (Özçalışkan & Goldin-Meadow, 2011), and allow children to increase their word repertoire. Conventional gestures such as waving goodbye also become more frequent at this age (Iverson et al., 1994). Non-referential beat gestures, which contribute pragmatic and discursive meanings and help organize oral discourse production (Prieto et al., 2018), start to appear between 2 and 3 years. For example, Nicoladis et al. (1999) showed that French-English bilingual children started to produce beat gestures when they were able to string sentence-like complex utterances. The use of beat gestures noticeably increases with age, as complex linguistic skills develop (Colletta et al., 2010). Overall, the abovementioned studies show that different gesture types appear in different periods of development and are related to emerging linguistic abilities.

Gestures in Atypically Developing Children

The well-documented relation between gesture and language in typical development is also present in atypically developing (AD) children, for example, in children with autism (e.g., Ökcün-Akçamuş et al., 2019; Özçalışkan et al., 2016; see also Ramos-Cabo et al., 2019), Down's syndrome (Iverson et al., 2003), children at risk for language delay (Lüke et al., 2017, 2020), late talkers (Thal & Tobias, 1992), and children with Developmental Language Disorder (DLD)[14] (Blake et al., 2008; Mainela-Arnold et al., 2014).

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[14] The term Developmental Language Disorder has recently come into use (Bishop et al., 2016, 2017), before the same language impairment was known by

Gesture development, including rate of gesture use and gesture quality can be manifested differently in different children populations. For instance, gesture impairment is autism-specific, since children with autism show lower pointing gesture frequency than TD children or children with Down's syndrome (Mastrogiuseppe et al., 2015). At the same time, children with DLD use gestures at higher rates than their TD peers (Blake et al., 2008; Mainela-Arnold et al., 2014). Previous studies have shown that more frequent gesture production is associated with poorer language skills in DLD children, possibly due to their verbal deficits (e.g., Lavelli & Majorano, 2016). Moreover, studies by Wray and colleagues found that communication difficulties in children with DLD extend to other measures of gesture production, such as gesture accuracy, understood as the ability to accurately describe objects using gestures, and gesture comprehension (Wray et al., 2016, 2017).

Different gesture types can also be affected differently, for example, children with autism had more difficulties with pointing gestures (Carpenter et al., 2002) and the impaired use of gestures has been found to be indicative of language difficulties (see Ramos-Cabo et al., 2019, for an overview). The abovementioned evidence highlights the importance of studying developing gesture and language abilities together as gesture and language form a tightly organized system.

The Relation between Gesture Rate and Language Development

In the research on the relation between gesture and language, gesture rate—defined as the frequency with which children produce gestures—is one of the most studied gesture production variables. However, most studies have focused on the rates of pointing gestures in infants under two years of age and analyzed the interface between pointing and later vocabulary size and emerging syntax structures. Much less is known about how gesture rate is related to language measures in later stages of language acquisition, when

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terms Specific Language Impairment (SLI), language impairment or language delay.

other than pointing gesture types appear and children acquire more complex language skills.

A common measure used to assess these complex oral language skills in the later stages is narratives (Demir & Küntay, 2014; Stites & Özçalışkan, 2017). Narrative skills are the ability to string sentences together to convey extended speech (Applebee, 1980). In order to use language to form a longer discourse about past events, a good command of different aspects of language is needed, and that is why narratives are so popular with practitioners to assess language development (Botting, 2002). Children begin to produce their own narratives from approximately 3 years of age (Demir & Küntay, 2014) and within the preschool period and beyond assessing narrative skills provides us with a comprehensive measure that mirrors real-world language use in the explanation of children's daily experiences. The majority of narrative tasks proposed for preschool and school-aged children involve the child retelling a story. To assess narrative skills in children between ages 3 and 8, many studies have used a retelling task that involves presenting the child with the story first (the experimenter reads the story to the child) and then asking the child to retell the story that they just heard (Renfrew, 2006). Properties of narrative retellings produced by children can be evaluated in different manners, and one of the most common ways is to code for narrative macrostructure, that is, overall organization of the narrative (the combination of events into sequences which includes main crucial components of the story line such as an initiation, description of characters and their goals, chains of events, a resolution, etc.). The assessment of narrative macrostructure was put forward by Stein and Glenn (1979) and has been used in recent studies exploring the linguistic quality of children's narratives (e.g., Castillo et al., 2021; Demir et al., 2014, 2015; Vilà-Giménez et al., 2019; Vilà-Giménez & Prieto, 2020). It has been proposed that gesture use is related to narrative complexity and that the more complex narratives become in development (including macrostructure), the more gesture they include with the function to frame and organize information (Colletta et al., 2015). In short, we suggest that the macrostructure properties of narrative retellings stand out as a perfect candidate to assess the link between gesture rate and real-world language use, particularly beyond infancy (in a later developmental period when children start to produce extended discourse and use other types of gestures).

However, only a few studies have explored the relationship between gesture rate and subsequent narrative skills. For instance, Demir et al.'s (2015) longitudinal study found that children who used gestures more frequently to express character viewpoints when recounting a narrative at age 5 were more likely to produce more fully developed narratives at age 8 than children who gestured less often. These results seem to suggest that gesture rate has the same predictive value for narrative discourse skills as it does earlier for the acquisition of vocabulary and syntax. Another study by Colletta et al. (2015) with American, Italian, and French children, some aged 5 and others aged 10, showed that gesture develop in parallel with narrative skills in all language groups. In this study, older children produced more complex narrative and used discursive co-speech gestures that helped integrate the information conveyed through speech more frequently than the younger ones. In addition, there is evidence of the close relationship between gesture use and narrative development in bilingual children. Vilà-Giménez et al. (2019) and Vilà-Giménez and Prieto (2020) showed that the use of non-referential gestures in storytelling helps Catalan-Spanish bilingual aged 5 and 6 to have a better macrostructure of their narrative retelling. Similarly, Rohrer et al.'s (2022) study with Catalan-Spanish bilinguals between ages 5 and 9 found that non-referential gestures play a key a role in marking the information structure of children's narratives.

Despite the light shed on the relationship between gesture use and narrative skills by the abovementioned studies, the concurrent relationship between gesture rate and narrative skills appears to be less clear. For instance, Demir et al. (2015), although it confirmed the overall predictive value of gestures for narrative, found no concurrent link between gesture rate and narratives. Likewise, Nicoladis et al. (2016) showed no relation between 4- to 10-year-old children's gesture rate and the complexity of their narratives for three languages (French, Spanish, and English), since children who told more complex narratives did not necessarily produce more gestures during retelling.

The Relation between Gesture Accuracy and Language Development

While most of the previous research has focused on the presence of gestures and the frequency of their use (see Özer & Göksun, 2020, for a recent overview), there is another gesture production variable which has received somewhat less attention, namely gesture accuracy. In developmental research, gesture accuracy assesses the accuracy with which children either imitate gestures produced by adults or spontaneously produce gestures whose meaning can be immediately understood. For example, Wray et al. (2017) looked at the relationship between this variable, gesture accuracy—in addition to gesture rate—on the development of language skills in children with DLD aged 6 to 8 years compared to TD children of the same ages. Gesture accuracy was measured by means of two tasks. In the first one, the children were asked to describe eight different objects (e.g., *guitar*, *sword fight*) without speaking, and gesture accuracy was rated in terms of the child's ability to produce gestures conveying information about the objects; in other words, children had to spontaneously produce communicative gestures without recourse to any model which they could imitate. In the second task, the children were asked to imitate meaningless gesture sequences produced by an adult, and accuracy of a gesture was measured in terms of how closely it replicated the adult model. After both tasks, the children took a vocabulary test. The results showed that scores on the vocabulary test correlated with gesture accuracy scores, but did not correlate with gesture rate. In another study focusing on the function rather than the accuracy of gestures, Hughes et al. (2019) found that the function of gestures (e.g., to facilitate social interaction, to call attention to an object) used by 12-month-old infants with fragile X syndrome and infant siblings of children with autism better discriminated high-risk infants from low-risk control infants than the frequency of their gesture use.

The abovementioned study by Wray et al. (2017) notwithstanding, gesture accuracy has most often been analyzed in terms of children's ability to imitate an adult-produced model rather than to produce a gesture spontaneously. A series of studies along these lines have shown that gesture imitation abilities are related to language skills in both AD and TD children. As for AD children, Dohmen et al. (2016) showed a predictive relationship between language and body imitation (e.g., conventional gestures such as waving for greeting, facial expressions of emotions, as well as meaningless manual postures and actions with objects). The authors reported that poorer body imitation skills in 2-year-old AD German-speaking children predicted language delay at age 4. The results of another study by Ingersoll and Lalonde (2010) using the training paradigm and focusing on children with autism also pointed to the association between gesture imitation and language. Specifically, this study found that training that included both gesture imitation (manual gestures related to the child's play) and object-based imitation (actions with toys) had stronger benefits for autistic children's appropriate language use than object-based imitation training alone. With regard to TD children, the same positive relation has been found. Early studies from the 90-s have found that the imitation of arbitrary sequences of manual actions is related to the development of grammatical skills in infants between 24 and 30 months of age (Bates & Dick, 2002, for a review). A more recent study on 15- to 18-month-old infants by Hanika and Boyer (2019) also reported that imitative behaviors including meaningful manual gestures (e.g., waving hands), meaningless motor sequences (e.g. bending index finger), and actions with objects were associated with later language development. While the abovementioned studies found that gesture accuracy is linked to the developing vocabulary and grammar at early stages of language acquisition, at later developmental stages, when children start to string sentences together, the relation between gesture accuracy and language may be extended to more complex language measures such as narratives. The relation between gesture accuracy and narrative abilities was reported for bilingual children. A study by Castillo et al. (2021) with Catalan-Spanish bilingual preschoolers found that narrative performance was positively correlated with communicative gesture imitation scores but not with object-based imitation scores (actions with toys) in preschoolers. Our study builds up on this line of research and investigates the value of gesture imitation abilities in preschoolers (understood as the accuracy (or physical precision) with which children imitate of manual meaningful gestures, such as waving hands, wagging fingers, or clapping hands) in relation to language skills.

The Present Study

Overall, the present study focuses on 3- to 4-year-old TD children and seeks to explore the relationship of narrative skills with gesture rate and with gesture accuracy. Our main research questions are the following: (i) how narrative performance would relate to gesture development in the early preschool years and (ii) whether it would relate differently to different types of gesture measures (gesture rate vs. gesture accuracy). First, given the previous evidence on the relationship between gesture accuracy and different language measures across different child populations (e.g., Dohmen et al., 2016; Hanika & Boyer, 2019), we hypothesize that gesture accuracy will be strongly linked to narrative abilities in TD preschoolers too. Second, given that the results on the relationship between gesture rate and language are less conclusive—a positive relation in infancy (e.g., Colonnesi et al., 2010, for meta-analysis in infants between 9 and 33 months of age), and yet a negative relation in some clinical populations (e.g., Mainela-Arnold et al., 2014, in children between 5 and 10 years of age), or no relation in preschool and school-aged children (e.g., Nicoladis et al., 2016, in children between 4 and 10 years of age)—, we hypothesize that gesture rate measures will not be as equally indicative of a child's language skills as gesture accuracy.

The present study has two main novelties relative to previous investigations. First, the age range of the children under investigation is lower than that of the participants in previous studies. We believe that it is of particular interest to focus on the time frame between 3 and 4 years of age, since this is the period when children have just entered the stage of narrative development (McCabe & Rollins, 1994). Second, both gesture accuracy and gesture rate will each be assessed independently using new methods that were explicitly designed for this purpose and that are pragmatically relevant for 3-year-old children. In contrast to Wray et al. (2017) that looked into the imitation of meaningless gestures to assess gesture accuracy, we will use a task that involves imitation of naturalistic and meaningful gestures that occur in pragmatically relevant contexts. Similarly, to assess gesture rate, we will use a context-based gesture elicitation task, which is pragmatically relevant and which elicits semi-spontaneous gesture production from children. Since prior research has mainly investigated typically-developing school-aged, children, narrative retelling tasks prompted by wordless cartoon images have typically been used to measure gesture rate (e.g., Demir et al., 2015; Vilà-Giménez & Prieto, 2020; Wray et al., 2017). However, to our knowledge, this task has not been previously used with 3-year-old preschoolers as the cognitive and linguistic demands of the task are quite challenging for such a young population.

4.2. Method

Participants

Forty-six TD children were initially enrolled as participants in the study, all of them attending preschool programs at two public schools in the middle-income area of Sant Martí in Barcelona, Catalonia. The tested children population is Catalan-Spanish bilingual. Catalan is widely spoken in Catalonia and, according to municipal government statistics, Catalan has a strong position in the Barcelona neighborhood where the testing took place (77% of inhabitants speak Catalan and 96% understand it, in 2018 when the data were collected). Moreover, Catalan is main language of instruction at all Catalan public schools and children are immersed in Catalan from the start of school. Given these factors and in line with previous research on Catalan-Spanish bilinguals (e.g., Hübscher et al., 2020; Rohrer et al., 2022), the testing was also carried out in Catalan. However, the preschoolers' relative proficiency in Catalan might be variable, that is why in order to test whether the participating children had enough Catalan level expected for their age, we applied an expressive vocabulary test from the standardized Catalan language battery *Evaluación de Lenguaje Infantil, ELI* (Saborit Mallol & Julián Marzá, 2005). This test was designed for Catalan-speaking children up to the age of 6 and asks test-takers to name 30 every-day items in Catalan, yielding a score from 0 to 30. Based on the normative data provided in the validation study of the test (Saborit Mallol & Julián Marzá, 2005), a score of 6 (20% of the maximum score) corresponds to the lowest value obtained by typically developing 3-year-old Catalan-speaking children, with 9 being a reported mean for this population. Therefore, a score of 6 was set as the minimum necessary for inclusion in this study in order to ensure that participants could understand and complete the tasks of the study. Six of the children originally enrolled fell below this threshold and were therefore excluded from participation in the experiment. In addition, data from nine other children had to be excluded from our final analysis because either video material showing their performance was missing (*n* = 2), the experimenter committed procedural errors (i.e., providing incorrect prompts during the gesture accuracy task, *n* = 3) or the child failed to collaborate in the narrative task (*n* = 4).

All in all, the final dataset analyzed was based on 31 children (15 male, 16 female), their characteristics are reported in Table 1. Each child's parents signed a consent form prior to their child's participating and filled out a language questionnaire. The language questionnaire data confirmed that children were Catalan-dominant (the mean daily exposure to Catalan is 60%, *SD* = 21%). The study was approved by the ethics committee of the Universitat Pompeu Fabra.

Table 1. Participants' characteristics

	N	Gender		Age	Age range	ELI vocabulary subtest	ELI vocabulary subtest range	
		Boys	Girls				Possible values	Observed values
Study sample	31	15	16	3;9 (0;4)	3;3 – 4;2	10.55 (2.41)	0–30	6–16

Note: Age is indicated as years; months. ELI stands for the assessment battery L'avaluacio del Llenguatge Infantil (Saborit Mallol & Julián Marzá, 2005). For Age and ELI vocabulary subtest, mean values (standard deviation) and range of values are reported.

Materials and procedure

The experimental data analyzed in this study were collected as part of a larger project that included a varied set of linguistic and behavioral measures in a preschool setting (Pronina, Hübscher, Holler, et al., 2021) and was mainly conducted by the first and the third authors in the two schools indicated. For the present study, a total of three tasks were used from the original research project, namely, a multimodal imitation task, a context-based gesture elicitation task and a test designed to measure narrative skills.

The three tasks were conducted individually in a quiet room at each corresponding school. Before the start of the testing session, each child engaged in a warm-up conversation with the experimenter to help him/her feel comfortable. During this conversation the children's willingness to participate was ascertained by the experimenter. If the child needed a break at any time, the experimenter made sure to stop and resume the testing. If the child refused to participate or appeared uncomfortable, the task was discontinued. The child was seated on a chair in front of a tablet device next to an experimenter, with a video camera positioned to film the behavior of both throughout the experiment. The video recording was then used to analyze the child's performance on each task. The full three-task experimental procedure took roughly 30 minutes per child.

In the following subsections, we provide further details on the procedure used for data collection and analysis for each of the three tasks.

Multimodal imitation task. The purpose of this task was to assess the children's ability to accurately reproduce communicative and meaningful gestures, in other words, their gesture accuracy. The instrument used (described more fully in Castillo et al., 2021) is a 12-item test in Catalan based on examples from the Reciprocal Imitation Training technique used in behavioral training for children with autism (Ingersoll & Lalonde, 2010). It consists of a series of 12 short videos in which an actor is recorded verbalizing a series of utterances (e.g., exclamatives, imperatives, or questions) addressed at or referring to a teddy bear named Esmolet or a toy lizard, with each verbalization accompanied by an appropriate gesture. Gestures included conventional, iconic, or metaphoric gestures (see Cartmill et al., 2012). For example, as she tells the toy animals "Bravo! Well done!" she claps her hands together (see Figure 1 for examples of children's performance). After viewing each video, the child is asked to repeat the utterance and the gesture she or he has observed. Importantly, in this task the child is asked to imitate gestures that are framed in a pragmatically appropriate context, and therefore—

unlike non-contextualized or invented gestures—are truly communicative in their function.

Figure 1. Video stills showing a child producing gestures during the gesture imitation task trials 5 and 6.

Each child was tested separately by one experimenter in a quiet setting. The sequence of 12 test videos was preceded by a similar short video which served to familiarize the child with the experimental procedure. Each test video was played twice, the utterance and gesture were replicated by the experimenter, and then the child participant was asked to do the same. Test sequences were separated by short pauses.

Scoring. Gesture accuracy was rated on a 3-point scale from 0 to 2 by the third author. The participant's performance was scored 0 when the gesture produced bore no or very little resemblance to the adult model. A score of 1 was assigned when the child-produced gesture approximated but was not identical to the model. A score of 2 indicated that the child's managed to execute a gesture that was identical to the model. The third author scored all the data.

Inter-rater reliability. Data involving a total of 7 participants (23% of the total data collected) was randomly selected as a sample to ensure the reliability in the scoring system. The 7 videos of participants each performing 12 gestures were viewed and independently scored by two trained researchers, the first and second authors. Since three raters (an original scorer and two trained researchers) were involved, inter-rater reliability was calculated using Fleiss's multi-rater kappa (Fleiss et al., 1981). The results of the test revealed 76% agreement overall and a Fleiss's kappa of 0.76, suggesting a high degree of agreement among scorers.

Context-based gesture elicitation task. The purpose of this task was to assess how frequently children would produce gestures in a semi-natural context. To this end we used the Audiovisual Pragmatic Test (APT; Pronina et al. 2019), a comprehensive instrument of children's communicative abilities that has been successfully used to investigate expressive pragmatic skills in TD Catalan-speaking preschoolers (Pronina, Hübscher, Vilà-Giménez, et al., 2021b). In the APT procedure, an adult tester verbally describes to the child being tested a series of contexts to which they are asked to respond, such as "Imagine that you mother leaves for work. What would you say as she is walking out the door?" Simultaneously the child is shown on a laptop a picture illustrating the context described, such as a picture of a woman waving as she leaves home to a girl on a sofa. Though these contexts were designed to be appropriate for young children, it is also expected that the researcher administering the test will adapt them to the child test-taker as needed by, for example, giving the characters in the contexts names from the child's real life.

