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Pragmatics in the lifespan and in clinical groups: Investigating the development and decay of pragmatic skills and designing strategies to train them.

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Abstract

Pragmatic competence encompasses a wide range of skills such as the comprehension of figurative language and the respect of conversational rules. These skills are at the basis of fully functional communication in everyday contexts and pragmatic competence has been proved to correlate with quality of life in adults and with academic achievement as well as peer social relationships in children.

Despite this, the training programs currently available to promote these skills are very few, and in some cases their efficacy has not been proved with strict methodological criteria. In this scenario, we created two new training programs, one for children (the MetaCom) and one for adults (the PragmaCom), and we tested their efficacy through randomized controlled studies.

Preliminarily, we analyzed the development of metaphor comprehension in children, in order to better understand the role of ToM in metaphor processing. We found that the relationship between ToM and metaphor is not stable, but changes through middle childhood and according to the task. Moreover, we noticed that it is stronger in younger children, with a key turn point around the age of 9.

This same age was chosen as a target group to test the efficacy of the MetaCom training. Compared to a control training, we found that the MetaCom training led to improvements in metaphor understanding and that its benefits extended to reading comprehension. The MetaCom can thus represent a useful tool for teachers as well as practitioners, possibly to supplement with children-adapted readings such as "When dancers are butterflies and the atmosphere becomes a blanket: How the brain understands and misunderstands metaphors".

As for the PragmaCom, we tested it in two studies, involving a sample of healthy older adults and a group of patients with schizophrenia, respectively. In both cases, the PragmaCom led to improvements in pragmatic comprehension, even though we found that for older adults similar benefits were reached also though a cognitive training.

These results are discussed in terms of theoretical considerations about the development and decay of pragmatic abilities, and practical implications in scholastic and clinical settings, where these abilities can be promoted or rehabilitated.

Disclosure

Chapter 4 of this thesis is based on the following already published article:

- Bambini, V., Tonini, E., Ceccato, I., Lecce, S., Marocchini, E., & Cavallini, E. (2020). How to improve social communication in aging: Pragmatic and cognitive interventions. *Brain and Language*, 211, 104864. https://doi.org/10.1016/j.bandl.2020.104864

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Introduction

It is not easy to find a widely accepted definition of pragmatics. According to Levinson (1983), this is due to the fact that the "term *pragmatics* covers both context-dependent aspects of language structure and principles of language usage and understanding that have nothing or little to do with linguistic structure" (p. 9). This might also be the reason why pragmatic phenomena have been studied from several different points of view, becoming an interest of linguists, philosophers, psychologists and cognitive scientists. Saying that pragmatics studies language in use would be a definition wide enough to embrace both aspects mentioned by Levinson, but at the same time so vague that the discipline would have a never-ending list of fields of study, when, in fact, it focuses on some defined phenomena (Airenti, 2017). Lately, in an attempt to formulate a definition of pragmatics, Airenti (2017) described it as the study of those abilities required to use (and understand) language appropriately, according to the communicative context in which the conversation takes place.

Going beyond the issues related to defining it, pragmatics is necessary, besides semantics and syntax, to understand how language in communication works because often there is a gap between what a speaker literally utters and the meaning that they want to convey. This is the case, for instance, of indirect requests, figurative language (e.g., metaphor, idioms, proverbs, etc.), irony and sarcasm. Also, even when these pragmatic phenomena are not present in the conversation, sometimes communication is not functional, despite semantic and syntactic rules are respected. All these phenomena were not explained by the first (and only, before Grice's account) theoretical model of communication: the code model (as named in Sperber & Wilson, 1986), which is an integration of models designed in the first half of the 20th century and earlier (Blackburn, 2007). In this model, communication is effective when the signal encoded by the speaker reaches the hearer who can decode the signal received applying the same code used by the speaker, when no disturbing noise covers the signal while traveling. Even though

this model is good enough to explain some explicit communicative exchanges, it is not adequate to justify the comprehension of implicit communicative content (as in the case of the expressions listed above).

To fill this gap, Grice (1975) developed an inferential model of communication, grounded on the Cooperative principle. According to this principle, co-conversants expect each other to contribute to the conversation in a meaningful way, respecting four rules, also defined as Conversational Maxims: the maxim of quantity, quality, relation and manner. Nevertheless, the speaker might intentionally violate these rules in order to achieve different communicative aims. For example, they might violate the maxim of quantity because they want to hide some information, or the maxim of quality because they are using a metaphor to enhance imaginative processes and memorization in the hearer, or simply because they are lying. In Grice's model, comprehension is not only based on decoding, as in the code model, but also on inferencing: in order to understand the speaker, especially in cases when communication is not explicit, the audience needs to infer the speaker's intentions to cooperate in the conversation and interpret what is uttered in these terms.

Elaborating on Grice's intuitions that expectations of cooperation guide the hearer to the understanding of speaker's meanings and that inference has a role in communication, Sperber and Wilson's (1995) Relevance Theory claims that comprehension is guided by expectations of relevance and that inferential processes play a major role in comprehension (Origgi & Sperber, 2000; Sperber & Wilson, 2002), both for explicit (explicatures) and implicit content (implicatures). Following a path of least cognitive effort and guided by presumptions of optimal relevance, the audience interprets what is uttered in a way that satisfies their expectations of relevance, getting to the most plausible meaning. According to Relevance Theory, pragmatic interpretation is a metapsychological process dependent on a mind-reading module. Nevertheless, the authors acknowledge the particularity and importance of comprehension in communication and argue that a dedicated module, a metacommunicative module, developed as a specialization of the general mind-reading (or Theory of Mind, ToM) module (Sperber & Wilson, 2002).

As Bosco et al. (2018) pointed out, this idea led to the use of pragmatic tasks as ToM tasks, and vice versa, and this led in turn to findings which supported the idea that pragmatics is a submodule of Theory of Mind. This was further corroborated by the finding that in children the two abilities seem to develop in parallel. For instance, Sullivan et al. (1995) tested children's ability to discriminate between lies and jokes, and they found that children were able to accurately complete the task only after they developed second-order ToM abilities. Similarly Winner and Leekam (1991) found that children understand irony only after they acquire second-order ToM skills. Nevertheless, the relationship between pragmatics and ToM is not straight forward, since findings are contrasting. Bosco et al. (2017) did find a correlation between first-order ToM and deceit, but they did not find a correlation between second-order ToM tasks and irony, proving that ToM alone was not able to explain children's performance in all pragmatic tasks. Consequently, the authors supported the idea that the relationship between pragmatics and ToM might simply be conceived in terms of partial overlap or collaboration (Bosco et al., 2018), instead of reducing pragmatics to mind-reading. Moreover, the authors highlighted the importance of an accurate distinction between ToM and pragmatic tasks, in order to be sure about what construct is being measured.

Lecce, Ronchi, et al. (2019a) and Del Sette et al. (2020) further explored this field, investigating the relationship between ToM and pragmatics in the analysis of children's metaphorical abilities. Starting from the finding that metaphors whose content focuses of physical characteristics are understood earlier in development than metaphors based on psychological-mental aspects (Vosniadou et al., 1984; Wang & Dowker, 2010), Lecce, Ronchi, et al. (2019a) investigated the role of ToM in explaining middle-age children's performance in physical and mental metaphors in a cross-sectional study (they recruited children from 9 to 12 years of age). Results showed that there was a unique relationship between ToM and the interpretation of mental metaphors in children of 9, but not in older children. This suggested that the involvement of ToM in pragmatic phenomena might be related to the content of the expressions used, more than to the phenomenon itself. Moreover, the finding

that ToM plays a role only in the youngest group assessed, seems to indicate that ToM might support pragmatic skills in the first phases of acquisition, but also that gradually the two abilities become independent from one another.

Extending these findings, Del Sette et al. (2020) analyzed the direction of the relationship between ToM and pragmatics, assessing children's metaphorical and mentalizing abilities in a longitudinal study. The authors found that metaphorical abilities and inferential skills about physical aspects support each other in a mutual way, while they argue that ToM development is favored by the tendency to mentally interpret psychological metaphors.

The study presented in Chapter 1 of this thesis was born in this framework. The paper "How metaphor understanding and Theory of Mind relate in middle childhood: individual and task-related differences" (conducted in collaboration with Prof. Lecce and colleagues from the Department of Brain and Behavioral Science of the University of Pavia, Italy, in preparation for submission to Journal of Memory and Language) investigates the relationship between two different metaphor tasks (a verbal explanation task and a referential task) and ToM in middle childhood focusing on three age groups (8-, 9-, and 10-year-old children). The study was designed after acknowledging that different pragmatic tasks can lead to different results and conclusions (Kalandadze et al., 2019), and that the previously mentioned studies on the relationship between ToM and metaphor comprehension only focused on one task (the Physical and Mental Metaphors task, PMM; Lecce, Ronchi, et al., 2019a). The aim was to see if the relationship between ToM and metaphor comprehension changed according to participants' age and to task demands. We found that, controlling for socioeconomic level, working memory, grammar, and vocabulary knowledge, the role of ToM is different in each age group and the relationship between ToM and metaphor comprehension takes different directions in the two tasks. Furthermore, we found that, generally speaking, the effects of ToM on metaphor understanding are more relevant for younger children (the groups of age 8 and 9).

Furthermore, this work showed a gradual and slow improvement in metaphor comprehension between and within groups, confirming the finding of Winner et al. (1976). Considering the importance for children to comprehend metaphors in the scholastic setting and in everyday life to understand some concepts and express themselves more easily (Katz, 1996; Ortony, 1975), a training program too speed up metaphor skills development may be necessary. Focusing on children of 9 years of age, who proved to have a good comprehension of metaphors but with margins of improvement, in a second study, we created and tested the efficacy of a new metaphor comprehension training program (the MetaCom). This work is presented in Chapter 2 and titled "Efficacy and benefits of the MetaCom training to promote metaphor comprehension in typical development" (conducted and written in collaboration with Prof. Lecce and colleagues from the Department of Brain and Behavioral Science of the University of Pavia, Italy, and submitted to First Language). Besides providing a tool for teachers or speech therapists to train metaphor comprehension in children, a training study is also very important because it can help us establish causal relationships between the variables considered and could allow for theoretical considerations about the process studied (Pexman et al., 2019). The existing tools created to achieve this aim are very few. In addition, the efficacy of most of them has not been proven scientifically and often they lack theoretical basis. Therefore, it is difficult to tell if they work, and, if they do, it is difficult to draw conclusions that could be of use for the scientific community. The availability of an effective training, grounded on solid theoretical basis, could help avoid these issues and give important information to guide future research.

The MetaCom is gounded on the relevance-theoretic view of metaphor, which focuses on inferential and contextual aspects in the comprehension of this particular figure of speech. The effects of the MetaCom were tested against a control training focusing on text comprehension. Only children in the MetaCom group improved in a metaphor verbal explanation task and showed transfer effects to reading comprehension. This suggests that it is possible to train metaphor comprehension

in children, by focusing on inference making and taking into consideration the context in which the metaphor was presented, even without training ToM skills.

Always with the intent of helping children to understand metaphors, this thesis also contains a short contribution, included in Chapter 3 and titled "When dancers are butterflies and the atmosphere becomes a blanket: How the brain understands and misunderstands metaphors" (written in collaboration with Prof. Kalandadze from Østfold University College, Halden, Norway; accepted for publication in Frontiers for Young Minds). This paper consists in a text for young readers (age range 8-11) where the importance of metaphor and its comprehension mechanisms are explained with a target-appropriate language. This contribution might be used by teachers and professionals to familiarize children with this important communicative tool. Additionally, we added to the text some suggestions that could guide children when dealing with peers with autistic-spectrum disorders (ASD) when they do not understand a metaphor. Children with ASD often present difficulties in understanding figurative language [Happé (1993); Happe1994] and would benefit from some specific communication treatment (see for example Melogno & Pinto, 2014; Melogno et al., 2017; Mashal & Kasirer, 2011) and from the help of their typically developing peers. Disorders of pragmatic abilities can indeed create difficulties in everyday communication, which in turn negatively affect children's social participation and relationships (Cain et al., 2005; Nippold, 1991).

If this is true for children, the same is for healthy older adults. Pragmatic skills are particularly vulnerable in the last stages of life, and a decline was observed (Messer, 2015). Difficulties touch both the comprehension (Bischetti et al., 2019; Champagne-Lavau et al., 2012; Grindrod & Raizen, 2019; Uekermann et al., 2008) and the production (James et al., 1998; Ruffman et al., 2010) spheres.

Yet, no intervention programs are currently available for healthy older people. That's why, in a third study titled "How to improve social communication in aging: Pragmatic and cognitive interventions" (conducted and written in collaboration with Prof. Cavallini and colleagues from the Department of Brain and Behavioural Science of the University of Pavia, Italy), presented in Chapter 4 and published in

Brain and Language, we developed a novel training program to improve pragmatics (PragmaCom) in older adults. We tested its effects compared with an active cognitive control group. We found that both the PragmaCom and the control group showed improvements in pragmatic skills such as metaphor comprehension and producing on-topic speech. This suggests that it is possible to train pragmatic abilities in older adults both with a specific pragmatic training and with a more general cognitive training. An analysis of individual characteristics involved in the improvement showed that pragmatic performance at post test was predicted by individual cognitive factors in the control group, but not in the PragmaCom group. These findings might indicate that, relying less on individual characteristics than the cognitive training, the PragmaCom training program could be more suited to train pragmatic abilities in older adults with different levels of cognitive profile.

Besides having a complex development and the tendency to decline with age, pragmatic abilities are also susceptible to disruption in some pathological populations. For instance, in a previous study I co-authored, we found that people with traumatic brain injury have an impairment in global pragmatic skills (Arcara et al., 2020), which is in line with previous literature on the comprehension of sarcasm (Channon et al., 2005), indirect requests (Evans & Hux, 2011) and with studies on production, showing that these patients' speech is often characterized by errors of cohesion and coherence (Carlomagno et al., 2011; Marini et al., 2011).

Similar difficulties have been reported also for patients with injuries caused by a stroke in the right hemisphere, dementias, developmental disorders, sensory disorders and mental illness (for a review see Cummings, 2017). In particular, a pragmatic language deficit seems to be a core feature of schizophrenia (Bambini, Arcara, Bechi, et al., 2016a). In these patients the comprehension of metaphoric expressions is impaired (Tavano et al., 2008), together with the recognition of irony (Varga et al., 2013) and the understanding of indirect speech acts (Corcoran, 2003) and in general with the detection of violations of the gricean maxims (Tényi et al., 2002). It has been argued that a deficit in abstract thinking, defined as "concretism" (Bleuler, 1911), is at the basis of such deficit. People with schizophrenia tend to

show difficulties in going beyond the concrete meaning of what is said. Moreover, they also have deficits in pragmatic production, which is characterized by tangential speech and difficulties in respecting the conversational maxims broadly speaking (Corcoran et al., 1995; Mazza et al., 2008).

These difficulties have been ascribed to a deficit of ToM (Frith, 1992) and, consequently, treatment programs focusing on mentalizing abilities have been developed to improve communication skills and social interactions in patients with schizophrenia (Kayser et al., 2006; Roncone et al., 2004). Yet, Bosco et al. (2012) showed that ToM impairments cannot account for all pragmatic difficulties in these patients (for example, they do not explain patients' difficulty in the recognition of actor's meaning). Acknowledging this, Gabbatore et al. (2017) trained a group of patients with schizophrenia with their recently developed Cognitive Pragmatic Treatment (CPT), which proved to be effective in improving communication in patients with traumatic brain injury (Gabbatore et al., 2015). The CPT focuses on improving patients' inferential abilities in the linguistic, extralinguistic and paralinguistic modalities, addressing pragmatics, ToM and executive functions. In particular this treatment program targets the recognition of the speaker's communicative intention and speech act (sincere, ironic, and deceitful).

Nevertheless, the CPT does not address other pragmatic phenomena, as the comprehension of figures of speech such as, metaphors, idioms and proverbs or the production of on-topic speech. Additionally, it was not tested in a randomized controlled trial, which is a gold standard to measure the effects of a training. Therefore, we decided to test the efficacy of the PragmaCom in the rehabilitation of these impaired skills in patients with schizophrenia. In the study presented in Chapter 5 and titled "It is time to address language disorders in schizophrenia: Efficacy of a novel training targeting the pragmatics of communication (PragmaCom)" (conducted and written in collaboration with Dr. Bosia and colleagues from the Schizophrenia Research and Clinical Unit, Department of Clinical Neurosciences, IRCCS San Raffaele Scientific Institute, Milan, Italy, and in preparation for submission to NPJ Schizophrenia), 30 patients with schizophrenia were assigned either

to the PragmaCom group or to a control group, engaged in activities like reading newspapers and discussing about the news. Results showed that the PragmaCom training led to significant improvement in communicative skills, as well as in symptoms such as concretism, compared to the control group.

To conclude, the purpose of this thesis was to investigate pragmatic abilities directly, with an experimental study as in Chapter 1, and through training studies, which offer the possibility to draw causal connections between variables. The theoretical implications of the results of these studies are discussed in the conclusions of this thesis. Furthermore, we wanted to address a gap in the literature of pragmatic training programs and provide clinicians with new effective tools to train pragmatic abilities in different populations (children and adults, healthy people and patients).

1

How metaphor understanding and Theory of Mind relate in middle childhood: Individual and task-related differences

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Abstract

Recent literature highlighted task demands and individual differences in language and social cognition as important predictors of metaphor comprehension, but their role in the development of metaphorical skills remains unclear. This study investigates the relationship between Theory of Mind (ToM) and metaphor understanding in middle childhood taking into account task demands. We analyzed the role of ToM in predicting metaphor comprehension as assessed via verbal explanation in minimal contexts (Experiment 1) and a referential task in narrative contexts (Experiment 2) in 8-, 9-, and 10- year-old children. In the verbal explanation task, ToM affected metaphor understanding in 9-year-olds, whereas in the referential task ToM effects were observed also in younger children. These findings suggest that metaphorical skills start to capitalize on ToM earlier in development when the context is rich and allows for pragmatic inferencing. Also, the role of ToM in metaphor comprehension seems to diminish as children get older.

Keywords: pragmatics, experimental pragmatics, metaphor, Theory of Mind, metaphor comprehension, pragmatic development

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1.1 Introduction

Metaphor is defined as a "figure of speech that illuminates one dimension of a particular object by drawing attention to its similarity to an object from another realm of experience that normally is viewed as dissimilar" (Winner et al., 1976). From the linguistic point of view, it is one of the most radical instances of the gap between the literal and the speaker's intended meaning, eliciting pragmatic inferencing base d on the context of use (Wilson & Carston, 2007). Metaphor has been largely studied from the processing point of view (Gibbs et al., 2006; Gildea & Glucksberg, 1983; Giora, 2003; Glucksberg, 2003), to shed light on the mechanisms involved in its understanding. The most recent literature in this field has focused attention on the role of individual differences in predicting metaphor comprehension. Research has highlighted the contribution of differences in cognitive skills such as intelligence (Kazmerski et al., 2003; Stamenkovi et al., 2019, 2020), verbal ability (Blasko, 1999), executive control (Columbus et al., 2015), working memory (Chiappe & Chiappe, 2007), and analogical reasoning (Trick & Katz, 1986) in adults' metaphor understanding.

Besides cognitive difficulties strictly speaking, difficulties in metaphor comprehension have been associated also with socio-cognitive skills, as Theory of Mind (ToM) – i.e., the ability to attribute intention, desires and beliefs to oneself and to others, and to use this information to interpret others' behavior (Premack & Woodruff, 1978). For instance, deficits in ToM were found to play a role in explaining difficulties of patients with schizophrenia in understanding metaphorical expressions (Brüne & Bodenstein, 2005; Champagne-Lavau & Stip, 2010; Champagne-Lavau et al., 2006). Nevertheless, findings on the relationship between ToM skills and metaphor comprehension are mixed. In a study on healthy participants, Olkoniemi et al. (2016) found a correlation between emotion recognition and sarcasm, but they did not find such link with metaphor comprehension.

Lately, also literature on child development has started to analyze metaphor comprehension using an individual difference approach. Two recent studies investi-

gated the role of verbal abilities and intelligence in explaining metaphor comprehension outcomes in children (Deckert et al., 2019; Willinger et al., 2019). Willinger et al. (2019) tested children of 7, 9 and 11 and found a developmental step in metaphor comprehension between the age of 9 and 11, which was mainly predicted by cognitive flexibility under time pressure and information processing speed. Later, Deckert et al. (2019) recruited children of four age groups (from 7 to 10 years) and found that their metaphorical skills improved with age, particularly between age 9 and 10, and that verbal intelligence was positively correlated with metaphor comprehension, especially for older children.

Regarding the role of individual differences in ToM on metaphor comprehension, it was extensively investigated in the study of the performance of atypically developing children, especially of children with Autistic Spectrum Disorders (ASD), who often present difficulties in understanding figurative language (Happé, 1994, 1993). Happé (1993) tested children with ASD with a metaphor task where participants were asked to complete a sentence selecting the correct metaphorical ending, among given alternatives. This study proved that only children with ASD who were able to pass first-order ToM tasks were able to understand metaphors. Their performance was also positively correlated with their ToM skills, assessed with the Strange Stories task. Overall, the results of this study confirmed the relevance-theoretic claim that ToM is necessary for metaphor comprehension (Sperber & Wilson, 1995). However, Norbury (2005) objected that ToM might ease metaphor comprehension, but it is not a sufficient condition granting metaphor understanding: comparing the performance of children with ASD and typically developing children in an adapted version of the metaphor task used in Happé (1993), the author found that in both groups broad semantic knowledge played a greater explanatory role than ToM skills in metaphor comprehension outcomes. A potential issue in this study is that part of the semantic knowledge task used, the Test of Word Knowledge (ToWK; Wiig & Secord, 1992), tested also children's ability to understand figurative language, which might explain the stronger relation between this measure and metaphor comprehension, which turned away possible associations with ToM. Despite this,

basic language skills are indeed fundamental for the understanding of non-literal expressions and pragmatic phenomena broadly speaking, as confirmed by Whyte and Nelson (2015) in a cross-sectional study comparing ASD children and typically developing children. Additionally, the study revealed that also ToM skills, tested with the Reading the Mind in the Eyes Test (Baron-Cohen et al., 2001), were correlated to figurative language understanding in both ASD and typically developing children, even when controlling for basic semantic skills. This might suggest that metaphor comprehension is not linked to either basic semantic knowledge or to ToM skills, but that both aspects play a role in its processing. Nevertheless, the measure of nonliteral language used in this study (the Nonliteral Language subtest of the Comprehensive Assessment of Spoken Language; Carrow-Woolfolk, 1999) included metaphors, indirect requests and ironical statements, which proved to rely differently on ToM skills (Happé, 1993; Szücs, 2013), then this results cannot be considered as conclusive.

While the literature on the role of ToM in metaphor comprehension in atypical populations is flourishing, little is known about the relationship between these constructs in typically developing children. Few recent studies tried to fill this gap. Szücs (2013) recruited preschool children and assessed their metaphorical and ToM skills. The author found that ToM was not necessary for metaphor understanding: children with poor performance in first-order ToM tasks were as good at understanding metaphors as children with developed ToM skills, disconfirming Happé (1993) results. Differently, Lecce, Ronchi, et al. (2019a) assessed metaphor comprehension in middle-childhood participants with a new tool, the Physical and Mental Metaphors (PMM) task. The PMM included metaphors with different types of content, i.e., metaphors based on physical and psychological (or mental) characteristics, and two different outcomes, i.e., a measure of accuracy, evaluating children's ability to find a metaphorical connection between topic and vehicle of the metaphorical items presented, and one of interpretation, i.e., a measure of how mental or physical the interpretation of the metaphor was. In this study, the authors found a special link between the interpretation of mental metaphors and

ToM skills (assessed using a selection of non-pragmatic stories from the Strange Stories task; Happé, 1993) in children of 9 years of age but not in older children (10, 11 and 12 years of age). This led to the hypothesis that the relationship between ToM and metaphor understanding changes throughout development, being stronger in younger children, and getting weaker as they get older. This result adds to a body of literature on individual differences and metaphor comprehension focusing of cognitive variables as working memory and executive functions, proving that the strategies used for processing metaphors change over development (Carriedo et al., 2016; Johnson & Pascual-Leone, 1989; Prat et al., 2012).

Del Sette et al. (2020) designed a longitudinal study in order to investigate the direction of the relationship that links ToM and metaphor comprehension in middle childhood. The authors used an expanded version of the PMM task used in Lecce, Ronchi, et al. (2019a) to test metaphor comprehension, and the Strange Stories task (as in Lecce, Ronchi, et al., 2019a) as a measure of ToM. Results showed that metaphor accuracy was bidirectionally connected with general inferential skills (measured with Strange Stories requiring inferences on physical states and not on mental states), while children's tendency to interpretate mentally mental metaphors predicted their ToM skills at T2. Moreover, both Lecce, Ronchi, et al. (2019a) and Del Sette et al. (2020) found that the relationship between metaphor comprehension and ToM in middle childhood is independent of children's vocabulary knowledge, confirming Whyte and Nelson's (2015) results.

Despite the interesting conclusions that these studies suggest, they all present a limitation: in each of them metaphor comprehension was assessed with only one task. This is crucial to point out since task demands have been shown to critically influence participants performance and, consequently, study results (Kalandadze et al., 2019). For instance, an issue of task demands could be at the basis of the differences found in the literature of metaphor acquisition in typically developing children, leading to results which proved that metaphors are interpreted literally until 6/7 years of age in early studies (e.g., Winner et al., 1976), and to more recent findings, showing that 3-year-old children can already understand the metaphorical

meaning of a sentence (Pouscoulous & Tomasello, 2020). In the majority of the studies designed between the 1970s and the 1990s, metaphorical comprehension was tested with verbal explanation tasks, asking children to articulate the meaning of the given metaphor. Requiring a high level of linguistic, metalinguistic, and executive skills (Kalandadze et al., 2019), this task may be too complex for pre-school age children or children in early childhood, therefore not appropriate to test their metaphor comprehension abilities. Differently, studies relying on act out tasks, as in Pouscoulous and Tomasello (2020), could be more suited for this purpose. Moreover, in a metanalysis, Kalandadze et al. (2019) showed that studies performed using different tasks suggested contrasting conclusions about the difficulties of children with ASD in figurative language comprehension compared to matched controls. Additionally, the authors showed that one property that should be taken in consideration relatively to the metaphor task used, is the presence or absence of context in the items presented to participants, given that context supports metaphor understanding (Cameron, 1996; Vosniadou, 1988). Often, metaphor tasks require children to explain the meaning of metaphors presented in minimal context. Presenting metaphor in minimal context leaves the sentence open to different forms of metaphorical interpretation, which might make it difficult for children to select the most relevant properties that link topic and vehicle of the metaphor. Such tasks might put an extra load on ToM skills, given that children need to take the perspective of the experimenter in order to understand what she might refer to when using the given metaphor and what is the best way to explain its meaning.

Other tasks ask children to read stories in which metaphors are embedded and to answer to comprehension questions about the story, as in the referential task used in Noveck et al. (2001). Following the relevance-theoretic account of metaphor (Carston, 2012), an informative context could make it easier for the reader/hearer to understand metaphors, making the properties of the topic and the vehicle rapidly accessible. While reading the story, context-based inferences would lead children to drop some properties of the elements of the metaphor and to keep

the most salient ones, narrowing its denotation and incrementing the likelihood of accurate metaphoric comprehension. At the same time, a richer context might be more difficult to process, requiring the reader/hearer to recruit ToM skills to take the perspective of the characters involved in the story in order to understand the narrative (Mason & Just, 2006, 2009).

1.1.1 The present study

This work aims at shedding further light on the relationship between individual differences in ToM skills and metaphor comprehension in middle childhood, taking into consideration the variability induced by task demands and properties, to overcome the limitations of previous studies. Consequently, we designed two experiments varying according to the task in which children were involved. Since this study addressed children in middle childhood, which proved to be a crucial developmental phase for metaphor comprehension (Deckert et al., 2019; Willinger et al., 2019; Winner et al., 1976) and its relationship with ToM (Del Sette et al., 2020; Lecce, Ronchi, et al., 2019a), we selected two tasks suitable to detect developmental and individual differences in this population.

In Experiment 1, children were asked to perform a metaphor verbal explanation task. We used a modified version of the extended PMM task (Del Sette et al., 2020; Lecce, Ronchi, et al., 2019a), as used in Tonini et al. (n.d.). This task assesses children's ability to understand metaphors in minimal context and their ability to verbally explain the meaning of the metaphors presented.

In Experiment 2, children were engaged in a referential task (adapted from Noveck et al., 2001). This task includes metaphors embedded in rich contexts and requires less metalinguistic abilities, compared with the PMM. In the referential task, children were required to read some stories presented on a computer screen and to answer a yes-or-no comprehension question after each story. Reading times and accuracy were recorded. In both experiments we preliminarily analyzed intergroup differences in metaphor comprehension, before focusing on the contribution of ToM in explaining the performance of children in the metaphor tasks. We

controlled for socioeconomic status, working memory, vocabulary knowledge and receptive grammar.

Following the hypothesis drawn in Lecce, Ronchi, et al. (2019a), that the role of ToM gradually becomes less important in metaphor understanding as children age (as found for other cognitive abilities; Carriedo et al., 2016; Johnson & Pascual-Leone, 1989; Prat et al., 2012), we expected the contribution of ToM to be significantly relevant for the younger age groups (age 8 and 9) compared to the older group. Furthermore, we expected to observe a difference in the results of the two tasks. At this regard, considering the literature reviewed above, we hypothesized two scenarios. On the one hand it is possible that ToM skills are more relevantly involved in determining the performance in the PMM task compared to the referential task, since in verbal explanation tasks children may need to make a mindreading effort to take the perspective of the adult who is asking them to explain the meaning of the metaphor (Kalandadze et al., 2019). On the other hand, the referential task might involve ToM skills in a more relevant fashion, since narrative contexts require the reader to take the perspective of the characters in order to understand the metaphors in the story (Mason & Just, 2006, 2009).

1.2 Experiment 1

1.2.1 Materials and Methods

1.2.1.1 Participants

We recruited 169 participants belonging to three age groups: 56 eight-year-old children, 85 nine-year-old children, 28 ten-year-old children. Children were recruited in primary schools and assessed during class hours allowing every child to take part in assessment. Before running data analyses we excluded those children who met one or more of the following exclusion criteria: presented a diagnosis of developmental learning disorder (17 children: three in the 8-year-old group, eight in the 9-year-old group, and five in the 10-year-old group), presented a severe intellectual disability (one child in the 8-year-old group), presented hearing deficits

(one child in the 10-year-old group), or were not native speakers of Italian (six children in the 9-year-old group). The final samples of children consisted of 145 children: 52 eight-year-old children (19 F, MAge = 8.54, SDAge = 0.28), 71 nine-year-old children (38 F, MAge = 9.39, SDAge = 0.27), 22 ten-year-old children (14 F, MAge = 10.42, SDAge = 0.25).