The full APT contains 35 such contextual prompts. Following the test protocol, all of them were administered to the child. A subset of 10 of the administered items (available at the OSF) as then selected and used in this study because they were thought to be pragmatically more likely to elicit a gestural response. For example, in the item intended to elicit a farewell, it was thought likely that the child would accompany a verbal message such as "Goodbye!" with a waving gesture, or produce a gesture alone (see Figure 2, left photo). Our choice of items was confirmed during the actual test by the fact that the children consistently did produce a contextually appropriate gesture (with or without a verbal utterance) in response to the selected contextual prompts. The ability of a test item to elicit a gesture varied from 67% to 6%. We defined "context-appropriate gesture" as any gesture that did not deviate from the pragmatic context described and produced as a logical, meaningful and deliberate communicative response to the item. We included gestures produced by means of arm, hand or head movements, as well as facial expressions (see Bavelas & Chovil, 2018).

In total, 81 gestures were identified in our 31 video recordings. Most (72%) were conventional gestures such as head shakes accompanying negative responses to a *yes/no* question, head nods accompanying affirmative responses, hand waves during greetings, and movements of the index finger to the lips to signal “Silence!” (see Figure 2, right-hand panel). This is in line with previous findings on gesture use in early childhood which suggest that conventional gestures are among the most frequently used gesture types (Kumin & Lazar, 1974). The remaining responses (28%) included examples of iconic gestures (e.g., a raised index finger meaning “one”), deictic gestures (e.g., pointing to an object in the picture that was mentioned in the verbal prompt), and facial expressions such as frowning while contradicting a statement.

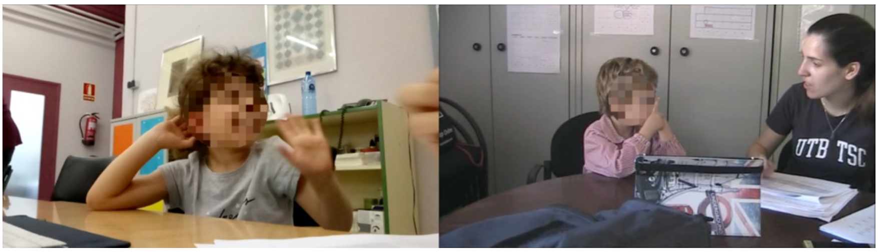

Figure 2. Video stills showing participants producing two conventional gestures during the context-based gesture elicitation task (APT). Left, waving goodbye; right, signaling “Silence!”.

Scoring. The gestures from video recordings were analyzed by the second author. If a child made a gesture in response to a prompt, they were awarded one point. If they did not produce a gesture, they received a score of 0. Because they were exposed to ten prompts, the maximum gesture rate score was 10 per child and the minimum 0. The second author scored all the data.

Inter-rater reliability. Data involving a total of 7 randomly selected participants (23% of the total data collected) was independently scored by the first and the third authors. While scoring the performance of this task, the raters were blind to the scores that children obtained in other tasks. To ensure it, the subset of participants in each reliability analysis was different (and randomly selected). Moreover, reliability analyses were performed with time intervals meaning that even if some participants within the random samples coincide, the scoring of one task does not influence the scoring of this task. The raters viewed the videos of children performing the task and marked the absence of the presence of a gesture for each item. The results showed 83% of overall agreement and a Fleiss's kappa of .75, proving a high degree of agreement among scorers.

Narrative skills test. The purpose of this task was to assess the children's ability to retell narratives about characters and sequences of events. Narrative retell tasks are frequently used in studies about children's narrative skills. In this instance, the Renfrew Bus Story test (Renfrew, 2006) was adapted for Catalan speakers. The test consisted of a story including a sequence of events revolving around a bus, a set of colorful images for visual support, and a toy to which the child would retell the story.

First, the experimenter told a story about the main character (the bus) to the participants while simultaneously showing them pictures on a laptop computer illustrating the characters in the story and the sequence of events described. The experimenter did not use gesture during the model. Subsequently, the children were instructed to retell the story to a stuffed toy animal. The toy was only introduced when children were asked to retell the story so that they would be motivated to perform the task, because they were aware that the experimenter was already familiar with the story but the toy was not. If at any point in the retelling the participant failed to continue the task despite prompting from the researcher or indicated that they did not wish to go on, the task was discontinued.

Scoring. Narrative abilities were assessed by the first author by scoring the child's narrative performance on scale from 0 to 6. The scale was designed to assess children's ability to retell narratives using descriptive rubrics (Vilà-Giménez et al., 2019). If the child's narrative included only the names of characters and other descriptive details, it received a low score, while if the narrative also described sequences of events that were causally related, it received a higher score. (For the rubrics used for scoring see Castillo et al. (2021). The narratives were scored by the experimenter administering the test.

Inter-rater reliability. Again, an inter-rater reliability test was conducted on the scores of 7 randomly selected participants (23% of the total data) assigned by an original scorer and two trained researchers, the second and third authors. While scoring narratives, the raters were blind to the scores that children obtained in other tasks. Two researchers independently watched and scored the 7 videos of participants performing the test. The results showed substantial agreement among coders, with 71% of agreement overall and a Fleiss's kappa of 0.72.

Statistical analyses

In order to answer our research questions about how narrative performance relates to gesture development in the preschool years and specifically whether it relates differently to different gesture skills, we analyzed the relationship between narrative scores and the two gesture scores available (gesture accuracy and gesture rate) via correlation and regression analyses. First, Pearson bivariate correlations between narrative scores, gesture accuracy scores, gesture rate, as well as the age were performed. Then a multiple linear regression analysis was run with the two measures of gesture performance together with age serving as predictors, and narrative performance included as a dependent variable. An assessment of collinearity between predictors was performed before running the model using the condition number *k*. No collinearity between predictors was found ($k > 30$ was used to define harmful collinearity, following Baayen, 2008). All scores were standardized prior to the analysis. Quality of fit was reported as adjusted R^2. Analyses were performed with R, version 4.0.2 (R Core Team, 2020). The dataset analyzed in this study is available in the OSF repository[15].

4.3. Results

We determined the required sample size post-hoc using G*Power Version 3.1 (Faul et al., 2007). Post-hoc achieved power was calculated for the multiple regression analysis using inputs of 0.05 for alpha, 31 for total sample size, and 3 for the number of predictors. The level of power to detect a medium effect (.03) was 0.908, which is higher than the recommended acceptable of 0.8 (J Cohen, 1988).

[15] https://osf.io/698hy

Descriptive statistics and correlational analyses

Descriptive statistics for gesture accuracy, gesture rate, and narrative scores are shown in Table 2.

Table 2. Means, standard deviations, and range of values.

Variable	*Mean*	*SD*	Range of possible values	Range of observed values
Gesture accuracy	10.23	6.28	0–24	0–22
Gesture rate	2.61	1.82	0–10	0–7
Narrative structure	2.39	1.93	0–6	0–6

To answer the research question of how narrative abilities relate to different gesture skills (gesture accuracy and gesture rate), we carried out a series of correlations. First, we analyzed whether the children's narrative skills were related to the ability to accurately reproduce communicative gestures (gesture accuracy). The results showed a significant positive correlation between these two scores ($r(29) = .45$, $p = .011$). Second, we analyzed whether the children's narrative skills were related to the number of gestures they produced during the context-based elicitation task (gesture rate). The results showed no significant correlation between gesture rate scores and narrative structure scores ($r(29) = -0.23$, $p > .05$). None of the measures was significantly correlated with age (all *p*s > .05). All bivariate correlations between measures are reported in Table 3.

Table 3. Bivariate correlational matrix among measures.

Variable	1	2	3
1. Gesture accuracy			
2. Gesture rate	.26		
3. Narrative structure	.45*	-0.20	
4. Age	.14	.11	.00

Note: $^{*}p < .05$.

Multiple regression analysis

To further investigate the relationship between narrative performance and the two gesture measures, that is, gesture accuracy and gesture rate (while controlling for age), we carried out a multiple regression analysis. The results of the multiple linear regression model revealed that the two gesture scores and age explained together 26% of the variance ($R^2 = .26$, $F(3,27) = 4.461$, $p < .001$). In line with correlation results, gesture accuracy was a significant positive predictor of narrative performance ($\beta = .82$, $p = .002$), suggesting that the children who produced more accurate gestures also achieved better narrative scores. On the other hand, gesture rate emerged as a significant negative predictor of the narrative scores ($\beta = -0.54$, $p = .034$), suggesting that children who gestured more frequently produced narratives that were more poorly structured. In other words, as gesture accuracy scores increased, the predicted narrative scores increased too, whereas as gesture rates increased, the predicted narrative scores decreased (see Figure 3).

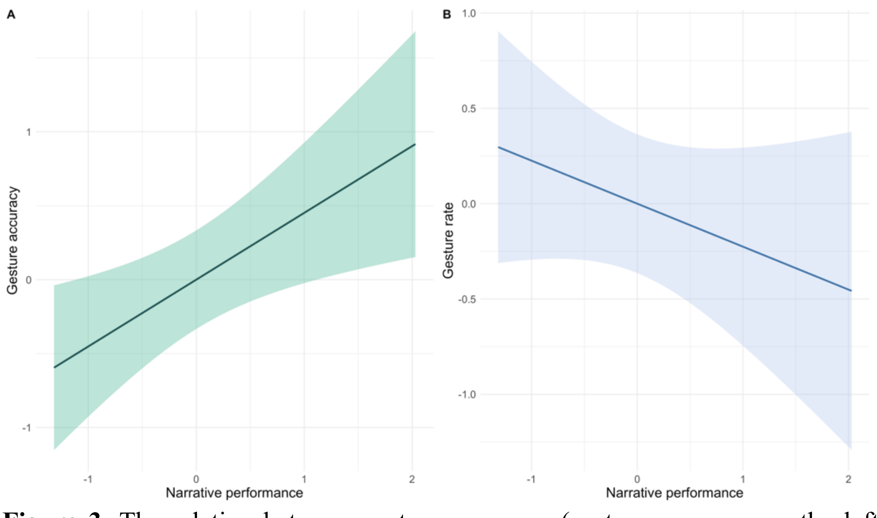

Figure 3. The relation between gesture measures (gesture accuracy on the left panel and gesture rate on the right panel) and narrative performance, as estimated by regression analysis.

4.4. Discussion and conclusions

The present study aimed to assess the relationship between the gestural and narrative abilities of young TD preschool children, and compared two measures of gesture use, namely, gesture accuracy and gesture rate, as predictors of narrative skills. We focused on a particularly relevant age range, 3 to 4 years, because this is when the onset of narrative discourse takes place in children. The final multiple regression analysis highlighted a significant positive effect of gesture accuracy on narrative performance, while gesture rate turned out to be a negative predictor of narrative performance. Together, these results help us advance in our understanding of developmental relation of gesture and narrative and specifically suggest that (i) there is a link between gesture and the ability to produce well-structured narratives since the onset of narrative production (3 years), (ii) this link is complex because narrative abilities relate differently to different gesture measures: positively to gesture accuracy and negatively to gesture rate. To our knowledge, no previous studies have compared the usefulness of two types of gesture measures (i.e., gesture rate as measured using a context-based elicitation task, and gesture accuracy as measured using an imitation task involving meaningful gestures) and further analyzed them in the context of their relationship with preschool children's narrative skills.

The Relevance of Gesture Accuracy

The key finding of this study is the positive association between gesture accuracy and narrative skills, indicating that children who can accurately replicate gestures also produce better narratives and that this accuracy is also predictive of their ability to produce well-structured narratives. On the one hand, this result can be explained by the fact that both the gesture accuracy task and the narrative retelling task involved an imitation component, since the child was asked to replicate either a gesture or a verbal narrative, respectively. On the other hand, this finding aligns with previous research showing that gesture imitation is related to language at early stages of development. For example, it has been shown that gesture imitation skills are related to the acquisition of vocabulary during the first two years of life (Carpenter et al., 1998; Hanika & Boyer, 2019; Snow, 1989) and to the steep curve in the development of grammar skills in 24- and 30-month-old infants (Bates & Dick, 2002). Our results are also consistent with the one study available on school-aged children (6- to 8-year-olds, both DLD and TD), which showed that the imitation of meaningless manual sequences was related to vocabulary (Wray et al., 2017). Moreover, these findings corroborate research on AD children showing that gesture imitation can promote language development (Ingersoll & Lalonde, 2010). The consistency of these previous results is particularly striking given that they involved different populations of children, language skills and time points in development. Our results thus expand upon previous research by showing that gesture accuracy is related to oral narrative language in TD children in preschool stages.

The Relevance of Gesture Rate

By contrast, the relationship between narrative abilities and gesture rate appears to be negative at the preschool stage. The regression analyses indicated that gesture rates by children in a context-based elicitation task were a negative predictor of their narrative skills. First, these findings differ from previous findings in early infancy that showed that the frequency and diversity of gestures used (mostly pointing gestures) were linked to enhanced vocabulary and grammar skills at older ages (Colonnesi et al., 2010; Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009), which served in turn as building blocks for more advanced communication skills. Possible differences in findings in infants and preschoolers could be explained by the fact that gestures serve different functions at different developmental time points. Language develops rapidly in the first years of life and the integration of gestures into language also changes greatly in complexity and purpose. While pointing gestures in dyadic contexts have a crucial communicative function in preverbal children, paving the way for later verbal development, it could be that as words take over as the primary means of communication, gesture use becomes less relevant in discourse settings and, therefore, individual differences may emerge in the natural use of gesture in narrative discourse. While some children may be more inclined to accompany their narrative discourses with gestures, others are not (see Özer & Göksun, 2020, for an overview on variation in gesture use). Moreover, there are other, non-linguistic factors such as the task itself, motivation and participants' culture which have been shown to affect the frequency with which people gesture (Alibali, 2005). In our view, the negative results regarding the relationship between gesture rate and narrative skills indicate the changing role of gesture throughout the first years of life, showing that during the preschool period gesture does not reliably predict language anymore and the use of gesture may vary across children.

Secondly, the negative relation reported in this study also points to a facilitating and compensatory function of gestures in language production. Children who display higher gesture rates produce narratives with poorer macrostructure, that is, are less able to organize their oral language productions. This inverse relation is also attested in previous studies on atypical development (e.g., Mainela-Arnold et al., 2014) and second language acquisition (see Graziano & Gullberg, 2018, for an overview). These previous findings suggest that children use gestures to compensate for language skills when the latter are insufficient to express a certain meaning. Focusing on this compensatory role of gesture, Pine et al. (2007) found that gestures facilitated lexical retrieval in children aged 6–8. In line with these prior results, we contend that an increase in gesture use at this stage, and in the context of pragmatic responses like saying good-bye to your mother by waving your hand, might be indicative of a compensatory use of gestures to replace verbally communicated lexical meaning, which, in turn, is indicative of the ability to use verbal language to produce well-structured narratives.

Gesture Accuracy vs. Gesture Rate

Taken as a whole, our findings are indicative of the importance of taking into account a variety of gesture measures in assessing multimodal skills. Gesture quality—that is, accuracy of imitation—is a positive indicator of children's language skills–, while gesture quantity—that is, gesture rate—stands out as a negative predictor. A similar pattern of results was also found in AD children by Hughes et al. (2019) and Wray et al. (2017), who highlighted that only gesture imitation was related to vocabulary in school-aged children. Overall, different gesture measures reflect the relationship between gesture and complex language skill to organize discourse in different ways. Overall, while findings regarding the value of gesture rate in preschool and older children may vary across studies, the accuracy with which children imitate gestures consistently points to strong links with language skills.

On a theoretical level, our study adds further support to key claim of the Growth Point theory by McNeill (2005) that gesture and language form an integrated system of communication. Narratives require the coordination of language skills for the purpose of communication to orally convey information in a narrative format, which includes main macrostructure elements. In a parallel fashion, gesture imitation requires the integration of motor and social skills for the purpose of communication to express pragmatically relevant information via multimodal means. Our findings suggest that speech and gesture develop together, as children's level of oral narrative skills was matched with their gestural communication imitation abilities, which confirms McNeill's (1992, 2005) claim that language and gesture act as one tightly organized communicative system. While it has been amply demonstrated in the literature that gesture and speech occur together in an integrated manner, the relationship between different gesture and speech may be manifested in different ways when accounting for confounding factors. Building on the Growth Point theory by McNeill, functionalist gesture theories such as Interface hypothesis (Kita & Özürek, 2003) and Gesture-for-Conceptualization hypothesis (Kita et al., 2017) highlight the need to account for the cognitive processes that give rise to gesture production. The result that children with lower narrative scores produce more gestures can be interpreted within the two abovementioned functionalist gesture theories (see also Goldin-Meadow et al., 2009). Children tend to employ gesture more in cognitively challenging conditions arising from a lower linguistic competence. In other words, children with lower language proficiency and ability organize their discourse on the macrolevel would use more gestures.

Clinical Implications

These findings have a number of clinical implications. First, we would like to highlight the need to use gesture as an informative indicator of language development. Previous research has provided convincing evidence on the link between gesture and language acquisition in both typical and atypical development by demonstrating that gesture use is predictive of language development and indicative of language difficulties (see Colonnesi et al., 2010; Ramos-Cabo et al., 2019, for reviews). In line with this, we found that gesture accuracy index points to individual differences in narrative skills in TD children. This might be also extended to AD children, as gesture could possibly be used as a marker of language skills in both TD and AD children.

Second, clinicians should be aware of potential differences across tasks when assessing gestural abilities. This study has demonstrated that different gesture tasks lead to different outcomes: while gesture accuracy is a positive predictor of narrative performance (in line with Castillo et al., 2021; Hanika & Boyer, 2019), gesture rate is a negative one. In light of this, we propose that, in addition to gesture rate, speech-language pathologists should consider other measures of gesture performance such as gesture accuracy when evaluating their linguistic and gestural abilities. In general, a more thorough analysis of gesture is needed. Existing assessment tools are typically limited to caretakers' questionnaires or checklists (e.g., CCC-2, Bishop, 2003; MB-CDIs, López-Ornat et al., 2005; LUI, O'Neill, 2009; Pragmatics Profile and Pragmatics Activity Checklist subtests of the CELF, Wiig et al., 2009) and therefore they do not provide direct empirical observation of the child's gesture abilities and lack the depth of analysis. Another popular tool to assess gestures, NEPSY-II (Korkman et al., 2007), is focused on motor movements required for gesture production (imitation of hand positions, manual motor sequences task) rather than on (communicative) gesture *per se*. Finally, Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP, Wetherby & Prizant, 2002) is an example of a structured observation assessment that analyses gesture use but only by coding quantitative information related to gesture frequency in 6-24 months of age population. Overall, gesture is integrated in standard assessment instruments only in a vague manner while it is clear that different facets of gesture performance can inform about the child's linguistic and communicative development and should be taken into account in clinical assessments.

Finally, a better understanding of the gesture-language developing system could serve not only for clinical assessment but also for improving clinical intervention practices. Given the foundational role of gesture in communicative development, gestural interventions might be a promising strategy to improve language use in children. We suggest that in developing training programs targeting language and communicative abilities multimodal cues such as gesture should not be left behind. Moreover, in accordance with the results of this study, we recommend to speech-language pathologists to consider including naturalistic and meaningful gestures that can occur in real-word social contexts. Even though gesture imitation programs capitalizing on daily social contexts are still rare, there are some successful examples of behavioral intervention approaches in children with autism and DLD involving gestures, such as Reciprocal Imitation Training developed by Ingersoll and colleagues (Ingersoll, 2012; Ingersoll & Lalonde, 2010), a theatre intervention by Corbett et al. (2017) and some experimental gestural interventions and targeting word learning (Lüke & Ritterfeld, 2014; Vogt & Kauschke, 2017). All in all, future research should further investigate the value of multimodal programs that tackle the value of gesture in clinical assessment and treatment of language abilities.

Limitations and Future Directions

One potential limitation of our study is the relatively small sample size (N = 31), though the model yielded a power of .91 to detect a medium-size effects. Second, although children's language proficiency in Catalan was ensured, children actively acquire both Catalan and Spanish languages at the same time and the bilingual status of children may have possible implications in the process of narrative and gesture development. Further research is needed to tackle the question about the potential effects of bilingualism in gestural and narrative performance. Third, we should bear in mind potential task effects in the results. Studies examining gesture rate may yield different results depending on the task used (spontaneous play interactions vs. wordless cartoon retelling task vs. context-based elicitation task) and the particular age under investigation (pointing gestures at early stages of language acquisition vs. co-speech gestures at later stages), as well as other social factors such as the children's familiarity with the interlocutor. For instance, it might be the case that the task employed in this study is more interactive and communicative than the retelling task and therefore elicits higher gesture rates. Finally, the investigation of gesture rate and gesture use in young children warrants the control of other factors, such as potential discomfort brought about by the experimental environment or the communicative style of the child, which has been shown to affect gesture rates side by side with various other non-linguistic factors (Alibali, 2005). Thus future research into gesture use by young preschoolers should perhaps be conducted in the context of communicating with caregivers, which tends to induce little to no anxiety in children. Similarly, future research should compare gesture accuracy and gesture rate measures in the context of a wider developmental window and investigate both concurrent and longitudinal correlations with a variety of language skills.

Conclusion

All in all, the present study has contributed to expanding our knowledge about the relationship between gesture production skills and language skills during the preschool years. Importantly, our study has confirmed the strong links between gesture production (specifically gesture accuracy skills) and language skills in TD children and has highlighted the importance of assessing multimodal skills in different ways. Thus, our results provide a detailed insight into the relationship between narrative discourse abilities and gestural repertoires of children at a crucial time of language development by comparing two measures of gesture use. In more general terms, our findings add further strength to the hypothesis that language and gesture are two integrated sister systems and support a multimodal view of human communication.

5

CHAPTER 5:
TRAINING EXPRESSIVE PRAGMATICS AND SOCIAL COGNITION

Pronina, M., Hübscher, I., Holler, J., & Prieto, P. (2021). Interactional training interventions boost children's expressive pragmatic abilities: evidence from a novel multidimensional testing approach. *Cognitive Development*, *57*, 101003. https://doi.org/10.1016/j.cogdev.2020.101003

5.1. Introduction

In the preschool years, children gradually develop the ability to interact with the social world around them. This ability is highly relevant for children's everyday life because it impacts their social relationships and the quality of their interactions (Matthews et al., 2018). Much attention has been devoted to studying the ability to interact socially and its underlying skills, particularly in the domain of social cognition and pragmatics. The present article builds on this previous research and examines how children's developing social cognition and expressive pragmatic abilities can be boosted in the preschool years by focused training.

Social cognition is an umbrella term that refers to a set of cognitive and emotional abilities that are applied in social situations (Harvey & Penn, 2010). One ability generally included in this set is the ability to attribute mental states to other human beings and to make predictions about their behavior, known as Theory of Mind (ToM), a term coined by Premack and Woodruff (1978; see also Perner, 1991, and Wellman, 2014, for a review). In the developmental field, ToM skills have received considerable attention, particularly in the last forty years (see Henry, Phillips, Ruffman, & Bailey, 2013; Wellman, 2018, for a review). A large number of studies have demonstrated that the first ToM developmental milestone is reached in the preschool years, as children gradually develop the ability to detect and interpret the mental states of themselves and others (see Perner & Roessler, 2012; Wellman, Cross, & Watson, 2001; Wellman & Liu, 2004).

At present, ToM in children is traditionally measured by means of what are known as false belief tests (Wimmer & Perner, 1983). In order to succeed in these tests, the child must be able to reconstruct the false belief of others or his/her own previous false belief. For example, in the so-called "Sally and Anne" change-of-location task (Baron-Cohen, Leslie, & Frith, 1985), the child is required to predict that a puppet called Sally will mistakenly look for an object, which has been moved to a different place during her absence by Anne, another puppet, in the place where she last left it rather than in the place to which Anne has moved it. Another widely used standard false belief test is the "Smarties" unexpected content task

(Astington & Gopnik, 1988; Perner, Leekam, & Wimmer, 1987) in which children are asked to recall their initial false belief about the contents of a Smarties candy tube. However, just using false belief tests may not be sufficient to assess a child's developing social cognition, as it provides us only with a small glimpse of what social cognition is about (see Harris, 2006, for an overview of children's developing understanding of belief in the context of social cognition; Wellman, 2018, for a criticism of the exclusive use of the false belief paradigm). Another important aspect of social cognition is emotion understanding, which refers to the ability to infer others' emotions and feelings. It has been shown that even at 3.5 months of age, infants can recognize certain emotions in others through facial and prosodic cues (Kahana-Kalman & Walker-Andrews, 2001). However, it is only when they approach school age—as with their ability to detect false beliefs—that they become able to name emotions and understand the external causes of emotions in others (Pons et al., 2004).

As stated, the general focus of the literature on social cognition development has been on ToM skills, and, particularly, on the ability to understand false belief, with other components such as pragmatic skills receiving less attention. Pragmatic skills usually include the ability to recognize and express communicative intentions, infer other people's expectations and motivations, initiate conversations, respond with relevant information, and understand utterances in context. The development of these pragmatic skills, which are crucial in a child's daily social life (Matthews, 2014; Matthews et al., 2018; Norbury, 2014), is characterized by its own trajectory (Domaneschi & Bambini, 2020). However, despite its overall importance and relation to social cognition, the ability to socially interact with others has not been subjected to much research in the domain of social cognition (see Kunda, 1999, for the range of phenomena attributed to social cognition).

In order to address a child's developing social ability more comprehensively, it might be beneficial to focus on several skills simultaneously. In the present study we will assess the impact of a classroom-based intervention not only on preschool children's false belief understanding but also other aspects of social cognition (cognitive and affective aspects), as well as pragmatic skills. Such skills help children understand social behavior and social interactions and are closely linked to language development (Conte et al., 2019; Ornaghi et al., 2016). Both are also related to social competence (see C. Hughes & Leekam, 2004) and impact children's developing social relationships, influencing, for example, their popularity with peers, their capacity for leadership (C. C. Peterson et al., 2016), and even their academic achievement (Lecce et al., 2011; Lecce, Caputi, et al., 2014).

We hypothesize that training children to talk about mental states could potentially enhance not only their ToM understanding but their pragmatic competence behavior overall. Boosting the whole set of socio-communicative abilities early on in a child's development, especially expressive pragmatic skills which play an important role in the social interaction with others, may also be important from an educational point of view.

ToM training

In recent decades, training studies have focused on children's ToM development and have shown the beneficial effects of focused language-based interventions on ToM. The first ToM training studies focused on the use of false belief tasks and demonstrated that a child's performance on these tasks can be improved if the child is exposed to mental state language. These studies used a task specific approach, namely tasks which were specifically developed to help preschool children pass standard false belief tests, which generally consisted of providing them with feedback right after their performance on specific false belief sequences. The studies by Appleton and Reddy (1996), Slaughter and Gopnik (1996), Slaughter (1998), Clements, Rustin, and McCallum (2000), Melot and Angeard (2003) all demonstrated that after focused task-specific training preschool children improved in their ability to pass different false belief tests (e.g., change-of-location, unexpected content, appearance vs. reality distinction tasks). A more recent study by Lecce, Bianco, Demicheli, and Cavallini (2014) adopted this same approach and similarly reported positive results.

While these first studies showed that specific training providing feedback and explanations about the correctness of children's answers in false belief tasks can lead to improvements in ToM, other studies have tested whether training linguistic skills (specifically syntactic skills) can facilitate the development of ToM. A close relationship between ToM development and language has been shown in research (Astington & Jenkins, 1999; de Villiers, 1995, 2000; Happé, 1995; more recently Milligan, Astington, & Dack, 2007; Tager-Flusberg & Joseph, 2012), particularly the link between ToM and the acquisition of sentential complement syntax (e.g. de Villiers & Pyers, 2002; Slade & Ruffman, 2005). According to de Villier's account (de Villiers, 1995, 2000; de Villiers & De Villiers, 2000), the acquisition of sentential complements promotes false belief understanding because it provides children with the representational format needed for reasoning about false beliefs. More precisely, since in sentential complements the clause that may be false can be embedded in a main clause that is true, the very structure of complement clauses makes it possible to handle misrepresentation and serves as a bootstrap for false belief understanding (see, however, Perner et al., 2003; Tardif & Wellman, 2000, for a criticism of this view). Based on this, Lohmann and Tomasello (2003) conducted an intervention with 3-year-olds and showed that language-specific training played a key role in the development of the children's false belief understanding. In a similar study, Hale and Tager-Flusberg (2003) demonstrated that children trained in sentential complements improved their performance on a false belief task.

Another set of training studies have used conversation-based approaches to boost ToM performance. These studies have used storybooks whose texts included a variety of terms describing mental states[16] such as *know*, *think*, *get angry*, *get scared* to train ToM. However, contradictory results have been obtained. For example, Guajardo and Watson (2002) examined whether exposing preschoolers to storybooks which focused on mental states would facilitate ToM understanding and found that the group training did not lead to significant improvement, but the individual training did.

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[16] In the articles listed above, mental state terms are also referred to as *inner state terms*, *metacognitive language* and *mental lexicon*. The studies by Guajardo and Watson (2002) and by Astington and Peskin (2004) focus on the use of cognitive mental state terms (e.g., *know*, *think*), while the studies by Esteban et al. (2010) and Ornaghi et al. (2011) include both cognitive and emotional states.

A separate training study by Astington and Peskin (2004) yielded negative findings. In this study, storybooks were read to 4-year-old children at home, individually, and at school, as a group activity. However, while the experimental group was exposed to texts with a large number of mental state terms, the control group was told the same stories but without any explicit mental state terms. Though both groups showed improvement, surprisingly, children in the control group improved significantly more in a subsequent false belief explanation task than children in the experimental group. Another study by Esteban et al. (2010) with 3- to 4-year-old children also looked at the impact of storybook reading and subsequent discussion on children's performance on several individual ToM tasks and showed that the experimental group improved only in an unexpected location task, but not in an unexpected content task. In a similar study involving two age groups (3 and 4-year-olds), the experimental group engaged in conversations after listening to the stories, while the control group did not engage in any of the conversational activities (Ornaghi et al., 2011). This study also obtained mixed results, with an improvement in false belief understanding being found only in the older, 4-year-old group but no improvement seen in the 3-year-olds. Taken together, the findings from the above-mentioned studies suggest that training children in groups on mental state language through reading stories and discussion does not have a robust effect on ToM understanding.

It is important to mention that while the majority of studies within the conversational training approach have focused on false belief and applied false belief tasks to measure effects, a few of them have included other tasks. For instance, Astington and Peskin (2004) also measured the children's ability to comprehend and produce cognitive verbs. For their part, Ornaghi et al. (2011) also examined emotion understanding and pragmatic competence, which was measured with a brief pragmatic judgment test. Results revealed that training had a beneficial effect on emotion understanding and pragmatic competence only in younger, 3-year-old children, relative to a control group.

In sum, thus far findings with regard to the effects of conversation-based training with mental state language on ToM have been inconclusive. However, as mentioned above, most studies have focused on false belief measures and have not assessed other complementary competencies such as emotion understanding and pragmatic abilities.

The need for a multidimensional approach for assessing training effects

As mentioned, though awareness of false belief has been the primary focus of attention in prior research on social cognition, authors such as Wellman (2018) have criticized the false belief paradigm as an overly categorical measure for the very profound ability to attribute mental states to another person. Given these issues, using a multidimensional test battery can provide a more comprehensive understanding of a child's developing ability to interact socially. Thus, the current training study will adopt a multidimensional approach that incorporates not only false belief tests but also a mental state verb comprehension test, an emotion understanding test, and an expressive pragmatic test. It is expected that training children on the use of mental state terms (both cognitive and emotional) through conversation can also improve their conceptual understanding of underlying cognitive and emotional states. Therefore, we hypothesize also an improvement in the mental state verb comprehension test and in the emotion understanding test. Moreover, training children on taking perspective of the story characters and actively comparing such perspectives to their own may enhance their overall ability to be attentive to others' perspectives. We expect this to improve their ability to interact socially, as measured through an expressive pragmatic test in which children are presented with a series of social scenarios. The strategy of including multiple measures will allow for a more fine-grained empirical comparison of the efficacy of experimental interventions across tasks.

Although expressive pragmatic measures represent a comprehensive assessment of social ability, so far little attention has been devoted to assessing the potential positive effects on these skills of mental-state-related conversational interventions. As mentioned above, the study by Ornaghi et al. (2011) assessed gains in the receptive pragmatic competence of 3- and 4-year-old preschoolers, measured through a short pragmatic judgement test. Other intervention studies on pragmatic abilities have focused on specific and fairly advanced receptive pragmatic skills rather than on expressive pragmatic competence, training children, for example, on nonliteral meanings such as irony (Pexman et al., 2019; Szücs & Babarczy, 2017), metaphors (Białecka-Pikul, 2010; Cortés et al., 2018), or inferencing (Davies et al., 2020). In addition, most prior research on pragmatic training has concentrated on intervention programs designed to improve the pragmatic abilities of children with disabilities, specifically children with Autism Spectrum Disorder (for a recent review see Parsons, Cordier, Munro, Joosten, & Speyer, 2017; see also Adams et al., 2012), and also adults after traumatic brain injury (Bosco, Parola, et al., 2018; Gabbatore et al., 2015).

Thus, no study so far has fully assessed the potential effects of a focused classroom-based training intervention on the expressive pragmatic abilities of typically developing children. As for mental state verb comprehension and production, as we have seen, some previous studies have assessed the effect of conversational training on mental state verb comprehension along with other ToM measures (Astington & Peskin, 2004; Ornaghi et al., 2011). By the same token, other studies adopting a conversation-based approach have assessed affective social cognition. For example, in Tenenbaum, Alfieri, Brooks, and Dunne (2008) 5- to 8-year-old children were individually trained with story reading followed by explanatory conversations, yielding an increase in emotion understanding. Similarly, a study by Gavazzi and Ornaghi (2011) found that training 3- to 5-year-old preschool children in groups with conversational language games had a significant effect on their emotion comprehension. However, the present study is to our knowledge the first to assess the impact of conversational training on all three of these social cognition factors as well as expressive pragmatic competence.

Aims of the present study

The first overarching aim of the present study is to assess the potential positive effect of a four-week group-based conversational classroom intervention not only on false belief understanding, but also on two more aspects of social cognition (mental state term comprehension and emotion understanding) as well as expressive pragmatic abilities. We hypothesize that conversational mental state training for young preschoolers based on talking about mental and emotional states will enhance both their social cognition and their pragmatic skills. As mentioned above, we believe that such a multidimensional approach will provide richer insights into the effectiveness of training-based intervention than a unidimensional approach based exclusively on false belief tasks.

The second aim of the study will be to assess the potential effects of two different paradigms for conversational mental state classroom training, one involving conversation and verbal expression alone (*non-embodied* training) and the other involving both verbal and behavioral expression (*embodied* training), where children are asked to act out mental state concepts using gesture and prosody (see Adams et al., 2019 for an example of embodied training; see Pexman, 2019 for the role of embodiment in conceptual development). Following the embodied cognition approach which claims that cognition is highly dependent on sensory-motor experience, we test the hypothesis that we can boost the learning of new concepts (e.g., mental states) and pragmatic expressive behavior through perception and action (simulation). To our knowledge, this will be the first study to assess the role of embodied conversational training on social cognition and pragmatic learning. Given the strong relationship between pragmatic development and the development of multimodal communication, it is important to ask whether embodied forms of training are also effective for boosting expressive pragmatic abilities.

A growing body of research has highlighted that pragmatic development in children goes hand-in-hand with their use and understanding of gesture and prosody. First, many studies have investigated the co-development of gesture, prosody, and pragmatics at early ages, suggesting that in order to communicate their intentions preverbal children rely heavily on multimodal cues (see Esteve-Gibert & Prieto, 2018; Goldin-Meadow, 1998, 2014, for reviews). Second, several studies have shown that prosody and gesture continue to play an important role during the preschool years and pave the way for the acquisition of pragmatic skills (see Hübscher & Prieto, 2019, for a review). Despite this well-established relationship between pragmatics and multimodal development, however, little is known about whether multimodal training interventions based on face-to-face conversations can contribute to enhancing social cognition and expressive pragmatic skills. Since children benefit from multimodal cues and are sensitive to prosodic and gestural markers, we would expect that enacted training interventions that encourage the production of embodied, multimodal prosodic and gestural expressions of mental states and emotions will enhance their acquisition of social cognition and pragmatic skills. This study is intended to shed light on this issue. Though previous studies have assessed conversational mental state training interventions (with mixed results), no previous study has assessed the potential effect of embodied training interventions, that is, interventions involving the enactment of specific conceptual knowledge (mental states) through gestural and prosodic cues. If comparable training effects can be achieved with the embodied training paradigm we apply in the present study, this would be of particular relevance regarding children whose verbal language skills are weak, whether due to their developmental stage, linguistic impairments or a different linguistic background.

5.2. Method

The experiment consisted of a four-week between-subjects classroom-based training paradigm with a pretest and posttest design. Children 3 and 4 years of age were assigned to one of three training conditions: non-embodied conversational, embodied conversational, and control. From now on we will use the shorter term non-embodied and embodied conditions. This age range was selected because a large body of research has demonstrated that critical development of social cognition occurs during the early preschool period (e.g., Wellman, 2018).

5.2.1. Participants

Participants in the study were 3- to- 4-year-old Catalan-speaking children (*M* age = 44.75 months, *SD* = 3.27). All participants were preschoolers from two Catalan public schools located in the middle-income district of Sant Martí in the central district of Barcelona, where the population is largely Catalan-Spanish bilingual.[17] The main language of instruction in these schools is Catalan. Our training scheme was embedded within the school curriculum, that is, it was carried out during school hours, and a great majority of families (94%) provided written consent for their children's participation. Parents of participating children also completed an occupational status questionnaire, which yielded a mean ISEI score of 60.90 (*SD* = 13.23; see Ganzeboom, De Graaf, Treiman, & De Leeuw, 1992), confirming overall middle class status, as well as a language questionnaire regarding the daily exposure of their child to Catalan (mean overall exposure time = 59%, *SD* = 20.83). All children were typically developing children and had no history of speech, language, or hearing difficulties.