1.2.1.2 Design and procedure

Participants were evaluated in three separate sessions, two collective and one individual, lasting about one hour each. During the two collective sessions, socio-economic status, grammar, vocabulary and ToM abilities were assessed. The order of the tests was counterbalanced across classes. During the individual session, children completed a working memory task and the two experimental tasks, for the individual session children were randomly divided into two lists with two different orders of administration.

1.2.1.3 Assessment materials

Socio-economic status. The Italian translation of the Family Affluence Scale (Boyce et al., 2006) was used as a tool to measure the socio-economic status of children's families. It is a four-item measure of family wealth that investigates: the number of cars the family owns (range: 0 – 2), whether children have their unshared room (range: 0 – 1), the number of times children went on vacation the previous year (range: 0 – 3) and the family tablets and computers ownership (range: 0 – 3) for a total score range of 0 – 9. The questionnaire was presented on a printed booklet (one for each child) with questions displayed in a multiple-choice format.

Grammar. The Test for Reception of Grammar – Version 2 (TROG-2 – the Italian version of Suraniti et al., 2009) was used to measure children's understanding of grammatical structures. The test consists of 80 items, grouped into 20 blocks with four items each. Each block addresses a specific grammatical structure. For each item, a sentence is read aloud by the experimenter, and participants must

choose among four pictures, the one that better corresponds to the word spoken by the experimenter. Due to time constraints issues, only a subset of four blocks, selected to include different difficulty levels based on data in the literature (Edwards et al., 2011), was used. Blocks G (relative subject clause), K (reversible passive), S (relative object clause) and R (singular/plural inflexion) were selected. The total score range was 0 – 16. The examiner orally presented the sentence and children were asked to mark their choice on a printed booklet with items displayed in a multiple-choice format.

Vocabulary. Children's receptive vocabulary was measured with the Peabody Picture Vocabulary Test-Revised (PPVT-R – we used the Italian version of Stella et al., 2000). The PPVT-R consists of 175 items. Each item is composed of a word stimulus and an image stimulus. Each image stimulus contains four black-and-white drawings, one of which corresponds to the word stimulus. Children were asked to listen to the word read by the experimenter and then mark on their printed booklet one of the four drawings that best described the word's meaning. The starting point of the test is determined based on the child's age, going backwards if the child does not provide eight consecutive correct answers. To administer the test collectively, a range of 65 items was selected, starting 20 items before the item identified as the starting point for each age point. For age eight, the starting point was item 65 (selected range: 45 – 110); for age nine the starting point was item 70 (selected range: 50 – 115); for age ten the starting point was item 80 (selected range: 60 – 125). The final score was calculated according to the test manual.

Working Memory. Working memory was assessed with the Digit-span Backward task, taken from the Italian version of the Wechsler Intelligence Scale for Children – Revised (WISC-R; Orsini, 1993). The examiner listed a series of digit sequences, and participants were asked to recall them in reverse order orally. Participants completed seven sequences of digits with the number of digits increasing

in each sequence from two to eight. Each sequence was marked as passed (1) or failed (0); the total score ranged from 0 to 7.

Theory of Mind. Theory of Mind abilities were evaluated with the Strange Stories Task (Happé, 1994). The task consists of short stories describing social situations followed by an open-ended question that requires participants to explain a character's behavior. Seven mental stories were selected from the original task and administered (two involving double bluff; two involving misunderstanding; two involving persuasion and one involving a white lie). Participants had to answer the open-ended question in a written format and had no time limit. In line with scoring guidelines (White et al., 2009) participants' answers were rated on a 3-point scale (0 for an incorrect answer; 1 for a partially correct and implicit answer; 2 for a full and explicit answer). The total score ranged from 0 to 14 points.

1.2.1.4 Experimental Task

To assess participants' ability to comprehend nominal metaphors, we used a modified version of the extended Physical and Mental Metaphors task (Del Sette et al., 2020; the original version is of Lecce, Ronchi, et al., 2019a), as used in Tonini et al. (n.d.). Each item consisted of a single sentence expressed in the structure of nominal metaphors (i.e., "X is Y" where "X" is the topic and "Y" is the vehicle). The task was composed of 12 sentences, six requiring an inference about mental aspects of the metaphor's topic (mental metaphors), and six requiring an inference about physical aspects of the metaphor's topic (physical metaphors). Each metaphor receives an accuracy score, assessing participant's ability to articulate the link between the topic and the vehicle of the metaphor (0 incorrect; 1 partially correct; 2 correct) and an interpretation score, assessing children's tendency to focus on mental or physical features when explaining the meaning of the assessed metaphor (0 for no explanation; 1 for physical-behaviour interpretation; 2 for descriptive-evaluative interpretation; 3 for psychological interpretation). Starting from the interpretation scores, a specificity of interpretation index (Del Sette et al., 2020) was calculated

for each participant, subtracting the scores obtained for the physical metaphors from the scores obtained for the mental metaphors.

1.2.1.5 Data analysis

To analyze the results of Experiment 1, we fitted two models, one for each measure of the PMM task: accuracy and specificity of interpretation. Both models preliminarily analyzed the differences between age groups before focusing on the role of ToM in predicting the performance of each group in metaphor comprehension. The models, described in detail in the following paragraphs, were chosen accordingly to the type of outcome provided by each measure. In both cases we tested the nested interaction between Group and ToM to investigate whether ToM had a different role in explaining metaphor comprehension at different ages in middle childhood. The factor of Group (three levels: age 8, age 9, and age 10) was coded with a repeated contrast (Schad et al., 2020) comparing groups in ascending order (age 9 VS age 8, and age 10 VS age 9). Socio-economic status, working memory, vocabulary knowledge and receptive grammar were added to the models as covariates after centering each variable around the mean.

Before running the analysis, we pre-processed our raw data excluding participants whose accuracy deviated more than 2.5 SD from the mean of their reference group, by assessing each age group separately. We excluded one participant in the group of 9-year-old children.

To analyze the results of the Accuracy outcome in the Physical and Mental Metaphors task, coded on an ordinal scale, we fitted a Cumulative Link Mixed Model (CLMM) in R (R Core Team, 2018) with the clmm function from the *ordinal package* (Christensen, 2011). CLMM allowed us to analyze this data taking in consideration the variability which characterizes participants and items (treated as random structures). The model's formula was: DV~Group/ToM + (covariates) + (1|Participants) + (1|Items).

Table 1.1: Descriptive statistics for Experiment 2

	Group (N)		
	8 (51)	9(71)	10(22)
	M (SD)	*M* (*SD*)	*M* (*SD*)
Family Affluence Scale	1.83(0.27)	1.84 (0.29)	1.78 (0.38)
Digit Span-Backward	0.34 (0.11)	0.32 (0.12)	0.40 (0.12)
Peabody Picture Vocabulary Test-Revised	94.25 (3.78)	93.42 (6.58)	87.41 (9.28)
Test for Reception Of Grammar-2	0.95 (0.08)	0.97 (0.05)	0.97 (0.07)
Strange Stories	1.06 (0.40)	1.14 (0.39)	1.13 (0.41)
Physical and Mental Metaphors task (Accuracy)	1.13 (0.36)	1.22 (0.39)	1.49 (0.24)
Physical and Mental Metaphors task (Specificity of Interpretation)	0.60 (0.33)	0.85 (0.55)	0.89 (0.39)

For the Specificity of Interpretation outcome, which is a single index calculated for each participant, we fitted a linear model (lm function from the stats package). The model's formula was: DV~Group/ToM + (covariates).

1.2.2 Results

Descriptive statistics are presented in Table 1.1.

1.2.2.1 Accuracy

The model with Accuracy as dependent variable, showed that 10-year-old children performed better than 9-year-old children ($OR = 2.07$, $CI = 1.33 – 3.22$, $z = 3.22$, $p = .001$). The model shows that ToM abilities have a significant effect both in the 9-year-old group ($OR = 1.46$, $CI = 1.17 – 1.83$, $z = 3.32$, $p < .001$) and in the 10-year-old group ($OR = 1.62$, $CI = 1.09 – 2.42$, $z = 2.37$, $p = .018$): higher ToM abilities predict higher accuracy. Results are displayed in Figure 1.1.

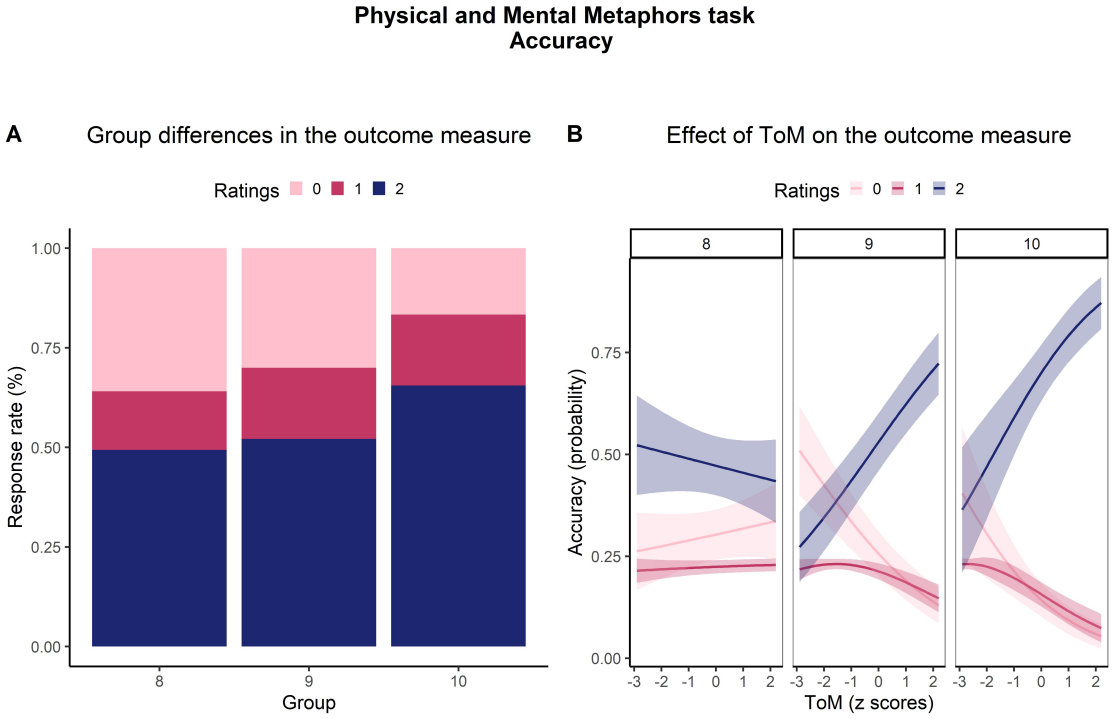

Figure 1.1: Plots displaying the results of the analysis on ToM effects on accuracy ratings in the Physical and Mental Metaphors task.
Plot A represents the percentage of ratings with value 0, 1 or 2 attributed to the responses given by each group (8-, 9-, and 10-year-old children). Plot B displays the probability for each rating as a function of ToM skills (z-scores) in each group as calculated by the clmm model on the nested interaction between ToM and Group with accuracy as dependent variable.

1.2.2.2 Specificity of Interpretation.

The model on Specificity of interpretation shows a difference between the group of 9- and 8-year-old children ($\beta = 0.25$, $CI = 0.10 - 0.40$, $t = 3.20$, $p = .002$): children of 9 are more precise compared to younger children in giving interpretations that lay on the physical or mental level for physical and mental metaphors respectively. No difference was found between children of 10 and children of 9. The model shows that ToM abilities have a significant effect in the 9-year-old group ($\beta = 0.11$, $CI = 0.00 - 0.21$, $t = 2.03$, $p = .045$) but not in the 8-year-old group ($\beta <$ -0.01, $CI =$ -0.13 – 0.12, $t =$ -0.06) and 10 years ($\beta = 0.14$, $CI =$ -0.05 – 0.32, $t =$ 1.46). Results are displayed in Figure 1.2.

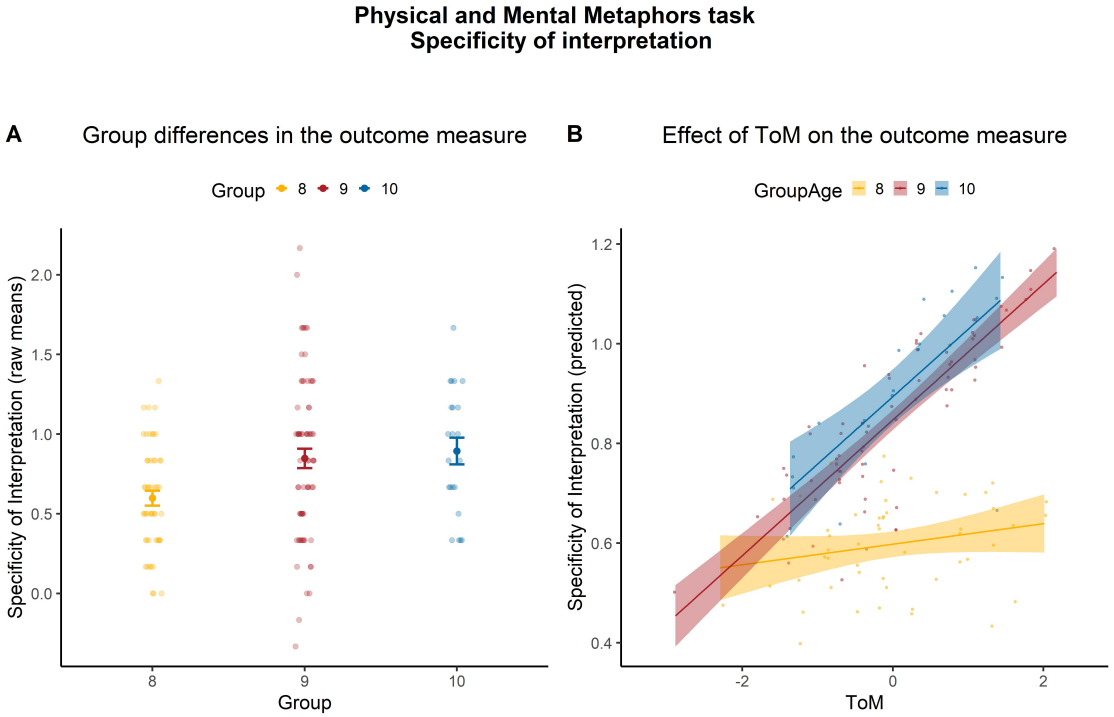

Figure 1.2: Plots displaying the results of the analysis on ToM effects on the specificity of interpretation measure of the Physical and Mental Metaphors task.
Plot A represents the specificity of interpretation means for each group (8-, 9-, and 10-year-old children). Bars represent the standard error for each group, while dots represent the mean score for each participant. Plot B displays the specificity of interpretation scores as a function of ToM skills (z-scores) in each group as predicted by the linear model on the nested interaction between ToM and Group with specificity of interpretation as dependent variable.

1.2.3 Summary

Experiment 1 aimed at analyzing the performance of children in the PMM, in order to investigate the role of ToM in predicting metaphor comprehension in each group. In this task children were asked to verbally explain the meaning of metaphors in minimal context.

The preliminary analysis on the developmental effects confirmed that there is a developmental step in metaphor comprehension between age 9 and 10, as found in previous studies assessing metaphor comprehension with verbal explanation tasks (Deckert et al., 2019; Willinger et al., 2019). Nevertheless, considering the specificity of interpretation measure, performance improved earlier, between 8 and 9 years of age. This suggests that before becoming more accurate in expressing clear

metaphorical links between topic and vehicle of the metaphor, children correctly understand to what dimension (physical or psychological) the sentence refers to and they are, therefore able to give interpretations which lay on the right domain. This result is in line with the results of Lecce, Ronchi, et al. (2019a) and extends them, pointing out differences in the developmental pattern that characterizes the two outcome measures of the PMM task.

Concerning the effects of ToM on metaphor understanding, results seem to indicate that ToM abilities support children performance both in accuracy and in specificity of interpretation, boosting the performance of children in both measures. Interestingly, this is true for children of age 10 in accuracy and for children of age 9 in specificity of interpretation, but it's not valid for children of 9 years of age in accuracy, since a significant effect of ToM on the performance of this group does not result in a significant difference in accuracy between the group of 9 years and the group of 8. This might suggest that ToM supports metaphor comprehension, but this latter ability requires other skills that are not fully developed by age 9, preventing children to reach a significantly higher level of performance when compared with younger children.

1.3 Experiment 2

1.3.1 Materials and Methods

Experiment 1 and Experiment 2 were both run at in the same experimental session. Hence, participants, design and procedure for Experiment 2 are common to the one described in Experiment 1, as well as the assessment materials, except for the experimental task, described below.

1.3.1.1 Experimental Task

To investigate children's ability to comprehend metaphorical referents, the referential task used in Noveck et al. (2001) was adapted for the Italian language. The task was composed of 16 pairs of eight-lines stories (some adapted from French to

Italian from Noveck et al., 2001, and some others created ex novo). In the first line of each story a referent was introduced, and in the seventh line a referential term was presented, which was the target of experimental manipulation: in one condition this referential term was metaphorical, and in the other condition, it was literal and specifically synonymic. Length and frequency were controlled for each pair of metaphorical and literal referents. Each participant could read only one of the stories in each pair, either the metaphorical or the literal version of the story. Therefore, two lists of 16 stories were created, each containing eight metaphorical and eight literal stories, plus eight filler stories that were the same in each list. The task was performed via computer. Participants were given the time to read each story at their own pace: once they finished reading one line, they could move to the following one pressing the spacebar. At the end of each story, a yes-or-no question concerning the identification of the referent was presented. Participants were asked to answer by button press. For the experimental conditions (literal and metaphorical), the answer was always "yes". For the control condition (fillers), the answer was always "no". Accuracy (range 0 – 8 for the metaphorical condition, and 0 – 8 for the literal condition), and reading times for the seventh line were measured (following Noveck et al., 2001).

1.3.1.2 Data analysis

Before running analyses, we checked for outlier participants in accuracy and for outlier observations in reading times, after excluding fillers from the pool of items. For accuracy we removed from analysis those participants whose performance in the literal condition was below 80%, to assure that children did not have difficulties with reading comprehension and with the computerized procedures. We excluded 34 participants: eight in the group of 8, 20 in the group of 9, and six in the group of 10. After cleaning the percentage of accuracy was 84% in the group of 8, 86% in the group of 9 and 93% in the group of 10.

For reading times, we excluded those target observations (i.e., reading times for the seventh line of each story) that were faster than 900ms and slower than 2.5

standard deviations from the mean of the participant's reference group, following Spotorno & Noveck (2014), who used a similar task with young adults. In this case we used this strategy for both the literal and the metaphorical condition separately. We removed 3.8% of target observations from the results of the group of 8, 2.9% from the group of 9 and 2.8% from the group of 10.

We tested the relationship between Condition (two levels: literal VS metaphorical sentences), Group (three levels: age 8, age 9, and age 10), and ToM (Strange Stories) for each of the two dependent variables considered (Accuracy and Reading times), in order to investigate the developmental trajectory of referential metaphor comprehension acquisition and the role of ToM in its development.

We fitted a Generalized Linear Mixed Model (for accuracy) and a Linear Mixed Model (for reading times) using the lme4 package (Bates et al., 2014) in R (R Core Team, 2018), with crossed random effects for Participants and Items. In the model for accuracy, we allowed also a random slope for Condition by Item (allowing for a random slope for Condition by Item in the model on reading times led to correlations with the intercept close to 1, while allowing a random slope by Participants in all models led to convergence issues). Before entering analyses, Reading Times were log-transformed to correct for data inherent skewness. All models preliminarily tested the nested interaction between Condition and Group: our interest was to look for changes between groups, compared in developmental order, in each of the levels of the factor Condition, namely the literal and metaphorical level. For Condition we set a treatment contrast with literal sentences as intercept, while for the Group variable we set a repeated contrast (age 9 VS age 8, and age 10 VS age 9; Schad et al., 2020). In order to investigate if ToM had a different role in explaining metaphor comprehension in these developmental phases, we included also our ToM measure in the nested interaction. Socio-economic status, working memory, vocabulary knowledge and receptive grammar were added to the model as covariates after centering each variable around the mean. The models' formula was: DV~ Condition /Group/ToM + (covariates) + (1|Participants) + (1+Type|Items).

Table 1.2: Descriptive statistics for Experiment 2

	Group (N)		
	8 (43)	9(47)	10(16)
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Family Affluence Scale	1.80 (0.28)	1.91 (0.25)	1.81 (0.35)
Digit Span-Backward	0.33(0.11)	0.33(0.12)	0.42 (0.12)
Peabody Picture Vocabulary Test-Revised	93.98 (3.74)	93.94 (6.45)	89.56 (7.57)
Test for Reception Of Grammar-2	0.95 (0.08)	0.97 (0.05)	0.99 (0.03)
Strange Stories	1.04 (0.40)	1.18 (0.41)	1.12 (0.41)
Referential task (Accuracy)			
literal	0.93 (0.07)	0.92 (0.06)	0.97 (0.06)
metaphoric	0.74 (0.19)	0.81 (0.15)	0.90 (0.10)
Referential task (Reading Times, s)			
literal	5.86 (1.96)	5.16 (1.39)	4.21 (1.05)
metaphoric	6.91 (2.20)	5.47 (1.25)	4.67 (1.18)

1.3.2 Results

Descriptive statistics are displayed in Table 1.2.

1.3.2.1 Accuracy

The model with Accuracy as dependent variable showed that there was significant main effect of Condition, with metaphorical stories receiving less accurate answers compared to literal stories (OR = 0.28, CI = 0.17 – 0.47, z = -4.83; $p < .001$). There was also a significant difference between the group of 9 and 8 (OR = 1.57, CI = 1.06 – 2.34, z = 2.24; p = .025) and between the group of 10 and 9 (OR = 2.06, CI = 1.04 – 4.08, z = 2.07; p = .038) only in the metaphorical condition. Considering the role of ToM, the model showed that there was a significant interaction between ToM and the performance of the group of 8 (OR = 1.36, CI = 1.01 – 1.85, z = 2.00, p = .046) and in the group of 9 (OR = 1.49, CI = 1.11 – 2.01, z = 2.64, p =

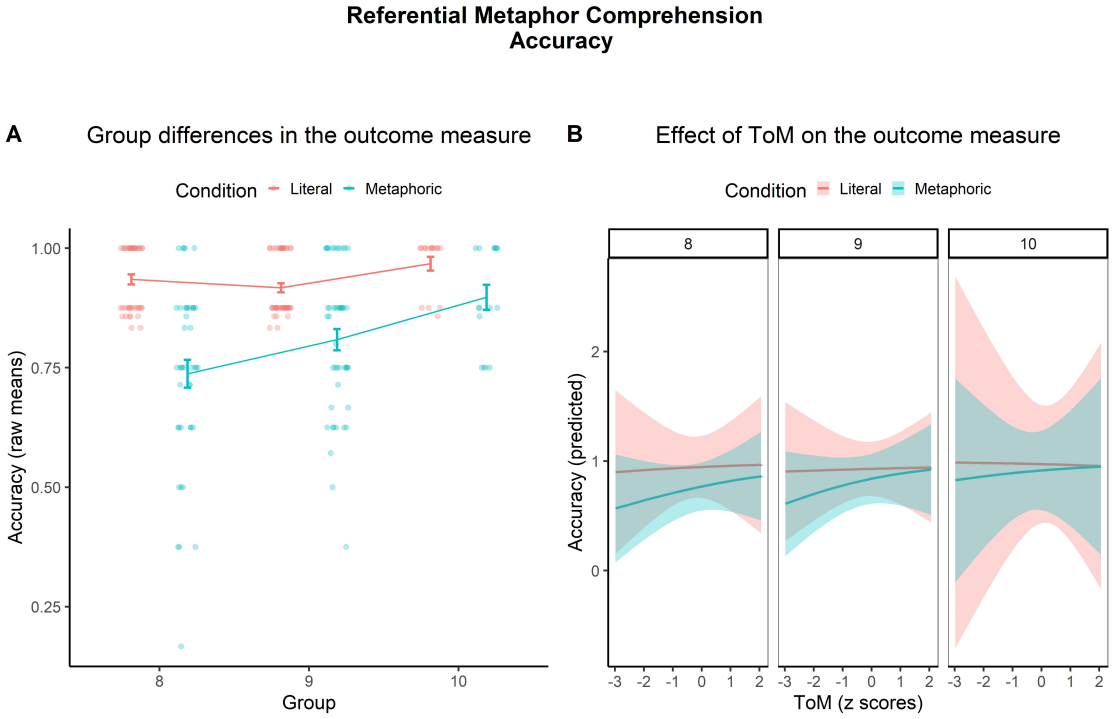

Figure 1.3: Plots displaying the results of the analysis on ToM effects on the accuracy measure of the referential task.
In Plot A lines connect the mean accuracy calculated for each group (8-, 9-, and 10-year-old children) and for each Condition (literal VS metaphoric). Bars represent the standard error for each group, while dots represent the mean accuracy scores for each participant. Plot B displays the accuracy scores as a function of ToM skills (z-scores) in each group as predicted by the generalized linear mixed model on the nested interaction between ToM, Group and Condition with accuracy as dependent variable. Colored bands represent the standard error.

.008) in the metaphorical condition. Results are displayed in Figure 1.3.

1.3.2.2 Reading Times

The linear mixed-effect model with Reading Times as dependent variable showed a main effect of Condition, with metaphorical sentences read more slowly than literal ones (β = 0.11, CI = 0.08 – 0.14, t = 6.87, $p < 0.001$). The group of 9 was significantly faster than the group of 8 years in the metaphorical condition (β = -0.19, CI = -0.31 – -0.08, t = -3.32, p = .001), and the group of 10 was significantly faster than the group of 9 both in the literal (β = -0.19, CI = -0.35 – -0.04, t = -2.43, p = .017) and in the metaphorical condition (β = -0.16, CI = -0.32 – -0.01, t = -2.09, p = .039). Considering the role of ToM, the model showed a significant

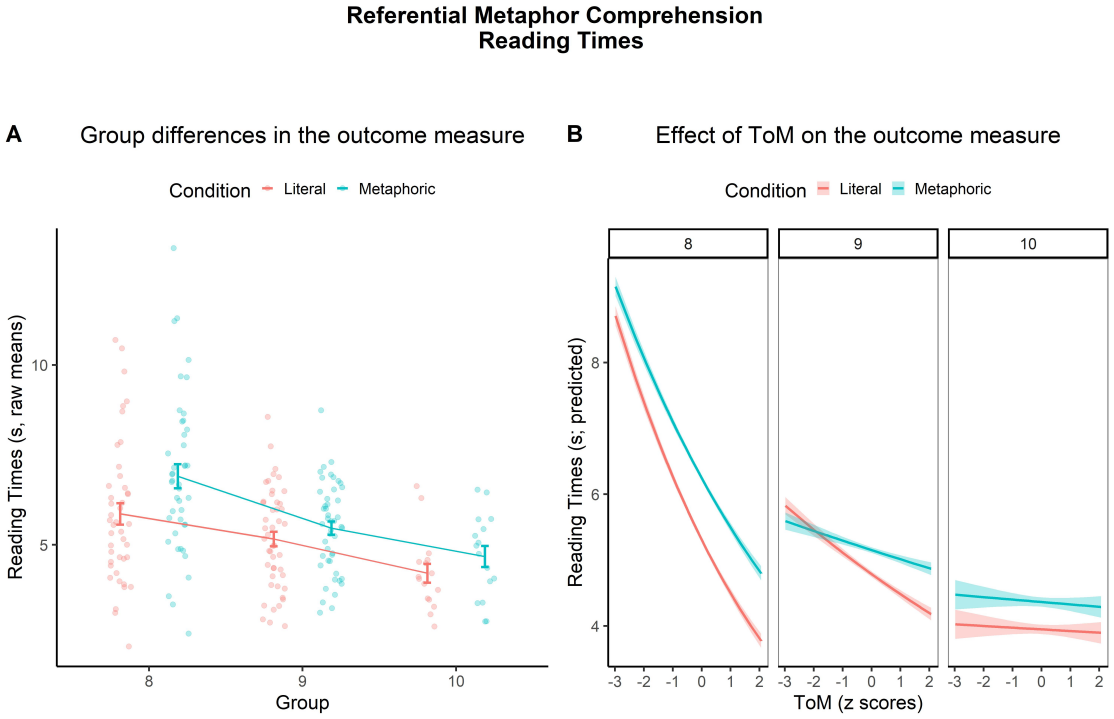

Figure 1.4: Plots displaying the results of the analysis on ToM effects on the reading times in the referential task.
In Plot A lines connect the mean reading times (recorded for the seventh line of each story of the Referential task) calculated for each group (8-, 9-, and 10-year-old children) and for each Condition (literal VS metaphoric). Bars represent the standard error for each group, while dots represent the mean score for each participant. Plot B displays reading times as a function of ToM skills (z-scores) in each group as predicted by the linear mixed model on the nested interaction between ToM, Group and Condition with reading times as dependent variable. Colored bands represent the standard error.

interaction between ToM and the performance of the group of 8 both in the literal (β = -0.17, CI = -0.26 – -0.07, t = -3.54, $p < .001$) and in the metaphorical condition (β = -0.13, CI = -0.22 – -0.04, t = -2.74, p = .007): higher ToM scores were associated with faster reading times. Results are displayed in Figure 1.4.

1.3.3 Summary

Experiment 2 was designed to investigate the effects of ToM on the performance of children in a referential task (adapted from Noveck et al., 2001). In this task children needed to answer yes-or-no comprehension questions related to the identification of a metaphorical or literal referent presented in the stories that children were asked to read.

Preliminary analysis on the developmental difference between age groups showed a gradual improvement across groups in accuracy in the identification of metaphorical referents and in reading times, which is in line with Noveck and colleagues' findings and extends them, showing that younger children have more difficulties in identifying metaphorical referents than older children and in reading sentences that contain them.

Considering the role of ToM, results showed that mentalizing skills have an effect both on accuracy and on reading times, already starting at 8 years of age. Interestingly, the effect of ToM on reading times was limited to the younger group included in the study (age 8) and it was not selective for metaphor: this confirms the results of a recent study of Lecce et al. (2021), showing that ToM abilities are linked to reading skills in general. In this particular case, higher ToM abilities might help children follow the characters and understand their points of view, enhancing children's comprehension of the story and allowing them to read the target sentence faster, as a consequence. This hypothesis is confirmed also by the results on accuracy: 8-year-old children with higher ToM skills reach a higher level of accuracy. In the group of 9-year-old children instead, the effect of ToM is seen only in accuracy, probably because children at this age have already reached a proficient level of reading, which ToM skills alone cannot further enhance. At this age, though, ToM seems to support the ability to correctly identify the link between the target and the referent in the stories of the referential task, given that an effect of ToM on the performance is associated with higher accuracy in this group compared to the younger group. A different strategy seems to be adopted by the group of 10-year-old children, which proved to have a higher performance than the group of 9 years of age, independently of their ToM level.