Although initially 117 students were enrolled in the training, 34 (14 from the control group, 10 from the non-embodied group, and 10 from the embodied group) ultimately had to be excluded from analysis, for different reasons. First, 15 of the initial recruits failed to meet the 20% minimum score in a screening test of Catalan vocabulary proficiency (see section 2.3.1 below). Subsequently, two children missed school and dropped out of the study, while 17 others were too restless or inattentive to participate during either the pretests or posttests (i.e., 11 children constantly refused to answer and participate, for example, by answering "I don't know" to the majority of the questions or providing only one type of answer, such as "yes" or "please" in response to all items; 5 children became distracted or tired so the testing session was stopped; one child asked to return to the class before completing all tasks). This left a final study sample of 83 children, of whom 46 were female and 37 male.

5.2.2. Materials and Procedure

This section will describe first the materials and procedure used in the screening measure and the pretest and posttest sessions, then the

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[17] According to the Barcelona City Council's Department of Statistics database for 2018, which can be accessed at https://www.bcn.cat/estadistica/catala/dades/anuari/cap06/C0616010.htm, 96% of the population of Sant Martí understands Catalan and 79% speaks it.

intervention. A diagram of the experimental procedure can be seen in Figure 1.

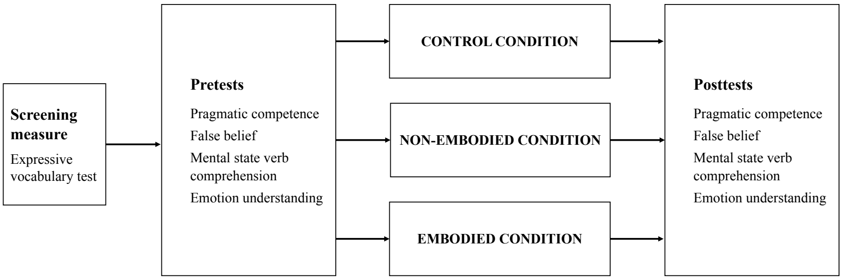


Figure 1: Experimental procedure.

Screening measure. Since Catalan was to be the language employed during the training intervention, participants were given a screening test to confirm that they all had a sufficient command of Catalan to successfully understand the tasks. The measure used was an expressive one-word vocabulary test designed to measure the lexical knowledge of Catalan-speaking children aged 0 to 6 by means of picture-naming tasks (Saborit Mallol, Julián Marzá, & Navarro Lizandra, 2005). The stimuli consist of 30 pictures of common objects such as a tree or a coat. Each participant is given credit for every correctly named item, and the total score (from 0 to 30) is then normalized on a 0–100 scale. For purposes of the present study, a minimum score of 20% was set as the eligibility threshold for participation. As noted above in Section 2.1, data from 15 children were excluded from analysis on this basis.

Pretest and posttest tasks. Pretest and posttest, which took place respectively before and after the four-week training intervention, followed identical procedures. Each child was tested individually at their corresponding school during school hours. The child was brought from his/her classroom to a quiet room where he/she was seated at a table beside an experimenter, either by the first author or by one of three trained research assistants. All testing was conducted in Catalan and the full session lasted around 30–35 minutes. Testing followed the same order for all children, with emotion understanding being tested first, followed by mental state verb comprehension, false-belief understanding, and pragmatic competence. The materials used to measure these abilities and the corresponding procedure are described in detail below.

Pragmatic competence. Children's expressive pragmatic competence was assessed by means of the Audiovisual Pragmatic Test (APT) (Pronina et al., 2019), which was designed to assess pragmatic abilities in Catalan-speaking children from early childhood to adolescence. The test was developed to assess expressive pragmatic abilities in terms of the appropriateness of a spoken reaction to a discourse prompt. The general design, item coverage, and elicitation procedure of the APT is based on currently used pragmatic tests for children (e.g., TOPL-2 (Phelps-Terasaki & Phelps-Gunn, 2007b) and CASL–2 (Carrow-Woolfolk, 2017)). In broad terms, the procedure is based on the Discourse Completion Task method, in which an everyday social context is described and then the participant is asked to respond with the speech act that would be most natural in that context. The APT contains a total of 47 items, accompanied by illustrations, that represent different contexts that might plausibly occur in a child's everyday life (see Figure 2 for an example).

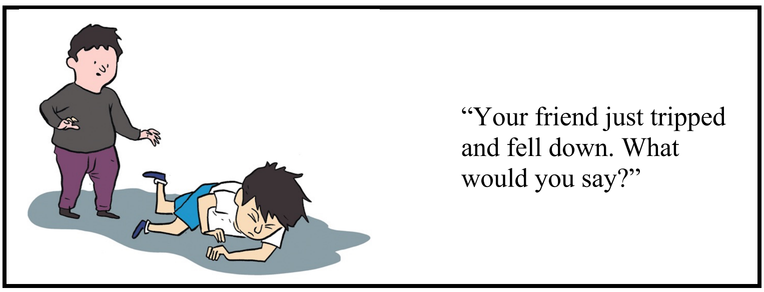


Figure 2. Sample item from the Audiovisual Pragmatic Test showing text in English translation and illustration intended to elicit an expression of concern for a friend.

For the purposes of this study, only the first 35 items were selected, given that the test takers were 3- to 4-year-old children who would be unlikely to have encountered in their daily lives the more complex pragmatic situations presented in the last 12 items. The items were presented in a fixed order, and two familiarization trials were carried out, prior to the test trials. For each item, the examiner described the social situation represented in the picture in a lively fashion appropriate for a preschooler while the child looked at the illustration displayed on the computer screen. The examiner then asked the child to respond appropriately as if he/she was taking part in the situation.

Each answer was given a score ranging from 0 to 2. A score of 2 was given if the answer was a target speech act of high pragmatic quality, meaning that the child managed to utter the intended speech act and showed social adjustment. For example, in a situation in which the child was prompted to ask for a piece of cake, if the child uttered a sentence along the lines of "Can I have a piece?" this was given a score of 2, since it was the target requesting speech act and the child had reacted appropriately from a social point of view. By contrast, a score of 1 was given if the child managed to produce the target speech act but the answer was not quite socially appropriate. Depending on the situation, this might mean that the child said too much or too little or answered too directly. For example, if when asking the aunt for a piece of cake the child said something like "Give me a piece", the answer was given a score of 1 since the child was able to express a request but was too demanding or insufficiently polite in doing so. A minimum score of 0 was given if the child did not provide any answer, provided an unrelated answer, or answered in a socially inappropriate way. For example, if when refusing the cake the child said, "Give me more", the answer was scored as 0 since the child had clearly not understood the situation. If when prompted to express concern for a friend who had just tripped and fallen down the child did not manage to express worry and simply said something like "You fell" in a blunt way, a score of 0 was given. On the other hand, an appropriate answer to this item like "Are you alright? Do you need help?" was scored as 2. Each participant's scores were averaged to produce a general pragmatic appropriateness score, the maximum score possible being 70 (35 items × maximum 2 points). The total duration of the APT was around 15 minutes.

False belief understanding. The first type of measure used to assess children's social cognition tested their false belief understanding. Two tests were used for this purpose. The first one was the classic "Sally and Anne" change-of-location task (Baron-Cohen et al., 1985), in this instance adapted to Catalan (Armstrong et al., 2018). The task was presented in video format, with the video showing short sequences involving puppets (see Figure 3). The child was asked two questions, the first a false belief test question ("Where will the princess look for the ball?"), the second a control question ("Where is the ball really?"). A score of 1 was given for each correct answer to the two questions.

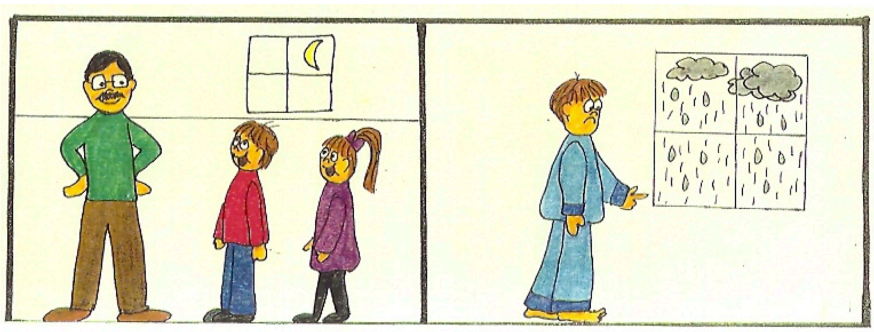
Figure 3. Stills of a video sequence from the false belief task. From left to right: (1) the princess puts a ball in the purple box and leaves; (2) the lion moves the ball from the purple box to the gold box; (3) the princess comes back.

The second measure was the "Smarties" unexpected content task (Gopnik & Astington, 1988). In this task, the experimenter gives the child the characteristic tube in which Smarties chocolate candies are sold. In this case, the Smarties tube used in the original task was replaced with a similar tube used by a local candy brand, *Lacasitos*, which would be familiar to Catalan children. The child opens the tube and finds that it contains pencils, not candies. The experimenter then asks the child two questions, in this order: a self-test question ("What did you think was in the box before you opened it?") and an other-person-test question ("What would your friend think was inside the box before it was opened?"). A score of 1 was given for each correct answer to the two questions. Scores from the two tasks were added to yield a composite ToM score ranging from 0 to 4. The administration of the two tasks took approximately 5 minutes in total.

Mental state verb comprehension. A second measure of the cognitive aspect of social cognition, the conceptual comprehension of cognitive mental states, was assessed using the Metacognitive Vocabulary Test (MVT) (Astington & Pelletier, 1998), which is designed for 3- to 7-year-old children. The test consists of a total of 12 short stories accompanied by images and measures children's ability to discriminate among mental state verbs describing the main character's state of mind (see Figure 4). Following Ornaghi et al. (2011), only the first six stories were used due to the young age of the participants. The mental state verbs assessed in the first six stories include *know*, *remember*, *guess*, *figure out*, *wonder*, and *forget*. For the purposes of this study, the test was translated from

English into Catalan by the second author of the study, with the translation checked by a Catalan native speaker.

First, two training items were administered so that the child would understand the test procedure. Then the six stories from the MVT were read to the children. After each story they were asked to select which of two cognitive verbs correctly described the main character's state of mind. One point was awarded for each correct verb choice. The range of possible total scores was therefore from 0 to 6. The duration of the test was around 5 minutes.



"Then Dad comes into the room and says, "Time for bed. If it's sunny tomorrow, we'll go to the park." In the morning John gets out of bed and looks out the window. He sees the rain pouring down. "Oh no," says John, "Look at that! We won't be going to the park today." Tell me: Does John *know* it's raining or does John *remember* it's raining?"

Figure 4. Sample item from English version of the Metacognitive Vocabulary Test showing the illustration (left) and corresponding text to be read to the child (right), including the prompt question in which the child is asked to decide between two mental state verbs (in italics).

Emotion understanding. To assess the affective aspect of social cognition, the Emotion Matching Task (EMT), originally designed for English-speaking preschool-aged children by Izard, Haskins, Schultz, Trentacosta, and King (2003) was used. The EMT has been translated and adapted for preschool children in Spain (Alonso-Alberca et al., 2012), and the Spanish version has also been translated into Catalan by the same authors. The EMT measures the emotion comprehension of 3- to 6-year-olds and focuses on four basic emotions: happiness, sadness, anger, and fear/surprise. In the present study, only the two most discriminating parts of the EMT were administered: the expression-situation matching subtest and the expression labeling subtest. The expression-situation matching subtest consists of a total of 12 items. The child is asked to indicate which of the four pictures expressing diverse emotions or a 'neutral' face match a described situation (see Figure 5, left panel). Following standard procedure, children were awarded one point for each correct answer, yielding a possible maximum score of 12 points. The expression labeling subtest consisted of a total of 12 pictures that assess the child's ability to name emotions (see Figure 5, right panel). Children were awarded one or two points, depending upon accuracy in labeling, for each correct answer, yielding a possible maximum score of 24 points. The range of possible total scores was thus from 0 to 36. Altogether the EMT took approximately 10 minutes.

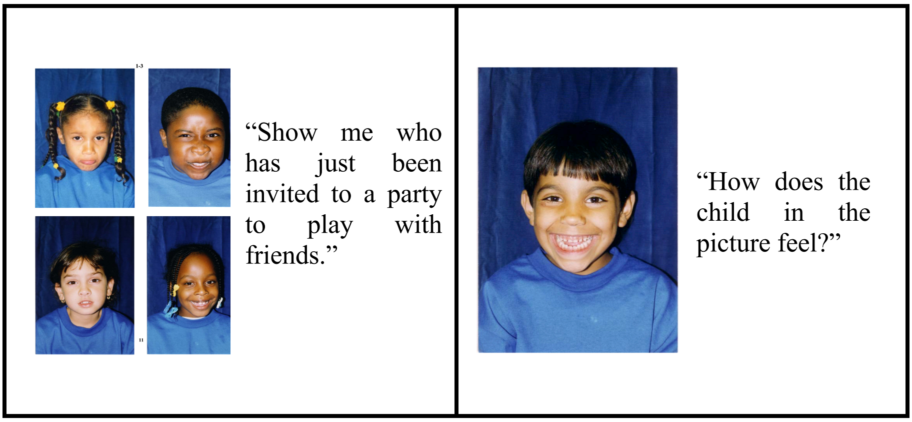


Figure 5. Sample items from the English version of the Emotion Matching Task showing texts to be read to the child and accompanying illustrations. Left panel shows a sample from the expression-situation matching subtest, with children displaying, clockwise from top left, sad, angry, happy, and neutral expressions. Right panel shows a sample from expression labeling subtest.

Training sessions. The materials for the eight training sessions were taken from the *The Adventures of Jack and Theo* (Ornaghi & Grazzani, 2020), a set of stories specifically designed for and used in the training study by Ornaghi et al. (2011). The set comprises 16 stories arranged in order of increasing difficulty that narrate the adventures of two characters, Jack and Theo. The first eight stories were translated into Catalan for use here (a sample is provided in the Appendix). Then high-quality audio recordings were made of the stories being read aloud in child-directed speech by a preschool teacher under the supervision by the second author to ensure that the engagement level expressed by the reader was uniform. Finally, eight short videos were created using the audio tracks accompanied by illustrations from the original materials by Ornaghi et al. (2011)[18].

The eight stories used in this study are enriched with two types of mental state terms, both cognitive (e.g., *think, know*) and emotional (e.g., *get angry, get scared*). A total of 12 mental state terms were trained: eight of them were cognitive mental state terms and four of them emotional mental state terms (see Table 1). Each of the eight stories trained two terms, either one cognitive state and one emotional state, or two cognitive states. For example, in the sample story provided in the Appendix, the two terms are *believing* (cognitive) and *getting upset* (emotional). Thus, the eight cognitive state terms each appeared once in the full set of eight stories, whereas the four emotional state terms each appeared twice.

Table 1. Target cognitive and emotional mental state terms contained in the training materials.

Cognitive mental state terms	Emotional mental state terms
wanting	*getting delighted*
remembering	*getting upset*
knowing	*getting angry*
thinking	*getting scared/surprised*
believing	
deciding	
doubting	
wondering	

Once the audiovisual prompt materials were ready, scripts were prepared for the trainer who would conduct the training sessions in the two experimental groups. In contrast with Ornaghi et al. (2011), the scripts for the training procedure were highly controlled. After listening to the story, the children in the experimental groups participated in a group interaction with the teacher. The key difference between the two experimental conditions consisted in the

[18] All training materials including stories in video format in Catalan, scripts, instructions and examples of training sessions can be found on the specifically designed educational website https://entrenemlesemocions.wordpress.com.

instructions given by the experimenter. In the non-embodied condition, children were asked to tell what the story character or they themselves say when they have a certain mental state, whereas in the embodied condition, children were (1) asked to tell the same but, importantly, (2) the experimenter also encouraged children *to show* what the story character or they themselves do when they have this mental state. In this manner, the non-embodied group answered only verbally during the training, while the embodied group answered verbally and also enacted the answers. Since the training in both groups was kept the same amount of time, the embodied group necessarily practiced less in answering verbally, i.e., using mental state terms and focused primarily on the enactment of the different cognitive and emotional states.

As exemplified in Table 2, which contains part of the script for Story 8 (see Appendix), all scripts followed the same general scheme. First, the trainer directs the children's attention to the first target term; once discussed, the second target term is introduced. Questions for both target terms also follow the same design: the children are asked a series of six questions in a fixed order. However, as can be seen in the table, the non-embodied training vs. embodied training variants of the script differ with regard to the second and fifth of these questions: questions in the non-embodied variant merely ask the children to report what story characters said, whereas questions in the embodied variant ask the children to report what characters said and to show what they did.

Table 2. English translation of partial script for training session corresponding to Story 8, showing the variants corresponding to the two experimental conditions. Target emotional state term: *getting upset*.

Non-embodied condition	***Embodied condition***
1. Do you remember that in the beginning of the story Theo asked Sara the Sea-Turtle: "What happened? Why are you crying?" Today we are going to play using the words "getting upset". Do you remember why Sara was upset and why she was crying?	
2. *What did Sara <u>say</u> when Theo found her stuck in a hole?*	**2.** **What did Sara <u>do</u> when Theo found her stuck in a hole? Can you tell me what she <u>said</u>?**

3. What makes you upset?	
4. What makes your friends upset?	
5. *What would your friend say if his favorite toy broke?*	**5. What would your friend say if his favorite toy broke? What would he do in this situation? Can you show me?**
6. Well, children, you've been very good. We have been playing using the words "_____". (Children finish the sentence)	

The two variant scripts were previously memorized by the trainer, a professional primary school teacher and stage actress. She was also instructed to provide positive feedback for every appropriate response, which would be either verbal or multimodal depending on whether she was working with the non-embodied or embodied group. Also, if it was apparent that the children were having troubling responding, the trainer was instructed to ask additional questions to encourage participation. In all instances, the children were to be given a model answer regardless of how they performed. For example, for the term *getting upset* trained in Story 8, the trainer would give an example of the verbal answer "I'm so upset, I got stuck in a hole and I can't get out" in the non-embodied condition. In the embodied condition, the experimenter would provide the same verbal answer but also use appropriate prosodic and gestural cues to express being upset as she spoke; the gestural and prosodic patterns were stipulated for each of the target mental states and rehearsed by the trainer prior to the experiment (see Figure 6). Further, in the embodied condition, children were to be encouraged at certain points to enact the target mental state as a group.

Target term: **getting upset**	Target term: **getting delighted**	Target term: **thinking**	Target term: **remembering**
Gestural cues: Head down, downcast eyes, downturned mouth, lowered eyebrows	Gestural cues: Smiling, brightened eyes, raised eyebrows	Gestural cues: Wrinkled and furrowed eyebrows, averted gaze	Gestural cues: Upturned gaze, squinted eyes, hand on mouth or chin
Prosodic cues: Reduced pitch range, slower speech rate	Prosodic cues: Increased pitch range, increased speech rate, high intensity	Prosodic cues: Less varied pitch range, normal speech rate	Prosodic cues: Hesitations (silent or filled pauses), slower speech rate, rising intonational contour

Figure 6. Examples of the trainer modeling target terms and the prosodic and gestural cues employed for each term.

The materials and training sessions for both conditions were previously piloted on a group of 19 3-year-old children, who did not take part in the subsequent main study.

Following the administration of the pretest, the participating children were assigned to one of three different conditions. In order to guarantee a homogeneous distribution of children across the three conditions, a special algorithm[19] was written to control for potential differences in the abilities measured. Once the children were distributed into groups according to the results of the algorithm, a separate one-way ANOVA analysis was run for each pretest measure, results on the expressive vocabulary screening test, and age to check that the three groups were not statistically different. For comparison purposes all test scores were normalized to a 0–100 scale. As can be seen in Table 3, ANOVA analysis confirmed that the groups did not significantly differ ($p > .05$ in all cases).

[19] The python algorithm that was used to assign participants to experimental conditions while taking into account children's class distribution and preserving general similarity of conditions across groups is freely available on Github repository.

Table 3. *P* values resulting from three-group ANOVA comparison of pretest measures, screening test scores, and mean age.

Measures	***p***
Pretest:	
Pragmatic competence	.72
False-belief understanding	.62
Mental state verb comprehension	.46
Emotion understanding	.98
Screening test	.53
Mean age	.56

Children underwent one of three possible interventions in small groups of about 12 children over four weeks in eight sessions lasting between 20 and 25 minutes. Sessions occurred twice a week on nonconsecutive days. They took place in a quiet classroom at the children's school and were videotaped using three cameras simultaneously. One camera was directed at the experimenter, another at the children, and the third provided an image of the full setting.

The three between-subject conditions distinguishing the groups were: 1) no specific training in social cognition or pragmatic competence skills (the control group, 30 children); 2) training consisting of experimenter-led conversations which encouraged children to reflect on the mental states of themselves and others (the non-embodied experimental group, 27 children); and 3) training consisting of conversations which encouraged children to not only reflect on but also act out mental states (the embodied experimental group, 26 children). In all three conditions, at the beginning of each session, the children watched a video telling a story enriched with mental state vocabulary (see Table 1). Children in the control group then simply carried out non-conversational activities related to the story, like drawing pictures or solving puzzles depicting sea creatures and other animals, for the remainder of the session. By contrast, children in the experimental groups received one or the other variant of the conversational training intended to enhance their social cognition and pragmatic competence skills. Unlike the control group, these two groups followed scripted procedures.

However, the time taken up by the intervention sessions was kept strictly uniform across all three groups.

We will now describe the procedures followed in the two experimental groups. The same trainer performed the training for both groups. The first author also remained present during each session in order to monitor the time and ensure proper execution of the script by the trainer. Depending on the group, the trainer followed one or the other variant of the script. In the non-embodied training group, this meant involving the children in a question-driven narrative-based conversation in which they were asked to reflect on a particular mental state in not only themselves but also other people. In the embodied group, children were asked to both reflect on the target concept and also act it out using prosody and gesture. In each session, this procedure was followed for two separate mental states, linked through one of the stories involving Theo the Shark. The two photos in Figure 7 show the experimental setup of training sessions in the non-embodied and embodied conditions.

Figure 7. Training session photographs. The left panel shows the non-embodied condition, and the right panel the embodied condition.

Throughout each training session, the trainer encouraged participants to use the target terms as much as possible. She also motivated children to participate actively in the conversation and ensured that all of them were involved in the activity. After the completion of each individual session, each child's level of engagement in the training session was evaluated together by the trainer and the first author who remained present during all training sessions. The child’s participation, concentration and adequacy of responses were given a separate score using a Likert scale ranging from 0 (low participation, low concentration, non-adequate and unrelated responses) to 5 (high participation, high concentration, adequate and related responses) and then were combined into a composite engagement score. An independent samples t-test analysis showed that the two training conditions did not differ significantly in the level of engagement ($t(51) = 0.18$, $p = .86$).

5.2.3. Statistical analyses

The data from pretest and posttest were compared within and across the three groups using a linear mixed-effects model in R version 3.6.1 (R Core Team, 2020) with the *lme4* package (Bates, Mächler, Bolker, & Walker, 2015). A total of four linear mixed-effects models were run with each of the tests measuring different abilities assessed (pragmatic competence, false belief understanding, mental state verb comprehension, and emotion understanding) as the dependent variable. Condition (three levels: control condition vs. non-embodied training condition vs. embodied training condition), Test (two levels: pretest vs. posttest), and their interaction were set as fixed factors. Predictors were coded using mean-centered effects coding. Likelihood ratio tests suggested that inclusion of the Age variable significantly improved the fit of all four models, therefore Age was also set as a fixed factor. A random intercept was set for participants; random slopes were not included due to non-convergence of the model. The post-hoc pairwise comparisons were computed with the *emmeans* package (Lenth et al., 2018). Partial eta-squared values for effect sizes were extracted using the *sjstats* package (Lüdecke, 2016). Using likelihood ratio tests, the gender variable was found to be not statistically significant for models and was left out of future subsequent analyses. The engagement variable could not be included in the linear mixed models due to the missing data for the children in the control group who were not given the engagement score. However, in order to check for possible effects of the engagement level, we run four linear regression models, with the gain of the outcome variables (pragmatic competence/ false belief understanding/ mental state verb comprehension/ or emotion understanding) as a dependent variable and the engagement score as an independent variable. In none of the four models did the engagement variable turn out to be a significant predictor.

We conducted a set of four post hoc power analyses using the software package G*Power (Faul et al., 2007), one for each model.

A generally acceptable power is of .80 (J Cohen, 1988). The power of all four statistical models was greater than .80 to detect a small effect size (0.25) and with α at .05.

The analyzed dataset is available on Github repository.

5.3. Results

Pragmatic competence

For pragmatic competence, the linear mixed-effects model analysis revealed a significant main effect of Test ($\beta = 2.26$, $t = 4.024$, $p < .001$) and Age ($\beta = 5.17$, $t = 3.702$, $p < .001$). There was no significant main effect of Condition. The full estimates are given in Table 4. The estimated mean percentages of correct responses were 21.15 ($SD = 15.06$) for the pretest and 25.66 ($SD = 13.84$) for the posttest. Further, a significant interaction between Condition and Test was found for pragmatic competence ($\beta = 1.40$, $t = 2.484$, $p = .015$), showing a difference in the pragmatic scores among control, non-embodied, and embodied conditions depending on the time of the administration of the test (pretest vs. posttest). Post hoc pairwise comparisons likewise showed a difference in the pragmatic scores among control, non-embodied, and embodied conditions depending on the time of the administration of the test. Specifically, post hoc pairwise comparisons revealed that the difference between pretest and posttests pragmatic scores was statistically significant in the two experimental groups ($\beta = -5.71$, $t = -2.897$, $p = .005$ for non-embodied group, $\beta = -0.81$, $t = 3.746$, $p < .001$ for embodied group), with better scores in the posttest, but not in the control group ($\beta = -7.53$, $t = -0.433$, $p = .666$).

Table 4: Model specification and estimates for pragmatic competence

Fixed effects	*β*	*SE*	*t*	*p*
Intercept	23.41	1.38	16.92	< .001
Condition	-0.51	1.40	-0.362	.718
Test	2.26	0.56	4.024	< .001
Age	5.17	1.40	3.702	< .001
Condition: Test	1.40	0.56	2.484	.015

To illustrate this, the mean observed percentages of correct responses by test time for each training condition are given in Table

5, along with estimates and partial eta-squared values. These patterns are graphically illustrated in Figure 8.

Table 5: Mean (SD) percentages of correct responses on pretest and posttest, *β, SE, t*, and *p* values and effect sizes (ηp^2) for the test of pragmatic competence, broken down by condition.

	Pretest	Posttest	*β*	*SE*	*t*	*p*	ηp^2
Control condition	22.76 (16.98)	23.57 (16.41)	-7.53	1.87	-0.433	.666	.009
Non-embodied condition	20.95 (13.83)	26.67 (11.10)	-5.71	1.97	-2.897	.005	.202
Embodied condition	19.51 (14.30)	27.03 (13.41)	-0.81	2.01	3.746	< .001	.256

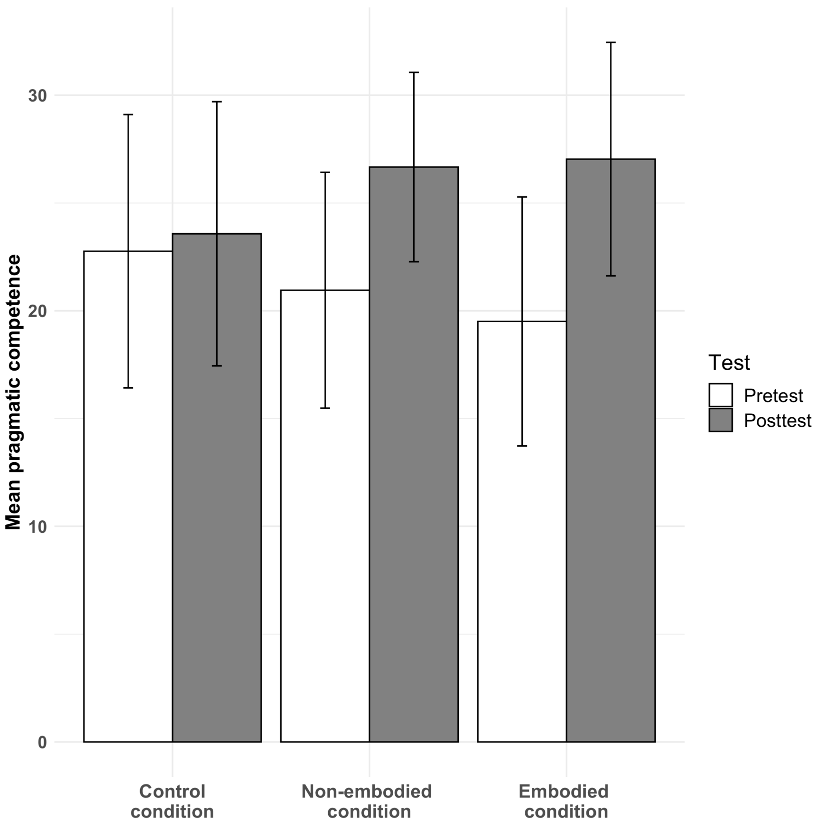


Figure 8. Mean overall pragmatic score, broken down by condition (control vs. non-embodied vs. embodied) and test (pretest vs. posttest). Error bars represent 95% confidence intervals of the means.

False belief understanding

The linear mixed-effects analysis showed no significant main effect of Condition, Test, or Condition × Test interaction for false belief understanding; only Age turned out to be significant (β = 6.88, t = 3.602, p = .001). The full estimates are given in Table 6. The mean percentage of correct responses at the pretest was 35.83 (*SD* = 23.38), 41.67 (*SD* = 23.00), and 40.38 (*SD* = 24.57) for the control, the non-embodied and the embodied group, respectively. At the posttest, the mean percentage of correct responses was 35.83 (*SD* = 18.20), 45.37 (*SD* = 25.04), and 39.58 (*SD* = 23.22) for the control, the non-embodied and the embodied group, respectively.

Table 6: Model specification and estimates for false belief understanding.

Fixed effects	β	*SE*	*t*	*p*
Intercept	39.71	1.90	20.893	.000
Condition	1.17	1.92	0.607	.546
Test	0.55	1.51	0.367	.715
Age	6.88	1.91	3.602	.001
Condition: Test	-0.03	1.52	-0.018	.985

Additional analyses that took into account the type of false belief task and initial ToM performance at pretest did not lead to substantively different results.

Mental state verb comprehension

With regard to mental state verb comprehension, no significant differences between pretest and posttest scores were found for any of the groups. There was no significant main effect of Test or Condition and no significant Condition × Test interaction; Age was the only significant predictor (β = 3.96, t = 2.308, p = .024). The full estimates are given in Table 7. The mean percentage of correct responses at the pretest was 47.78 (*SD* = 21.77), 53.70 (*SD* = 17.50), and 48.72 (*SD* = 16.28) for the control, the non-embodied and the embodied group, respectively. At the posttest, the mean percentage of correct responses was 52.30 (*SD* = 21.23), 50.62 (*SD* = 17.59), and 47.44 (*SD* = 18.07) for the control, the non-embodied and the embodied group, respectively.

Table 7. Model specification and estimates for mental state verb comprehension.

Fixed effects	*β*	*SE*	*t*	*p*
Intercept	50.11	1.71	29.389	.000
Condition	-1.17	1.72	-0.681	.498
Test	0.11	1.51	0.098	.922
Age	3.96	1.72	2.308	.024
Condition: Test	-1.24	1.14	-0.089	.280

Emotion understanding

The linear mixed-effects analysis revealed a significant main effect of Test ($\beta = 8.11$, $t = 7.885$, $p < .001$) and a marginal effect of Age ($\beta = 2.90$, $t = 1.980$, $p = .051$) for emotion understanding. No significant main effect of Condition was found, nor any significant interaction between Condition and Test. The full estimates are given in Table 8.

Table 8: Model specification and estimates for emotion understanding.

Fixed effects	*β*	*SE*	*t*	*p*
Intercept	5577	1.45	38.431	< .001
Condition	1.15	1.46	0.787	.433
Test	8.11	1.03	7.885	< .001
Age	2.90	1.46	1.980	.051
Condition: Test	1.52	1.03	1.478	.143

Mean percentages of correct responses on emotion understanding pretests and posttests as well as estimates and partial eta-squared values for each condition are given in Table 9.

Table 9. Mean (SD) percentages of correct responses on pretest and posttest, *β, SE, t*, and *p* values and effect sizes (*ηp2*) on the test of emotion understanding, broken down by condition.

	Pretest	Posttest	*β*	*SE*	*t*	*p*	*ηp2*
Control condition	47.50 (16.69)	61.20 (17.12)	-13.7	3.42	-4.010	< .001	.303
Non-embodied condition	48.25 (18.15)	62.24 (14.64)	-14.0	3.60	-3.884	< .001	.214
Embodied condition	47.33 (17.59)	68.59 (13.96)	-21.3	3.67	-5.791	< .001	.539

5.4. Discussion and conclusions

The results obtained in the present study reveal that young preschool children who received training in either of the two experimental conditions (non-embodied or embodied conversational training) significantly improved their pragmatic skills as compared to a control group that received no training. Pairwise comparisons confirmed that the pragmatic competence posttest score improved relative to from the pretest score only in the two experimental conditions. On the other hand, with regard to social cognition skills related to false belief understanding, mental state verb comprehension, and emotion understanding, these remained unchanged from pretest to posttest in all conditions.

One of the main findings of the study is that training preschoolers through either non-embodied or embodied conversation about mental state leads to an improvement in their pragmatic score, suggesting that children benefit from a short classroom specific intervention in acquiring pragmatic competence. It is worth noting that the duration of training sessions was kept constant across the two different experimental groups (and also the control group). As a consequence, while the children in the non-embodied group had solely practiced the use of mental state terms, the children in the embodied group had less opportunity to practice using these verbs since part of the session was devoted to acting them out. Crucially, however, the results show that the two types of training were equally effective. The fact that children in the embodied condition did as well as (and even slightly better than) the children in the non-embodied group, despite experiencing less exposure to verbal training, is a significant finding, because it means that bodily actions can be as effective as the use of words.

Placing our results in a broader context of training studies within the embodiment framework, in line with prior research, this study shows the efficacy of embodied training. Previous embodied interventions provided evidence that the effect of embodied training was comparable or even more pronounced than the non-embodied training. They demonstrated that embodied training can foster a variety of competences in children, such as reading skills (Adams et al., 2019) and numerical competences (Dackermann et al., 2017), and can help with learning a foreign language (Macedonia & Knösche, 2011). Overall, our findings emphasize the value of embodied training also for the domain of pragmatic abilities and support a multimodal view of language that the role of embodiment in training mental states. All in all, these findings suggest that the embodied training has great potential to be adapted to children with low verbal abilities or atypically developing children (e.g., children with Autism Spectrum Disorder or Language Impairment) who would especially benefit from it. If comparable training effects can be achieved with the embodied training paradigm we apply in the present study, this would be of particular relevance regarding children whose verbal language skills are weak, whether due to their developmental stage, linguistic impairments or a different linguistic background.

While the two types of conversational training had beneficial effects on pragmatic abilities, the performance on the social cognition tasks surprisingly did not differ across conditions in the posttest. With respect to false belief understanding, none of the three groups (control, non-embodied, and embodied) showed any significant increase in false belief performance. Modified analyses that included only children who achieved at most a 50% score in the false belief tasks in the pretest or took into account the type of false belief task did not improve the statistical model. Our results contrast with the positive results of the first training interventions on ToM (Appleton & Reddy, 1996; Lecce, Bianco, Demicheli, et al., 2014; Melot & Angeard, 2003; Slaughter, 1998; Slaughter & Gopnik, 1996). The different training outcomes on ToM performance found in the current and the previous studies may be most likely due to differences in the nature of the training. In the abovementioned training studies, children were essentially trained to pass false-belief tasks and enhanced their performance on these tasks at the posttest. Although we used the same standard measures of false-belief at pretest and posttest, our training consisted of interactive conversations about the mental state concepts presented in the stories, so that children were not directly trained to perform on false-belief tasks, which might explain why no effect on ToM ability was found. The present results also contrast with the specific linguistic interventions carried out by Hale and Tager-Flusberg (2003) and Lohmann and Tomasello (2003). In these linguistic interventions, children were trained on specific syntactic structures that provide children with the format for representing false belief responses and, as a consequence, the training helped them to pass false-belief tasks. By contrast, in the present intervention, children were not specifically trained to handle false belief tasks through syntactic structures, and the training focused on conversational narrative-based rather than linguistic aspects of false-belief understanding. In line with our results, other conversational training studies reported negative (i.e., no improvement in ToM) or mixed findings (e.g., improvement only in some ToM tasks but not others) (Astington & Peskin, 2004; Esteban et al., 2010; Guajardo & Watson, 2002; Ornaghi et al., 2011). Importantly, it is known that children gradually acquire an understanding of mental states (see Wellman & Liu, 2004) and a lack of a positive effect on ToM may be explained by false belief tasks using an 'all-or-nothing' evaluation approach being unable to detect small developmental achievements. All in all, it seems that, in contrast with more focused training tasks (false belief training and syntactic structure training), the present study underlines that conversational training does not necessarily lead to improved performance on ToM, but is highly suited to training pragmatic skills.