1.4 General Discussion

The main aim of this study was to analyze the relationship between ToM and metaphor comprehension in different age groups in middle-childhood (age 8-, 9-,

and 10) in tasks with different cognitive and linguistic demands. In Experiment 1, we used a verbal explanation task with metaphors presented in minimal context, while in Experiment 2, we used a referential task in which metaphors were embedded in stories. To the best of our knowledge, this is the first study exploring this topic with an analysis of different metaphor tasks. We hypothesized that, generally speaking, the effect of ToM would be stronger in predicting metaphor comprehension in younger participants and it would gradually decrease with their age. Additionally, we expected to see differences in the extent to which ToM relates to metaphor according to the tasks used and their different properties, such as the presence of a minimal or rich context.

Our first hypothesis was partially confirmed: results of both experiments showed that the relationship between ToM and metaphor is mainly observable in the younger groups of 8 and 9 years of age. However, also the group of 10-year-old children showed some effects, albeit limited to the accuracy scores in the verbal explanation task. Our second hypothesis instead was fully confirmed. The analyses on the two metaphor tasks showed an effect of ToM on children's metaphor understanding at different ages according to the task used: in the referential task such effect was already observable for children of 8 years of age, while in the verbal explanation task ToM predicted children performance starting from age 9. These results suggest important implications from the theoretical and applicative point of view, shedding new light on the relationship between ToM and metaphor comprehension.

Before discussing these findings in detail, we find it important to briefly comment on our preliminary results on the developmental changes in metaphor comprehension.

The referential task seemed to be easier for children than the verbal explanation task, showing improvements in performance in younger groups than the Physical and Mental Metaphors task. This is in line with previous studies which proved the higher difficulty of verbal explanation tasks, both for children with atypical development (Kalandadze et al., 2019) and for adults with pathological conditions

(Arcara et al., 2020; Perlini et al., 2018). Moreover, children's metaphoric comprehension skills changed also among the measures used to assess them: in particular, in the Physical and Mental Metaphors task, accuracy was found to significantly improve at the age of 10, while, when the specificity of interpretation measure was considered, children of 9 already showed a higher performance compared to the younger group. These findings highlight how it is important to consider the role of the structure of the task and what it measures in order to be able to draw clear and specific conclusions, as pointed out by Gibbs and Colston (2020). For example, with accuracy in the Physical and Mental Metaphors task, we were measuring children's ability to explain metaphors, to articulate the link between topic and vehicle of the metaphor, which is a different skill than understanding to what domain (mental of physical) the metaphor refers to. Showing an improvement in younger children, this latter measure might reflect a metaphorical thought that precedes metaphorical language (Alessandroni, 2017), allowing children to detect to what the metaphorical expression refers, before being fully able to explain it.

Moreover, these measures are different than those used in the referential task in Experiment 2. Here, children's performance is evaluated on the basis of their accuracy in answering to yes-or-no comprehension questions and of the time taken to read the target sentence. Thus, in this case, the accuracy measure assesses a more general comprehension of the story that is achieved only if the link between the metaphorical or literal referents were correctly associated with the target. Reading times measure the ability of children to process the sentences containing literal or metaphorical sentences. The results of this study show that these abilities improve throughout middle childhood, confirming the results of Noveck et al. (2001).

Coming to the main focus of this study, namely exploring the relationship between ToM and metaphor comprehension, the finding that these variables are more strongly interrelated in children of age 8 and 9, as predicted by our first hypothesis, suggests that the role of individual differences in ToM on metaphor comprehension decreases with age. This adds to a body of literature claiming that the strategies on which more developed skills, such as metaphor comprehension,

are based can change over the course of development. For instance, Carriedo et al. (2016) showed that, in adolescents, metaphor comprehension strategies rely on executive functions more than in young adults. Cragg and Chevalier ((2012)) argued that cognitive flexibility in children and adults relies on similar but not identical processes, suggesting a developmental change in the strategies adopted. Our results showed that the relationship between ToM and metaphor is not constant in time, but fades as children grow older and acquire new inferential skills that can support metaphorical understanding. With these findings we extend the results of Lecce, Ronchi, et al. (2019a), who found this pattern when analyzing the interpretation scores of the Physical and Mental Metaphors task, proving that this is true also for a different task, as the referential task used in Experiment 2. As we previously pointed out, this is particularly true for the results of Experiment 2, in which a referential task was used and ToM was found to be relevant for the performance of 8- and 9-year-old children, while Experiment 1 only partially confirmed this hypothesis, since we found an effect of ToM also in children of 10 years of age. This paves the way to the discussion of our second hypothesis.

Besides observing a gradual decrease in the role of ToM in explaining metaphorical performance in children, we also expected to see differences in the way in which the two abilities interact when comparing tasks with different properties. At this regard, we postulated two scenarios according to previous literature. A first possibility was that ToM would be more involved in the verbal explanation task used in Experiment 1, because it required to interact with an experimenter and to try to understand her point of view in order to find an efficient way to explain the metaphor. A second option was that mentalizing skills would be more strongly recruited in the referential task used in Experiment 2, in which narrative contexts made it necessary for children to take the perspective of the characters to follow the stories and understand the plots (Mason & Just, 2006, 2009) and therefore the metaphor. Moreover, the presence of a rich context fosters inference making processes which require ToM skills (Del Sette et al., 2020). Our results seem to suggest that both scenarios can be true and that ToM supports metaphor

comprehension at different ages according to the characteristic of the task and its demands. In the following paragraphs we will describe in detail our results in light of this consideration.

In the referential task, the effect of ToM is observed in faster reading times for both literal and metaphorical conditions in 8-year-old children. In this case ToM is linked with reading skills in general and not related exclusively to metaphor. According to a recent study of Lecce et al. (2021) individual differences in ToM are significantly associated with reading comprehension abilities. Consequently, we might hypothesize that in young children, whose reading skills are still developing, a higher level of ToM can speed up the process of reading via fostering comprehension: the higher the ability to understand the point of view of the characters, the higher and faster the general comprehension and the speed in processing the target sentence. When looking at the accuracy scores, the effect of ToM is seen only in the metaphorical condition in 8- and 9-year-old children. This means that both children with low and high levels of ToM reach the same level of accuracy in the literal condition of this task (even if it takes longer to read the target sentences for children with low ToM in the group of age 8), while only children with more developed ToM skills reach higher metaphoric comprehension. These results might suggest that the recruitment of ToM to follow the characters in the story (Mason & Just, 2006, 2009), is particularly important when metaphors are present: identifying the target of a metaphorical referent requires the reader to understand what the characters of the story think of the target/referent, assuming their perspective.

Moreover, the presence of metaphors in short stories has been shown to create a sense of intimacy by stimulating emotional responses (Bowes & Katz, 2015). Thus, it is possible that children with more developed ToM skills are more involved in the story and therefore show a higher level of comprehension.

In the verbal explanation task, the effect of ToM is observed in older children, starting from age 9. When considering the index of specificity of interpretation (the ability to psychologically interpret mental metaphors), the effect of ToM was significant only in the group of 9-year-old children. This confirms the results

of Lecce, Ronchi, et al. (2019a), highlighting the special link between ToM and this measure in children of this age, and extends them, showing that higher ToM abilities led to a higher specificity of interpretation in children of age 9 compared to younger children. When considering accuracy in this task, an interesting result is that ToM predicted metaphor comprehension in children of 9 years of age, but this did not lead to a significant difference in accuracy between children of age 9 and the younger group, as found instead for children of age 10. We hypothesize that this means that ToM skills can efficiently support metaphor, leading to a higher level of performance, in an explanation task only when other skills are developed enough to reach a higher level in metaphor comprehension. It might be argued that one of such skills is vocabulary knowledge, but our results do not point to this direction, since this variable was included in all our models as covariate, without showing any significant effect in explaining the variability of the data collected in this study (nor did any of the other covariates considered: socioeconomic status, working memory and receptive grammar). We acknowledge that an effect of vocabulary might be observed for some conditions or some groups if a model was fitted considering the nested interaction between Group and Vocabulary, but this was beyond the purpose of this study, which wanted to focus on the relationship between individual differences in ToM and metaphor comprehension, controlling for other linguistic and cognitive measures relevant for metaphor processing. It would be indeed interesting to investigate in future studies the separate contributions of vocabulary, syntax and cognitive components such as executive functions using an individual difference approach in the comparison of different metaphor tasks.

Moreover, to shed further light on the relationship between ToM and metaphor understanding, future studies should investigate what task properties contribute to enhance the recruitment of ToM: in the present studies it was not possible to say it with certainty, given that the selected tasks differed on many levels (i.e., response format, modality, presence or absence of context, type of nominal metaphor used).

Another limitation of the present work is that the recruited groups had heterogenous numerosities, especially the group of 10-year-old children, which presented a

lower number of participants compared to the other groups. Therefore, we cannot rule out the possibility that different patterns of results would emerge with more homogeneous samples.

Despite these limitations, our findings have important implications both from the theoretical and the practical point of view. From a theoretical perspective, this study confirmed that using tasks with different demands and properties leads to different results when considering both children's proficiency in metaphor comprehension and in its relationship with other skills, as ToM. In particular, the presence or absence of context and different response modalities might affect the strategies used and the cognitive resources needed. Thus, in order to understand how metaphor comprehension processing develops, it is of great importance to use ecological tasks, in which metaphors are embedded in supportive contexts, as usually happens in real communication. The widespread use of verbal explanation tasks in which metaphors are presented in isolation or in minimal context (e.g., Deckert et al., 2019; Lecce, Ronchi, et al., 2019a; Willinger et al., 2019; Winner et al., 1976), might have led to misleading results. In particular, when considering the contribution of ToM in metaphor comprehension, the use of items which did not present an appropriate context, might have led to overlook the role that ToM has in comprehension in ecological environments.

From a practical perspective, the findings of this study suggest that it might be useful to train also ToM skills, in order to improve children's metaphor understanding. In a recent work, Tonini et al. (n.d.) showed that it is possible to train metaphor understanding in typically developing children, with benefits which extended to general reading comprehension skills. Taking in consideration the results of the present study, it might be possible that training both metalinguistic abilities, as in Tonini et al. (n.d.), and ToM, might further foster children's comprehension skills, promoting their success in class and in communication in general.

2

Efficacy and benefits of the MetaCom training to promote metaphor comprehension in typical development

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Abstract

Although metaphors are essential tools in everyday communication and educational settings, the literature lacks evidence of effective training tools to promote metaphor comprehension in typical development. Grounding on theoretical pragmatics, we developed a novel metaphor comprehension training (MetaCom) for school-age children that focuses on inferential and contextual aspects of metaphors. The effects of the MetaCom were tested against a control training focusing on text comprehension in a randomized controlled trial. Only children in the MetaCom group improved in the ability to verbally explain the meaning of a metaphor. Moreover, only the MetaCom showed transfer effects to reading comprehension. These findings suggest that targeting inference and attention to context is key to promote metaphor understanding, and that the benefits might extend to linguistic and communicative skills at large. The MetaCom training can thus represent a promising tool for educational programs, possibly also in atypical populations.

Keywords: metaphor; pragmatics; training; figurative language; Relevance-Theory; experimental pragmatics

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2.1 Introduction

Reaching full-fledged metaphor skills represents an important achievement in language development, as metaphors can help accomplish several goals in communication, such as talking about abstract and complex concepts, increasing memorability, expressing feelings, provoking thoughts, etc. (Katz, 1996; Ortony, 1975). Figurative language is very common also in teachers' classroom language, where it can be used to admonish, praise, express humor and sarcasm (Kerbel & Grunwell, 1997) and, most importantly, as a pedagogical tool (Littlemore et al., 2011). Evans and Evans (1989) showed that participants who attended statistics classes were metaphors were used performed better than controls (who attended classes in which no metaphor was used), both in statistic problems similar to those taught, and in novel ones. As Cameron (2003) explains in a thorough analysis of the use of metaphor in class, this results might be related to the ability of metaphor to induce cognitive change and, as a consequence, promote learning and comprehension in children. Albeit there is evidence that children might be able to comprehend metaphors at a very early age when presented with simple tasks (Di Paola et al., 2020; Pouscoulous & Tomasello, 2020), studies have shown that the full-fledged ability to understand the meanings of metaphors and articulate their complex nuances is not in place until adolescence (Del Sette et al., 2020; Lecce, Ronchi, et al., 2019b; Winner et al., 1976). Hence, promoting the understanding of metaphors in children should be of primary importance to improve their communicative skills and learning opportunities.

Despite this, very few studies have targeted the promotion of metaphor skills in typical development. In one of these studies (Biaecka-Pikul, 2010), preschool children were trained to understand metaphors through either verbal or non-verbal cues. For instance, children were prompted to understand the similarity between a girl dressed in green and a frog through verbal explanations or pictures. The study included also a control group who received no cue. No difference in performance was found between the experimental and the control groups, proving the training

ineffective. More recently, Cortés et al. (2018) developed a training that involved asking and prompting four 6-year-old children to express some characteristics of a person, animal or object without saying it explicitly. For example, children were asked to describe a t-shirt as being red without using the words "red" and were prompted to use metaphors (e.g., *the t-shirt is a tomato/strawberry/raspberry*). Results showed an improvement in metaphor production after the training.

Other training programs (Mashal & Kasirer, 2011; Melogno et al., 2017; Persicke et al., 2012) have been used with children with Autism Spectrum Disorders (ASD), due to their difficulties in metaphor comprehension (Kalandadze et al., 2019; Melogno et al., 2012). The most common strategy in these programs is based on thinking maps (i.e., a visual representation in which the metaphor's topic and vehicle are written in two main circles and the features of each of these two concepts are reported in smaller circles connected to the main ones). The focus is thus on the operations underlying metaphor comprehension at the conceptual level. Results indicated that the training programs were effective, with improvements in metaphor comprehension from pre- to post-training.

In sum, despite some initial evidence of efficacy, the metaphor training studies are modest in number and present some limitations: in most cases the samples were very small [e.g., four children in Cortés et al. (2018); four children in Melogno et al. (2017); three children in Persicke et al. (2012)) and the trained group's performance was not compared with an active control group. Additionally, these programs paid little attention to the communicative aspects of metaphor and to the role of context, which has been described as an essential factor in promoting metaphor comprehension (Cameron, 1996; Vosniadou, 1988; Wilson & Carston, 2007).

This study had two main aims. The first was to design a new training program to promote metaphor comprehension in typically developing school-age children and to test its effects in a randomized controlled trial. The second was to test the generalizability of the trained ability to other linguistic and communicative tasks requiring pragmatic inferential skills. Concerning the first aim, taking into consideration the limitations of the previous studies and the recommendations for

effective training programs (Durlak et al., 2011), the initial step was to design a metaphor comprehension training program (MetaCom) with the following characteristics: (i) grounded in a strong theoretical framework which considers the communicative function of metaphor and the context in which it is used; (ii) explicit, involving explanations and reasoning about metaphor definition and characteristics; (iii) effective when compared with an active control group.

As a grounding theory (i), we followed Relevance Theory, which – compared to other models – offers an account of metaphor considered in its communicative aspects (Wilson, 2011) and describes the interplay of word meaning, context, and inferencing underlying metaphorical interpretation. According to the relevance-theoretic view, in the understanding of a metaphor like *Sally is a chameleon* (from Wilson & Carston, 2007), the encoded concept CHAMELEON is broadened by dropping some logic-definitory properties (e.g., *being an animal and having a long tongue*), while some other properties, accessible through context-based inferences, are promoted (e.g., *fitting their surroundings*), resulting in a narrower denotation (Carston, 2012). Further inferences lead to the interpretation of the metaphor, for instance, 'Sally is inconsistent' or perhaps, in a different context, 'Sally is not reliable'. Thus, metaphor comprehension is derived through a series of pragmatic inferences that involve exploring the encyclopedic properties of lexical concepts and taking context into account. This was the ground for our training strategy: we taught children how to adjust the lexical concepts by selecting the relevant properties and use the context in order to infer and explain the meanings of metaphors.

The choice of creating an explicit training program (ii), where children are told the aims and the content of the training, was taken in adherence to the Sequenced, Active, Focused, and Explicit (SAFE) recommendations for effective programs (Durlak et al., 2011). Additionally, we aimed at promoting children's metapragmatic awareness, defined as "the acknowledgement of those contextual features that determine the extent to which a given linguistic routine may be appropriate for a particular situation" [Safont Jordà (2003), p. 48; see also Ifantidou (2014)),

since there is evidence that metapragmatic training programs lead to higher improvements than non-metapragmatic ones (Szücs & Babarczy, 2017). Therefore, throughout the training sessions we explicitly told children what metaphors are and the routines through which they are understood.

Finally, the effects of the MetaCom were compared with that of a control training (iii), designed to closely match the MetaCom in structure, length, and intensity. The control training focused on text comprehension based on explicitly provided information, without stimulating pragmatic inferences. Therefore, the comparison between the effects of the MetaCom and the control training helps rule out the possibility that focusing on the textual context might suffice to promote metaphor understanding. Moreover, the control training allows to rule out possible learning effects in to the tasks used in the study.

Concerning the second aim (i.e., investigating the generalizability of the trained skills), we complemented the assessment of metaphor comprehension in a verbal explanation task (main outcome measure) with the evaluation of three transfer abilities. Specifically, we tested children also in another metaphor comprehension task (near transfer), in a task requiring the comprehension of implicit meaning from short dialogues and in the comprehension of complex texts (far transfer). Since the MetaCom training focuses on the pragmatic inferential mechanisms underlying metaphor comprehension, we expected that its benefits would extend to other tasks requiring pragmatic inferences, such as conversation and text understanding (Cain & Oakhill, 1999).

We tested the effects of the MetaCom on typically developing children aged nine, given that this developmental stage precedes the key turning point of 10 years of age in verbal explanation tasks on non-literal language, with children being able to express figurative meanings yet in partial ways and not at adult-like levels (Lecce2019; Vulchanova et al., 2011; Winner et al., 1976). Children of this age, therefore, have room of improvement in the outcome measure selected for this study. Furthermore, we controlled for a number of variables associated with metaphor comprehension, such as receptive language (i.e., vocabulary knowledge

and syntactic comprehension) and working memory (e.g., Carriedo et al., 2016; Norbury, 2005).

2.2 Methods

2.2.1 Participants

To calculate the necessary sample size, we ran a power analysis based on the ANOVA used in this study to estimate the significance of the improvements. Results showed that a sample of 54 participants was necessary to reach a 0.8 power with a medium effect size ($f = 0.25$). Anticipating some dropouts and exclusions, we selected classes large enough to exceed this number by some margin.

Sixty-six fourth-grade children were recruited from four classes in northern Italy. At the beginning of the study, parental written consent was collected for all children. After pre-training assessment, children in each class were randomly divided into groups which were casually assigned either to the MetaCom (35 children) or the control training (31 children).

Participants were then excluded from the analysis if they presented at least one of the following characteristics: (1) diagnosis of learning disorder, (2) not speaking Italian from birth, (3) missing either pre- or post-training assessment, (4) > 95% accuracy in the main outcome measure (Physical and Mental Metaphors task) at pre-training. The final samples consisted of 33 children (19 F, *M*age= 9;3, age range= 8;8-9;8) in the MetaCom group and 25 children (13 F, *M*age= 9;3, age range= 8;8-9;7) in the control group. Removal of participants at ceiling (> 95%) was applied on this sample for the analysis of the transfer tasks.

2.2.2 Design and Procedure

The design included three main phases: a pre-training assessment, a training phase and a post-training assessment.

The pre-training assessment was conducted in three sessions: one individual and two collective (due to time constraints imposed by the scholastic setting). In this phase both control measures and main outcome measures were assessed.

The training phase involved two training programs: the MetaCom and the control training. They had a similar format (i.e., they used narratives as prompts followed by exercises on linguistic aspects stimulating both comprehension and production) and both consisted of two sessions per week, for two consecutive weeks, for a total of four sessions of 50 minutes each.

The post-training assessment included two sessions, one individual and one collective. In this phase only the outcome measures were assessed. The mean time between pre-training and post-training assessment was one month. Figure 2.1 illustrates the design of the study.

2.2.3 Assessment

The following control measures were assessed at pretest: socioeconomic status (Family Affluence Scale), receptive grammar (Test for Reception Of Grammar-Version 2), receptive vocabulary (Peabody Picture Vocabulary Test-Revised), and working memory (Digit-span Backward). See Appendix A for a detailed description of the control measures.

The following outcome measures were assessed both at pre- and post-test:

Physical and Mental Metaphors task (PMM): We used a modified version of the 12-item PMM task (Del Sette et al., 2020). In order to be able to detect possible training-induced improvements, we excluded those metaphors that in the longitudinal study of Del Sette et al. (2020) obtained a ceiling score in more than 70% of children at both time points. The excluded metaphors were replaced by other metaphors with same structure and lower familiarity (see Appendix A, Table A.1, for a description of the item characteristics). Participants were asked to verbally explain the meaning of nominal metaphors (e.g., *Dancers are butterflies, Daddy is a volcano*). Following Del Sette et al. (2020), each answer was coded for

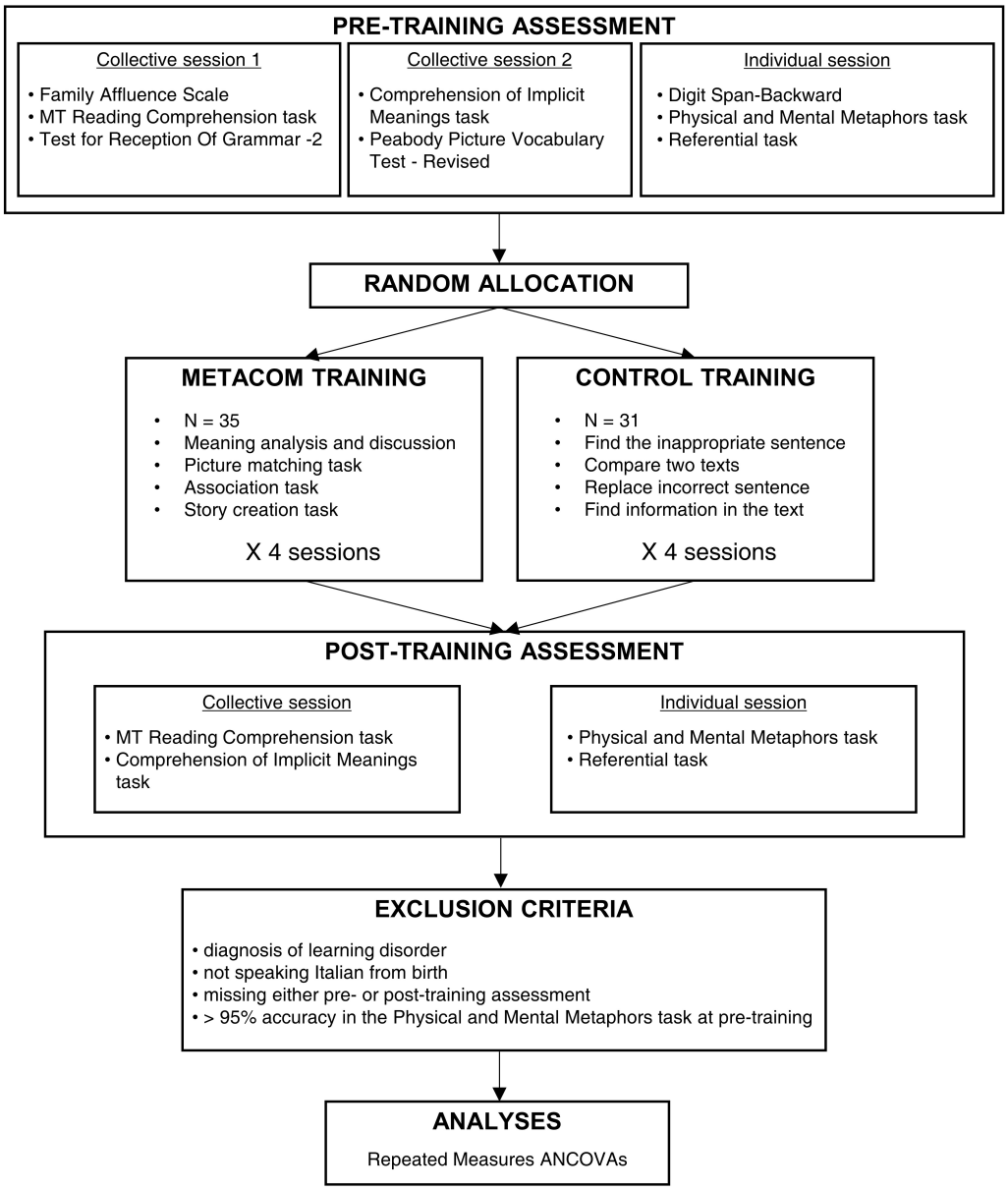

Figure 2.1: Design of the study on the efficacy of the MetaCom training

accuracy (i.e., the ability to articulate the link between the metaphor's topic and vehicle) on a scale from 0 to 2 (total score range 0-24) where 0 means totally wrong and 2 means correct. For example, for the metaphor *Dancers are butterflies*, the answers *Dancers tend to stay... to rest on the floor* would be rated as 0, *Because they are good at doing both slow and fast movements* would receive 1 point, and *Dancers are very graceful, as graceful as butterflies, when they dance* would be rated as 2. Two raters independently coded 25% of the total responses (including both pre- and post-training assessment) and the coding showed strong interrater reliability (Cohen's *kappa* = .86). We considered accuracy in the PMM as the primary outcome measure of the MetaCom training, since it assesses a skill that is trained in the MetaCom, that is, the ability to explain the meaning of metaphors presented in the nominal form (i.e, *X is Y*).

Referential task: This task was adapted from Noveck et al. (2001). It includes 16 pairs of eight-line stories (some adapted from French to Italian and others created ex novo). The first line introduced a referent (e.g., *soldier*). The seventh line contained a referential term that was the target of the experimental manipulation: metaphorical in one condition (e.g., *gorilla* for *soldier*) and literal in the other (specifically synonymic; e.g., *guard* for *soldier*). Metaphorical and literal referents were matched for length and lexical frequency. Each participant was presented with only one version of the story, either metaphorical or literal. The task was performed via computer and children were asked to read the stories at their own pace, passing from one sentence to the other pressing the spacebar. At the end of each story, participants needed to answer a yes-or-no question regarding the identification of the referent, by button press (see Figure 2.2 for a description of the procedure). Following Noveck et al. (2001), we measured accuracy in answering the question (total score range 0-8 for metaphorical condition and 0-8 for the literal condition) and reading times of the seventh line of each story. Since the Referential task evaluated the comprehension of a different type of metaphor compared to the trained ones (referential vs. nominal), we considered it as a measure of near transfer.

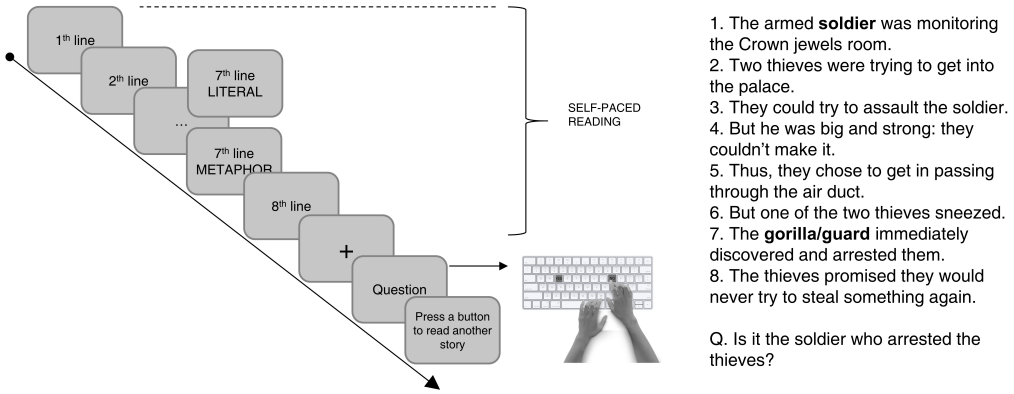

Figure 2.2: Experimental procedure of the Referential task

Comprehension of Implicit Meanings ("Comprensione dei Significati Impliciti"): This task was taken from an Italian standardized battery for assessing pragmatic abilities in children (Lorusso, 2009). Children were asked to read three short dialogues and answer some questions addressing aspects that are left implicit and can be inferred from the context (total score range 0-14). This is an example of story: *"My arm is terribly sore!" Mauro said, laying on the examination table. "Don't worry, I'll give you some medications that will relieve the pain" [in Italian, the courtesy form was used] Roberto answered*, which was followed by questions such as *Where are they?, What is Roberto's job?* Every answer (14 in total) was coded with 0 if the answer was totally wrong, 0.5 if it was partially correct and 1 if it showed a full understanding of the situation (total score range 0-14). Thus, in the example presented above, at the question *Where are they?* the answer *At their home* would be rated as 0, the answer *At the pharmacy* would receive a 0.5, and the answer *In the doctor's office* would be rated as 1. We considered this task as a measure of far transfer, since it evaluates a different aspect of the pragmatic competence than the one trained in the MetaCom.

Memory and Transfer Standardized Reading Comprehension battery (MT Reading Comprehension): We used the story "The ancestors' cave" from the reading comprehension battery of Cornoldi and Colpo (1998). The story was followed by ten multiple-choice comprehension questions (total score range: 0-10). For instance, the story contained the passage *Towards the bottom, in the distance, you could*

see another opening, and when we arrived there, a new cave larger than the first welcomed us with a ray of light, followed by the sentence completion question *The interior of the cave. . . , with the following options: . . . was a long, narrow tunnel; . . . was very low and you could not stand up; . . . had walls full of strange drawings; . . . formed a very large cavern.* Answering correctly required a deep comprehension of the text and inferential reasoning abilities. Therefore, we considered this task as a far transfer measure.

2.2.4 Training Programs

2.2.4.1 MetaCom training

Each of the four sessions of the MetaCom was structured around the analysis of one or two nominal metaphors, each constituting an 'item'. Each item consisted of four tasks:

1. *Meaning analysis and discussion*: A story containing a target nominal metaphor (e.g., a story about a city with traffic congestion containing the metaphor *Some cities are jungles*) was presented as prompt. Children were asked to answer a question about the meaning of the metaphor and then the trainer started a group discussion. The discussion focused on identifying the encyclopedic features of the concept encoded by the metaphor's vehicle (for *jungle*, being a large and dense group of trees and plants, being full of animals, being messy, etc.), and analyzing the context (the city and the traffic), in order to select those properties that were relevant for the specific situation. This task aimed at teaching children to adjust concepts to the communicative situation (e.g., jungle as a chaotic place) and to understand the implicated meaning of the metaphor (that some cities are very chaotic) through pragmatic inference.

2. *Sentence-picture matching task*: Children were asked to select the picture that represented the meaning of the learned metaphor among three alternatives representing three different interpretation of the target metaphor: one

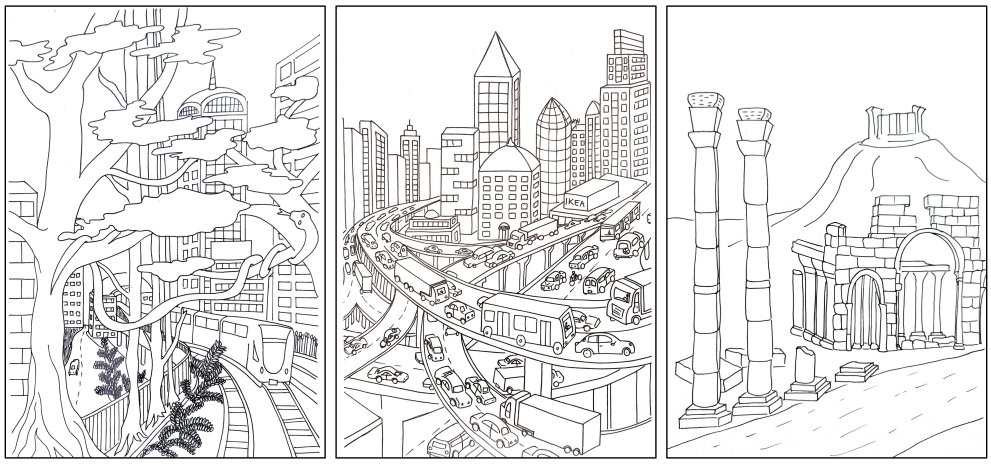

Figure 2.3: Example of the three pictures in the Sentence-picture matching task of the MetaCom

illustrated the literal meaning of the vehicle (e.g., a city with lianas typical of a jungle, Figure 2.3A), one depicted the metaphorical meaning of the vehicle (a chaotic city, Figure 2.3B), and one was a non-related representation of the metaphor's topic (the ruins of an ancient city, Figure 2.3C). This task aimed at consolidating the knowledge about the meaning of the metaphor.

3. *Association task* (adapted from Willinger et al., 2019). Children were provided with four isolated words (e.g., *jungle, leopard, market, cat*), including the metaphor's vehicle (e.g., *jungle*), and they were asked to look for metaphorical associations between them. There were different pairing possibilities: some were literal (e.g., *leopard-jungle*) and one was metaphorical (*market-jungle*) based on the meaning learned in the previous tasks (jungle as a chaotic place) but extended to another topic (i.e., market instead of city). This task aimed at strengthening the learned metaphorical meaning and promoting its generalization to other contexts.

4. *Story creation task*: Finally, participants were asked to create a story using the learned metaphor (e.g., *to be a jungle*) to strengthen the knowledge of the

metaphorical meaning and metaphor's underlying processes and to increase children's awareness of the importance of context for the comprehension of metaphors.

All the metaphors targeted in the MetaCom were different from the metaphors included in the assessment. Two types of metaphorical items were included in the MetaCom: single and double. Whereas single items targeted one metaphor (e.g., *to be a jungle*, as described above), double items targeted one metaphor used twice, in two different contexts and with two different meanings. In case of double items, the four tasks targeted one meaning first and then the other. The purpose of double items was to further increase the awareness that context plays an important part in retrieving the appropriate metaphorical meaning. See Appendix A for an example of double item.

The first session included a presentation of the training and an explanation of what a metaphor is and how it can be used in communication, In short, children were told that a metaphor "is a sentence like this: 'Giovanni's room is a pigsty', which describes something or someone, in this case Giovanni's room, with qualities and characteristics of something or someone else, in our example a pigsty" and that using metaphors "allows us to better communicate what we think or how we feel, because it allows us to draw the attention of our listeners on some qualities of an item or of a person and it fosters our imagination". In addition to this introduction, children were presented with one single item. The other sessions included either two single items or one double item.

All sessions were held in group, but children were invited to reason individually on the questions and to write down their answers on their booklet, before starting a group discussion. The trainer gave corrective and positive feedback. At the end of each session, children were given a card with a drawing related to the content of the session and a short, written reminder about what they had learned.

2.2.4.2 Control training

In order to match the MetaCom training, the control training also included four sessions based on narratives and exercises for stimulating text comprehension. As in the MetaCom, children were encouraged to work individually before starting a group discussion and they were given positive and corrective feedback. More specifically, the exercises constituting the control training were selected from existing tools (Gruppo MT et al., 2003; Zoccali, 2016) generically devoted to improving comprehension of written texts. We selected those exercises that focused on the analysis of explicit contents and that involved only low-level inferential abilities. Following the distinction of Cain and Oakhill (1999), these tasks required 'text-connecting inferences' (a type of inference needed to connect sentences), which differ from 'gap-filling inferences' (needed to retrieve information that is not explicitly reported in the text) or pragmatic inferences (which are necessary to derive implicit meanings). For example, children were asked to find the sentence in a text that was out of context, or the word that was incorrect in given sentences and to answer questions using information explicitly reported in the text.

At the end of each session, children were given a card related to the content of the session, as for the MetaCom group.

2.2.5 Data Analysis

We first conducted independent sample t-tests to explore possible differences between the two groups at pre-training. Then, data were analyzed using five repeated measures ANCOVAs, in which the dependent variables were considered one at a time: accuracy in the Physical and Mental Metaphors task (main outcome), accuracy and reading times of the metaphorical condition in the Referential task (near transfer), accuracy in the Comprehension of Implicit Meanings task and in the MT Reading Comprehension task (far transfer). Time (Pre-training, Post-training) and Group (MetaCom, Control) were included as within and between factors, respectively. In all analyses, the scores obtained in the Family Affluence

Scale, Digit-span Backward, Peabody Picture Vocabulary Test-Revised, and Test for Reception Of Grammar-2 were added (after centering around the mean) as covariates. Furthermore, in the analyses on transfer tasks, the scores obtained in the Physical and Mental Metaphors task at pre-training were added as a covariate, to analyze generalization independently of the initial level in the trained ability. Using the same strategy, in the repeated measures ANCOVAs on the Referential task (both accuracy and reading times), the scores for the literal version of the stories were added as a further covariate, in order to evaluate possible changes in metaphor comprehension independently of improvements in general text comprehension.

Repeated measures ANCOVAs were followed by a priori planned comparisons to assess specific differences between pre- and post-training scores within each group, regardless of the presence of a significant Time X Group interaction. Moreover, to compare the training gains between the two groups, when ANCOVAs resulted in a significant interaction, we calculated Hedge's g effect size coefficient, where $g = \frac{(Gain\ MetaCom:\ PostPre)(Gain\ Control:\ PostPre)}{Weighted\ pooled\ SD\ at\ Pre}$. Data were analyzed using Jamovi (jamovi project, 2019).

2.2.6 Data Availability Statement

The dataset analyzed in this study is available in the Open Science Framework repository at the link https://osf.io/sa73u/?view_only=a7f26e960bee475c80948a968c63022c.

2.3 Results

Descriptive statistics of the sample at pre- and post-training are provided in Table 2.1. T-tests showed that the two groups did not differ for any variable at baseline (Table 2.2).

Table 2.1: Descriptive statistics of the two training groups at pre- and post-training on control and dependent variables

	MetaCOm		Control	
	Pre-training *M* (*SD*)	Post-training *M* (*SD*)	Pre-training *M* (*SD*)	Post-training *M* (*SD*)
Family Affluence Scale	7.5 (1.19)	-	7.29 (1.15)	-
Digit span - Backwards	2.19 (0.78)	-	2.19 (0.81)	-
Test for Reception Of Grammar 2	15.40 (0.95)	-	15.60 (0.59)	-
Peabody Picture Vocabulary test-R	93.40 (7.99)	-	95.10 (5.21)	-
Physical and Mental Metaphors task	13.82 (5.47)	16.50 (4.42)	15.16 (4.86)	16.10 (4.55)
Referential task Accuracy				
Metaphor	5.44 (1.75)	6.51 (1.48)	5.61 (1.75)	6.67 (1.68)
Literal	6.40 (1.18)	6.92 (1.30)	6.33 (1.37)	6.83 (1.47)
Referential task Reading Times (s)				
Metaphor	5.59 (1.46)	4.91 (1.38)	6.34 (1.78)	5.36 (2.00)
Literal	5.23 (1.54)	4.66 (1.51)	6.02 (2.02)	5.13 (1.81)
Comprehension of Implicit Meanings task	9.97 (2.06)	10.90 (2.28)	10.07 (2.44)	10.70 (2.57)
MT Reading Comprehension task	6.83 (1.71)	7.52 (2.01)	6.55 (1.79)	6.15 (2.23)

Note:
The sample size of the MetaCom group and the Control group was 33 and 25, respectively, for all control measures and the main outcome measure (Physical and Mental Metaphors task). For the transfer tasks, after removal of participants at ceiling, the sample size for the MetaCom and the Control group was 27 and 18 (Referential task), 33 and 21 (Comprehension of Implicit Meanings task), 29 and 20 (MT Reading Comprehension task).

2.3.1 Main Outcome Measure

The repeated measures ANCOVA[1] on the Physical and Mental Metaphors task (Figure 2.4A) yielded a significant main effect of Time [$F(1, 52) = 23.37$, $p < .001$, $\eta^2 p = 0.31$] and a significant Time x Group interaction [$F(1, 52) = 5.08$; $p = .028$; $\eta^2 p = 0.09$]. Planned comparisons showed that the MetaCom group improved over time ($p < .001$, $d = 0.54$), while no difference was found for the Control group ($p = .11$, $d = 0.19$). Hedge's g analysis on gains showed that the difference in gains across training conditions was moderate ($g = 0.\ 35$).

[1]We obtained the same pattern of results when covariates were excluded from analyses.

Table 2.2: Independent sample t-tests comparing the two training groups on control and dependent variables at pre-training

	df	*t*	*p*	*M* diff	*SE* diff	Cohen's *d*
Family Affluence Scale	56	-0.79	.44	-0.17	0.22	-0.21
Digit span - Backwards	56	-0.06	.95	-0.02	0.26	-0.02
Test for Reception Of Grammar 2	56	1.21	.23	0.19	0.15	0.32
Peabody Picture Vocabulary test-R	56	0.72	.48	0.20	0.28	0.19
Physical and Mental Metaphors task	56	0.97	.34	1.34	1.38	0.26
Referential task - Accuracy (metaphor condition)	43	0.32	.75	0.17	0.51	0.09
Referential task - Reading times (s) (metaphor condition)	43	1.55	.13	0.75	0.47	0.48
Comprehension of Implicit Meanings task	52	0.16	.88	0.10	0.62	0.05
MT Reading Comprehension task	47	-0.55	.59	-0.28	0.51	-0.16

2.3.2 Near Transfer Task

For the Referential task, the repeated measures ANCOVA on accuracy (Figure 2.4B) showed only a main effect of Time [$F(1, 37) = 14.08$; $p < .001$; $\eta^2 p = 0.28$]. Planned comparisons revealed that both the MetaCom group ($p = .004$, $d = 0.66$) and the Control group ($p = .014$, $d = 0.61$) improved significantly over time. Similarly, the repeated measures ANCOVA on reading times (Figure 2.4C) in the Referential task showed only a main effect of Time [$F(1, 37) = 20.32$; $p < .001$; $\eta^2 p = 0.35$], with a significant improvement over time in both groups (MetaCom: $p < .001$, $d = 0.48$; Control: $p = .010$, $d = 0.52$).

2.3.3 Far Transfer Tasks

Considering the Comprehension of Implicit Meanings task, the repeated measures ANCOVA (Figure 2.4D) showed only a main effect of Time [$F(1, 47) = 7.20$; $p = .010$; $\eta^2 p = 0.13$]. Although the interaction was not significant, planned

comparisons revealed a significant difference between pre-training and post-training in the MetaCom group (p = .008, d = 0.43) and not in the Control group (p = .11, d = 0.24).

Differently, the repeated measures ANCOVA on the MT Reading Comprehension task (Figure 2.4E) yielded a significant Time X Group interaction [$F(1, 42) = 4.91$; p = .032; $\eta^2 p$ = .11] and a main effect of Group [$F(1, 42) = 4.63$; p = .037; $\eta^2 p$ = 0.10]. Planned comparisons showed that the MetaCom group improved significantly over time (p = .034, d = 0.37), while the Control group's performance did not significantly change from pre- to post-training (p = .27, d = 0.20). Hedge's g analysis showed that the difference in gains across training conditions was medium (g = 0.63).

2.4 Discussion

The first aim of this study was to test the effects of a new theoretically-grounded metaphor comprehension training program (MetaCom) in typically developing children of 9 years of age, in a randomized controlled trial. Results showed that, compared to a control training and controlling for vocabulary, grammar, working memory, and socioeconomic status, the MetaCom training enabled children to reach a better comprehension of nominal metaphors, as reflected in higher scores at post-test than at pre-test in the main outcome measure (i.e., the Physical and Mental Metaphors task). The second aim was to test if the ability learned in the MetaCom would transfer to other tasks requiring pragmatic inference. Results showed that only the MetaCom training improved children's reading comprehension abilities as assessed in the MT Reading Comprehension task. In addition, there is some evidence, albeit not conclusive, that the MetaCom might improve other pragmatic skills, such as understanding referential metaphors (as evaluated in the Referential task) and the ability to derive information from the context (as measured in the Comprehension of Implicit Meanings task). Collectively, this study introduces two novel results in the panorama of metaphor and pragmatic training: first, it

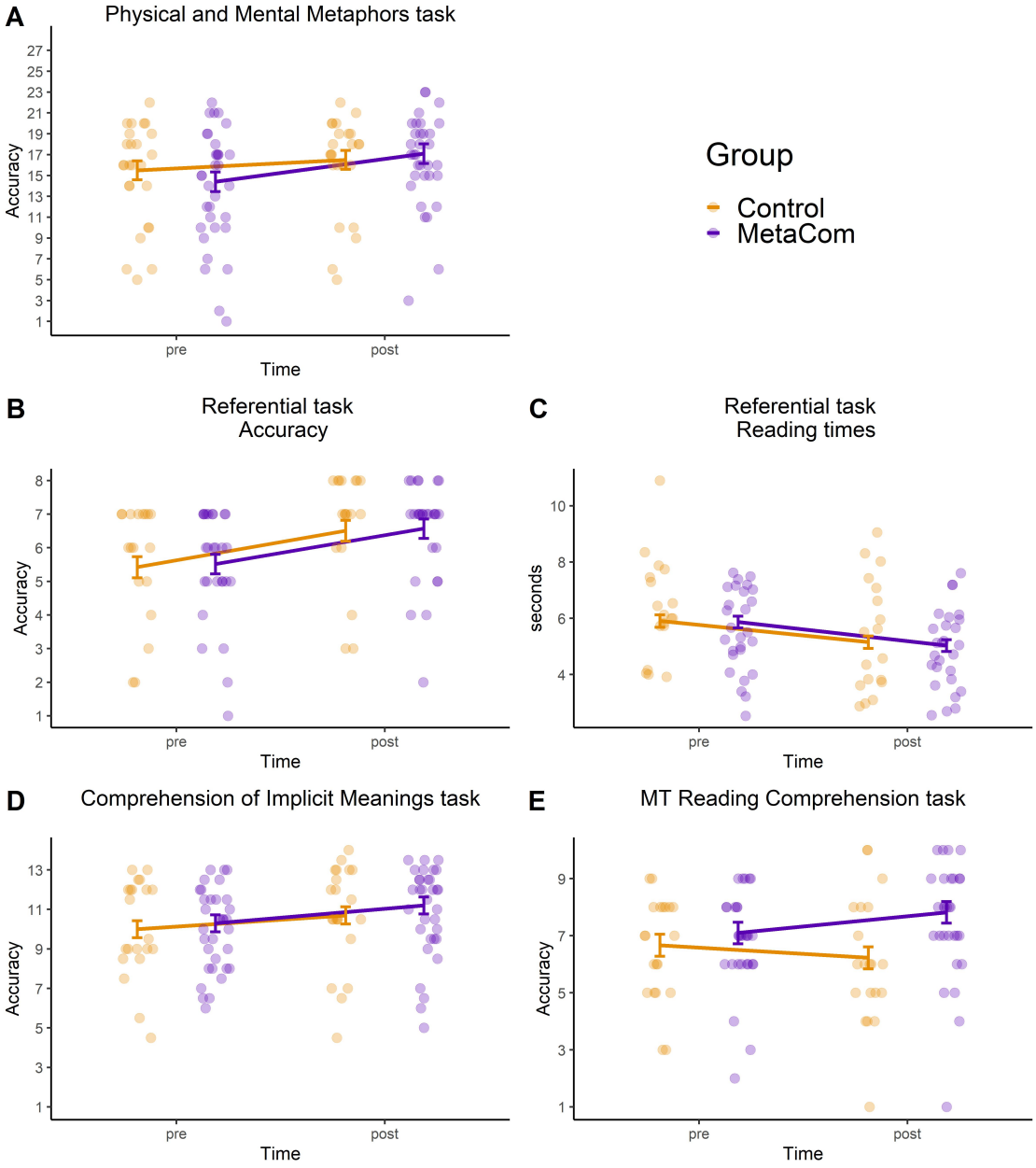

Figure 2.4: Estimated marginal means for the MetaCom and control group in the main outcome measure and in the transfer tasks.\ The figure shows the estimated marginal means for the repeated measures ANCOVAs (Time X Group) on the main outcome measure (plot A), near transfer task (plot B and C), and far transfer tasks (plot D and E). In each plot, lines connect the estimated marginal means of the two groups between pre- and post-training time points; bars represent the standard error of the mean and dots display the mean of the observed scores for each participant.

is possible to promote metaphor comprehension in typically developing children, and, second, the acquired metaphor skills can transfer to other linguistic and communicative domains.

Starting with commenting upon the first aim of the study and the improvement in the main outcome measure (i.e., the Physical and Mental Metaphors task), one of the key elements explaining the efficacy of the MetaCom in promoting the comprehension of metaphors can be traced back to its solid theoretical framework. Following the relevance-theoretic account of metaphor (Wilson & Carston, 2007), the main strategy of the MetaCom was to teach children how to adjust lexical concepts by selecting the relevant properties and to infer novel meanings using the contexts. By being encouraged to focus on context and how this can modify word meanings, children were offered a procedure to solve metaphors, which they could learn and generalize to other metaphorical items. This context-based inferential procedure, with its generalizability, is likely to be the key element of success of the MetaCom. It is interesting to note that a similar strategy, that is, centered around inferential mechanisms, turned out to be effective also in improving older adults' pragmatic skills, including metaphor comprehension, as shown in a recent study employing a training program for healthy aging (Bambini, Tonini, et al., 2020). The evidence coming from the latter study, coupled with the findings of the current study, points to the key role of inference in promoting pragmatics across the lifespan, from childhood to aging. Theoretically, the improvement in metaphor comprehension after the MetaCom also speaks in favor of the psychological validity of the pragmatic model of metaphor comprehension proposed by Relevance Theory, specifically the relevance-guided inferential procedure (Wilson & Carston, 2007). More generally, our findings corroborate the ultimate aim pursued by post-Gricean pragmatics of offering a psychologically plausible model of human communication (Wilson, 2006).

Another element that possibly contributed to the efficacy of the MetaCom in ameliorating metaphor comprehension is its explicit strategy, based on promoting children's metapragmatic awareness. The MetaCom program started with an

explicit explanation of what a metaphor is and its role in communication, and described the routine for metaphor comprehension, namely, the search and use of contextual elements to shape word meaning. Children were explicitly asked to reason on these aspects throughout the sessions. This might have contributed to shape a more effective training compared to those based on implicit cues((e.g., Biaecka-Pikul, 2010). More generally, explicitness seems an important characteristic of training programs targeting pragmatic inferences. Converging evidence comes from the efficacy of other training programs which adopted an explicit strategy, such as the pragmatic training for older adults in Bambini, Tonini, et al. (2020) and the irony comprehension training for children in Szücs and Babarczy (2017).

Regarding the second aim and the generalizability of the skills learned in the MetaCom training, our findings showed that the MetaCom did not only teach children the ability to understand metaphors, but also gave them a competence that they could generalize to at least some other linguistic and communicative tasks. Starting with the most relevant result, we found that the MetaCom group improved in the reading comprehension task (i.e., the MT Reading Comprehension task) with a medium effect size, while the control group did not. To make sense of this finding, it is important to highlight that the MetaCom training was built with the intent to stimulate pragmatic inference, that is, the derivation of implicit meanings, while the control training focused on contextual aspects and involved only text-connecting inference, for instance understanding if a sentence fits the context, which is a lower-level type of inference compared to the pragmatic one. According to Cain and Oakhill (1999), children's ability to draw high-level inferences (such as gap-filling inferences) is a stronger predictor of reading comprehension than text-connecting inferences . Our findings are in line with this view and suggest that not only gap-filling inferences but also high-level pragmatic inferences such as those involved in metaphor understanding impact reading comprehension skills. By contrast, simply focusing on text-connecting aspects, as done in the control training, does not seem to be enough to improve reading comprehension. This result is important from at least two points of view. First, it suggests a causal effect of metaphor

comprehension on reading comprehension, thus corroborating evidence on the important role of general inference-making in the development of reading skills (Cain et al., 2004). Second, at the applicative level, our results suggest a new strategy to promote reading comprehension. Till now, only few interventions targeting specific linguistic aspects have succeeded in improving reading comprehension, and with small effect sizes (mean Hedge's g = 0.05, from the review in Rogde et al., 2019). Innovating with respect to existing training programs, focusing on high-level language aspects such as metaphor might represent an effective strategy to promote reading comprehension and enhance literacy skills.

Considering the other two transfer tasks, the conclusion that the MetaCom is beneficial is less straightforward than in the case of reading comprehension. As regards the Comprehension of Implicit Meanings task, there is some evidence of an improvement due to the MetaCom, given the fact that planned comparisons revealed that the experimental group improved from pre- to post-training. To elaborate on this finding, it is useful to consider that the Comprehension of Implicit Meanings task consists of brief dialogues involving conventions and social norms (e.g., the script followed when someone goes to the doctor and the use of the courtesy form). The MetaCom did not specifically teach the comprehension of social rules, but it focused on inferential skills, which might be beneficial to inferences in social situation. In line with this idea, there is evidence that metaphors activate social knowledge and can increase one's sensitivity to social cues (Bowes & Katz, 2015; Del Sette et al., 2020). It is thus plausible that the MetaCom leads to a better performance in the ability assessed by the Comprehension of Implicit Meaning task, as indicated by the planned comparison considering pre- and post-training scores in the experimental group. However, the lack of interaction between Time and Group does not allow to rule out that another type of extra-curricular activity, such as the one proposed to the control group, might also have an effect in improving the ability to infer implicit meanings in conversation. This is plausible too, given that the control training focused on context, which is a key element to correctly derive social inferences. Moreover, our findings do not allow us to exclude the case that

children might have become better in the Comprehension of Implicit Meanings task because of a learning effect, that is, that children became better when presented with the dialogues the second time.

The results obtained in the other transfer task (Referential task), which targeted the comprehension of an untrained type of metaphors (i.e., referential metaphors embedded in story contexts), are similar to the ones reported for the Comprehension of Implicit Meanings. Children in the MetaCom group were more accurate in identifying referents expressed metaphorically and had faster reading times at post-training. However, similar changes were observed also in the control group, as indicated by the planned comparisons and the lack of interaction between Time and Group. A possible explanation is that both training programs targeted the textual context, promoting attention to its elements and connections between sentences, and this might have been enough to promote the understanding of referential metaphors. In other words, when metaphors are embedded in stories, training attention to textual context suffices to improve their comprehension, even without focusing on the high-level inferential aspects of meanings. The MetaCom is thus beneficial for the reading and comprehension of referential metaphors, but its efficacy seems to be non-specific. Moreover, as for the Comprehension of Implicit Meanings task, also for the Referential task we cannot exclude that improvement was due to a learning effect, that is, that children of both groups familiarized with the task and became more accurate and faster in identifying metaphorical referents when tested the second time.

In sum, while in the main outcome measure evaluating metaphor understanding and in the reading comprehension transfer task the efficacy of the MetaCom seems robust, there is a range of other tasks where results are promising yet not conclusive. Future studies are needed to ascertain the generalizability of the skills learned in the MetaCom to other types of figurative language and social inferences and whether training metaphors is the only viable route to achieve improvements in other pragmatic tasks.

We acknowledge that this study has some other limitations that should be considered in future studies. Firstly, we assessed children improvements immediately after training, but we did not perform a later follow-up. Further research is needed to test if improvements in metaphor and transfer tasks are long-lasting. Secondly, the MetaCom effects were observed in children of 9 years of age, thus preceding the key turn point observed at 10 years of age in the development of metaphor (Lecce, Ronchi, et al., 2019b; Vulchanova et al., 2011; Winner et al., 1976), but we don't know if the training is effective for other age ranges, and in particular for younger children. Moreover, we controlled for some important predictors of metaphor comprehension (receptive language, working memory and socioeconomic status), but we did not consider other potentially relevant ones. One of these is Theory of Mind (ToM). The literature has shown that, although the two domains do not overlap (Bosco et al., 2018), ToM is associated with at least some aspects of metaphor, especially when the latter expresses psychological contents (Del Sette et al., 2020; Lecce, Ronchi, et al., 2019b).

Finally, one pivotal aspect to investigate in future studies is the efficacy of the MetaCom in children with developmental disorders, for whom figurative language represents a challenge and a focus of intervention (Benjamin et al., 2020; Kalandadze et al., 2019; Pexman et al., 2019). There is already evidence of effective metaphor training programs for children with ASD based on thinking maps (e.g., Mashal & Kasirer, 2011). It would be important to see if the MetaCom, focusing on the communicative rather than the conceptual side of metaphor, can lead to improvement as well.

2.5 Conclusions

The main contribution of this study is presenting an effective program to promote metaphor comprehension in typically developing children. This is something that was missing in the panorama of available tools and it can be used by teachers and educators to help children benefit from the numerous advantages of a successful

metaphor comprehension (Littlemore et al., 2011; Ortony, 1975). Furthermore, we showed that training metaphor comprehension produces improvements in reading comprehension and possibly in some other social-pragmatic communicative tasks, thus carrying a number of benefits that extend from the scholastic setting to children's daily life.

3

When dancers are butterflies and the atmosphere becomes a blanket: How the brain understands and misunderstands metaphors

Tamara Kalandadze[1], Elisabetta Tonini[2], Valentina Bambini[2]

Abstract

When we speak, we often say something different from what we actually mean. For example, at a ballet we might say that the dancers are butterflies. Dancers are not really butterflies, but this is not a lie: it is a metaphor, a figure of speech very common in our everyday language and in books. In this article, we explain what metaphors are, why we use them and what happens in our brains when we encounter a metaphor. Understanding a metaphor actually requires a lot of brain work. That is why metaphor understanding is not always easy. Some groups of people find metaphor understanding particularly difficult, for example, very young children and people who have autism spectrum disorder. At the end of the article we suggest what teachers can do to help those with difficulties in metaphor understanding.

Keywords: metaphor, figurative language, autism, fMRI, theory of mind

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3.1 What is a metaphor and why is it useful?

A metaphor is a figure of speech that is used as an alternative way to communicate ideas that normally might need a complex explanation. A metaphor does that by creating images in a person's mind. Almost any type of word can be used metaphorically, especially nouns, verbs, and adjectives. Take for example the noun "butterfly". Imagine that a friend of yours, Sarah, is talking about a ballet and says: "Those dancers are butterflies!" You probably start thinking of graceful colorful insects. But you also understand that Sarah does not mean that the dancers are insects. Sarah is speaking metaphorically, and she means that dancers are beautiful. But why doesn't Sarah simply say that? The magic of metaphors is that, they can communicate a lot of information with few words. This happens because metaphors create images in your mind and these images give you more information faster than when someone describes something without using metaphors.

In our example, Sarah wants to communicate more details, than simply saying that the dancers are nice, that their movements are so elegant and delicate that they resemble those of butterflies. Metaphors have a sort of superpower compared to literal expressions, as they allow us to say more than our words mean.

Because of this superpower, metaphors can also be helpful when talking about things that can be difficult to explain. For example, feelings, emotions, or complex scientific ideas. Imagine that during your science class your teacher says: 'The atmosphere is the blanket of gases that surrounds the Earth'. The sentence is not stating that atmosphere is really a blanket, but that the atmosphere surrounds the Earth and helps keep it at the right temperature, as a blanket covers a person and keeps them warm. With this metaphor your teacher can explain how the atmosphere works in a very simple and effective way. Also, imagining the atmosphere as a blanket helps you remember what the atmosphere is and how it works. That happens because you know what a blanket looks like and you know what it is used for. The fact that a metaphor helps us to remember concepts is another of its superpowers. These superpowers of metaphors have been studied for more than

2000 years. Ancient Greeks and Romans were interested in metaphors as tools to communicate and persuade others. Yet, at that time metaphors were seen as means for the creative use of language, such as poetry. Nowadays we know that metaphors are very common in our daily language and communication. For example, when someone is talking to you, they might use six metaphors for every minute that they talk! However, the price for being a powerful communication tool is that a metaphor requires your brain to put more effort into understanding, compared to a sentence that does not contain metaphor.