Concerning mental state verb comprehension, as in the case of false belief understanding, the results showed that training did not lead to improved performance in any of the groups, whether experimental or control. This is consistent with previous studies reporting negative results after a similar conversational training (Astington & Peskin, 2004) and preschoolers' failure on the mental state verb comprehension test after conversational training on emotions (Grazzani & Ornaghi, 2011). Importantly our results on this task show that 3- to 4-year-olds still could not fully discriminate between different mental state verbs, as the percentage of correct choices found was at chance level (around 50%), both at pretest and posttest. Prior research suggested that the acquisition of mental state terms is a slow process that begins around 4 years of age and continues over a long period of time, with some terms being acquired only in the school years (Antonietti et al., 2006). So, it could be that 3- to 4-year-old children were simply too young to pass this task, as it is generally recommended for use with children older than 4.

Regarding the emotion understanding test, children in all three conditions performed significantly better in the posttest than in the pretest. Again, although all three groups improved, the differences in posttest scores across conditions were not significant. In our view, the fact that the control group also showed improvement can be explained by the nature of the specially designed stories read to the children in all three conditions, in which emotional concepts played a prominent role. The results suggest that exposure to stories enriched with emotional state terms, even when the terms are not specifically trained and discussed with children, can enhance children's emotion comprehension. The same effect did not hold for mental state verbs since, as mentioned above, the test of mental state verb comprehension may have been too complicated for the preschoolers. Finally, an alternative explanation for the improvement in emotion understanding in all three conditions could be the learning effect obtained from the repetition of the task in the posttest phase.

From a methodological perspective, the current findings reveal the importance of adopting a multidimensional perspective in the assessment of social abilities in young preschool children, and importantly include measures of the children's expressive conversational pragmatic competence. To our knowledge, Ornaghi et al. (2011) is the only prior study to have assessed the effects of conversational training in promoting typically developing preschooler's pragmatic abilities (albeit receptive, not expressive, abilities), obtaining mixed results and different effects for different age groups. Importantly, instead of the short pragmatic judgement test used in Ornaghi et al.'s study, the present study used a more comprehensive expressive pragmatic task in which the children were presented with a series of everyday social contexts and then asked to use language in a social way themselves. Though Ornaghi et al. (2011) also trained children in understanding and actively using mental state language, the present intervention was twice as short, yet positive effects were nonetheless obtained. The results of this study thus help to highlight the important role of language-based conversational training in improving preschooler's expressive pragmatic abilities. On one hand, one might expect the same pattern of results for receptive pragmatic domains, such as conversational perspective-taking ability or figurative language comprehension since the understanding of beliefs, emotions, and perspectives is crucial for these pragmatic abilities. On the other hand, though, since the results of the present study showed no positive training effects in the receptive domains (e.g., understanding of false belief, mental verb comprehension it is also plausible that the training might not have an impact on other receptive pragmatic skills such as metaphor or irony comprehension. Future research may shed more light on this issue. In the context of our study, and in comparison, with other developmental measures, the expressive pragmatic test has been shown to be a highly sensitive tool that successfully captures children's learning outcomes with respect to social cognition measures. We thus suggest that researchers and practitioners include a measure of children's expressive pragmatic skills in studies that seek to assess mental state training outcomes in preschool children.

From a theoretical point of view, the results of the present study shed light on the complex relation between ToM and pragmatics, which is still open to debate (see Pronina et al., submitted discussing the relation of ToM and pragmatic ability in development). Though it is indisputable that pragmatics and ToM are conceptually related (Cummings, 2015), the specific nature of this relationship is still unclear. Divergent theoretical perspectives about the link between the two have emerged (Lecce et al., 2019): according to one approach (Frank, 2018; Westra & Carruthers, 2017), ToM is regarded as pragmatic in nature; according to another approach (Sperber & Wilson, 2002), pragmatics is regarded as a sub-module of ToM. Additionally, a view proposed by Bosco, Tirassa, et al. (2018) argues that ToM and pragmatics may overlap in functioning but are not identical. Our results showed that mental state training only led to improved pragmatic scores but had no influence on false belief performance. This finding highlights the distinct outcomes brought about by training on ToM and pragmatics, adding new evidence in support of the notion that ToM and pragmatics might be separable capacities, in line with Bosco et al. (2018). In addition, our results show that mental state understanding, a capacity which has been primarily associated with ToM, can foster the ability to interact in a socially appropriate way, an ability which was not directly trained. Thus, the observed development of the ability to interact socially points towards a generalization effect of the intervention. The training on mental states may have sharpened children's awareness of not only the mental states but also the emotions of others, enhancing their ability to interact socially. In other words, children's increased ability to pay attention to others' perspectives, which is necessary to achieve successful communication, combined with their increased ability to react in a socially appropriate way, resulted in improved performance on the pragmatic test. In sum, the results from the study provide indirect evidence that ToM and pragmatics constitute two distinct but complementary abilities and also show the generalization effect of mental state understanding on pragmatic abilities.

This study has a few limitations. First, it would have been of value to extend the duration of training in order to detect potential differences between the two experimental conditions. The posttest scores of the two training groups differed as indicated by the larger effect sizes in the embodied group for the pragmatic competence and emotion understanding variables; however, the difference was not statistically significant. Based on the difference in effect size in the present study, one might expect more prolonged training to lead the embodied group to outperform the non-embodied group. Second, it would have been useful to have the children perform the same battery of tests again several months after the posttest to test the longevity of the intervention effects. Future research will be needed to confirm and expand on the present findings.

Overall, the present study highlights the important role of conversational classroom interventions in improving pragmatic abilities, whether accompanied by embodied communicative behaviors or not. These results are of special relevance to educational practices since the sort of conversational training described here can be easily applied to a variety of preschool classroom contexts, as well as laying the foundations for socio-cognitive training-test batteries with atypically developing children. From an educational point of view, it is important to highlight that the current experimental conversational classroom intervention, both embodied and non-embodied, was carried out in the naturalistic context of schools and can thus be easily applied to a variety of educational settings. To this end, the training materials used in this study and accompanying instructions are freely available online at https://entrenemlesemocions.wordpress.com to aid preschool teachers to incorporate aspects of conversational training through embodiment into their classrooms. Moreover, the current findings reveal that from a methodological perspective it can be beneficial to adopt a multidimensional perspective and to include measures of children's expressive pragmatic competence to obtain a more complete picture of their developing socio-communicative abilities.

6

CHAPTER 6: GENERAL DISCUSSION

Until now, the focus of developmental research investigating pragmatic abilities in children of preschool and school age has largely been on the receptive non-multimodal (verbal) domain. Much less is known about expressive pragmatic abilities and multimodal skills (prosody and gesture) in children. The present PhD thesis has tried to fill this gap and has adopted a multimodal framework of pragmatics with which to investigate the interface between expressive pragmatic abilities related to speech act production, other developing linguistic skills, and socio-cognitive abilities related to understanding of others' mental states.

The current thesis has reported on the results of four empirical studies that focus on the expressive pragmatic abilities of young preschoolers (ages 3–4) and their relationship with multimodal, structural linguistic, and socio-cognitive skills. The target population of the four independent studies, each one presented in a dedicated chapter, was a cohort of more than 100 children between ages 3 and 4. In this final chapter, we provide a discussion of the main issues addressed in these studies in light of the current state of the art. The chapter is divided into seven sections. We first provide a brief summary of all four studies (6.1), followed by the discussion of the highlights of the thesis with regard to (i) the link between pragmatic development, structural language, and social cognition (6.2) and (ii) the link between pragmatic development and multimodal language, that is, prosody and gesture (6.3). The last sections concern the methodological implications of the results presented in this thesis (6.4), their educational and clinical implications (6.5), and their limitations and directions for future research (6.6). We close this chapter with a general conclusion of the thesis (6.7).

6.1. Overview of findings

The main goal of this thesis was to explore the expressive pragmatic abilities of preschool-aged children (ages 3–4) when using language communicatively in everyday situations, by analyzing the relationship of these abilities with a comprehensive set of skills, including multimodal language (prosody and gesture), structural language, and social cognition. Study 1 (Chapter 2) analyzed the interplay of both structural language (vocabulary, syntax) and social cognition (ToM, emotion understanding, metacognitive vocabulary) with pragmatic and prosodic abilities, respectively. The following two studies focused on the link between pragmatic competence and such facets of multimodal language as prosody (Study 2) and gesture (Study 3). Study 2 (Chapter 3) examined the status of prosody as a pragmatic marker and Study 3 (Chapter 4) looked into the relationship between gestural and narrative abilities. Finally, Study 4 (Chapter 5) consisted of a 4-week pragmatic intervention that tested whether a language-based training—both multimodal and non-multimodal—involving mental state language can improve pragmatic and socio-cognitive skills in preschoolers. Below, we summarize the key findings and scientific discoveries from each of the four studies.

The first study, entitled 'Expressive pragmatics and prosody in young preschoolers are more related to structural language than to social cognition' (Chapter 2), adopted an individual differences approach to exploring which linguistic and socio-cognitive skills better support communicative pragmatic abilities at the ages of 3–4 in typically developing children. The main aim of the study was to investigate the respective role of structural language (vocabulary and syntax) and social cognition[20] (ToM, emotion understanding, and metacognitive vocabulary) in expressive pragmatics and prosody. Results from an SEM analysis showed that both expressive pragmatic and prosodic abilities were strongly predicted by structural linguistic skills, namely, lexical and, especially, syntactic skills. In contrast to language, social cognition did not predict pragmatic and prosodic scores. While the vast majority of prior research investigating the relationship between pragmatics, structural language, and social cognition in preschoolers has focused on receptive, inferential pragmatic abilities, this study adds novel findings related to expressive pragmatic skills and demonstrates for the first time that expressive pragmatics in young

[20] In this study, a narrower term 'mentalizing' was used in order to highlight that all three components of social cognition that were included (ToM, emotion understanding, and metacognitive vocabulary) were analyzed in an integrated fashion.

preschoolers draw on linguistic abilities to a greater extent than socio-cognitive abilities.

The second study, entitled 'Bridging the gap between prosody and pragmatics: the acquisition of pragmatic prosody in the preschool years and its relation with Theory of Mind' (Chapter 3), explored the development of pragmatic prosody (i.e., the ability to convey a set of pragmatic dimensions through prosody) in 3- to 4-year-old children. The investigation centered on the prosodic expression of different speech acts, namely, unbiased assertions, unbiased requests, biased assertion, biased requests, basic and complex expressive acts. Furthermore, this study also addressed the link between the acquisition of pragmatic prosody skills and the development of ToM abilities. The results showed that children adopt prosodic features to encode different kinds of pragmatic meanings. Specifically, 3- to 4-year-olds use a variety of prosodic strategies for unbiased assertions and unbiased requests, as well as basic expressive acts. Besides this, they start to express more advanced pragmatic meanings, such as biased speech acts and complex expressive acts, through prosody; however, they have greater difficulty with them. Further analyses revealed that ToM alone is not sufficient to explain children's prosodic scores. This study is the first to adopt a holistic and comprehensive approach to investigating pragmatic prosody skills in children by including a rich panoply of communicative uses of prosody for the expression of pragmatic meanings. Overall, this study was able to demonstrate the interplay between children's employment of prosodic markers and pragmatic expressions, and in doing so highlighted the importance of bridging the gap between prosody and pragmatics when accounting for children's pragmatic and prosodic development.

In our third study, entitled 'Narrative abilities at age 3 are associated positively with gesture accuracy but negatively with gesture rate' (Chapter 4), we assessed the relationship between another multimodal component of language—that is, gesture—and expressive narrative skills. In this investigation, we focused on a subset of the same cohort of 3- to 4-year-old typically developing children and analyzed the link between narrative skills and two types of gesture measures, namely, gesture accuracy and gesture rate, which were each elicited through pragmatically relevant tasks.

To our knowledge, this is the first study to compare the effect of different types of gesture measures in typically developing preschoolers and analyze them in the context of their relationship with children's narrative skills. Multiple regression analyses indicated that gesture imitation scores (i.e., gesture accuracy) were a significant positive predictor of narrative performance, whereas gesture rate (i.e., gesture frequency) scores had a negative effect on narrative scores. These findings point demonstrate that narrative abilities and gestures continue to be related in the preschool years, albeit in different ways. Also highlighted in the findings are the differences between different measures of gesture production: while the ability to imitate gestures positively predicts preschoolers' narrative abilities, gesture rate predicts them negatively. Overall, this study shows that multimodal abilities (and, specifically, gesture abilities) make up a complex system that is integrated into language in different forms and for different purposes at different developmental stages.

The fourth and last study of the thesis, entitled 'Interactional training interventions boost children's expressive pragmatic abilities: evidence from a novel multidimensional testing approach' (Chapter 5), reported the results of a training experiment on multimodal and non-multimodal language-based pragmatic interventions with children between 3 and 4 years of age. The main goal was to assess the potentially positive effect of a training program on expressive pragmatic abilities and social cognition. The program, conducted in a classroom setting, lasted 4 weeks and consisted of conversations with small groups of children about mental state language. In addition, this study explored the beneficial effects of two training paradigms: one involving conversation that used verbal language alone (non-multimodal or non-embodied condition) and the other involving both verbal and multimodal language (multimodal or embodied condition). The results of the linear mixed effect models indicated that the children in the experimental groups (the two training conditions) significantly improved their expressive pragmatic skills compared to the children in the control group, who had received no training. In contrast, no training effects were found on the children's socio-cognitive skills (ToM, emotion understanding, and metacognitive vocabulary). This is the first study to investigate the effect of language-based pragmatic interventions on expressive pragmatic abilities in preschool children, as well as on social cognition, and the first one to include multimodal language as a training condition in order to foster pragmatic and socio-cognitive development.

In sum, the results of the four studies jointly revealed a strong link between preschoolers' expressive pragmatic abilities and their general language competences, both multimodal and non-multimodal. We established the importance of structural linguistic skills such as syntactic and lexical skills, along with prosodic and gestural components, in pragmatic development. On the other hand, ToM and other socio-cognitive skills have been found to play a lesser role in expressive pragmatic abilities during the early preschool years. Therefore, the overall findings point to the fact that during the preschool years, expressive pragmatic abilities are more closely related to other linguistic skills than to socio-cognitive abilities governing the understanding of others' minds. These findings also highlight the role of multimodal linguistic cues in the expression and fostering of pragmatic knowledge.

6.2. Pragmatic development: A link to structural language and social cognition

A trending topic in developmental and clinical research is the investigation into individual differences in pragmatic skills among children and the relationship of pragmatic skills with other linguistic and socio-cognitive abilities that may account for this variation (e.g., Andrés-Roqueta et al., 2021; Andrés-Roqueta & Katsos, 2017; Lecce et al., 2019; Matthews et al., 2018). Two domains are usually explored in relation to pragmatic ability: structural language (most often vocabulary), and social cognition (most often ToM). This thesis followed a multidimensional approach to the assessment of linguistic and social cognition skills and examined the relationship among expressive pragmatic skills, vocabulary, syntax, ToM, emotion understanding, and metacognitive vocabulary, while also controlling for the role of age, SES, and bilingual language dominance.

The results obtained in Study 1 clearly demonstrate that only structural language is predictive of pragmatic ability. Both vocabulary and syntax measures were found to be positive predictors of pragmatic scores in multiple regression analysis, and syntax stood out as a stronger predictor. In the SEM analysis, the latent factor of language created from both vocabulary and syntax variables was a strong significant predictor of pragmatics. These findings emphasize the role of structural language in the development of expressive pragmatic abilities, supporting results of previous research in preschool and school-aged typically developing children (Angeleri & Airenti, 2014; Bernard & Deleau, 2007; De Rosnay et al., 2014; Filippova & Astington, 2008; Massaro et al., 2014; Matthews et al., 2018; Nilsen et al., 2011). It is also in line with findings on atypically developing children which showed that structural language skills were the most important predictors of a variety of pragmatic skills (e.g., metaphor comprehension, idiom comprehension, pragmatic scales of the Children's Communication Checklist) (Andrés-Roqueta et al., 2021; Norbury, 2004, 2005). While previous research has mainly investigated receptive pragmatic abilities (e.g., irony comprehension, referential communication), our study is the first to focus on expressive pragmatic skills involved in common social scenarios, and it adds to the literature with the novel finding on their link with structural language. We contend that the reason behind the fact that structural language is strongly implicated in the success with expressive pragmatics in young preschoolers is that both lexical and syntactic planning processes, such as lexical retrieval and structure building, need to be recruited for the appropriate verbal discourse production. Without the ability to structure and formulate speech, children cannot produce pragmatically relevant discourse.

Unlike the case with structural language, our results indicate that the role of social cognition skills (measured as ToM, emotion understanding, and metacognitive vocabulary) in predicting expressive pragmatics in preschoolers is negligible. On the one hand, this finding is in line with previous studies that included preschool-aged children and which reported mixed results on the link between pragmatics and ToM (Angeleri & Airenti, 2014; Banasik, 2013; Bernard & Deleau, 2007; Bosco & Gabbatore, 2017a, 2017b). On the other hand, this result differs from the findings of the studies on older children (starting from the age of 5), which found consistent evidence of the relationship between pragmatics and ToM (e.g., Del Sette et al., 2020; e.g., Filippova & Astington, 2008; Lecce et al., 2019; Massaro et al., 2013; Nilsen et al., 2011; Winner & Leekam, 1991). We propose three possible explanations for these results. The first one has to do with the type of pragmatic skills under consideration. While the non-literal language understanding that was tested in prior research draws strongly upon the inferential abilities to derive speakers' mental states, the pragmatic discourse production tested in Study 1 may lean more on linguistic tools rather than socio-cognitive abilities. The difference in the specific subtype of pragmatic skills may explain the contrast between our findings and the findings in older children, as it is possible that the latter studies on older children found a strong relationship between pragmatic and ToM because they focused their assessment on receptive pragmatic skills.

Related to this, the second explanation touches upon the type of socio-cognitive skills investigated here. Pragmatic behavior is deeply connected with the social world. It depends on social context (Brown & Levinson, 1987) and impacts social relationships (Agostoni et al., 2021). Specifically, previous studies have confirmed that different pragmatic skills are associated with peer acceptance (e.g., Del Sette et al., 2021) and prosocial behavior in children (e.g., Paulus, 2017). Socio-cognitive skills related to understanding of others' minds are core components of social cognition, but there are also other socio-cognitive skills, which underlie our social ability. These include affiliation, agent recognition, biological motion perception, empathy, social attention, and social learning, among others (see Happé et al., 2017, for a review). While our findings indicate a weak relationship between expressive pragmatics and the socio-cognitive skills tested, it is possible that results may change when examining other components of social cognition and may point to a stronger relationship.

Finally, the missing relationship between pragmatics and social cognition in preschoolers may be due to the developmental stage under examination. It might also be the case that this relationship changes throughout development. In this way, while in the early preschool years the link between pragmatics and social cognition is not yet strong, it may become more robust over time, and is therefore present in later development, as indicated by studies on school-aged children. This vision of the developing architecture of pragmatics is in line with findings by Lecce et al. (2019), which proposed that the association between the pragmatic ability to interpret mental metaphors and ToM evolves throughout middle childhood, being stronger in 9-year-olds than in 10- to 12-year-olds. Similarly, Del Sette et al. (2020) suggested that metaphor comprehension and inferential abilities are bi-directionally related over time: they mutually influence one another and develop side by side. More generally, some studies have proposed that the relationship between language and ToM may also change over time (e.g., Im-Bolter et al., 2016). All in all, it may well be the case that more implicit and complex discursive aspects requiring ToM are not involved in the simpler expressive pragmatics assessed through reactions to common social scenarios in the early preschool age, and only later does social cognition start playing a greater role in pragmatic ability.