3.2 What happens in the brain when people try to understand metaphors?

To understand a metaphor, you need to create a link between what people are talking about (in our example it is the dancers) and another word, apparently completely unrelated (e.g., butterflies), and work out which characteristics these two parts might share (e.g., looking beautiful and moving elegantly). To do so, your brain needs to perform some tasks. First, your brain needs to search for the meaning of the single words in your vocabulary – a sort of dictionary where the words that you have learned are stored. Then, the brain needs to understand how the words in the sentence can be connected: the knowledge of grammar that you have acquired since you were very young helps your brain with this task. Additionally, your brain needs to find extra information in memory (the so-called 'world knowledge') about the things we are talking about. In our example, the information to retrieve is that dancers in a ballet usually move in elegant and graceful ways, that they often jump and spin, and that also butterflies move from flower to flower elegantly. The brain also needs to understand the point of view of the person saying the metaphor in the given context. Does Sarah actually like dancers? The ability that helps us with this is called 'theory of mind'. Luckily, most of our brains can do all these tasks very quickly, so that in less than a second we are able to understand the meaning of a metaphor. How do we know all this? Scientists have developed powerful tools

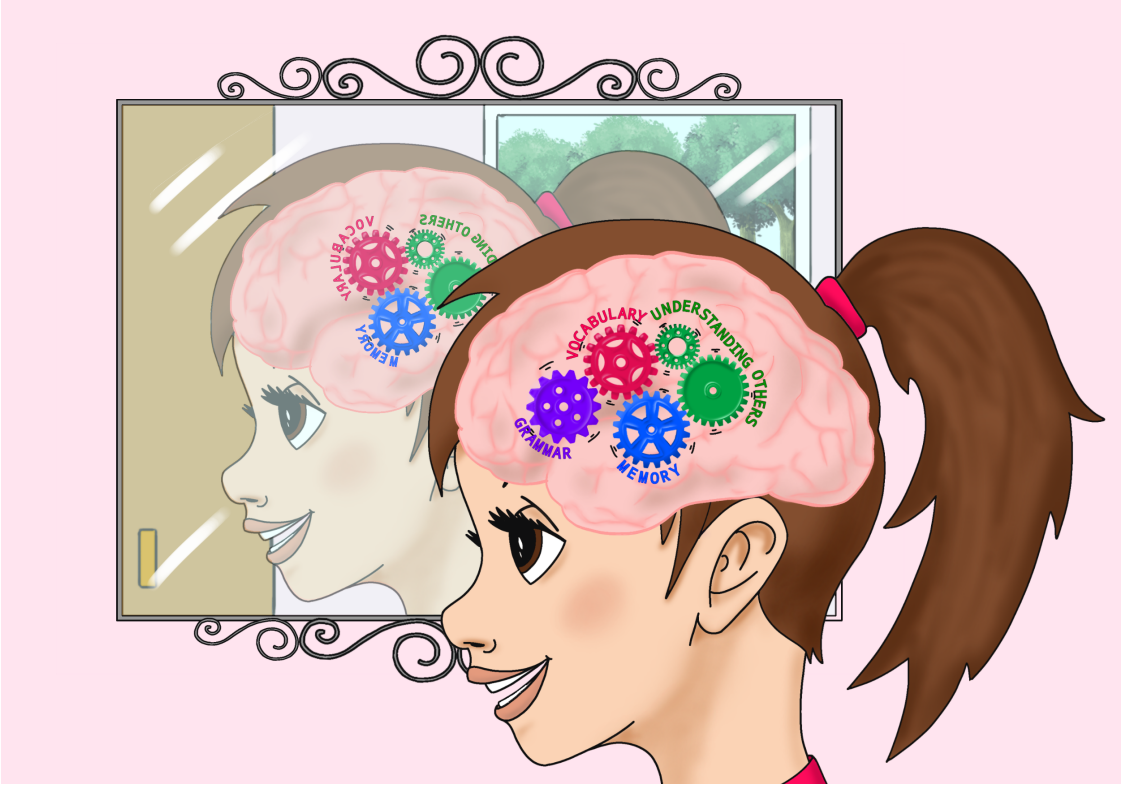

Figure 3.1: Metaphor understanding cogs on both sides of the brain

to explore how the brain works. For example, there is a technique called fMRI that allows us to take a picture of the parts of the brain that are involved in metaphor understanding, and there are many! Let's think about each area of the brain as a cog in a clock mechanism. When understanding a metaphor, the cogs of vocabulary and grammar are active; these are in the frontal part of the brain, close to the left side of your forehead. Then we have the memory cog, which is placed under the language cogs. Finally, the cogs of understanding others' thoughts (theory of mind) are involved, and they are located in the back of your brain. You can see all these cogs in Figure 3.1: there you see the left side of the brain, and, reflected in the mirror, you can also see the right side of the brain. Both sides are involved in metaphor understanding (Bambini et al., 2011)!

3.3 Learning to understand metaphors: easy for some, difficult for others

The brain is more complex than a watch because the cogsof the brain change as you to learn new things. Also, the cogs involved in metaphor understanding develop over time. In babies, these cogs cannot connect to each other to make the mechanism work properly. Babies do not have enough vocabulary or grammar knowledge, they do not have enough experience in their memory storage, and and thy may not understand other people's thoughs as well yet. This is why young children might understand some simple metaphors, but they will often interpret complex ones more literally – which means they will misunderstand what the person really means. For example, when hearing the metaphor 'The carrot with hair' (Pouscoulous & Tomasello, 2020), children might be able to point to the correct picture of a carrot with its leaves attached to the top part, among other pictures. At the same time, they might take our example of the dancers that are butterflies literally – and think that dancers are actually insects. This is what happens to the boy in Figure 3.1. As kids grow older, they get better in all the skills necessary for metaphor understanding, and between the ages of 10 and 14 they usually begin to understand and explain metaphors more or less as well as adults (Winner et al., 1976).

Another important case in which the cogs of metaphor might not work as expected is the case of people with autism spectrum disorder (autism). Why does this happen? Scientists have suggested two answers to this question. One answer is that children who have autism often struggle to understand metaphors because sometimes their vocabulary cogs does not develop as expected at their age. So, they might not know all the different meanings of a word and all the parts of an idea. Therefore, they might not be able to figure out the characteristics that the two elements of a metaphor share, as we discussed in relation to young children. Another answer is that people with autism often find it hard to understand metaphors because their theory of mind cogs do not work properly.

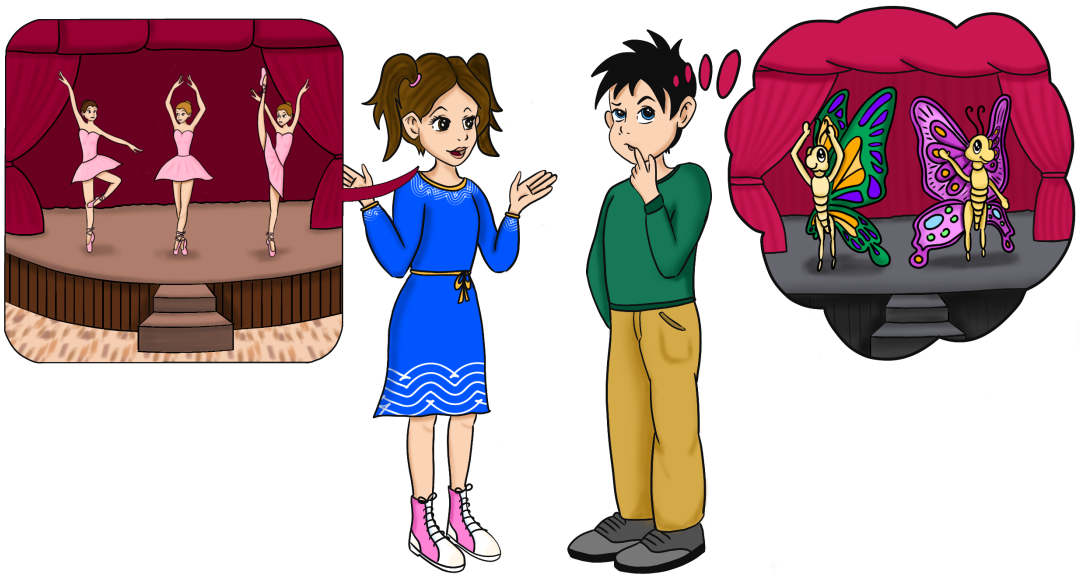

Figure 3.2: Example of metaphor misunderstanding

For example, they might have difficulties understanding that Sarah really likes the dancers. The cause of these difficulties might be differences in children with autism's brain: through fMRI, scientists have seen that the cogs in the brains of children with autism do not always rotate with the same rhytm when understanding metaphors. This means they cannot support the understanding of this group of words (Chouinard et al., 2017). Also, people with with for example schizophrenia might ? have difficulties to go beyond the concrete/basic meaning of words, and might therefore struggle with understanding metaphors.

What are the consequences of these difficulties? Since we know that metaphors are used very often in communication, children and adults with autism might be confused and feel awkward in many situations. Also, they might feel lonely in class/at work and children's learning chances could be reduced because they don't understand the metaphors that teachers use, or that they encounter in schoolbooks. Therefore, those who struggle with metaphors need help.

Scientists have provided some recommendations on how teachers and speech and language therapists may help children to develop their metaphorical skills. One commonly used strategy is called 'thinking maps', and it is a sort of game with words. There are two big bubbles: one of them contains one element of

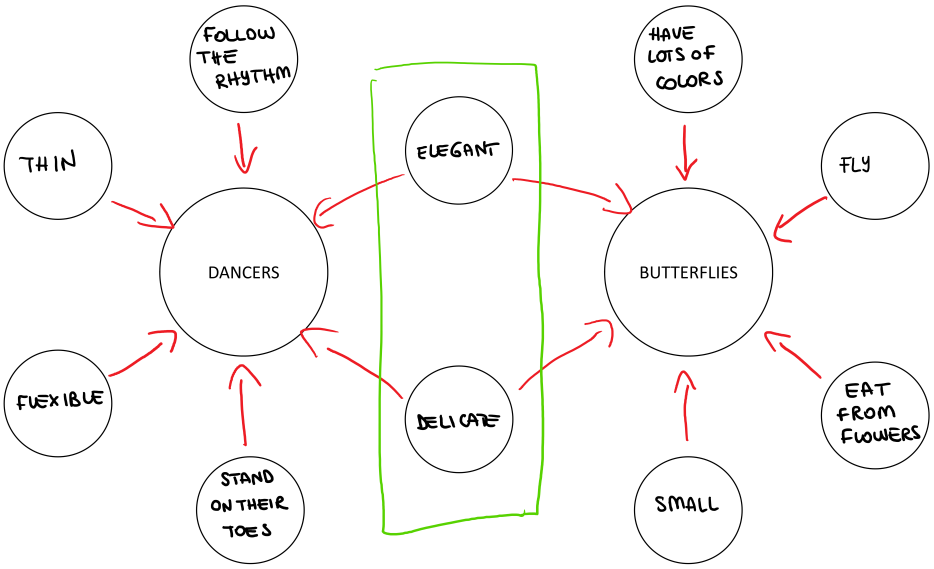

Figure 3.3: Thinking maps

the metaphor (e.g., dancers), and the other contains the second element (e.g., butterflies). In the surrounding smaller bubbles, children need to write all the characteristics they know about the two elements and connect them to the element they refer to. Children are finally asked to identify characteristics that are shared by the two elements and which might be used to explain the metaphor (see Figure 3.3 for an example). This game can be taught to children who struggle with metaphor understanding so that they can use it when they encounter other metaphors. Teachers can also use this game in class to help their students.

Are you inspired and want to play with metaphors? What you can do now is to count the metaphors in this article, and then, after reading this, you can take the first book or newspaper you can see, open it on a random page and see how many metaphors you can find. Start training your brain!

3.3.0.1 Glossary:

Theory of mind: The ability to understand your own and others' thoughts, intentions, and emotions. Thanks to theory of mind, we can understand other people's points of view.

fMRI: 'Functional Magnetic Resonance Imaging' is a technique that measures blood flow and can detect which parts of the brain are active when we do something, such as reading or counting.

Autism spectrum disorder or autism: A condition that affects brain development. People with autism have various difficulties with social communication. They also often repeat the same movement or behavior. Approximately 1% of people in the world have autism.

Speech-language therapist (SLTs): experts in communication and language. SLTs treat many types of communication problems and work with people of all ages, from babies to adults.

Schizophrenia: a serious condition that affects how the brain works and is characterized by confused thinking, speech and behavior. People with schizophrenia often misunderstand things around them. They might hear a voice that no one else can hear or see an image or smell something that is not real. They can also believe in something that no one else believes in. Schizophrenia is a life-long disease and affects from four to seven per 1000 persons.

4

How to improve social communication in aging: Pragmatic and cognitive interventions

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Abstract

Among all aspects of the linguistic and communicative competence, pragmatics seems especially vulnerable in aging, due also to cognitive decline. However, pragmatics has never been considered as an intervention target in healthy aging. Here we tested the effects of a novel training program to improve pragmatics (PragmaCom) in older adults, compared with an active cognitive control group in a randomized-controlled-trial design. Both the PragmaCom group and the control group improved in pragmatic skills such as understanding metaphors and avoiding off-topic speech, indicating that it is possible to improve pragmatics in aging both with a specific training and with a cognitive training. Individual cognitive factors predicted pragmatic improvement in the control group, while in the PragmaCom group benefits were less dependent on individual characteristics. We discuss the results in terms of pragmatic plasticity, highlighting the importance of these findings for promoting older adults social communication and well-being.

Keywords: Pragmatics, Training, Aging, Metaphor, Off-topic verbosity, Social communication

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4.1 Introduction

Pragmatics refers to a set of abilities including selecting an appropriate conversation topic, responding properly to conversational partners, inferring the speaker's meaning beyond the literal meaning of words, for instance in the case of indirect requests up to the most radical cases of non-literal language such as metaphors and irony (Grice, 1975; Sperber & Wilson, 1995). Thus, pragmatics is key for successful communicative exchanges and represents a key component of social communication (Hyter, 2017). Pragmatic disruption, therefore, poses a considerable risk to the maintenance of chosen life roles and social relationships, with consequences for quality of life, as largely documented across a range of pathological conditions (Bambini, Arcara, Bechi, et al., 2016a; Cummings, 2014; Jagoe, 2017).

Concerning the non-pathological aging population, the literature has shown that pragmatic abilities show a decline compared to younger adults (Messer, 2015). In the domain of discourse production, the most prominent feature associated with aging is the tendency to produce off- topic speech, leading to an alteration of conversational purposes, shifting from the transmission of precise information to a peculiar stress upon autobiographical narratives or personal situations (James et al., 1998; Ruffman et al., 2010). In addition, discourse coherence, measured in terms of links between utterances, was shown to be affected by age (Marini et al., 2005). Studies tackling receptive pragmatic abilities showed age-related changes in the domain of figurative language, including the comprehension of metaphors (Champagne-Lavau et al., 2012; Mashal et al., 2011), idioms (Grindrod & Raizen, 2019), and proverbs (Uekermann et al., 2008). Also, age affects the comprehension of jokes (Bischetti et al., 2019; Mak & Carpenter, 2007; Uekermann et al., 2006) as well as their appreciation (Shammi & Stuss, 2003).

Despite the intuitive possibility that the decline in pragmatics exhibited by older adults affects their social relationships and quality of life, to the best of our knowledge pragmatic skills have never been a target of intervention in healthy aging. This opens up a totally new field of investigation, which we ventured in this study

by using a novel theoretically-based training program to improve pragmatics and by testing its effectiveness in a sample of older adults, compared with an active cognitive control group. In order to plan the study, we took into account evidence in the relevant literature regarding: 1) previous pragmatic training programs for clinical populations; 2) previous cognitive training programs for older adults; 3) the relationship between pragmatics and the general cognitive and verbal resources in older adults. In what follows we will examine these three domains, before outlining the rationale of the study.

Although there are no training studies targeting pragmatics in healthy older adults, there are a few remediation studies involving adult clinical populations (for a review see Blake et al., 2013; and Lundgren & Brownell, 2016). Tompkins et al. (2011) developed a training program that aimed to stimulate inefficient language comprehension processes by creating contextual constraints: specifically, this program helps in matching language and context to manage conversation and the understanding of non-literal language. Another tool is the Cognitive Pragmatic Treatment, which targets the recognition of the speaker's communicative intention and speech act (sincere, ironic, and deceitful) both in the linguistic and extra-linguistic modality; it was reported to be effective in traumatic brain injury (Gabbatore et al., 2015; Parola et al., 2019) and in schizophrenia (Gabbatore et al., 2017). Focusing on discourse production, Togher et al. created a communication training for patients with traumatic brain injury and their caregivers that is centered on turn-taking and verbosity (Togher et al., 2013; Togher et al., 2009; Togher et al., 2012). Focusing instead on figurative language and specifically metaphor, Lundgren et al. developed exercises based on thinking maps, which were used in samples of patients with right hemisphere damage (Lundgren et al., 2011) and traumatic brain injury (Brownell et al., 2013). Albeit often including very limited samples of participants and no control groups, overall these studies are indicative of some degree of 'pragmatic plasticity', and they suggest that it is possible to remediate acquired disorders of the pragmatic function. A different perspective is taken by the Promoting Aphasics Communicative Effectiveness (P.A.C.E.), which

is a pragmatic approach to language rehabilitation (Davis, 2005). In the P.A.C.E. setting, the clinician and the patient exchange new information and equally take turn in the conversation as sender and receiver by picking up a card from a stack and communicating the depicted information. Feedback from the clinician is based on the patient's success in communicating the message (Seron & de Partz, 1993). Although it is framed in the pragmatic model of communication and it might be suited to treat some pragmatic difficulties (such as the difficulty in maintaining the conversational topic), the P.A.C.E. procedure does not specifically target inferential pragmatic skills, but rather functional communication, that is, the ability to use verbal and non-verbal means to convey information (Seron & de Partz, 1993). Hence, its use has been limited to patients with aphasia (Carlomagno et al., 1991; Carlomagno et al., 2000).

More evidence on healthy aging is available in the field of cognitive training. Aging research has shown, also in the third and fourth ages, the potential of cognitive plasticity and the efficacy of cognitive and meta-cognitive interventions (Hertzog et al., 2008) targeting memory (Borella et al., 2010; Bottiroli et al., 2013; Cavallini et al., 2010), reasoning (Anand et al., 2011), decision making (Rosi et al., 2019), and even socio-cognitive abilities such as theory of mind (Cavallini et al., 2015). Moreover, the field of cognitive training has provided extensive evidence of the role of individual differences, including age, baseline level, and cognitive profile, in training (Borella et al., 2017; Cavallini et al., 2019; Lecce, Ceccato, et al., 2019; Lövdén et al., 2012; Zinke et al., 2014), showing that some individuals benefit more than others despite being exposed to the same program and materials. Hence, it is interesting to investigate the underlying mechanisms that lead to these differences and if they are relevant also for pragmatic training.

The role of cognitive factors is especially interesting in relation to pragmatics, because the literature has evidenced strong relationships between pragmatic skills and cognitive resources in older adults. For instance, in the study of Daniluk and Borkowska (2020), the most important factor predicting the scores in all the subtests of a pragmatic assessment battery was the overall level of cognitive

abilities (as measured with the Mini-Mental State Examination test). Among the various cognitive aspects involved in pragmatics, several studies have highlighted the importance of executive functions, especially inhibition and working memory. Starting with figurative language, studies have emphasized the role of inhibition (as assessed through the Stroop task and the Hayling test) in metaphor understanding, linked to the suppression of literal and irrelevant meanings (Morrone et al., 2010). Verbal fluency is another language-based executive task which has been related to figurative language, for instance in the study of Grindrod and Raizen (2019), where difficulties with ambiguous idioms were restricted to older adults with reduced verbal fluency. Older adults' difficulties in humor understanding have been related to poor executive resources in terms of both inhibition (Stroop task) and working memory, as assessed with the letter-number sequencing task (Uekermann et al., 2006). The production of off-topic speech has been related to reduced executive skills, as measured through different inhibition-related tests (Arbuckle & Pushkar Gold, 1993), although for this aspect the literature hosts conflicting findings (Burke & Shaffo, 2008). Indeed, the relationship with cognitive skills seems to vary a lot across different pragmatic tasks (Bambini et al., n.d.).

Another domain worth attention is lexical/semantic knowledge. While studies reported that word retrieval difficulties are associated with aging (Burke & Shafto, 2004), vocabulary knowledge is not (or very little) affected (Bowles et al., 2005; Bowles & Salthouse, 2008; Burke & Shaffo, 2008). We can assume that the preserved vocabulary knowledge has a protective effect on pragmatic skills, and specifically on the understanding of those figurative aspects that are part of the vocabulary. For the understanding of more creative figurative expressions, we can expect that older adults will consider more metaphorical expressions as familiar compared to younger adults, since they have had more time to accumulate knowledge (either vocabulary or general information). Indeed, a study by Mashal et al. (2011) found that older adults judge novel metaphors as more familiar than younger adults, although it must be pointed out that increased familiarity is not equal to accuracy (Uekermann et al., 2008). In sum, the baseline general cognitive

resources as well as language skills represent important factors that should be considered when planning training programs addressing pragmatics in aging.

4.1.1 Rationale of the study

Combining this evidence together, we decided to construct a novel training program targeting the pragmatics of communication (PragmaCom) with the following characteristics: (i) broad scope, (ii) theoretically sound, and (iii) based on a learner-oriented approach.

Given that difficulties in pragmatics encompass both expressive and receptive aspects, we argued that a training with a broad scope (i), namely targeting both comprehension and production, could be the most effective to enhance social communication in older adults. Therefore, in the PragmaCom we addressed a range of different figurative language expressions (to train comprehension) and different conversational situations (to train production).

Theoretically (ii), the PragmaCom training is grounded in the Gricean model of communication (Grice, 1975), where communication is seen as a cooperative activity in which speakers try to offer a contribution to the ongoing conversation that is appropriate, in terms of sincerity (Maxim of Quality), amount of information (Maxim of Quantity), on-topic content (Maxim of Relevance), and clarity (Maxim of Manner). The assumption that speakers are cooperative and adhere to the conversational maxims is also deemed to be a heuristic to guide utterance comprehension, production, and inferencing. Starting from this model, the strategy of the PragmaCom is to exploit violations in the use of the maxims to increase awareness of the pragmatic mechanisms of communication and then restore knowledge about such mechanisms through meta-pragmatic reasoning. Compared to another training program based on the Gricean communicative model such as the P.A.C.E., the PragmaCom differs mainly in that it targets the inferential aspects of communication, that is, the derivation of implicit meanings and the adjustment to the interlocutor's perspective in conversation, rather than functional communication and basic referential skills. Therefore, the PragmaCom is more

suited to address the kind of pragmatic difficulties that might be experienced by fluent speakers, such as healthy older adults, whereas the P.A.C. E. is more suited to promote word finding and communicative effectiveness in non-fluent speakers (Carlomagno et al., 2000).

Exercises in the PragmaCom are framed in a learner-oriented approach (iii), in which older adults are treated as active partners. Previous findings showed the importance of a learner-oriented approach in attempting to achieve the generalization of older adults' behavior (Bottiroli et al., 2013). The learner-oriented approach helps participants understand that the trained skills can be applied to a variety of materials across many contexts, and it is thus suited to achieve successful pragmatic behavior across a variety of communicative situations.

Moreover, we compared the efficacy of the PragmaCom in promoting pragmatic skills with an active control training program. We decided to include an active control group instead of a passive control group because several scholars argue that, compared to a passive control group, active control groups may benefit from a number of advantages, mostly related to the control for the placebo or Hawthorne effects, that is, the assumption that people's behavior will be affected by their level of involvement (Clark et al., 2017). More specifically, the choice of an active control group might help controlling for variables that otherwise would differ between the experimental and the control group, such as the amount of experimenter contact, the familiarity with the research team and setting, expectancy effects and motivation (Redick et al., 2015). Using an active control group thus helps rule out (although it might not completely eliminate) alternative explanations for observed improvement effects in the experimental group. In our specific case, we opted for an active control training that, format-wise, adopted the same approach and characteristics of the experimental training, and, content-wise, consisted of a cognitive stimulation. Specifically, we employed a cognitive training program based on memory, processing speed, and reasoning activities (Bottiroli et al., 2013, 2017; Cavallini et al., 2010), which was administered to the active control group and compared with the PragmaCom group in a randomized controlled trial design.

It is important to note that this training did not specifically target the cognitive substrates of pragmatics but rather it was aimed at stimulating cognitive functioning in general. As the PragmaCom, the cognitive training used a learner- oriented approach, where older adults were treated as active partners, and was of the same duration and intensity as the PragmaCom.

To assess pragmatic skills pre- and post-training, we administered the Assessment of Pragmatic Abilities and Cognitive Substrates (APACS; Arcara & Bambini, 2016a), a standardized test to evaluate pragmatics in clinical populations and previously used in pathological aging (Bambini, Arcara, Martinelli, et al., 2016; Carotenuto et al., 2018; Montemurro et al., 2019). However, since APACS is a test for clinical pupulations and the effect of age in the norm-group are limited (Arcara & Bambini, 2016a), we complemented the assessment with two other tasks adapted from previous literature, one evaluating receptive pragmatic skills and specifically the ability to infer metaphorical meanings (i.e., the Physical and Mental Metaphors task; Lecce, Ronchi, et al., 2019b; Del Sette et al., 2020), and the other evaluating expressive pragmatic skills and specifically the propensity to off-topic speech (Arbuckle & Pushkar Gold, 1993; Pushkar et al., 2000). Control variables (Mini-Mental State Examination, phonemic fluency, and vocabulary knowledge) were also collected.

The aims of our study were two. First, we aimed at testing the effects of the PragmaCom on pragmatic skills compared with an active control training devoted to cognitive stimulation. Our focus was on pragmatic skills as outcome (measured via the APACS, the Physical and Mental Metaphors task, and the off-topic verbosity). Based on previous evidence obtained from clinical populations (e.g., Gabbatore et al., 2015; Lundgren et al., 2011; Parola et al., 2019), we expected the PragmaCom to be effective and to observe 'pragmatic plasticity' in aging. Secondly, we aimed at investigating the role of individual aspects in determining the training benefits. Based on previous evidence that some individuals benefit more than others despite being exposed to the same program and materials depending on age, initial performance, and cognitive characteristics (e.g., Borella et al., 2017;

Cavallini et al., 2019; Zinke et al., 2014), we expected individual differences to be predictive of pragmatic improvement. We took into account the following factors of individual variation: age, baseline performance in pragmatics (Physical and Mental Metaphors task and off-topic verbosity), and a language-based cognitive index. The language-based index was calculated as a composite score derived from the vocabulary knowledge test and the phonemic fluency test. In light of previous evidence that figurative language comprehension in older adults is linked to vocabulary knowledge and fluency (Grindrod & Raizen, 2019; Mashal et al., 2011), we expected the language-based cognitive index to be predictive of differences in training benefits. This investigation would also, on the practical side, indicate who can benefit the most from which intervention.

4.2 Materials and methods

4.2.1 Participants

One hundred sixteen Italian-speaking older adults voluntarily took part in this study. They were randomly allocated either to the experimental group administered the PragmaCom training or to the control group administered the cognitive training. From this initial sample, 48 participants were excluded due to missing data (dropout, non- adherence, and missing pre- or post-assessment), with no differences between percentages of exclusion in the two groups (43% in the PragmCom group and 39% in the control group, $t(114) = -0.47$, $p = .64$). Reasons for missing data were typically family commitments, health issues or medical appointments. See Appendix B (Table B.1) for the detailed analysis of dropout/non-adherence/missing assessment. Nineteen additional participants (13% in the PragmaCom; 23% in the control group) were excluded because they presented one or more of these characteristics: age younger than 60 years, previous participation in training studies to promote social communication, presence of cognitive impairments (as assessed with the Mini-Mental State Examination; Folstein et al., 1975) or diagnosis of neurological disease. The final sample consisted of 49 participants: 32 in the

PragmaCom group (24F, *M*age = 68.75, age range =60–78, *M*education = 12.42, education range =8–18) and 17 in the control group (15F, *M*age = 68.12, age range = 60–83, *M*education = 11.12, education range = 5–17).

The study was approved by the Ethics Committee of the Department of Brain and Behavioral Sciences of the University of Pavia (nř 19/2017). Prior to participation, all participants were informed about the aims of the study and signed the informed consent, according to the Declaration of Helsinki.

4.2.2 Design and procedure

Participants took part in pre- and post-training assessment sessions. At both timepoints the assessment consisted in two sessions, one performed individually and one collectively, in which screening (Mini- Mental State Examination), control variables assessing cognitive and verbal aspects (phonemic fluency and vocabulary), and the outcome measures (pragmatic abilities) were tested. The mean time between the pre-training and the post-training assessment sessions was six weeks. Both the PragmaCom and the cognitive control training programs consisted of four two-hour sessions, once a week, for four consecutive weeks. All sessions were held in groups of 15 participants on average and guided by an expert trainer, who provided positive and corrective feedback.

4.2.2.1 Assessment materials

The following tests were administered only at pre-test:

Mini-Mental State Examination (MMSE, individually assessed): The MMSE is a screening test useful to detect cognitive impairments, especially in older adults. It consists of six parts, each assessing a different cognitive ability (orientation to time and space, immediate and delayed memory recall, attention and calculation, language, and praxia). The total score is 30, and the cut-off score for cognitive impairment is 24.

Phonemic fluency (collectively assessed): Participants were asked to write down the highest number of words beginning with three specific letters (we used the letters F, A, and S, which are the most commonly used; Strauss et al., 2006). Only Italian words were considered as correct, excluding proper names. Participants were allowed one minute and a half for each letter. The final score consisted in the total number of words produced in the three conditions.

Vocabulary knowledge (collectively assessed): Vocabulary knowledge was assessed with a test adapted to the Italian language from the Primary Mental Abilities test (PMA; Thurstone & Thurstone, 1963). In this multiple-choice task, participants are asked to select the correct synonym for 50 given words, choosing among five options for each word, in eight-minute time (total score range: 0–50).

The following tests were administered both at pre- and post-training:

Assessment of Pragmatic Abilities and Cognitive Substrates (APACS; individually assessed): This test was developed by (Arcara & Bambini, 2016a) to assess pragmatic language disorder in Italian speaking individuals. APACS consists of six tasks devoted to assessing different aspects of the pragmatics of communication, targeting both production and comprehension: Interview (evaluating pragmatic aspects such as informativeness and coherence during a semi- structured interview), Description (assessing the ability to produce relevant information while describing a picture), Narratives (assessing the comprehension of implicit and explicit information provided in an orally presented text), Figurative Language 1 (assessing the ability to understand figurative language through a multiple-choice task), Humor (assessing the ability to understand humor through a multiple-choice task), Figurative Language 2 (assessing the ability to understand figurative language through a verbal explanation task). Six task scores are derived, one for each task; moreover, three composite scores (Pragmatic Production, Pragmatic Comprehension and APACS Total) are derived from the six task scores, each ranging from 0 to 1.

Physical and Mental Metaphors task (PMM; collectively assessed): As a more fine-grained measure of receptive pragmatic skills than the APACS Pragmatic Comprehension score, we created a novel adult- appropriate version of the PMM

task originally developed for children (Del Sette et al., 2020; Lecce, Ronchi, et al., 2019b). Fourteen novel nominal metaphors in the form X is Y were used, including physical metaphors (e.g., "Some singers are nightingales", meaning that they sing very well) and mental metaphors (e.g., "Some friends are anchors", meaning that they are supportive and they are people on whom you can count), depending on whether they referred to physical or mental characteristics. Further information on the items' characteristics are provided in the Supplementary Material (Table S2). Metaphors were presented in written format, and participants needed to explain their meaning by writing down the answers in a booklet. Answers were rated for the ability to articulate the salient link between the topic and the vehicle of the metaphor and received an accuracy score that ranged from 0 to 2 (where 0 is incorrect, 1 is partially correct, and 2 is correct). The total score ranged from 0 to 28.