Given these patterns of results, the findings of Study 1 seem to speak in favor of the theoretical approach that sees pragmatics within the linguistic domain (Akmajian et al., 2010; Verschueren, 2012), as only language has been found to be strongly linked to expressive pragmatics. By contrast, the evidence coming from Study 1 does not corroborate a cognitive view of pragmatics, according to which pragmatics is dependent on a mindreading module (Sperber & Wilson, 2002, 1985) and relies on underlying cognitive processes (Bara, 2010). However, in our view, this theoretical conclusion in which pragmatics pertains to the linguistic rather than socio-cognitive domain should be considered in light of pragmatics being a multifaceted phenomenon. As illustrated in the Introduction, pragmatics is not homogenous construct, as it consists of different subcomponents, all of which contribute to our ability to use language appropriately. In line with Andrés-Roqueta and Katsos (2017, 2020), we claim that it is important to distinguish between different types of pragmatic abilities and tasks. Since receptive pragmatic abilities may rely more on social cognition, we leave open the possibility that general pragmatic abilities may call on a combination of both language and social cognition skills. This proposal is in line with the recent psychological models proposed in Hyter (2017) and Snow and Douglas (2017) that suggest that pragmatic competence is grounded in various components, including language, ToM, and emotional states, among others.

Finally, the results from two studies (Study 1 and Study 4) of the present thesis add some new findings to a wider debate on the relationship between pragmatics and ToM (e.g., Bambini, Arcara, Martinelli, et al., 2016; Fairchild & Papafragou, 2021; Montemurro et al., 2019). Within the framework of cognitive pragmatics, it has been proposed that pragmatics is a subcomponent of a general mindreading ability (i.e., ToM). In practice, this view has led to the interchangeable use of pragmatic and ToM tasks, which, in turn, has led to findings which provide support to the assumption that pragmatics is a submodule of ToM. By contrast, Bosco et al. (2018) argued against this perspective and claimed that pragmatics and ToM may overlap in functioning but are not identical, since ToM alone cannot explain pragmatic performance. The results of Studies 1 and 4 offer support to this view and add evidence that (expressive) pragmatic skills in early preschool years are to some extent detached from ToM. For instance, Study 1 clearly demonstrated that social cognition scores could not predict the children's performance in the expressive pragmatic task, and Study 4 provided more indirect evidence for the distinction between pragmatics and ToM. In this training study, we assessed the effect of a language-based pragmatic intervention on both pragmatics and ToM. Importantly, we carefully controlled for the methodology of the assessment, and pragmatics and ToM were measured with different tasks. If pragmatics and ToM were identical, we would expect the training to have similar effects on the two. However, the results from Study 4 indicated that language-based training on mental states caused the improvement in expressive pragmatic ability but not in ToM. The different outcomes of the training on pragmatics and ToM offer complementary evidence in support of the idea that pragmatics cannot be reduced to ToM skills and that the two modules represent separable capacities.

In sum, our results demonstrate that expressive pragmatic abilities in the early preschool years rely more on structural language than on socio-cognitive skills related to understanding of others' minds, which corroborates the linguistic view of pragmatics and provides evidence that pragmatics and ToM constitute distinct abilities.

6.3. Pragmatic development: A link to multimodal language (prosody and gesture)

The results of the work presented in this thesis highlight the close link between expressive pragmatic skills to use language socially and multimodal language. In the previous section, we have discussed the role of structural language, such as vocabulary and syntax, in explaining and predicting pragmatic competence. Core language skills have traditionally been the focus of developmental research investigating individual differences in pragmatic abilities (De Rosnay et al., 2014; Filippova & Astington, 2008; Massaro et al., 2014; Nilsen et al., 2011) and they are often explored—or at least controlled for—in clinical investigations into pragmatic deficits (e.g., see Bambini, Arcara, Bechi, et al., 2016; Bambini, Arcara, Martinelli, et al., 2016; Cappelli et al., 2018; Carotenuto et al., 2018). While structural language skills focus on verbal language alone, mounting research has argued for a multimodal approach to language and has illustrated that language does not only occur in the verbal domain (Kendon, 1980; Levinson & Holler, 2014; McNeill, 1992). This line of research has convincingly demonstrated the important role of multimodal prosodic and gestural cues in communication, both in adults (see Brown & Prieto, 2021, for a review) and children (see Esteve-Gibert & Guellaï, 2018, for a review). Despite this, so far, research on children's acquisition of pragmatics in relation to other developing abilities has generally neglected multimodal aspects of language. This thesis has adopted a multimodal approach to language, and has shown for the first time that multimodal language, and not only structural language, is related to expressive pragmatic skills in young preschool children.

Study 1 found a strong relationship between pragmatics and structural language and, in addition, highlighted the parallelism in findings for pragmatics and prosody. The map of associations that emerged for pragmatic and prosodic abilities is remarkably similar, which strengthens the idea of the parallel development of the two, as well the importance of accounting for prosodic ability when investigating pragmatic development. Building on these results, the following Studies 2, 3, and 4 of the thesis delved into the analysis of multimodal language and explored preschoolers' expressive pragmatic skills in relation to prosodic and gestural cues, using different experimental designs. In a nutshell, Study 2 exemplifies how young preschoolers express different pragmatic meanings through prosody, Study 3 demonstrates the link between pragmatic skills and gesture accuracy skills, and Study 3 shows how multimodal language-based pragmatic training involving both gesture and prosody can foster pragmatic development. These findings are discussed below.

Study 2 adopted a descriptive approach, and its results allowed us to build a pragmatic prosody profile of young preschool children. The study analyzed the use of prosody for the expression of pragmatic meanings and identified the pragmatic uses of prosody that have been acquired at this time point in development. The findings showed that preschoolers deal well with the prosodic expression of basic pragmatic meanings such as unbiased assertions and requests, and basic expressive speech acts. These results are in line with the prior research on the acquisition of intonation (Frota et al., 2016; Prieto et al., 2012). As for the expression of more advanced pragmatic meanings, such as biased assertions and requests, and complex expressive speech acts, they have been found to be significantly more difficult for preschoolers. This finding is consistent with a number of previous studies on prosodic development (Chen, 2018; Hübscher, Vincze, et al., 2019) and, more broadly, research on the acquisition of other linguistic means for the expression of pragmatic biases (e.g., Diessel & Tomasello, 2001; Papafragou, 1998; Antje Sauermann et al., 2011). Compared to the previous literature, which tended to focus on a particular pragmatic area only, this study is the first to cover a broader picture of the pragmatic prosody abilities of preschoolers by assessing a wide range of pragmatic meanings and prosodic strategies to express them. Overall, these results emphasize the need for bringing together research on the acquisition of pragmatics and prosody when accounting for children’s language development.

A specific goal of Study 3 was to explore how narrative skills in preschoolers relate to two types of gesture measures (gesture accuracy and gesture rate). Extensive research on infants has suggested that gesture accuracy, understood as gesture imitation skills, is related to language acquisition and specifically to the acquisition of vocabulary (Carpenter et al., 1998; Hanika & Boyer, 2019; Snow, 1989) and grammar (E. Bates & Dick, 2002). Some studies on atypically developing children have also indicated that the accuracy of the imitation of motor manual sequences is associated with vocabulary in 6- to 8-year-old children with DLD (Wray et al., 2017) and that imitation training involving pragmatically-relevant gestures can help language development in children with autism (Ingersoll & Lalonde, 2010). Study 3 was the first to test the association between gesture accuracy in the imitation of pragmatically relevant multimodal expressions and expressive pragmatic skills in preschool-aged children. We found that gesture accuracy correlates with and predicts narrative skills, showing that children who are able to accurately replicate pragmatically relevant gestures in discourse are also able to produce better-structured narratives. Our results are thus in line with previous findings on infants and atypically developing children, and expand it by adding new evidence on the role of gesture imitation in typically-developing preschoolers' pragmatic skills. Based on the previous findings and the new findings yielded by Study 3, we can conclude that the ability to accurately reproduce gestures is not only consistently related to core language skills, but also to the ability to use language in social contexts.

The results of the positive relationship between the ability to accurately reproduce gesture in social contexts (i.e., gesture accuracy) and the ability to produce language in context (i.e., pragmatics) contrast with the results on gesture rate, which was found to be a negative predictor of pragmatic ability. The relationship with gesture rate appears to be complex and changes over the course of one's development. On the one hand, prior research in infancy (first 2 years of life) has established that the frequency of pointing gesture use and diversity of gestures are intrinsically linked to language, as they are positive predictors of later vocabulary and grammar skills (Colonnesi et al., 2010; Iverson & Goldin-Meadow, 2005; Rowe & Goldin-Meadow, 2009, among others). On the other hand, some studies did not find this relation in older children. Nicoladis et al. (2016) and Demir et al. (2015) reported that gestures (i.e., defined as any deliberate hand movements in Nicoladis et al. (2016) and movements in which the narrator performs the character's actions from a first-person point of view in Demir et al. (2015)) produced by preschool- and school-aged children (4–10 and 5–8 years of age) during narrative tasks could not be taken as a concurrent indicator of narrative skills.

While the results of Study 3 confirm the link between gesture rate and narrative skills, at the same time, they differ from the findings in early infancy because they point to the inverse (i.e., negative) direction of the relationship. These differences in patterns of results found in infants and preschoolers could be attributed to the different functions that gestures have at different developmental stages. Language and gesture undergo rapid development in the first years of life and gesture integrates into language in different ways, and for different purposes at different time points. In the absence of verbal language, pointing gestures produced by preverbal infants have a key communicative purpose. Yet at later stages of development, when verbal means take over as the primary mode of communication, gestures may become optional and less relevant in discourse settings, since they are a subject of individual variation (see Alibali, 2005; Özer & Göksun, 2020, for details). Furthermore, considering these results in the light of clinical and second language acquisition research, the negative relationship between gesture rate and pragmatic skills might be explained by the facilitating and compensatory function of gestures in narrative discourse. First, studies on atypical development indicated the compensatory role of gesture in language production, providing more evidence for the inverse direction of the relationship (e.g., Florit-Pons et al., 2021; Mainela-Arnold et al., 2014; Pine et al., 2007). For example, a review by Florit-Pons et al. (2021) showed that children with DLD gesture more than typically developing children. Second, Graziano and Gullberg (2018) reported that second language learners use (referential) gestures to compensate for their (lexical) difficulties. Similar to these results, it could be the case that the increased number of gestures produced by preschoolers has a compensatory role and serves to replace, rather than support, lexical units expressed verbally. All in all, while gesture accuracy is a reliable positive predictor of language and pragmatic skills across ages and populations (Ramos-Cabo et al., 2019), the relationship with gesture rate varies across ages and changes in purpose over time.

Regarding the causal effects of multimodal training on pragmatics, the results of Study 4 demonstrate the effectiveness of language-based training involving gestural and prosodic cues in order to scaffold pragmatic competence. This study clearly showed that a classroom intervention that involves embodiment of mental states (e.g., observing and producing prosodic and gestural cues to refer to them) can lead to an improvement in expressive pragmatic skills by preschoolers at posttest. These findings add new evidence regarding the role of multimodal language in promoting pragmatic development. It is important to highlight the fact that both multimodal and non-multimodal types of training were found to be equally effective. This is a non-trivial finding because it shows the power of bodily actions: they can be as effective as words and thus have strong potential as tools for facilitating developmental change. In fact, the larger (though not significant) effect sizes were obtained for multimodal pragmatic training, which might also suggest a certain advantage for this type of training.

In the broader context of multimodal training studies, our results confirm and expand the results of previous investigations by showing that embodied techniques within multimodal interventions can also be effective in boosting expressive pragmatic skills. Previous multimodal interventions on other abilities, linguistic or mathematical, provided evidence that the effect of multimodal training was comparable, or even more pronounced, than the non-multimodal training. They demonstrated that multimodal training can foster a variety of competences in children, such as oral narrative abilities (Vilà-Giménez & Prieto, 2020), reading skills (Adams et al., 2019) and numerical competencies (Dackermann et al., 2017), and can help with learning a second language (see Macedonia & Knösche, 2011, for a review). At the phonological level, multimodal interventions have been found to be able to improve global pronunciation (Gluhareva & Prieto, 2017; Llanes-Coromina et al., 2018). In addition, a number of recent studies have shown that multimodal interventions involving hand gestures and movements encoding different phonological features (e.g., prosodic features such as rhythm and pitch, and segmental features such as vowel and consonant contrasts) are beneficial for phonological learning (Baills et al., 2021; Baills & Prieto, 2021; Li et al., 2020, 2021). All in all, our findings emphasize the value of multimodal interventions for boosting another language domain, such as expressive pragmatics, and ultimately support a multimodal view of language.

In sum, this thesis has provided consistent evidence for the relationship between expressive pragmatic abilities involving discourse production in everyday social scenarios and multimodal language in typically developing young preschoolers by showing empirical evidence that multimodal cues are harnessed for the early expression of pragmatic meanings, are associated with pragmatic competence, and can help to boost children's pragmatic development.

6.4. Methodological implications

6.4.1. Pragmatic assessment

In this section, we turn to the methodological implications of the research presented in this thesis. To date, the pragmatic literature on preschool and school-aged children has tended to focus on receptive pragmatic skills, such as the understanding of referential expressions (e.g., Grigoroglou & Papafragou, 2019; Matthews et al., 2007; Nilsen & Graham, 2009), scalar implicatures (e.g., Barner et al., 2011; Katsos & Bishop, 2011; Noveck, 2001; Pouscoulous et al., 2007), metaphors (e.g., Del Sette et al., 2020; Lecce et al., 2019; Pouscoulous & Tomasello, 2020), and irony (e.g., Angeleri & Airenti, 2014; Filippova & Astington, 2010; Harris & Pexman, 2003; Nilsen et al., 2011). In this thesis, we have challenged this almost exclusive focus on receptive pragmatics, and broadened this paradigm by exploring expressive pragmatic skills in young preschoolers. We contend that expressive pragmatic skills should be taken into consideration in order to have a more thorough understanding of pragmatic development, as the bias towards receptive inferential pragmatic abilities might have blurred the general picture of children's pragmatic development and their associations with other linguistic and socio-cognitive abilities.

With the aim of comprehensively assessing expressive pragmatic skills in Catalan-speaking, young preschoolers, we created the Audiovisual Pragmatic Test (APT). The APT was used in all four studies included in the thesis. As we discuss in the Introduction (see sections 1.2.2 and 1.5.5), to our knowledge, currently there is no pragmatic instrument available which directly assesses day-to-day expressive pragmatic competence in children, while taking into consideration multimodal forms of pragmatic expression. The APT tool was developed prior to the data collection in this thesis and targets daily pragmatic expressive behavior, including the multimodal expression of pragmatic meanings. The validity analyses showed good-to-excellent results in terms of psychometric properties, namely, internal consistency, construct and convergent validity, test-retest and interrater reliability, confirming that the APT is a reliable, valid and robust instrument for assessing pragmatic abilities in childhood. Moreover, the results of this thesis have shown that the APT is an efficient, practically sound, and easily applicable instrument, which is able to reliably elicit data from children of 3 years and upwards. The APT is a fine-grained instrument, which allowed us to carry out the assessment of the variables of interest for young preschoolers in all four studies of the thesis. First, as shown by Study 1, the APT can be applied in order to collect measures of expressive pragmatic and prosodic abilities, since it uses everyday social scenarios and elicits pragmatically based prosodic productions in children. Second, as shown by Study 2, the APT can be successfully used to build up a pragmatic prosody profile of preschoolers because it assesses a broad range of pragmatic areas, such as different speech acts, information structure, epistemic meanings, and politeness. Third, in Study 3, the APT has been found to be suitable for assessing rates of gesture production in preschoolers, since it uses a semi-spontaneous elicitation procedure in pragmatically relevant contexts. Finally, in Study 4, the APT has been found to be a highly sensitive tool that can successfully capture children's learning of expressive pragmatic skills within the context of a training study.

All in all, the application of the APT test to all studies of the thesis constitutes a methodological contribution to the area of developmental pragmatics. The results of all four studies have shown that the APT is a valid instrument for assessing expressive pragmatic skills in the preschool years (starting at 3 years of age), and which integrates the multimodal perspective. We further believe that the APT can be easily adapted to other languages and is suitable for a wide age range of children, allowing researchers to track the acquisition of expressive pragmatic skills during different developmental stages. This suggests that the APT has the potential to be of great utility in future research on multimodal pragmatic development across different ages and languages. Expanding on the idea of the inclusion of expressive pragmatic skills into general pragmatic assessments, the findings of the present dissertation indicate that children's developing abilities should be tested in a holistic way.

6.4.2. Social cognition and language assessment

The results of the studies of this thesis (and especially Study 4) have led to the claim that children's social cognition and language should also be tested holistically. We believe that in order to capture complex developing abilities that are made up of various components, such as social cognition and structural language, a multidimensional approach is essential. First, throughout the thesis we have seen the usefulness of assessing both the cognitive and affective aspects of social cognition. Previous research exploring the interplay between pragmatic abilities and social cognition generally included the measures of ToM only (e.g., Bernard & Deleau, 2007; Bosco & Gabbatore, 2017b), whereas emotion understanding was not usually taken into account. Incorporating various components of social cognition (i.e., ToM, emotion understanding, metacognitive vocabulary) has provided us with a more representative picture of the development of these abilities and their role in pragmatics-related domains.

Second, we have also observed the advantage of assessing structural language by considering a variety of different language skills, including multimodal language skills. In the studies on typical development, the list of language variables is often limited to receptive vocabulary (e.g., Angeleri & Airenti, 2014; Filippova & Astington, 2008), while syntax and the measures of expressive language skills are rarely considered. Nevertheless, some studies on atypical development (e.g., Norbury, 2004; Whyte et al., 2014), as well as the findings of Study 1, highlight the special role of syntax in pragmatic ability. Importantly, we claim that the assessment of language should target not only verbal skills but also multimodal language abilities such as prosody and gesture. As discussed in the Introduction (see section 1.5.1), research has shown that speech, prosody and gesture are well integrated semantically, pragmatically and temporally, and constitute a single communicative system (Cutler et al., 1997; Kendon, 1980; Levinson & Holler, 2014; David McNeill, 1992; Pierrehumbert & Hirschberg, 1990). Moreover, previous studies have documented the use of prosody and gesture in the expression of pragmatic meanings (Goldin-Meadow, 1998;

Hübscher et al., 2017; Hübscher, Vincze, et al., 2019; Hübscher & Prieto, 2019). However, multimodal language components are often neglected in the assessment of language (including pragmatic abilities). The results of Study 2 have brought further evidence that prosodic skills serve as pragmatic markers in communication, and the findings of Study 3 further support the claim that language and gesture form an integrated system. Overall, the results of this thesis illustrate the importance of taking multimodal forms of language expression into account when assessing children's developing language skills in the preschool years.