Off-Topic Verbosity (OTV): In order to obtain a more fine-grained measure of pragmatic production than the APACS Pragmatic Production score, we measured OTV in the speech produced during the APACS Interview task. More specifically, interviews were manually transcribed according to the orthographic transcription rules of oral texts adopted in the CLIPS (Corpora e Lessici di Italiano Parlato e Scritto) project (Savy, 2007). Following Arbuckle and Pushkar Gold (1993) and Pushkar et al. (2000), we classified each participant's turn based on the presence (score 1) or absence (score 0) of speech irrelevant to the topic under discussion. Since the APACS interview is a semi-structured interview and, therefore, the number of turns varies depending also on the number of questions asked by the interviewer, for each participant we calculated a measure of "OTV propensity", defined as the proportion between the number of times the participant's turn was off-topic (i.e., it scored 1) and the total number of turns. Examples of scoring of off-topic and non-off-topic turns are offered in the Supplementary Material (Table S3).

The OTV analysis was done on a subsample of 24 participants (12 for each group), which was determined starting from the 12 participants in the control group who were assessed with APACS at both time points and consented to audio recording, and then selecting 12 age-matched participants from the PragmaCom group.

4.2.2.2 Training programs

PragmaCom training. Framed in the Gricean model of communication and taking the assumption that speakers cooperatively adhere to conversational maxims as a guide to utterance comprehension and production, the PragmaCom aims at restoring the knowledge of the maxims to help coping in social communication. For instance, when the speaker utters something blatantly false (i.e., violating the Maxim of Quality), as in the case of figurative language, the hearer is prompted to look for an implicated meaning on the basis of the assumption that she must be ultimately cooperative. The PragmaCom prompts reasoning about the maxims by presenting exercises based on story contexts where communicative mismatches happen (misunderstanding of figurative meanings or inappropriate discourse production) and encouraging the discussion on the pragmatic mechanisms that were violated. The strategy is therefore meta-pragmatic (Szücs & Babarczy, 2017), in that participants are invited to reflect about the failure of the conversational maxims and are explicitly taught about how to respect the conversational maxims.

In order to train pragmatic skills both in comprehension and in production, two types of exercises were created: one type was devoted to the comprehension of pragmatic meanings in figurative language (including different expressions such as nominal metaphors, transparent idioms, and proverbs), and the other type was devoted to the production of appropriate speech (including a variety of communicative difficulties with respect to the Maxims of Quantity and Relation, e.g., overinformativity, underinformativity, and off-topic speech).

Each exercise in the PragmaCom unfolds through four phases, schematically represented in Figure 4.1. Phase 1 (*Detection of a communica-tive mismatch*) presents a story context featuring a communication problem due to a failure in using one of the Gricean maxims, which the participant is encouraged to recognize and discuss upon. In phase 2 (*Reconstruction of the mechanism and learning of the rule*), the participant is invited to recover the correct communicative behavior for the pro-posed context. Phase 3 (*Generalization of the rule to other contexts*)

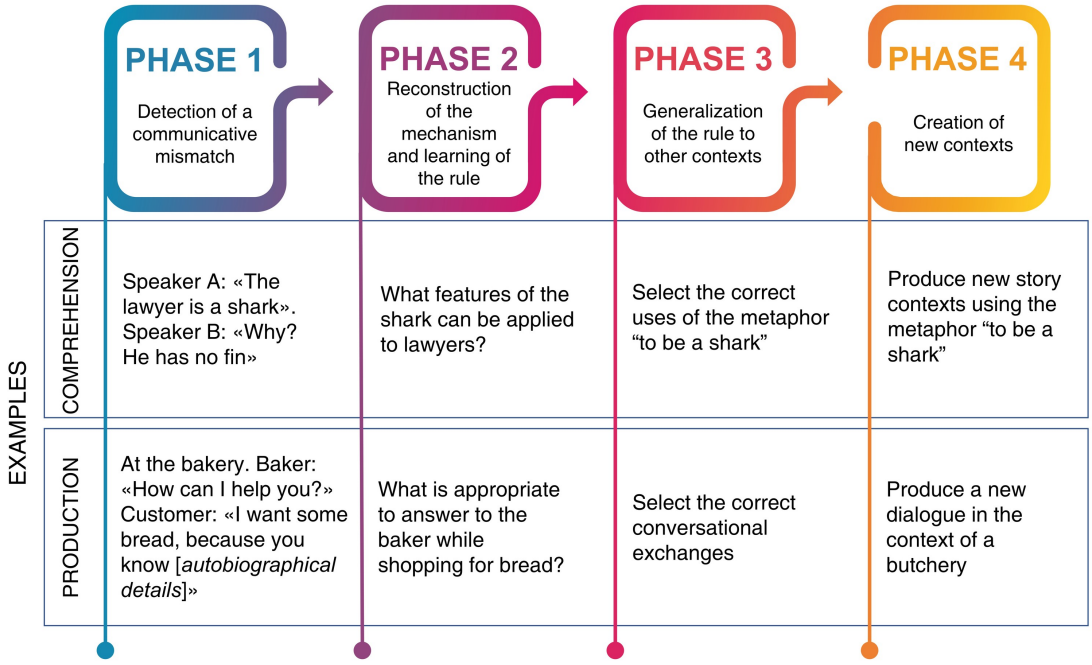

Figure 4.1: Schematic representation of the phases and items in the PragmaCom training.

and phase 4 (*Creation of new contexts*) aim at promoting generalization, by encouraging the analysis of other contexts and by prompting the use of the correct communicative behavior through the creation of a new story context.

More specifically, in the exercises targeting pragmatic comprehension, a story context in which a character misunderstands a figurative expression (e.g., the metaphor "That lawyer is a shark") by interpreting it literally ("Why? He has no fin") is presented, and the participant is invited to identify the cause of the misunderstanding (phase 1). Next (phase 2), the participant is encouraged to reflect on the literal meaning of the expression and to use elements from the context to infer the figurative meaning ("The lawyer is aggressive"). In phase 3, new contexts are considered, with correct and incorrect uses of the figurative expression at stake ("to be a shark"). Finally (phase 4), the participant is invited to create a novel story containing the trained figurative expression. For production, phase 1 starts with a dialogue in which one of the speakers violates a conversational maxim (e.g., a person listing a lot of autobiographical details while shopping at the bakery, thus being off-topic). In phase 2, participants are guided through

the analysis of the elements of the conversation which are necessary/unnecessary or related/unrelated to the context of the dialogue. In phase 3, participants are asked to select appropriate conversational exchanges among different options, and in phase 4, the participant is asked to write a new dialogue (for instance in the context of a butchery) and apply the learned rules.

Furthermore, all sessions were enriched with ecological items, such as newspaper articles or videos featuring figurative expressions or ineffective communicative exchanges, which were then analyzed and discussed. All exercises included figurative expressions or topics of conversation which were different from those presented in the pre- and post-training assessments.

The training was held in groups. However, in order to be sure that everybody was actively engaged in the training sessions, participants were first invited to individually reason on the questions and to write down their answers in a booklet, before the trainer started a guided group discussion.

Cognitive training. This intervention was primarily based on a previous memory training (Bottiroli et al., 2013, 2017; Cavallini et al., 2010), which was adapted in order to target cognitive skills more broadly. More specifically, exercises targeted memory, speed of processing, and reasoning skills. For memory, the trainer first explained a non-verbal mnemonic, that is, the interactive imagery strategy (Cavallini et al., 2010), offering several examples. This strategy consists of creating an internal image depicting the interaction of the items (e.g., a cat with a moon spot on its forehead to remember "moon" and "cat" words). Hence, it is a visual memory strategy, based on relational encoding, which en-hances the organization of to-be-learned materials. Following the in-structions, participants were requested to complete a range of memory exercises (e.g., associative learning and free recall tasks) using this learned strategy. For speed of processing, exercises requested, for instance, to identify as fast as possible if two stimuli (e.g., pattern of lines) were the same or different (adapted from Salthouse & Babcock, 1991). For reasoning, we used the Raven's Progressive matrices (Raven et al., 1983), adapting them to

Table 4.1: Activities in the Cognitive training

Sessions	Activities
Session 1	Instructions on the interactive imagery strategy applied to cued recall tasks, with commented examples
	Memory task: cued recall 3 words pairs (followed by group discussion and feedback)
	Memory task: cued recall 5 words pairs (followed by group discussion and feedback)
	Speed of processing: letter comparison (42 items within 3 minutes)
Session 2	Memory task: cued recall 15 words pairs (followed by group discussion and feedback)
	Instructions on the interactive imagery strategy applied to free recall tasks, with commented examples
	Memory task: free recall list of words (5 items) (followed by group discussion and feedback)
	Memory task: free recall list of words (10 items) (followed by group discussion and feedback)
	Speed of processing and inhibition: timed visual search task, with distractors (9 items)
Session 3	Reasoning: Raven Colored Matrices (23 items)
	Speed of processing and visual reasoning: timed visual recognition task (7 items)
	Memory task: cued recall 25 words pairs (followed by group discussion and feedback)
	Memory task: free recall list of words (25 items) (followed by group discussion and feedback)
Session 4	Instructions on the interactive imagery strategy applied to facename task, with commented examples
	Memory task: facename task (16 items) (followed by group discussion and feedback)
	Speed of processing: letter comparison (60 items within 3 minutes)

be collectively presented. Activities varied both within and between sessions and were of increasing difficulty. Activities in each session are described in Table 4.1.

Past studies on the original memory training upon which the current cognitive training is based showed reliable improvements in the targeted ability (Cohen's ds ranging from 0.60 to 1.10). For example, the first study examining the effects of this training compared the experimental group with a control group (Cavallini

et al., 2010); in the training group, the increase in memory performance in the two practiced tasks was of 10.5%, compared to the 1.5% change in the control group. Even if the efficacy of the current, enriched, cognitive training was not directly examined in previous studies, we were confident on its positive effects on memory. We nevertheless checked this assumption by measuring memory performance both at the beginning and at the end of the training program, and, as expected, we found a significant improvement (see Appendix B, Table B.5).

4.2.3 Data analysis

4.2.3.1 Preliminary analysis on the three outcome measures (APACS, PMM, and OTV)

Before running the main analysis, we performed a preliminary analysis to ensure that participants' scores obtained at pre-training assessment (considered as baseline) were such that improvement in pragmatic skills was possible. Among the three outcome measures, this preliminary step was especially important for the APACS, since this test was designed to detect pragmatic impairments in clinical populations rather than typically aging population. We inspected the scores obtained at pre-training assessment and calculated the percentage of participants who had an accuracy higher than the 80% for each outcome measure (APACS, PMM and OTV). Results showed that more than the 90% of participants reached a mean accuracy greater than the 80% in the APACS test (100% of participants in Pragmatic Production and in APACS Total score, 91% in Pragmatic Comprehension), while only the 33% and the 46% obtained more than 80% accuracy scores in the PMM task and OTV propensity measure, respectively. Thus, the APACS test was excluded from further analyses and only the accuracy score obtained in the metaphor comprehension task (PMM) and the score obtained in the evaluation of off-topic verbosity propensity (OTV) were considered as outcome variables. Furthermore, for PMM we established an accuracy threshold and excluded from the analyses the participants who obtained an accuracy score higher than 95% in the pre-training assessment.

4.2.3.2 Testing the effectiveness of the training

In order to achieve our first aim (i.e., testing the effects of the PragmaCom training in older adults), we first checked with independent sample t-tests that the PragmaCom and the control groups did not differ for age, education, and any of the measures collected at pre-test. Second, we performed a repeated measures ANOVA for each of the outcome variables (PMM and OTV). Time (pre-training and post-training) was set as within participants variable and Group (PragmaCom and control) as between participants variable. Significant results were followed by post- hoc pairwise comparisons.

4.2.3.3 Investigating the role of individual differences in training benefits

In order to accomplish our second aim (i.e., evaluating the effects of individual differences on the training benefits), we first performed a correlation analysis on the whole sample, and then a series of hierarchical regressions for each group separately. For these analyses, in order to reduce the numbers of predictors, a language-based index was derived by summing the z-scores calculated for the fluency task and the vocabulary knowledge task.

Concerning the correlations, we calculated Pearson's correlation coefficients between age, language-based index, and the outcome variables (accuracy in PMM and OTV propensity) assessed both at pre- and post-training, to investigate the relationship between age, cognitive abilities, and pragmatics. We also calculated the correlations between the pre- and post-training scores for each outcome variable, to investigate the relationship between the baseline level and the post-training level.

Hierarchical regressions were performed to analyze the role of baseline performance, age, and the language-based index in pragmatic performance at post-training, separately for the two training groups. The post-training scores for the two outcome measures (PMM and OTV) were set as dependent variable in separate regression analyses. For each outcome variable, the baseline score was

Table 4.2: Descriptive statistics of the two training groups at pre- and post-training assessment on all control and outcome variables

	PragmaCom Group			Control Group		
	N	Pre-training M (SD)	Post-training M (SD)	N	Pre-training M (SD)	Post-training M (SD)
Age	32	68.75 (5.37)	-	17	68.12 (6.38)	-
Education	31	12.42 (2.49)	-	17	11.12 (3.90)	-
Phonemic fluency	32	43.41 (9.84)	-	16	42.44 (13.44)	-
Vocabulary knowledge	32	46.16 (3.04)	-	17	42.24 (12.16)	-
APACS Total	30	0.93 (0.04)	0.94 (0.03)	12	0.94 (0.03)	0.94 (0.04)
Physical and Mental Metaphors task	32	19.00 (5.27)	21.56 (3.88)	17	18.29 (6.66)	20.29 (5.99)
Off-Topic Verbosity	12	0.28 (0.18)	0.18 (0.13)	12	0.21 (0.19)	0.15 (0.15)

entered first (model 1), followed by age and the language-based index in the second step (model 2).

4.3 Results

Descriptive statistics are presented in Table 4.2.

4.3.1 Effectiveness of the training

The two groups did not differ at baseline for any of the assessed variables (see Table 4.3).

4.3.1.1 Physical and Mental Metaphors task

Repeated measures ANOVA on the PMM task showed only a main effect of Time [$F(1,47) = 19.68$, $p < .001$, $\eta^2 p = 0.30$]. Post-hoc pairwise comparisons confirmed

Table 4.3: Independent sample t-tests comparing the PragmaCom group and the control group for the control and the outcome measures at pre-training

Variable	*df*	*t*	*p*	*M* diff	*SE* diff
Age	47.00	-0.37	.72	-0.63	1.72
Education	23.30	-1.24	.23	-1.30	1.05
Fluency	46.00	-0.28	.78	-0.97	3.41
Vocabulary knowledge	17.08	-1.31	.21	-3.92	3.00
APACS Total	40.00	1.26	.21	0.02	0.01
Physical and Mental Metaphors	47.00	-0.42	.68	-0.72	1.73
Off-Topic Verbosity	22.00	-0.99	.34	-0.07	0.08

Note:
For the Education and Vocabulary knowledge variables, Levenes test showed significance; therefore Welchs t-test for unequal variances was used. In all other cases comparisons were calculated with Students t-tests.

that both groups obtained a higher score at post- than at pre-training, with the PragmaCom group leading the effect and showing a greater effect size compared to the control group [Pragma Com: $t(47) = 4.23$, $p < .001$, Cohen's $d = 0.55$; Control: $t(47) = 2.40$, $p = .020$, Cohen's $d = 0.32$] (see Figure 4.2A).

4.3.1.2 Off-Topic Verbosity

Repeated measures ANOVA on OTV propensity showed only a main effect of Time [$F(1,22) = 5.23$, $p = .032$, $\eta^2 p = 0.19$]. Post-hoc pairwise comparisons suggested that this result was driven by the improvements of the PragmaCom group, in which the difference between pre- and post- training scores approached significance [$t(22)$ = -2.05, $p = .052$, Cohen's $d = 0.63$], compared to the control group [$t(22)$ = -1.18, $p = .25$, Cohen's $d = 0.34$] (see Figure 4.2B).

4.3.2 Individual differences on the training benefits

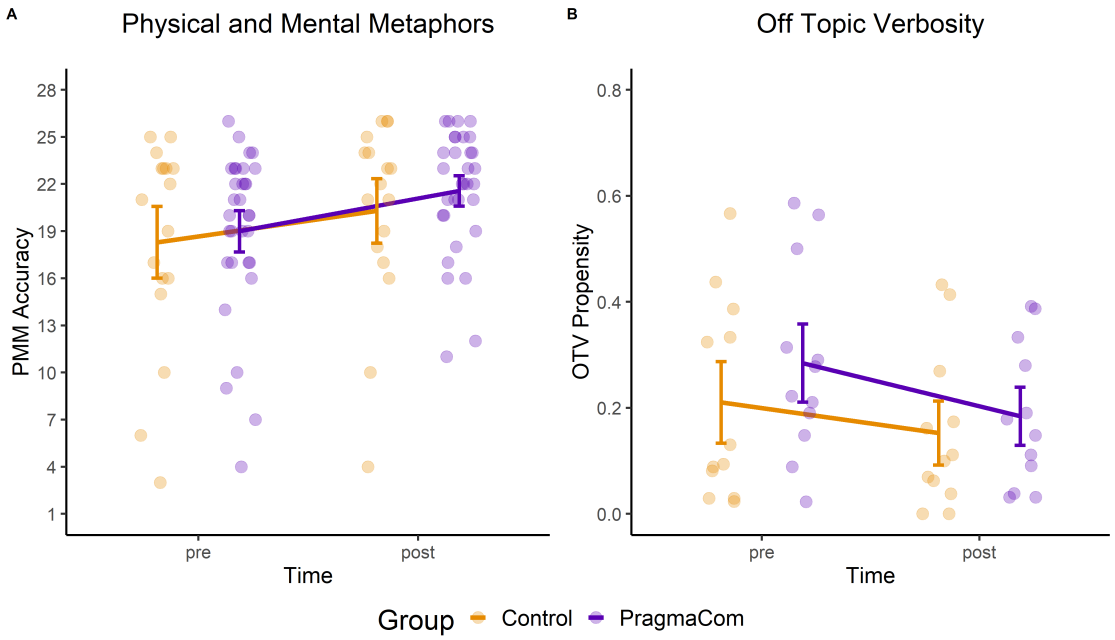

Figure 4.2: Scatterplots showing the performance across time of the two groups (PragmaCom and control) in the two outcome measures. The performance of the two groups in the Physical and Mental Metaphors (PMM) task and the scores obtained in the Off-Topic Verbosity (OTV) propensity measure are displayed in plot A and plot B, respectively. Lines connect the means of the two groups between the pre- and post-training time points. Bars represent the standard error of the mean and dots display the mean score for each participant.

4.3.2.1 Correlations

The results of the correlation analysis are displayed in Figure 4.3. Age was significantly and negatively associated only with the PMM task, both at pre- and post-training assessment (pre: $r(47) = -0.41$, $p = .004$; post: $r(47) = -0.46$, $p = .001$). No significant correlations were found between age and OTV propensity, neither between age and the language-based index. The language-based index correlated significantly with the PMM task, in a positive fashion at both time points (pre-training: $r(47) = 0.70$, $p < .001$; post-training: $r(47) = 0.77$, $p < .001$), but not with the OTV propensity measure. Pre- and post-training scores correlated both in the PMM task and in OTV (PMM: $r(47) = 0.81$, $p < .001$, OTV: $r(22) = 0.50$, $p = .013$).

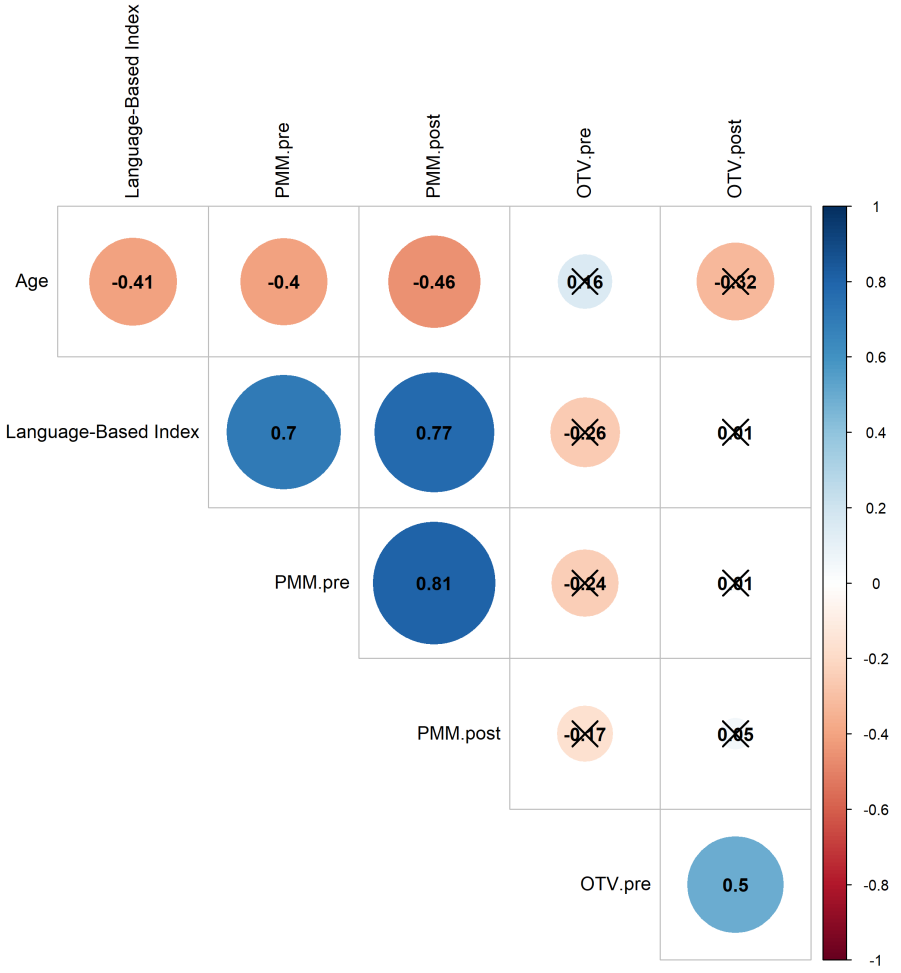

Figure 4.3: Correlogram displaying the relationship between age, language-based index and the outcome measures at pre- and post-training in all participants. The figure represents the Pearson's correlation coefficient (r) between participants' age, language-based index, and scores obtained pre- and post-training in the two outcome measures (Physical and Mental Metaphors task, PMM, and Off-Topic Verbosity propensity, OTV). Color blue indicates positive correlations, while color red indicates negative correlations. Color intensity and the size of the circles are proportional to the correlation coefficients, which are reported also as numbers for further clarity. The legend on the right side of the correlogram shows the correlation coefficients and the corresponding colors. Xs mark non-significant correlations ($p > .05$). Degrees of freedom are 47 for all correlations except for those involving the OTV measures, in which degrees of freedom are 22.

4.3.2.2 Regressions

The results of the regression analysis are displayed in Table 4.4.

Physical and Mental Metaphors task. The regression analysis with the PMM scores at post-training as dependent variable and the PMM score at pre-training as single predictor (model 1) showed that the baseline PMM score explained a significant amount of variance in both groups [PragmaCom: $F(1, 30) = 42.40$, $p < .001$; control: $F(1, 14) = 36.03$, $p < .001$]. When age and the language-based index were introduced in model 2, the two groups showed a different pattern of results. In the PragmaCom group, the second model did not significantly explain any further variance [$\Delta F(2, 28) = 2.53$, $p = .10$]. On the contrary, in the control group the second model significantly increased the amount of explained variance [$\Delta F(2, 12) = 4.62$, $p = .033$]. Further inspection of coefficients revealed that the language-based index was the only significant predictor of post-training PMM score ($p = .011$), reducing the predicting role of the baseline performance ($p = .087$).

Off-Topic Verbosity. Results of model 1 showed that baseline performance was a significant predictor of post-training OTV propensity in the control group [$F(1, 10) = 40.67$, $p < .001$], but not in the PragmaCom group [$F(1, 10) = 0.004$, $p = .95$]. Adding age and the language- based index in model 2 did not explain further variance in either of the two groups [PragmaCom: $\Delta F(2, 8) = 1.65$, $p = .25$; control: $\Delta F(2, 8) = 0.45$, $p = .65$].

Additional analysis. Additional regression analyses were performed in the control group only, to investigate whether the improvement in memory could explain the improvement in pragmatics. Results showed that memory gains had no effects on the improvement in the PMM and OTV tasks (see Appendix B, Table B.6).

Table 4.4: Hierarchical regressions on PMM and OTV scores at post-training in the PragmaCom and Control group.

			Model 1		Model 2				
		Independent variable	Baseline		Baseline		Age	Language-based index	
PMM	PragmaCom	B	0.56		0.44		-0.90	0.72	
		SE B	0.09		0.11		0.58	0.58	
		β	0.77	***	0.60	***	-0.18	0.18	
		R^2 model 1 = 0.59							
		R^2 model 2 = 0.65							
	Control	B	0.75		0.34		0.15	1.70	
		SE B	0.13		0.18		0.89	0.56	
		β	0.85	***	0.37		0.02	0.60	*
		R^2 model 1 = 0.71							
		R^2 model 2 = 0.79							
OTV	PragmaCom	B	0.01		0.17		0.12	0.02	
		SE B	0.23		0.24		0.08	0.05	
		beta	0.02		0.23		-0.64	-0.13	
		R^2 model 1 < 0.001							
		R^2 model 2 = 0.29							
	Control	B	0.70		0.72		-0.01	0.02	
		SE B	0.11		0.13		0.04	0.02	
		β	0.90	***	0.92	***	-0.05	0.12	
		R^2 model 1 = 0.80							
		R^2 model 2 = 0.82							

Note:
*$p < .05$; **$p < .01$; ***$p < .001$.

4.4 Discussion

In this study we investigated the unexplored domain of pragmatic intervention in healthy older adults. We did so by creating a novel training program targeting pragmatic abilities, based on the Gricean model of inferential communication and addressing both production and comprehension with a learner-oriented approach. As a first aim, we examined the effects of the PragmaCom, compared with a cognitive training in a randomized controlled trial design. Results showed a main effect of time, which indicates that all participants improved after training, both the group administered the PragmaCom and the group administered the cognitive training. These findings are in line with our expectations about the efficacy of the PragmaCom, but they do not support its specificity. This has two important theoretical implications: 1) it is possible to enhance older adults' pragmatic skills, which is indicative of 'pragmatic plasticity' in aging; 2) both a training targeting pragmatics and a training targeting cognitive skills can have a positive effect on pragmatic skills, which points to the link between pragmatic abilities and the general cognitive profile.

Concerning the first implication, it is important to underline that the maintenance of a certain grade of plasticity in aging (Greenwood, 2007) has been largely demonstrated by the effectiveness of cognitive interventions aimed to preserve an adequate cognitive functioning, limiting the normal decline of several functions, including memory, decision making, and reasoning (Anand et al., 2011; Cavallini et al., 2010); Rosi et al. (2019)]. The novel finding stemming from our results is that plasticity in aging seems to extend beyond the domain of classic cognitive abilities to embrace also socio-communicative aspects. What our data seem to suggest is indeed that also the complex set of skills that allow to adjust the linguistic behavior to the contextual setting, to engage in successful conversational exchanges by offering an appropriate contribution and by inferring the speaker's intended meaning can be ameliorated by means of training, possibly mitigating the

age-related decline. Also, our data extend previous evidence of training-induced improvement in specific pragmatic skills in clinical conditions, for instance traumatic brain injury and right hemisphere brain damage (Gabbatore et al., 2015; Lundgren et al., 2011; Parola et al., 2019; Togher et al., 2012), by showing potential for improvement also in healthy aging.

By looking more closely at our findings and specifically at the results of the post-hoc comparison in the two outcome variables, it is interesting to note that the improvement seems to be more robust in the domain of metaphor understanding (where pre-post comparisons were significant in both groups) compared with off-topic verbosity (where, despite the main effect of time, pre-post comparisons were marginally significant – in the PragmaCom group – or non-significant – in the control group). It is certainly possible that the smaller effect observed for the production task is due to the smaller sample size that was analyzed for this outcome measure compared with the sample size of the comprehension outcome measure. However, it is also possible that this smaller effect size captures a genuine difference between domains and a greater difficulty of production compared to comprehension. Studies on language in aging have evidenced that several comprehension domains are relatively spared, while production, especially word retrieval and off-topic speech, are especially vulnerable [Burke and Shaffo (2008); Diaz et al. (2016); Zhang et al. (2019)). The greater difficulty of the pragmatic production task might thus in turn lead to a greater difficulty in ameliorating this aspect of the pragmatic competence through training.

The other relevant finding emerging from our data is that both the PragmaCom and the cognitive training are effective in promoting pragmatic skills. Although we did not explicitly target those abilities that are especially known to affect pragmatics such as inhibition and working memory, the cognitive training stimulated the general cognitive functioning (including abilities such as memory, reasoning, and processing speed). The cognitive training was successful in stimulating cognition (see the improvement in memory performance in the control group reported in Appendix B. Moreover, individuals who were stimulated cognitively generalized

to pragmatics, obtaining also a gain in the pragmatic tasks. We can interpret our finding as indicative of the importance of the general cognitive profile for pragmatic behavior in aging. Converging evidence comes from studies where the general cognitive profile of older adults has been related to pragmatics (Daniluk & Borkowska, 2020) and also from studies on clinical populations where performance in pragmatic tasks was associated with the severity of global cognitive impairment (Montemurro et al., 2019). In sum, training general cognition might suffice to improve pragmatic skills.

In commenting this finding, however, we are aware that the main effect of time observed in both groups can also be indicative of a learning effect. Indeed, in this case the absence of a no-training group does not allow us to completely rule out the learning effect. A further issue is represented by the use of the same test for metaphor comprehension at pre- and post-test, which might facilitate the retrieval of correct answers. While acknowledging that future studies should take into account these limitations, there are a number of elements which suggest that the observed improvement in pragmatics is likely to be genuine. First, a preliminary report describing the effects of the same training in patients with schizophrenia highlighted an improvement in pragmatics only in the experimental group, and not in the active control group (Agostoni et al., 2020). Second, test-retest is unlikely for tasks such as the Physical and Mental Metaphors one, since participants are not requested to identify pre-coded answers but rather to articulate the metaphor's meaning, and receive no feedback on their answers (for similar considerations on a similar test for children, see Melogno et al., 2017). Furthermore, the post-test happened at six-week distance from the pre-test. Finally, it is important to note that training cognitive skills is not the same as training pragmatics directly: in our study the effect sizes of the comparisons between pragmatic performance at pre- and post-training were bigger in the PragmaCom than in the control group, and we observed different patterns of predictors across groups. This latter point will be discussed in more detail below, in relation to the second aim.