It would be interesting to include a greater variety of assessment tasks related to multimodal language skills. As indicated by the results of Study 3, gesture quality—measured as accuracy in imitating pragmatically relevant gestures—is a positive predictor of narrative skills, while gesture rate—measured as the number of gestures produced—stands out as a negative indicator. Similar results were reported in the literature on atypically developing children. Wray et al. (2017) and Hughes et al. (2019) found that only gesture imitation scores were related to language (vocabulary) in children with DLD and high-risk infants (infant siblings of children with ASD and infants with Fragile X Syndrome). Therefore, different potential patterns of outcomes should be borne in mind when assessing different types of gesture skills. In light of this, we suggest that several measures of gesture performance should be considered when evaluating pragmatic and gestural skills.

All in all, the findings of the present thesis revealed that it is beneficial to adopt a multidimensional approach to the assessment of social cognition and social communication (pragmatics) abilities. Pragmatic skills have very rarely been included in the assessment of training effects on the development of social cognition and related areas. To our knowledge the only exception to this is the study by Ornaghi et al. (2011), which focused on receptive pragmatic abilities and used a short judgement test to assess them. We therefore recommend researchers and practitioners include several measures of social cognition and language (as well as a comprehensive measure of expressive pragmatic competence) in assessment batteries that aim to explore training effects in children.

6.5. Educational and clinical implications

6.5.1. Implications for educational and clinical assessment

First of all, we would like to emphasize the usefulness of the new assessment tool, the Audiovisual Pragmatic Test, for educational assessments. Preschool years are an important developmental period for the acquisition of pragmatic abilities, and the APT is applicable in educational practices for first determining children's expressive pragmatic competence and for then continually assessing pragmatic development. In the same vein, we believe that in future, after a necessary clinical validation, the APT may potentially be used for clinical assessment. The APT is freely available for researchers, educators, and clinicians. The full set of materials in both Catalan and English, accompanied with instructions, are available in open access (Pronina, Hübscher, Vilà-Giménez, et al., 2021a).

Furthermore, our results highlight the importance of gesture and prosody skills as informative indicators of pragmatic abilities and, more generally, language development. Previous studies, especially the studies on infancy, have provided empirical evidence for the link between prosody and language acquisition (Bhatara et al., 2018; Teixidó et al., 2018; Thorson, 2018), as well as between gesture and language acquisition, in both typical and atypical development (see Colonnesi et al., 2010; Ramos-Cabo et al., 2019; see also 1.5.3). In accordance with this line of research, this thesis has revealed that multimodal skills are also indicative of individual differences in pragmatic skills in typically developing preschoolers. The findings that gesture could be used as a marker of language skills may be also extended to atypically developing children (see also Wray et al., 2017). We propose that a child's prosodic and gesture performance is informative about their communicative development and should be considered (and trained) in both educational and clinical assessments.

6.5.2. Implications for educational and clinical interventions

Practically, the results of this thesis might be of relevance for educational and clinical interventions. Pragmatic abilities are the backbone of interpersonal success, social relationships, and everyday well-being (see Bambini, Tonini, et al., 2020; e.g., Gottman et al., 1975; Helland et al., 2014; Kemple et al., 1992; Murphy et al., 2014; Stangeland, 2017). Therefore, contributing to the fostering of pragmatic competence may have far-reaching, positive consequences for children's daily functioning, school performance, and peer relationships. Moreover, pragmatic interventions are very much needed, given the strong individual differences in pragmatic abilities displayed by children during the preschool and school years. Despite this, very few studies have developed pragmatic training interventions (see section 1.4.1), and almost all of them have targeted only specific receptive skills. Study 4 within this thesis is the first training study to target social day-to-day communication—that is, expressive pragmatics—in typically developing children. In this thesis, we would like to emphasize the relevance of expressive pragmatic abilities for children (it is thanks to them that children manage to communicate successfully in everyday life), and thus encourage teachers and speech-language therapists to promote these expressive pragmatic abilities. It should constitute a priority for educational systems and actors.

From an educational point of view, the present thesis highlights the important role of classroom language-based pragmatic interventions focusing on mental state language in promoting pragmatic abilities, both multimodal and non-multimodal. During the interventions, under the guidance of a teacher, children participated in conversational activities about mental states, both cognitive and affective, depicted by the characters in the stories. In this way, children were trained in mental states in conversational settings, while expressive pragmatic abilities in a variety of social scenarios were not directly promoted during the intervention. Why then were these interventions successful in fostering expressive pragmatics? We suggest that the observed development of the ability to interact socially points towards the intervention having a generalization effect. Conversation about mental states may have sharpened children's awareness of their own and others' cognitive states and emotions, leading to an enhanced ability to recognize others' perspectives. Since the ability to take others' points of view into consideration is necessary for social communication, by helping children to react appropriately within social situations, training this ability resulted in improved performance on the expressive pragmatic test. We highlight the fact that our pragmatic training program has proven to be effective and could thus be used in the Catalan preschool system in order to enhance children' pragmatic skills.

We would also like to highlight that the present intervention was conducted in the preschool classroom context and, therefore, can be easily adapted and applied to a variety of naturalistic school settings. Both multimodal and non-multimodal interventions can be of interest for a variety of educational settings. To aid preschool teachers with incorporating conversational pragmatic interventions into their classroom, a website Entrenem les emocions [Let's train emotions] (https://entrenemlesemocions.wordpress.com) was created containing all necessary descriptions, training materials, videos, and instructions in open access. We hope that this information will be useful for practicing educators and the whole training study (or some elements of it) will be employed in Catalan preschool classrooms. We also suggest that it would be worth investigating whether this language-based pragmatic intervention can be applied in intensive support environments.

In addition, building on the results of our training study and with Studies 2 and 3 showing the tight link between multimodal cues and pragmatics, we claim that the use of multimodal or embodied training can contribute greatly to the fostering of children's pragmatic development. Given the foundational role of prosody and gesture in communicative development, multimodal interventions could represent a promising strategy for improving language use in social environments for preschool children. Our results on the beneficial effects of multimodal training may be of special interest to speech-language therapists, since multimodal, less verbally demanding interventions would be suitable for atypically developing children with verbal deficits. We encourage clinicians to develop training programs targeting language and communicative abilities that incorporate multimodal strategies in a more decisive way. We hope that the work presented in this thesis lays the foundations for future pragmatic interventions for atypically developing children.

6.6. Limitations and future directions

One of the possible limitations of the present thesis is the fact that other socio-cognitive abilities were not considered. As discussed above, social cognition includes a number of abilities. Since the focus of the thesis is on the socio-cognitive skills related to understanding of others' mental states (ToM, emotion understanding, and metacognitive vocabulary), there are several other socio-cognitive aspects that were not taken into account in this work (e.g., empathy, social attention, social learning, etc.). Previous research suggests that other socio-cognitive abilities—for example, empathy—are related to pragmatic competence. Specifically, Esteve-Gibert et al. (2020) proposed that individuals with higher empathy skills disambiguate pragmatically ambiguous sentences better than less empathic individuals, and the study by Ornaghi et al. (2020) reported correlations between empathic skills and language abilities (including pragmatics) in children between ages 2 and 3. Future research exploring the relationship between pragmatic and socio-cognitive skills would benefit from a broader consideration of socio-cognitive aspects.

Moreover, this thesis did not include executive functions. Executive functions are a family of mental processes needed in order to behave and think in a controlled, flexible, and goal-directed way (Diamond, 2013). The core executive functions include such skills as working memory, inhibition control, and cognitive flexibility; other executive functions include relational reasoning, planning, organization, and self-monitoring. Some theoretical models have acknowledged the importance of executive functions for pragmatic abilities (Hyter, 2017; Snow & Douglas, 2017). Hyter (2017) proposed that inhibition and cognitive flexibility lie at the base of pragmatic competence and working memory is the "glue" that holds different components of social communication together. Similarly, Snow and Douglas (2017) considered executive functions as a cornerstone of pragmatic abilities, together with socio-cognitive skills. Prior empirical research also provides evidence that there is a link between executive functions and pragmatic skills (e.g., Filipe et al., 2020; see Matthews et al., 2018 for a review). Moreover, Blain-Brière et al. (2014) proposed that executive functions are especially important for expressive pragmatic skills in typically developing children of preschool age. More recently, a study by Filipe et al. (2018) reported that executive functions, such as working memory, inhibition, and divided attention, are related to prosodic abilities in 6- to 9-year-old children with high-functioning autism. Future studies investigating pragmatic development should explore in greater depth the effects of individual differences related to executive functions. One way of doing so is to control for executive functions and include them in the assessment in order to both determine their specific contributing role in explaining the variation in pragmatic competence and to refine our knowledge surrounding the map of associations between pragmatics, language, and cognitive skills.

Another possible limitation of the current work is the potential effect of multimodal tasks. As we have already pointed out in the previous section, different gesture elicitation tasks may yield different patterns of findings. In light of this, it seems necessary to develop a comprehensive battery of multimodal tasks in order to analyze the relationships between pragmatics, social cognition, structural language, and multimodal language to expand on the results of Study 1. Importantly, other factors that might have affected the results in the multimodal imitation task in Study 3 are children's shyness and their level of familiarity with the examiner. As indicated by Alibali (2005), the research into gesture use in children warrants the control of factors such as potential discomfort due to the experimental environment, the communicative style of the child, and other non-linguistic factors. It could be the case that the use of more ecological, interactive, and communicative tasks with preschoolers elicits slightly different results; for example, higher rates of felicitous prosodic productions or higher gesture rates. Therefore, the findings reported in this thesis need to be compared with future studies that use other tasks. Future research using different methodological approaches and contexts (e.g., communication with caregivers) can help us to broaden our understanding of the acquisition of multimodal language cues.

Future researchers may want to investigate different types of pragmatic skills and compare their links to other developing linguistic and cognitive abilities. As mentioned, previous pragmatic developmental literature has almost exclusively focused on receptive skills and the work presented in this thesis is one of the first attempts to explore preschoolers' expressive pragmatic skills. Future studies might look to assess both receptive and expressive pragmatics in children, as it may be the case that different patterns of specific associations for discourse production and non-literal language comprehension emerge, highlighting the heterogeneity of pragmatic developmental trajectories.

Furthermore, by adopting a multimodal approach to language, future research should analyze a wider developmental window and assess the developmental patterns of pragmatic skills in older, school-aged children. It would be interesting to test whether the relationship between expressive pragmatic abilities, other linguistic skills (both structural and multimodal) and social cognition changes over the course of childhood. This question could be assessed by performing a cross-sectional study investigating concurrent relationships between these variables in children of different ages. Moreover, a longitudinal approach in order to investigate changes in the cognitive architecture through childhood may be fruitful. While some studies are indicative of evolving developmental patterns (e.g., Im-Bolter et al., 2016, demonstrating that contributors to theory of mind change from middle childhood to early adolescence), in general the longitudinal relationship between pragmatic ability, linguistic and cognitive variables is yet to receive much attention.

6.7. General conclusion

In conclusion, this thesis advances our understanding of the development of expressive pragmatics which focus on the ability of children to successfully use social day-to-day communication. We have consistently shown that in the early preschool years, expressive pragmatics is tightly connected to language, both structural and multimodal, and less so to social cognition and ToM. We have provided evidence that expressive pragmatic abilities are associated with structural language skills and gesture development, and can be fostered through language-based non-multimodal and multimodal training. In contrast, we have found that the role of social cognition (ToM, emotion understanding, metacognitive vocabulary) in expressive pragmatics appears negligible at this developmental time point. Together, these findings demonstrate that in the preschool years, expressive pragmatics relies more on linguistic rather than ToM and other socio-cognitive skills, while also providing evidence that pragmatics and ToM constitute distinct abilities.

Moreover, this thesis emphasizes the importance of multimodal cues as crucial elements of pragmatic expression. First, pragmatic and prosodic assessment has revealed a developmental profile of 3- to 4-year-old children in which some areas of pragmatics (e.g., pragmatic biases) still need to be refined, confirming and expanding the results of previous studies. Second, we have shown that the ability to accurately imitate pragmatically relevant gestures is an important skill that is correlated with narrative performance, confirming the tight link between gestures and language use in preschool years and highlighting the potential role of gesture skills in assessing pragmatic outcomes.

Finally, our work has shown that language-based multimodal and non-multimodal pragmatic interventions are effective tools that can be used to promote pragmatic abilities, demonstrating the value and effectiveness of pragmatic training and ultimately supporting a multimodal view of language. Overall, the results have provided evidence that multimodal means are key in conveying a wide range of pragmatic meanings, are associated with pragmatic competence and can foster children's pragmatic development.

Jointly, the findings of the four studies presented in the current thesis indicate that the architecture of expressive pragmatics in the preschool years is strongly based on language rather than social cognition, and while highlighting the important role of multimodal language in pragmatic development.

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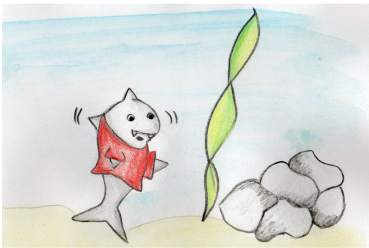
Appendices

Appendix A: Chapter 5

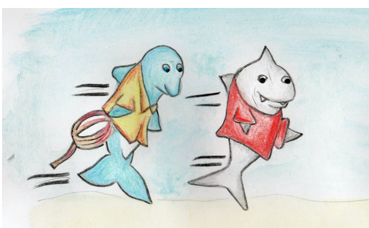
Sample story from the training materials in English translation

Story 8: Sara sea-turtle (target terms: *believing*, *getting upset*).

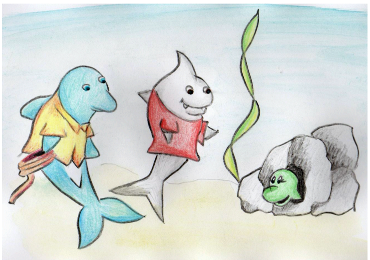


One day, Theo Shark was swimming along the bottom of the sea.
Suddenly, he heard a voice calling for help and he thought: "Someone is in trouble or in danger". He looked around and decided to try to find that person and help them.

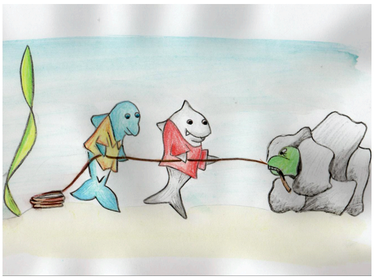
He tried to figure out where the voice was coming from by swimming about in all directions. When he came near some rocks he could hear the voice more strongly. He went right up to the rocks and saw an opening between two of them. He looked in and saw Sara Sea-Turtle who was crying. Theo asked her: "What happened? Why are you crying?".
Sara, upset and frightened, said: "I was gathering food for my little babies and I saw some delicious shellfish in this hole. I thought that my little ones would love them. I noticed that the hole was a bit small, but I decided to get in anyhow and now I'm stuck inside here and can't get out. Please help me!".
Theo replied: "Of course, don't worry, stay calm. I'll go and call my friend Jack Dolphin; he's sure to know how to get you out of there".



So Theo swum as fast as he could towards Jack's house. When he got there, he explained the situation to his friend, and Jack immediately had an idea: he decided that they would take a very strong rope with them to pull the sea-turtle out of the hole.

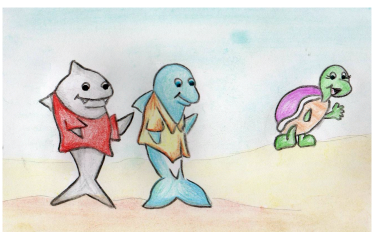


Together, Theo and Jack went back to Sara Sea-Turtle and when she saw them she felt a lot calmer because she know that two friends would do their best to get her out of the hole.
Theo Shark said: “We’re back, my friend Jack has brought a rope; now you’ve got to hold it tightly between your teeth and we’ll try to pull you out”.
Sara, feeling much better now, said: “OK”. She thought to herself: “I’ve got to try as hard as I can. I really hope it works!”.



Theo and Jack began to pull as strongly as they could, but no matter how hard they tried, they could not get Sara out. “This isn’t working”, said Jack. “She’s too stuck. We won’t be able to get her out on our own.”
So they decided to go and ask some other fish to help them.
“The more of us there are, the harder we will be able to pull!”, thought Jack.

After a while, Charlie Balloon Fish, Amadeus Hammerhead, Sally Eel and even Diego Seahorse came to help too.
When Sara saw so many other fish coming to help her she felt better straight away and tried even harder to free herself.



They all pulled on the rope as hard as they could, and after a number of attempts, the sea-turtle finally popped out of the hole she had been stuck in. Delighted to be free at last, she thanked Theo, Jack and all the other fish, before rushing home to feed her babies.
From that day onwards, Sara never went through narrow openings again in case she got stuck once more.

Appendix B: Publication list

The following publications are associated with this dissertation.

Peer-reviewed journal papers

Castillo, E., **Pronina, M.**, Hübscher, I., & Prieto, P. (2021). Narrative performance and sociopragmatic abilities in preschool children are linked to multimodal imitation skills. *Journal of Child Language*, 1–26. https://doi.org/10.1017/S0305000921000404

Pronina, M., Hübscher, I., Holler, J., & Prieto, P. (2021). Interactional training interventions boost children's expressive pragmatic abilities: evidence from a novel multidimensional testing approach. *Cognitive Development*, *57*, 101003. https://doi.org/10.1016/j.cogdev.2020.101003

Pronina, M., Hübscher, I., Vilà-Giménez, I., & Prieto, P. (2021). Bridging the gap between prosody and pragmatics: The acquisition of pragmatic prosody in the preschool years and its relation with Theory of Mind. *Frontiers in Psychology*, *12*, 2962. https://doi.org/10.3389/fpsyg.2021.662124

Papers in peer-reviewed conference proceedings

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. *Proceedings of the 19th International Congress of Phonetic Sciences. 5-9 August 2019, Melbourne, Australia*, 3145–3149.

Pronina, M., Hübscher, I., Vilà-Giménez, I., & Prieto, P. (2022). Pragmatic prosody development from 3 to 8 years of age: A cross-sectional study in Catalan. *Proceedings of the 11th International Conference on Speech Prosody. 23-26 May 2022, Lisbon, Portugal.*

Manuscripts under review or in preparation

Pronina, M., Castillo, E., Grofulovic, J., Prieto, P., & Igualada, A. (under review). Narrative abilities at age 3 are associated positively with gesture accuracy but negatively with gesture rate. *Journal of Speech, Language, and Hearing Research*.

Pronina, M., Hübscher, I., Vilà-Giménez, I., & Prieto, P. (in prep.). Tracking the development of pragmatic prosody in Catalan preschool and school-aged children.

Pronina, M., Prieto, P. (submitted) Acquisition of suprasegmental phonology in child bilingualism. In M. Amengual (Eds.), *Cambridge Handbook of Bilingual Phonetics and Phonology.* Cambridge University Press.

Pronina, M., Prieto, P., Bischetti, L., & Bambini, V. (under review). Expressive pragmatics and prosody in preschoolers are more related to language skills than to social cognition. *Language Learning and Development.*