The second aim of this study revolved around individual differences, which may constitute an important factor impacting training outcome. Preliminarily to the regression analysis, we ran a series of correlations between age, the language-based index, and pragmatic measures. The results of the correlations are quite interesting and hint at the important differences that exist between the different pragmatic aspects. To start with, age was significantly related to metaphor comprehension (both at pre- and post-training), but not to off-topic verbosity. While for metaphor comprehension age effects have been largely documented (Mashal & Kasirer, 2011; Morrone et al., 2010), for off-topic verbosity there is evidence that the effect of age is mediated by socio-cognitive factors such as emotion recognition (Ruffman et al., 2010). Although we cannot exclude that the age range in our sample was not big enough to capture the effect of age, our findings seem to indicate that off-topic verbosity might be related to other skills rather than age per se.

Coming to the role of the language-based index, we observed something similar to the pattern described for age, namely a significant correlation with metaphor comprehension but not with off-topic verbosity. This finding highlights that metaphorical skills in older adults are related to vocabulary knowledge and to executive aspects such as those measured in the fluency task, confirming previous evidence on figurative language processing in aging (Grindrod & Raizen, 2019). Importantly, the metaphors included in the Physical and Mental Metaphors tasks are novel metaphors: therefore, the ability to rely on accumulated word knowledge seems especially relevant (Mashal & Kasirer, 2011). Conversely, off-topic verbosity does not seem to be related to language-based cognitive skills. Indeed, for off-topic verbosity findings are diverse, and in general cognitive explanation (e.g., inhibition-based explanations) proved inconclusive to account for all instances of discourse difficulties (Burke & Shaffo, 2008). It is likely that off-topic verbosity depends on a multiplicity of factors that go beyond verbal and executive domains, touching upon social and intellectual abilities more broadly. Among these, it might be worth considering also the breadth of categorization. The phenomenon of off-topic verbosity has been largely investigated in the clinical perspective, especially in

terms of tangential and derailed discourse (Cavelti et al., 2018). In that context, off-topic speech is often considered in relation to thought disorganization. Specifically, derailment in discourse is taken as indicative of looseness of associations, that is, poor processes of conceptual association and formation (Bambini, Arcara, Bosinelli, et al., 2020; Cavelti et al., 2018). This might be a relevant line of investigation in aging too, given the evidence of a greater breadth of categorization (i.e., the tendency to use broader categories and cluster information to fewer categories) in older compared to younger adults (Mashal & Coblentz, 2014), which might lead to poor coherence in speech. In sum, these correlations show that individual factors such as age and language-based cognitive skills play a role in pragmatics, which is different across specific pragmatic domains. Because of this, it is also possible that training gains vary depending on individual characteristics and across pragmatic domains and types of interventions, as it will be examined below in relation to the outcome of the regression analysis.

To summarize the results of the regressions, the individual characteristics that played a role in pragmatic gains are the following: in the control group, we observed a predictive role of the baseline scores (in metaphor accuracy) and of the language-based index in post-training metaphor accuracy and a predictive role of the baseline scores (in off- topic verbosity) on post-training off-topic verbosity. In the PregmaCom group, only the baseline level (in metaphor accuracy) was a predictor of post-training metaphor accuracy, and there were no significant predictors of off-topic verbosity.

These findings seem to suggest a clear pattern: the individual characteristics are more influential in the control group than in the Pragmacom group. We can discuss this pattern by referring to the two models used to capture the association between variables that predict training gains: the magnification model and the compensation model. The magnification model (Kliegl et al., 1990; Lövdén et al., 2012; Verhaeghen & Marcoen, 1996) suggests that higher-performing individuals benefit more from cognitive training, as they are better equipped with the cognitive resources needed to make use of new strategies and abilities to successfully perform

the tasks. Conversely, the compensation model postulates that it is actually lower-performing individuals who tend to benefit more from the intervention, because they have more room for improvement and the training allows them to compensate for their difficulties (Lövdén et al., 2012). Our results in the control group seem consistent with the magnification model, in that the cognitive training magnifies individual differences and those with higher performance (in the specific task at baseline or in the language- based index) reached higher pragmatic scores after training. This is less of a case for the PragmaCom training, where the effect of individual predictors was minimal, indicating that the magnification view does not fully apply to it. It is interesting to compare these findings with those reported in a study that examined the effect of an intervention program on visual metaphor comprehension in individuals with intellectual disabilities (Shnitzer-Meirovich et al., 2018). In that study, receptive vocabulary predicted the learning of visual metaphors, over and above the type of intervention, with individuals with lower scores exhibiting increased learning. Both these data and our data seem to indicate that, when the training program specifically addresses pragmatic skills, it is not only the better skilled participants who benefit from it, but also those with poorer resources. Another parallel between the two studies is in the effect of language skills [the Peabody Pictures Vocabulary Test in Shnitzer-Meirovich et al. (2018) and the language- based index in our study) on metaphor, although in our case this is limited to the control group and does not extend to the PragmaCom group.

This difference in the role of the individual predictors across training types is important both theoretically and practically. Theoretically, it informs us about the underlying mechanisms supporting improvement. The cognitive training capitalizes on the individual's general cognitive skills; it magnifies the memory and reasoning skills of the higher performing individuals, leading to a better performance in pragmatic tasks that are associated with the global cognitive profile. Conversely, the PragmaCom directly addresses the core pragmatic mechanisms, restoring inferential and conversational rules. In this way, it manages to overcome, to some extent, individual characteristics. Practically, the difference in the predictors might

suggest who can benefit the most from which training, a piece of information which might be useful in order to adopt tailored remediation decisions. Although both trainings are effective, by being less dependent on individual factors, the PragmaCom training is potentially more suited for all older adults than the cognitive training. Interestingly, age did not turn out to be a significant predictor of post-training pragmatic performance in any group and for any task. This seems to suggest that older adults of all ages might improve in pragmatic skills, in line with what has been observed for some other cognitive aspects (Cavallini et al., 2019).

The results of this study should be interpreted within the context of its limitations. We have already discussed above the absence of a no- training group, which prevents us from completely ruling out that the improvement observed in the two groups is due to a learning effect. Future studies should thus try to replicate our findings, including also a no-treatment group. Another aspect that should be mentioned is the relatively small sample size, which prevents us from deriving conclusive patterns. This sample size was due to 41% of missing data (out of the 116 participants recruited), with 34% due to dropout or non-adherence (see Appendix B). Although there is very little evidence of dropout/non-adherence rate in cognitive training in healthy aging, when compared with the better documented dropout rate in cognitive interventions in clinical populations, our data are not inconsistent (29% in Mahncke et al., 2019; see also the meta-analysis in Szymczynska et al., 2017). Since the percentage of missing data was not different between the PragmaCom and the control group, it is likely that both training interventions were equally engaging. However, the collective nature of both training programs was difficult to reconcile with personal schedules, an aspect which was possibly worsened by the lack of incentives. For future studies, thus, it would be important to devise better strategies to avoid dropouts and non-adherence. Another limitation is the use of a single individual measure for cognition and language. Here, we limited our assessment to vocabulary knowledge and verbal fluency. Although this measure highlighted interesting links with the domain of metaphor comprehension, it is key that future research employs other measures,

such as working memory and inhibition, which are known to affect pragmatic performance. This would allow to clarify the role of the individual predictors in pragmatic intervention.

Finally, adding measures of the brain response to pragmatic and cognitive training would be highly informative to investigate whether cognitive plasticity is accompanied by cerebral plasticity and reorganization of brain circuits for pragmatics. Recent research showed that pragmatics-related skills, from the understanding of figurative language to the discourse aspects, rely on an extended network encompassing both hemispheres (Carotenuto et al., 2018; Diaz & Eppes, 2018; Hagoort & Levinson, 2014; Zacks & Ferstl, 2016). Studies on the brain correlates of language processing in aging have highlighted possible compensatory strategies, for instance related to the recruitment of the right hemisphere (Diaz et al., 2016). For pragmatic processing specifically, there is initial evidence that aging is associated with modifications in the brain activity for metaphor comprehension, affecting the patterns of interhemispheric cooperation (Mejía-Constaín et al., 2010). About brain reorganization following pragmatic training, however, the literature offers only one single-case study of a patient with schizophrenia. In this study, the Cognitive Pragmatic Treatment produced functional changes at the cerebral level, affecting frontal and temporal regions which possibly support the behavioral improvements in pragmatic tasks (Gabbatore et al., 2017). Elucidating if pragmatic intervention is capable of inducing brain modifications in the complex, bilateral patterns supporting pragmatics would be of primary importance both for the study of aging and for the understanding of the neural underpinnings of pragmatics.

Despite its limitations, we believe that this study discloses promising evidence of the possibility of training pragmatic skills in aging. We also believe that the PragmaCom training, with the advantage – compared with the cognitive training – of being suited for all participants independently of their individual characteristics, might represent an effective treatment option to increase social communication and wellbeing in healthy and possibly pathological aging.

5

It is time to address language disorders in schizophrenia: Efficacy of a novel training targeting the pragmatics of communication (PragmaCom)

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Abstract

Language and communication disruptions in schizophrenia are at the center of a large body of investigation nowadays. Yet, the remediation of such disruptions is still at its infancy. This is to our knowledge the first study to target directly what is known to be one of the most damaged language domains in schizophrenia, namely pragmatics, with strict methodological criteria. Specifically, we tested the efficacy of a novel treatment addressing the pragmatics of communication (PragmaCom) in a randomized controlled trial involving 30 patients with schizophrenia assigned either to the experimental group or to an active control group. Relative to the control group, the PragmaCom group showed greater improvement in a global measure of pragmatic skills and in metaphor comprehension. The PragmaCom exerted beneficial effects also on abstract thinking. We hope that these findings could pave the way to further projects where communicative difficulties are remediated in order to improve illness outcome.

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5.1 Introduction

It is estimated that a large proportion of individuals affected by schizophrenia suffers from communicative difficulties that affect the level of language use in context, known as pragmatic language disorder, with the frequency of impairment around 70-80%, depending on the specific study and assessment tool (Bambini, Arcara, Bechi, et al., 2016b; Colle et al., 2013). Pragmatic difficulties manifest themselves in different forms. One is disrupted discourse and conversation, characterized by tangentiality and derailment, as reported since the first descriptions of the illness. For instance, a patient asked "What city are you from?" might answer "Well, that's a hard question to answer because my parents... I was born in Iowa, but I know that I'm white instead of black so apparently I came from the North somewhere and I don't know where, you know, I really don't know where my ancestors came from..." (Andreasen & Grove, 1986). Other problems surface when the language is not 'concrete' but rather figurative, that is, when words are not used in their literal meaning but point to abstract properties, such as in the case of metaphors and proverbs (Bambini, Arcara, Bosinelli, et al., 2020; Brüne & Bodenstein, 2005; Tavano et al., 2008). An example is offered by the case of a patient who, when required to explain the meaning of "The lawyer is a shark" replied that the lawyer swims very fast [Bambini, Arcara, Bosinelli, et al. (2020);]. Difficulties are documented also in other contextual uses of language, such as understanding humor and irony (Bosco et al., 2019; Daren et al., 2020; Rapp et al., 2013), as well as narrative texts and speech prosody (Lucarini et al., 2020). These aspects have been at the center of a considerable amount research in the last year with a variety of methods, from the use of both ad hoc (Langdon et al., 2002) and standardized tests (Bambini, Arcara, Bechi, et al., 2016b; Colle et al., 2013) to computational approaches (de Boer et al., 2020; Elvevåg et al., 2007). Moreover, neuroimaging studies have elucidated that pragmatic difficulties are linked to brain dysfunction, for instance in the recruitment of frontal regions during figurative language comprehension (Kircher et al., 2007; Mashal et al., 2013)

and in event-related potentials and alpha-band activity during discourse processing (Boudewyn et al., 2017). All this evidence suggests that pragmatic difficulties represent a core feature of schizophrenia, not simply resulting from symptoms or treatment and strongly tied to the disorder's underlying biology (Bambini, Arcara, Bechi, et al., 2016b).

Another important element that emerged from this growing literature is that pragmatic difficulties, far from being marginally relevant problems, have a profound impact on the individual's daily life. For instance, difficulties in speech coherence and informativity jeopardize the social functions of individuals with schizophrenia (Bowie & Harvey, 2008), whereas the inability to grasp sarcasm affects recreational functioning (Sparks et al., 2010). Pragmatics skills are globally related to quality of life and interpersonal relationships (Agostoni et al., 2021), and, among several pragmatic aspects, the ability to understand metaphors seems one of the strongest predictors of functioning as well as employment (Adamczyk et al., 2016; Bambini, Arcara, Bechi, et al., 2016b).

Despite being diffuse and impacting functioning, communication disorders are still almost absent from rehabilitative care. From the general point of view, rehabilitative intervention in schizophrenia has gone through different phases. A major turn in the field has been determined since mid-1990s with the introduction of a treatment approach that targets the cognitive impairment of schizophrenia, that is, cognitive remediation therapy (Wykes & Spaulding, 2011). Cognitive remediation rapidly diffused in the last decades, providing evidence that cognitive impairments could be remediated and – most importantly – produced meaningful benefits in terms of outcome. A further advance happened with the introduction of social cognition remediation, that is, treatment aimed directly at social cognitive deficits in schizophrenia (Kurtz et al., 2016a). Evidence has been cumulated that social cognition skills can be improved too, allowing for further benefit in terms of functioning, including work competence (Bechi et al., 2019).

Conversely, intervention programs targeting language and specifically pragmatics are still a niche research context. Joyal et al. (2016) reviewed 18 studies (from

1971 to 2012) that aimed at improving language. Studies employed a variety of approaches, from cognitive remediation to meta-learning, and mostly found a significant improvement in discourse or fluency. However, as the authors pointed out, there is a general lack of theoretical models in the literature, and the intervention programs did not focus on training pragmatic skills specifically.

More recently, a training based on Cognitive Pragmatics has been proposed for schizophrenia, based on 20 sessions devoted to promote different communicative skills, from conversational (i.e., turn-taking) to narrative abilities, including also non-linguistic skills such as theory of mind and planning (Bosco et al., 2016). This program produced benefits in pragmatic skills from pre to post test in a sample of 17 individuals with schizophrenia (Bosco et al., 2016), accompanied also by functional changes at the brain level as resulting from a single case (Gabbatore et al., 2017). Other ongoing studies are targeting gesture and promoting speech-gesture integration, which is expected to produce improvement in the pragmatics of communication at large (Riedl et al., 2020). Overall, these initial studies are encouraging, supporting the malleability of pragmatic processes in schizophrenia. There is, however, a dearth of data from pragmatics-centered program and randomized controlled trials.

The aim of the present study is to bring the field of language and communication remediation a step further, by testing the efficacy of a pragmatic training with strict methodological criteria. To pursue this aim we used a recent training program developed to address the pragmatics of communication (PragmaCom), based on Gricean model of communication and tailored to patients with schizophrenia, compared with an active control training in a randomized control trial. The Gricean model assumes that in communicative settings speakers cooperate by adhering to a set of conversational maxims regarding the quality, amount and manner of the information to provide. The maxims also serve as a heuristic to accommodate the interlocutor's behavior and infer implicit meanings. The basic strategy of the PragmaCom is to prompt participants to reason on the conversational maxims, starting from the analysis of short texts in which speakers fail to use them, leading

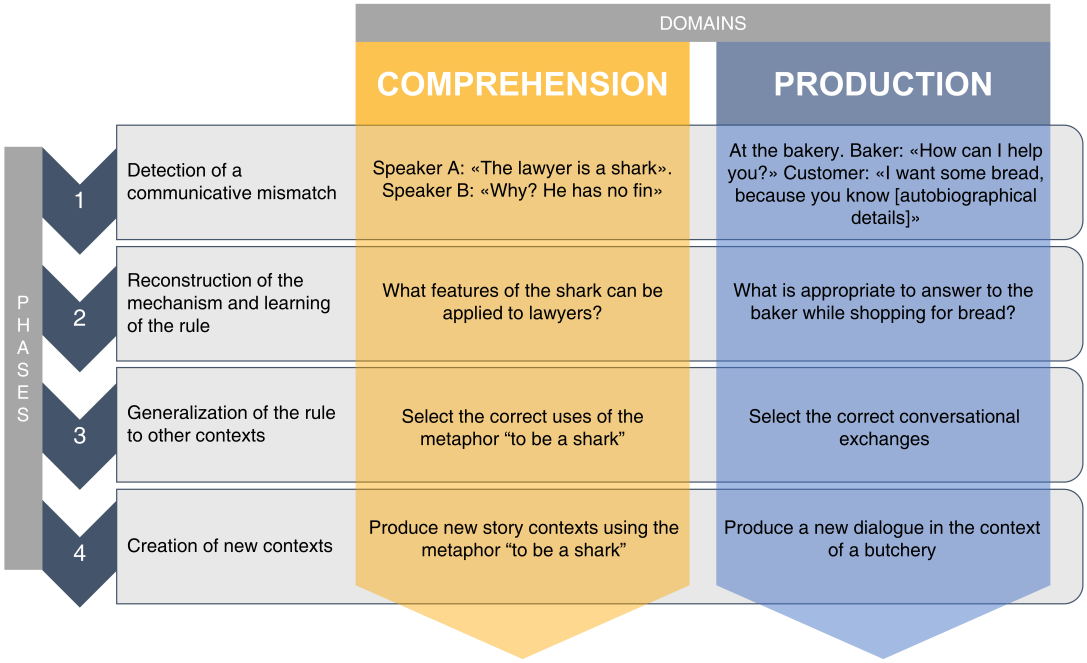

Figure 5.1: Structure of the items of the PragmaCom training program

to communication breakdowns such as the literal interpretation of a metaphor or off-topic speech. Exercises in the PragmaCom target both comprehension and production aspects (see Figure 5.1 for a schematic representation). Moreover, the training was enriched with ecological items, such as newspaper articles and videos.

To evaluate the training outcome, we used a global measure of pragmatic competence (the total score of Assessment of Pragmatic Abilities and Cognitive Substrates, APACS, test Arcara & Bambini, 2016b) and a more specific measure of pragmatic skills, consisting in a metaphor comprehension test for the assessment of metaphor comprehension via verbal explanation (the version for adults of the Physical and Mental Metaphors task, PMM; Lecce, Ronchi, et al., 2019a; Bambini, Tonini, et al., 2020). Furthermore, we were interested in testing generalization gains on a symptom closely related to pragmatics such as concretism, defined as the difficulty in abstract thinking (Bambini, Arcara, Bosinelli, et al., 2020; Harrow, 1974), and on functioning at large. Therefore, training outcome was evaluated also on a measure of abstract thinking (item N5 from the Positive and Negative Syndrome Scale for Schizophrenia, PANSS Kay et al., 1987) and of functioning

(Quality of Life Scale, QLS, Heinrichs et al., 1984). Since the PragmaCom addresses pragmatic skills directly, we expected to see improvements in APACS and in the PMM in patients who attended this program compared to participants engaged in the control training. Given the evidence of a link between pragmatics and abstract thinking (Bambini, Arcara, Bosinelli, et al., 2020), we expected that the benefits of the training would reduce concretism. We also expected an improvement in functioning, since pragmatics is an important predictor of patients' functional outcome (Agostoni et al., 2021).

5.2 Results

5.2.1 Participant characteristics at baseline

Demographic, clinical, cognitive, and functional measures stratified by groups (PragmaCom and active control) at the baseline are reported in Table 5.1. ANOVAs showed that the two groups did not differ at baseline for any of the measures.

5.2.2 Participant compliance to training

During the study, five patients (three in the PragmaCom and two in the active control group) dropped-out before the post-training assessment: one subject interrupted the rehabilitation program at the facility, three subjects withdrew from participation after the baseline evaluations, and one subject started a job before the post-training evaluations. The drop-out rate (16.6%) is in line with the average drop-out data for rehabilitation interventions (Villeneuve et al., 2010). As for the adherence to the treatment, the average percentage of attendance was 91.66% in the PragmaCom group and 76.92% in the active control group, showing a higher participation rate in patients who underwent the PragmaCom.

5.2.3 Training efficacy

Data on the performance on the outcome measures (i.e., pragmatic, psychopathological, and functional variables) stratified by groups (PragmaCom and active control)

Table 5.1: Participant characteristics at baseline

	Pragmacom	Active Control	Anova	
	M (*SD*)	*M* (*SD*)	*F*	*p*
Age (years)	40.87 (10.49)	44.00 (8.94)	0.77	.39
Education (years)	12.27 (2.74)	12.20 (1.97)	0.01	.94
Age at Onset (years)	22.93 (4.8)	24.60 (6.23)	0.26	.61
Sex (% male)	53.33	73.33	1.29	.25
Duration of illness (years)	17.93 (9.45)	19.40 (11.22)	1.49	.23
Chlorpromazine (equivalent doses)	408.94 (213.12)	481.71 (154.21)	1.12	.30
PANSS N5 Score	3.47 (1.13)	3.80 (1.66)	0.42	.52
BACS Executive Functions score	13.8 (4.88)	14.6 (4.91)	0.20	.65
Naming Task score	46.40 (1.72)	46.13 (1.96)	0.92	.35
Comprendo Task score	16.47 (2.26)	16.80 (3.41)	1.90	.18
APACS Total Score	0.82 (0.08)	0.80 (0.13)	0.10	.75
PMM Accuracy Score	11.80 (5.47)	11.40 (6.08)	0.19	.67
QLS Total Score	48.27 (12.4)	46.33 (20.47)	0.67	.42

Note:
The sample size for both the PragmaCom group and the Control group was 15. For the Sex variable, the result reported in the F column correspond to the Chi-square. PANSS = Positive And Negative Syndrome Scale for Schizophrenia; BACS = Brief Assessment for Cognition in Schizophrenia; APACS = Assessment of Pragmatic Abilities and Cognitive Substrates test; PMM = Physical and Mental Metaphors task; QLS = Quality of Life Scale.

after the training are reported in Table 5.2.

A series of ANCOVAs showed that the PragmaCom was effective in enhancing the performance in three out of four measures. The first ANCOVA showed that patients in the PragmaCom group significantly improved in global pragmatics compared to patients in the active control group, as revealed by the significant effect of treatment ($F(1,21) = 5.4$, $p = .03$) on APACS Total score. Results did not show a significant effect of the BACS Executive Functions covariate ($F = 1.05$, $p = .31$). The second ANCOVA showed a significant improvement of the ability to correctly interpret metaphors in the PragmaCom group, as revealed by the significant effect of treatment ($F(1,21) = 8.94$, $p = .007$) on PMM Total score. We found a significant effect of the BACS Executive Functions covariate ($F = 7.45$, p

Table 5.2: Outcome measures after the interventions, stratified by groups

	Pragmacom	Active Control
	M (SD)	M (SD)
APACS Total score	0.85 (0.07)	0.80 (0.12)
PMM Total score	16.58 (5)	12.77 (5.17)
PANSS N5 score	3.08 (0.90)	3.85 (1.68)
QLS Total score	51.83 (16.14)	49.08 (23.46)

Note:
APACS = Assessment of Pragmatic Abilities and Cognitive Substrates test; PMM = Physical and Mental Metaphors task; PANSS = Positive And Negative Syndrome Scale for Schizophrenia; QLS = Quality of Life Scale.

= .01). The third ANCOVA showed that patients in the PragmaCom significantly improved in abstract thinking compared to patients in the active control group, as revealed by the significant effect of treatment ($F(1,21) = 8.1$, $p = .01$) on PANSS N5 score. Results did not show a significant effect of the BACS Executive Functions covariate ($F = 0.73$, $p = .40$). Differing from the results of the three previous outcome measures, the fourth ANCOVA did not find a significant effect of treatment ($F = 1.2$, $p = .28$) on global daily functioning as measured by QLS. The BACS Executive Functions covariate did not yield a significant effect ($F = 0.82$, $p = .37$). The effects of the training are reported in Figure 5.2.

The magnitude of changes after the interventions (PragmaCom vs. active control) for APACS Total score, PMM Total score, PANSS N5 score, and QLS Total score is reported in Figure 5.3. Results of the gains from baseline to post-training in the PragmaCom group revealed a large effect size for the PMM Total score ($d = 0.77$) and effects sizes in the range of small-to-moderate for the other three measures (APACS Total score = 0.26; PANSS N5 score = 0.24; QLS Total score = 0.27). As for active control group, the effects were in the range of small-to-moderate for PMM Total score ($d = 0.30$) and negligible for the other measures (APACS Total score = 0.07; PANSS N5 score = 0.04; QLS Total score = 0.09).

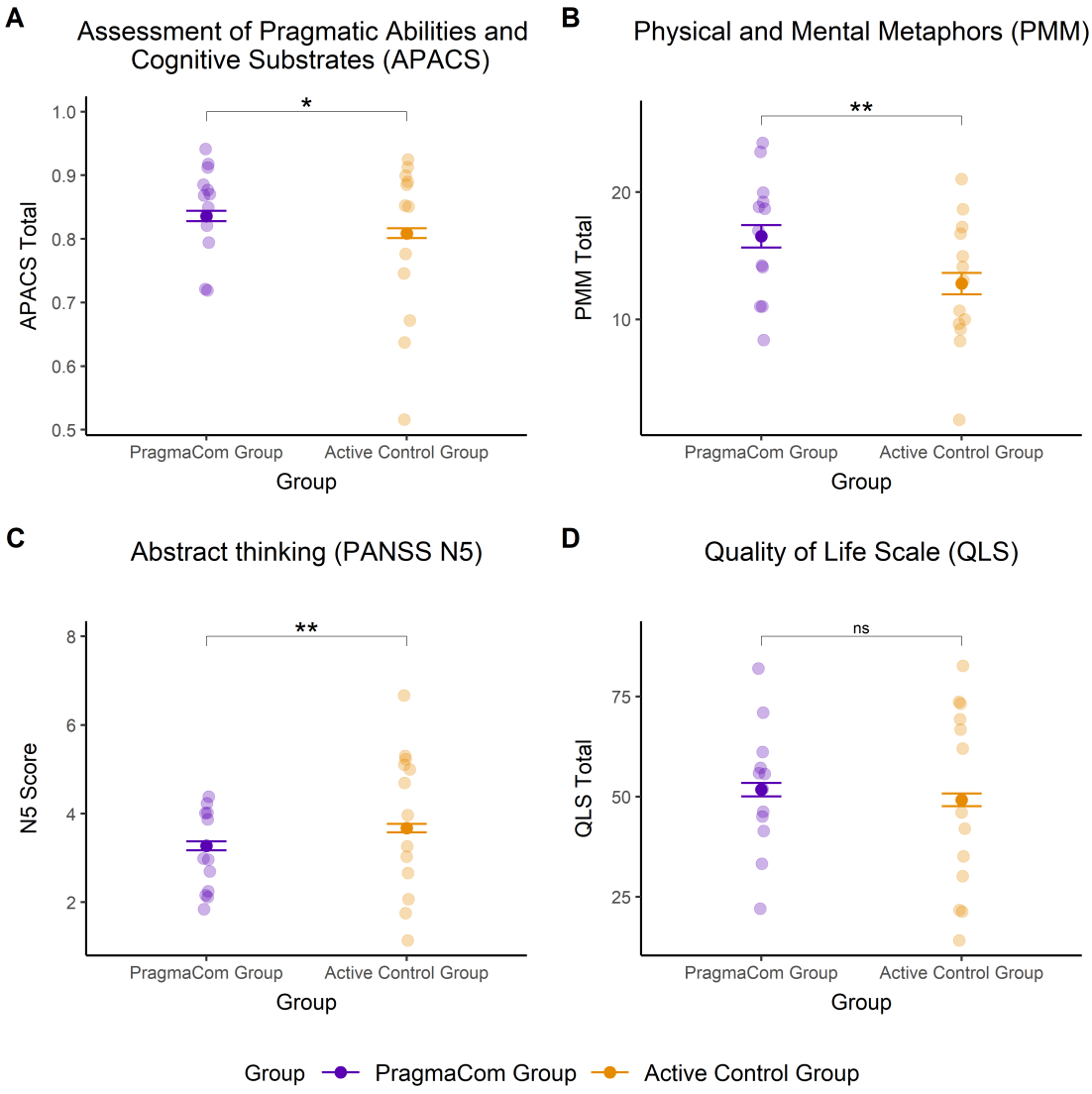

Figure 5.2: Scatterplot of the estimated marginal means for the PragmaCom Group and Active Control Group in the ANCOVAs on the four outcome measures. The figure shows the estimated marginal means for the ANCOVAs on the outcome measures (Assessment of Pragmatics Abilities and Cognitive Substrates, APACS, plot A; Physical and Mental Metaphor task, PMM, plot B; N5 item from the Positive And Negative Syndrome Scale for Schizophrenia, referring to abstract thinking abilities, plot C; Quality of Life Scale, QLS, plot D). In each plot, estimated marginal means of the two groups are represented by the bold dots; bars represent the standard error of the mean and light colored dots display the mean of the observed scores for each participant.

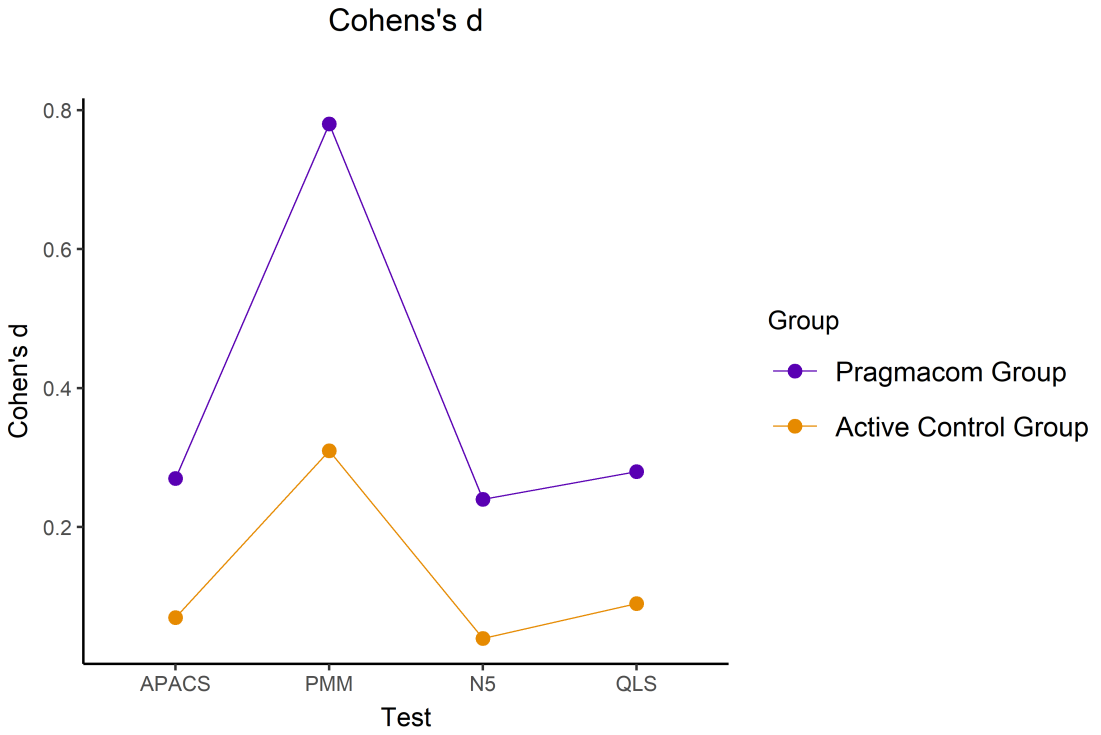

Figure 5.3: Effect size in the PragmaCom Group and the Active Control Group in the four outcome measures. APACS= Assessment of Pragmatic Abilities and Cognitive Substrates test; PMM= Physical and Mental Metaphors task; N5 = N5 item from the Positive and Negative Syndrome Scale for Schizophrenia; QLS= Quality of Life Scale.

5.3 Discussion

This study is, to our knowledge, the first to test a training program tailored to target the pragmatic difficulties of individuals with schizophrenia through a randomized controlled trial design. The results support the efficacy of the PragmaCom in improving the global pragmatic profile, as well as a specific pragmatic ability such as metaphor comprehension and the related symptom of concretism. The effect size of the improvements ranged from small-to-moderate to large, in line with those observed in social cognition intervention, which vary depending on the specific aspect under consideration 23. This generally positive pattern of results suggests that communicative skills can be improved through a pragmatics-centered intervention, and that the benefits might extend to specific psychopathological features.

Starting with the improvement in the two pragmatic measures, that is, the general pragmatic profile and the ability to understand metaphors, our positive

results are in line with our expectations and are also consistent with previous initial evidence on the malleability of pragmatic skills (Bosco et al., 2016; Gabbatore et al., 2017). Compared to the previous literature, we offer stronger evidence of the efficacy of an intervention focused on pragmatics, tested against a control group in a randomized controlled design. The efficacy of the PragmaCom program can be traced back to its theoretical grounds and its emphasis on core pragmatic mechanisms. As observed in the field of social cognition treatment, those programs that focus on broad cognitive skills and their underlying mechanisms rather than on specific skills and activities are likely to exert greater benefits (Fiszdon & Davidson, 2019).The exercises included in the PragmaCom stimulate general pragmatic mechanisms, via reasoning upon the rules of conversation and the consequences of their violation. In a nutshell, the PragmaCom presents participants with communicative exchanges where someone fails in using the conversational maxims (being for instance concrete in interpreting a non-literal statement or over-informative in dialogues), thus stimulating awareness on communicative dynamics. The focus on core underlying pragmatic mechanisms allows improvements at multiple levels.

The training effect on metaphor comprehension is especially encouraging. Performance in the metaphor verbal explanation task improved at a large effect size ($d = 0.77$), suggesting that the approach used in the PragmaCom is very beneficial in promoting the ability to retrieve the link between a metaphor's topic and vehicle, presumably because it touches upon the inferential machinery underlying metaphor understanding. The effect size of the improvement in the general pragmatic profile was, however, smaller ($d = 0.26$) than the one in metaphor comprehension. To make sense of this difference in outcome, it is important to highlight that the global pragmatic measure included expressive aspects: indeed, the APACS test encompasses the evaluation of discourse production and scene descriptions. It is possible that the PragmaCom is more effective in improving receptive rather than expressive pragmatic skills, due to its focus on inferential mechanisms. Production, conversely, requires also social adjustment aspects that are not directly addressed in the PragmaCom. In line with this explanation, a previous study using the

PragmaCom to train pragmatic skills in older adults also reported more robust improvement in metaphor understanding than in discourse production (Bambini, Tonini, et al., 2020). It might also be that the APACS test is a too coarse-grained measure of pragmatic production to reveal training-induced changes: in line with this idea, previous studies reporting improvement in expressive pragmatic aspects used other kinds of measures, more focused on the evaluation of speech (Joyal et al., 2016). In sum, the smaller magnitude of the effect size observed for the global pragmatic measure might be due to the global nature of the measure used (i.e., the APACS test), which includes aspects that might either be not strongly potentiated by the PragmaCom or not finely grained evaluated in the test itself.

Related to the improvement in metaphor comprehension, and of great clinical relevance, is the positive effect observed in the abstract thinking index. The N5 item of the PANSS evaluates impairments in the ability to form classifications and generalizations, based on similarities and proverbs. After the PragmaCom, patients improved in this measure, showing a reduced concrete mode of thinking. This is indicative of an important transfer gain of the PragmaCom. It is interesting to consider that, as illustrated in a recent meta-analysis (Kurtz et al., 2016b), social cognitive training program are known to exert significant effects on negative symptoms (whereas the gain on positive symptoms is less reliable). Our findings are compatible with this literature, in that also a training the focuses on communication such as the PragmaCom has a positive effect on a specific negative symptom such as concretism. The size of such effect is small-to-moderate, in line with the reported effects of social cognitive training on negative symptoms ($d = 0.32$ based on 10 studies in the meta-analysis, Kurtz et al., 2016b). This finding also points to the close link between abstract thinking and pragmatics, supporting the view (Bambini, Arcara, Bosinelli, et al., 2020) that concretism and the impairment in the pragmatic ability to infer the figurative meaning of non-literal expressions figurative language are two sides of the same coin, with the latter reflecting a psychopathological dimension and the former grasping the linguistic manifestation of the symptom.

Different from the previous outcome measures, the domain of quality of life did not show any improvement following the PragmaCom. On the one hand, this is in contrast with our expectations. Given the evidence that pragmatics affects functioning, with a key role in mediating the impact of cognition on the functional outcome, we expected that remediating pragmatic difficulties could have positive effect on the functional outcome. On the other hand, it must be pointed out that the time of the post-test was probably too close to the training to show effects on real-world activities. Previous literature in the field of cognitive remediation highlighted that transfer effects to daily functioning and measures such as work outcomes were greater in studies with longer rather than shorter follow-up, possibly because transfer to real-world indices requires time and opportunities to practice the restored skills and for other people to adapt to such changes (Bosia et al., 2007; Bowie et al., 2012; Cavallaro et al., 2009). Here the post-training assessment happened immediately after the treatment, whereas transfer of pragmatic gains to everyday activities presumably becomes visible after a longer time, as to allow for the changes in the communicative abilities to impact the relationships with others as well as personal autonomy.

Besides efficacy, it is important to spend a few words on the feasibility of the PragmaCom program. The PragmaCom is a novel training, till now tested only in older adults. Here the materials were optimized for what concerned complexity, duration and intensity, taking into account the pragmatic as well as the cognitive profile of individuals with schizophrenia and following the design adopted in previous effective socio-cognitive interventions (Bechi et al., 2012). The experience with the schizophrenia-tailored PragmaCom was positive, in that it revealed an active participation and a good adherence to treatment. The fact that the PragmaCom is a relatively brief, easy to implement, and low-cost therapy contribute to its feasibility.

Before discussing the possible implications of the PragmaCom, it is important to acknowledge the limitations of this study, which should be taken into account in

future studies. First, as mentioned above, we did not include a longitudinal follow-up assessment, which prevents us from evaluating the durability of the benefits, especially in terms of functioning and quality of life. Second, the sample is small. Second, albeit the effect sizes are in line with the literature, the sample was rather small. Larger samples are needed to determine the reliability of the effects. Third, we did not consider social cognition in the outcome measures. Given the strong link between pragmatics and social cognition (Bambini, Arcara, Bechi, et al., 2016b; Champagne-Lavau & Stip, 2010; Parola et al., 2018), it would be relevant to test whether communicative intervention can transfer to social cognition.

Despite the only moderate success in terms of magnitude of the effects and the lack of impact on functioning in the short term, the results of this study are encouraging concerning the efficacy of the PragmaCom and the malleability of pragmatics. In this light, the efforts to directly address pragmatics with the PragmaCom appear to be worth pursuing, for two main reasons. First, pragmatics supports a range of key functions in everyday life and social interaction, from the ability to engage in a conversation to the capacity of grasping the implicit nuances in a conversation and laugh at others' remark, with large impact on functioning. The pragmatic domain, thus, cannot remain ignored by rehabilitation. Second, the PragmaCom appears as a feasible, brief, low-cost intervention, that could be easily implemented in the clinical settings with a short standardized training for the therapists. The hope is that the findings of this study could contribute to bring communicative intervention from the niche to the center of therapeutic efforts.

5.4 Materials e Methods

5.4.1 Participants

Thirty patients affected by schizophrenia according to DSM 5 criteria (American Psychiatric Association, 2013) were recruited from the Department of Clinical Neurosciences, IRCCS San Raffaele Scientific Institute, Milan, Italy. All participants were Italian native speakers. Exclusion criteria were: severe traumatic brain injury

or neurological disorders, mental retardation, alcohol or substance abuse in the preceding 6 months, severe psychotic acutization in the preceding 3 months.

The protocol was approved by the local Ethical Committee, following the principles of the Declaration of Helsinki, and all subjects provided informed consent.

5.4.2 Study design

This is a prospective, randomized, single-blinded, monocentric study. Participants were randomly allocated either to the training aimed at enhancing pragmatics (PragmaCom group) or to the active control group. Both interventions consisted in 13 sessions, lasting about 40 minutes each, once a week. The work groups were made up of four/five individuals.

All patients were evaluated at the baseline for the outcome measures (i.e., global pragmatic skills and metaphor comprehension, psychopathology, and daily functioning) as well as for linguistic and cognitive abilities. After the training, patients were re-assessed for the outcome measures.

Since the study is single-blinded, examiners who administered pre- and post-training assessment were not allowed to know which treatment patients received.

5.4.3 Assessment

5.4.3.1 Outcome measures

Pragmatic abilities were evaluated with the Assessment of Pragmatic Abilities and Cognitive Substrates test (APACS; Arcara & Bambini, 2016b) and, as a more fine-grained measure of receptive pragmatic skills, with the Physical and Mental Metaphors task (PMM; Lecce, Ronchi, et al., 2019a; Bambini, Tonini, et al., 2020).

APACS is a validated tool to assess pragmatic skills in Italian, evaluating both production and comprehension domains through six tasks:

- Interview, evaluating the ability of engaging conversation through a semi-structured interview on autobiographical topics. Communication difficulties at the contextual-pragmatic level were evaluated (always/sometimes/never) and then converted into

scores (0/1/2 score, respectively); - Description, assessing the ability of producing and sharing informative descriptions of everyday situations. The identification of each salient element in each picture was evaluated (0/1/2 score for missed, partially correct or correct identifications); - Narratives, measuring the ability to understand the main aspects of a narrative text. Subjects were asked comprehension questions on discourse and pragmatic contents (0/1 or 0/1/2 score); - Figurative Language 1, evaluating the ability to infer non-literal meanings of idioms, metaphors, and proverbs through multiple-choice questions (0/1 score); - Humor, measuring the ability to comprehend verbal humor, by selecting the best punch-line of a story through multiple choice questions (0/1 score); - Figurative Language 2, assessing the ability to infer non-literal meanings of idioms, metaphors, and proverbs through verbal explanation. Scores were calculated for accuracy (0/1/2 score for wrong, partially correct or correct interpretations).

The following composite scores are obtained by calculating proportions of the original task scores and averaging these proportions: Pragmatic Production score, derived from the Interview and the Description tasks, Pragmatic Comprehension, derived from the remaining tasks, and APACS Total score, calculated by averaging Pragmatic Production and Pragmatic Comprehension scores. The variable of interest in this study was the APACS Total score, as it evaluates the global pragmatic functioning.

The Physical and Mental Metaphors task (PMM task) evaluates the ability to understand metaphors by requesting to explain the meaning of 14 novel metaphors, divided into physical and mental. Specifically, mental metaphors require an inference about mental states of metaphor's topic (e.g., *Adolescents are pendulum-clocks*), while physical ones involve inferences on physical features or behaviors of the topic (e.g., *Lifeguards are lizards*). Each answer is scored for accuracy, assessing the subject's ability to understand and articulate the link between the metaphor's topic and vehicle, on a 0/1/2 scale (0 for incorrect answers, 1 for incomplete responses, 2 for correct metaphor interpretations). The variable of

interest in this study was the PMM Total Accuracy score, assessing the metaphor comprehension skill for all types of metaphors.

Psychopathology was assessed with the Positive and Negative Syndrome Scale for Schizophrenia (PANSS; Kay et al., 1987). PANSS is a standardized measurement for typological and dimensional symptoms evaluation. It includes 30 items, divided into three subscales, assessing positive symptoms, negative symptoms and general psychopathology, respectively. A global measure of illness severity can be derived from the sum of the three subscales (PANSS Total score). According to the aim of the study, the variable of interest was PANSS N5 score, which is a measure of the deficit in abstract thinking.

Daily functioning was evaluated with the Quality of Life Scale (QLS; Heinrichs et al., 1984), a semi-structured interview assessing the capacity to establish and maintain social relationships, to obtain and maintain a job, to study and to collaborate in everyday housework and personal autonomy. QLS Total score is then calculated by summing all the items. The variable of interest in this study was QLS Total score, evaluating the evaluating global daily functioning.

5.4.4 Linguistic and cognitive measures

Linguistic abilities were evaluated with the Naming of Colored Photographs Task (Catricalà et al., 2013) and with the Comprendo Task (Cecchetto et al., 2012).

The Naming Task evaluates the vocabulary abilities and belongs to a broader battery for the assessment of semantic memory disorders. Participants were asked to name 48 stimuli, belonging to both living and non-living categories.

The Comprendo Task provides a measure of grammatical competence in Italian, by evaluating sentence comprehension across different syntactic structure types. We selected subtasks 4 and 5, which included sentences with embedded relative clauses bound either to the subject or to the object.

Cognitive abilities were assessed with the Brief Assessment of Cognition in Schizophrenia (BACS; Keefe et al., 2004; Anselmetti et al., 2008). The battery

evaluates those cognitive domains that are usually impaired in schizophrenia: verbal memory (words recall subtest), working memory (digit sequencing subtest), psychomotor speed and coordination (token motor task subtest), processing speed (symbol coding subtest), verbal fluency (production of words after semantic and literal cue subtest), and executive functions (Tower of London subtest). Raw scores of each BACS subtest were adjusted for age and education. From adjusted scores, equivalent scores were derived, based on normative values for the Italian population (Anselmetti et al., 2008). Equivalent scores are ranked into a 5-point interval scale (0 for pathological performance, 1 for borderline performance, 2/3 'normal' performance, 4 for better than the median performance). The variable of interest of this study was BACS Executive Functions score.

5.4.5 Interventions

5.4.5.1 The PragmaCom program

The PragmaCom is a training program addressing communicative-pragmatic skills and based on the model of communication proposed by H. P. Grice (Grice, 1975), built around the idea of a series of conversational rules (i.e., maxims) that guide speaker's behavior and inferential processes. The main strategy in the PragmaCom is to guide participants in the analysis of communicative mismatches, presented in short texts (e.g., stories, dialogues, newspaper articles), that arise from the violation of such maxims, in order to prompt the reasoning about the pragmatic mechanisms at play. The PragmaCom includes two types of exercises: one type is focused on pragmatic comprehension and addresses in particular the understanding of figurative language (metaphors, idioms and proverbs); the other type is focused on pragmatic production and is centered on the application of the Maxims of Quantity (overinformativity and underinformativity) and Relation (tangentiality and derailment).

Every exercise consists of four phases (Figure 5.1 provides examples for each phase): the first phase is dedicated to the detection of a communicative mismatch;

the second to the reconstruction of the mechanism needed to understand a figurative expression or to produce the appropriate speech; the third aims at prompting generalization, by extending the rule to other contexts; and the fourth and final phase asks the participant to actively formulate new contexts using the expression learned or applying the learned rules about the Maxims.

5.4.5.2 Active control intervention

Patients assigned to the control condition were engaged in a newspaper discussion group, as used in previous studies 48. After reading newspaper articles about recent local and political issues, patients were asked to summarize the most important information from articles and encouraged to express their opinions on the topics emerging from the articles. The main goal of this training was to improve basic cognitive functions such as working memory and selective attention and to reduce speech blockage and promoting social interaction. No focus, however, was placed on the rules of conversation or pragmatic inferential aspects.

5.4.5.3 Statistical analyses

A series of analyses of variance (ANOVA) was performed on demographic, pragmatic, linguistic, cognitive, clinical, and functional variables, in order to evaluate differences between groups (PragmaCom vs. active control) at the baseline. Chi square test was used for dichotomous variables.

The effect of the PragmaCom in enhancing pragmatic abilities, abstract thinking, and daily functioning was tested between groups by means of different ANCOVAs. We entered post-training measures as dependent variables, measures at the baseline as covariate, and treatment (PragmaCom vs. active control) as grouping variable. Compared to two-way ANOVA with Time as within-subject and Group as between-subject factors, this approach has the advantage of controlling for baseline invariance and regression to the mean, and has been used in several training studies involving individuals with schizophrenia (Buonocore et al., 2015; Moritz et al., 2011). Moreover, based on studies suggesting a correlation between executive

functions and pragmatic abilities (Champagne-Lavau & Stip, 2010; Mossaheb et al., 2014; Pesciarelli et al., 2014; Sponheim, 2003), we also included BACS Executive Functions score as covariate in all ANCOVA models.

Specifically, in the first model we entered APACS Total score after the training as dependent variables, APACS Total score and BACS Executive Functions score at the baseline as covariates, and treatment as grouping variable. In the second model, we entered PMM Total score after the training as dependent variables, PMM Total score and BACS Executive Functions score at the baseline as covariates, and treatment as grouping variable. In the third model, we entered PANSS N5 score after the training as dependent variables, PANSS N5 score and BACS Executive Functions score at the baseline as covariates, and treatment as grouping variable. Lastly, in the fourth model, we entered QLS Total score after the training as dependent variables, QLS Total score and BACS Executive Functions score at the baseline as covariates, and treatment as grouping variable.

Finally, to quantify the magnitude of changes after the interventions, effect sizes were estimated using Cohen's d (Cohen, 2013) for APACS Total score, PMM Total score, PANSS N5 score, and QLS Total score in both groups (PragmaCom vs. active control).

Analyses were performed with STATISTICA Software for Windows, version 8 (StatSoft Inc., Tulsa, OK, USA).

Conclusion

This thesis presents four studies on the investigation of pragmatic skills and on the development of new pragmatics-centered training programs for typically developing children, healthy older adults and patients with schizophrenia. In addition, this work includes a short contribution explaining the mechanisms involved in metaphor comprehension to a readership of very young scientists.

The first study (Chapter 1) investigated the relationship between Theory of Mind (ToM) and metaphor comprehension in middle childhood in two different metaphor tasks, and showed that the relationship between the two constructs investigated changes during development and according to the task. This suggests that metaphor comprehension strategies change with age, confirming the results of previous studies (Carriedo et al., 2016; Prat et al., 2012), and that tasks with different demands and properties can lead to different results, showing changes in the involvement of ToM when processing metaphor.

The second study (Chapter 2) shows that it is possible to train metaphor comprehension in children of 9 years of age, by focusing on exercises that address this skill directly, via inferential and context-directed exercises, as implemented in the MetaCom training program. Moreover, this study proves that stimulating metaphor comprehension leads to improvements in general reading skills.

The third study (Chapter 4) addressed healthy aging and investigated the possibility to train pragmatic abilities both with a specific training and with a more general cognitive training. Results showed older adults' metaphor comprehension and off-topic verbosity tendency can improve and that both training programs helped to reach this aim. An additional investigation of individual differences in age, baseline abilities and verbal skills as predictors of training outcomes showed that the cognitive training was prone to magnify the abilities of the most skilled participants, while the PragmaCom training was inclined to lead to more generalized benefits, independently from participants' baseline cognitive level.

The fourth and last study (Chapter 5) tested with positive results the efficacy of the PragmaCom in training pragmatic abilities in patients with schizophrenia. Improvements were observed both in a general measure of pragmatic competence (APACS; Arcara & Bambini, 2016a), and in specific measures of metaphor comprehension (PMM; Bambini, Tonini, et al., 2020), and abstract thinking (N5 subscale of the PANSS battery; Kay et al., 1987). No improvements were found in quality of life, but we argued that it might take more time and experience outside the hospital to see changes in this particular area.

The main aims of this thesis were to provide new insights in metaphor comprehension and pragmatic mechanisms generally speaking, and to fill the gap in the literature of pragmatic training programs, creating effective programs for typically developing children, healthy older adults and patients with schizophrenia.

Regarding the first aim, both the experimental study (Chapter 1) and the training studies (Chapter 2, 4, and 5) seem to confirm the importance of using contextualized items in order to investigate and restore metaphor comprehension mechanisms and pragmatic abilities in general. Metaphorical items embedded in context are indeed more ecological and, therefore, allow to analyze comprehension mechanisms as they take place in everyday life. In the first study presented in this thesis, for instance, the presence or absence of context affected the involvement of ToM skills in metaphor comprehension. Therefore, it might be argued that studies presenting children with metaphors in isolation resemble only partially how the process normally occurs, leading to results that do not fully reflect the functioning of the mechanisms at play in everyday life. In the training studies, analyzing the information extracted and inferred from the given contexts allowed participants to better understand the meaning of the metaphorical expression in exam and the appropriateness or inappropriateness of the speech produced.

In the case of metaphorical expressions, as Wilson and Carston (2007) explain, context helps understanding processes because it helps form pragmatic expectations which influence the mechanisms at the basis of pragmatic comprehension: lexical

narrowing (i.e., restricting the denotation of a word) and broadening (i.e., expanding the denotation of a word). Giving information about what directions narrowing and broadening processes should take, context can facilitate comprehension. When no context is provided, the plausible meanings for words and phrases are multiple (there is not much information that can guide the narrowing process), and the listener/ reader is forced to make extra effort to try to understand what the intentions of the speaker/ writer are. This may be the reason why ToM is involved in metaphor comprehension also in older children when metaphors are presented in minimal context (effect of ToM on the Physical and Mental Metaphors task scores in children of age 9 and 10), compared to when a rich context is provided (effect of ToM on the Referential task scores in children of age 8 and 9) (Chapter 1).

Moreover, the results of these studies point to the general conclusion that pragmatic skills rely on different strategies according to the life phase and the resources available at that time. This confirms the findings of those studies investigating the role of cognitive variables in metaphor understanding (Carriedo et al., 2016; Prat et al., 2012), showing a change in comprehension strategies between children and adults and according to individual differences in cognitive capacities. In Chapter 1, I showed that it is possible to see strategy differences even between age groups in middle childhood, which might be connected with a developmental step in metaphor comprehension observed at this age (Deckert et al., 2019; Willinger et al., 2019). Furthermore, the study on the metaphor training program for 9-year-old children (MetaCOm; Chapter 2), proved that this developmental shift can be accelerated, teaching children more efficient strategies to understand metaphors.

Continuing with the evidence that comprehension strategies change during the life span, the training study on older adults showed that training cognitive abilities is helpful to improve pragmatics, suggesting that pragmatics in this phase of life may rely on abilities such as memory and executive functions. Nevertheless, a training targeting pragmatic abilities specifically, as the PragmaCom presented in

Chapter 4, can offer an alternative strategy that can lead to improvements independently from the baseline cognitive level of participants. This hints to the hypothesis that pragmatic skills are supported by but not reducible to cognitive abilities.

In the future it would be interesting to investigate more in detail these differences across the life span using the same or equivalent tests for children and adults in order to compare results, including cognitive abilities and ToM for all samples in order to disentangle the role of each component in the different phases of life.

Commenting on the second aim of this thesis, the metaphor training for children (MetaCom) and the pragmatic training for adults (PragmaCom), proved to be effective. Importantly, results showed that the benefits of the pragmatic training programs extended also to other domains. In children, improvements in metaphor understanding and paraphrasing where associated to improvements of reading comprehension generally speaking. In patients with schizophrenia, besides a better performance in pragmatic tasks, also higher scores in abstraction measures where observed. To the best of my knowledge, the pragmatic training studies presented in this thesis are the first to bring evidence of transfer effects to other abilities, and this is a very important aspect that should be taken in consideration. Indeed, as recently Weng et al. (2019) pointed out, "explore transfer effects in cognitive [and socio-cognitive] training is meaningful and imperative". This can lead to extended benefits and improvements with relatively little effort and time consumption, which is very important especially for patients, who might easily experience fatigue.

In a nutshell, this thesis offers new insights on the mechanisms involved in metaphor comprehension in development and in pragmatic abilities generally speaking in healthy older adults and in patients with schizophrenia. Moreover, it provides teachers and clinicians with new effective tools to train pragmatic abilities in different types of populations, from childhood to old age, passing through pathological populations. The training programs presented in this work are different and they rely on different strategies for children and adults. Yet, they are all grounded on strong theoretical basis on the functioning of inferential communication as proposed by the Gricean and Relevance-Theoretic tradition. This is particularly important

since very few tools are available nowadays to train pragmatic skills, and most of them are not supported by theoretical basis or empirical studies confirming their effectiveness. This thesis was developed with the aim to address this gap in literature, being that these communicative aspects have an important role in social functioning and quality of life at large.

Appendices

A

Appendix A (Supplementary meterial for Chapter 2)

Table of contents: - A.1. Assessment Materials: a detailed description of the tests used to assess the control measures chosen for this study.

- A.2. Characteristics of the items of the Physical and Mental Metaphors task: contains a table with the characteristics of the items used in the modified version of the 12-item Physical and Mental Metaphors task (Del Sette et al., 2020; based on the original version of Lecce, Ronchi, et al., 2019b) used in this study.

- A.3. Training item example: contains the English translation of one of the double items used in the training, as an example of the structure of the items.

A.1 Assessment materials (control measures).

Family Affluence Scale: This short multiple-choice questionnaire, translated from the English version of Boyce et al. (2006), provides a score (total score range: 0-9) of the socioeconomic status of children's families. It investigates the quantity of cars and tablets/computers children's families own, whether children have their own unshared room, and how many times they went on vacation in the previous year.

Test for Reception Of Grammar-Version 2: We used the Italian version of Suraniti et al. (2009). This tool consists of a sentence-picture matching task evaluating the understanding of grammatical structures, and includes 80 items divided into 20 blocks, each addressing a specific grammatical structure. For time constraint issues, we used only a subset of four blocks, selected to include different difficulty levels for children aged 9, based on data in the literature (Edwards et al., 2011): blocks G (subject relative clause), K (reversible passive), R (singular/plural

inflection), and S (object relative clause). In order to administer the test collectively, the examiner orally presented the sentence and children were asked to mark their choice on a printed booklet (total score range: 0-16).

Peabody Picture Vocabulary Test-Revised: We used the Italian version of Stella et al. (2000). In this test, children are involved in a word-picture matching task assessing their receptive vocabulary knowledge. The starting point of the test is determined based on the child's age, going backward if the child does not provide eight consecutive correct answers. In order to administer this test collectively, we selected a range of 65 items, starting 20 items before the item identified as the starting point for age 9 (i.e., item 70). The examiner orally presented a list of words one at a time and children were asked to mark their choice on their booklet. The final score was calculated according to the test manual (total score range: 50-115).

Digit-span Backward: This working memory task was taken from the Italian version of the Wechsler Intelligence Scale for Children - Revised (Orsini, 1993). Participants were asked to repeat in reverse order seven sequences of digits listed by the examiner. The length of the series ranges from two to eight digits, presented ordinately, starting with the shortest sequence and ending with the longest (total score range: 0-7).

A.2 Characteristics of the items of the Physical and Mental Metaphors task

[H]

Table A.1: Characteristics of the items of the Physical and Mental Metaphors task

Source	Metaphor	English literal translation	Familiarity	Physical score	Mental score	Aptness	Frequency
Physical set							
Del Sette et al. (2020)	Gli scalatori sono scoiattoli	Climbers are squirrels	3.11	5.68	1.43	4.64	75.39
Del Sette et al. (2020)	Le ballerine sono farfalle	Dancers are butterflies	5.00	5.90	1.63	5.32	96.23
Del Sette et al. (2020)	I giocatori sono elefanti	Players are elephants	2.80	4.58	1.68	2.84	85.88
Del Sette et al. (2020)	Il cuoco è una botte	The cook is a barrel	4.24	5.84	1.44	4.76	16.12
New	Quella sposa è una nuvola	That bride is a cloud	3.68	5.58	1.96	4.00	208.48
New	Quel pugile è un panda	That boxer is a panda	2.42	4.67	1.33	2.79	8.48
Mental set							
Del Sette et al. (2020)	I soldati sono leoni	Soldiers are lions	3.07	3.36	4.50	3.75	158.83
Del Sette et al. (2020)	Il papà è un vulcano	Dad is a volcano	4.14	4.32	4.96	4.57	24.83
Del Sette et al. (2020)	La maestra è un ghiacciolo	The teacher is an icicle	4.08	3.42	4.52	4.32	5.10
Del Sette et al. (2020)	La nonna è una colonna	My grandmother is a column	4.16	2.88	5.56	4.80	27.98
Del Sette et al. (2020)	Quellalunno è una spugna	That pupil is a sponge	5.25	2.46	5.68	5.17	15.23
New	Le mamme sono agende	Moms are agendas	3.57	3.61	5.07	4.32	0.00

A.3 Training item example

TO BE A BEAR

STORY A)

Marcello is very happy because he is going to the aquatic park together with Luca and his father. When they arrive next to the swimming pool, Marcello is looking forward to dipping into the water. While they are taking their clothes off, the boy is surprised when Luca's father takes his t-shirt and his hat off. He says: "Luca, your dad is a bear!". "Yes, he is!" Luca answers.

1. What could Luca's father and a bear have in common?

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2. In the story, Marcello tells Luca that his dad is a bear. What does it mean?

    a. That Luca's dad has lots of hairs all over his body.
    b. That Luca's dad is an animal that lives in mountains.
    c. That Luca's dad is always busy because he works a lot.

3. Why does Marcello say that?

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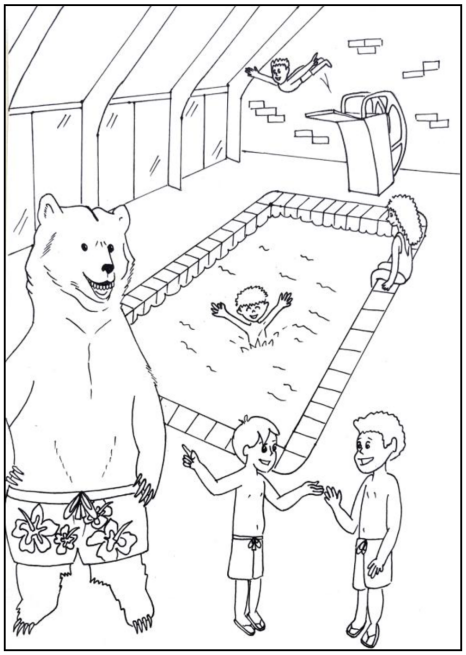
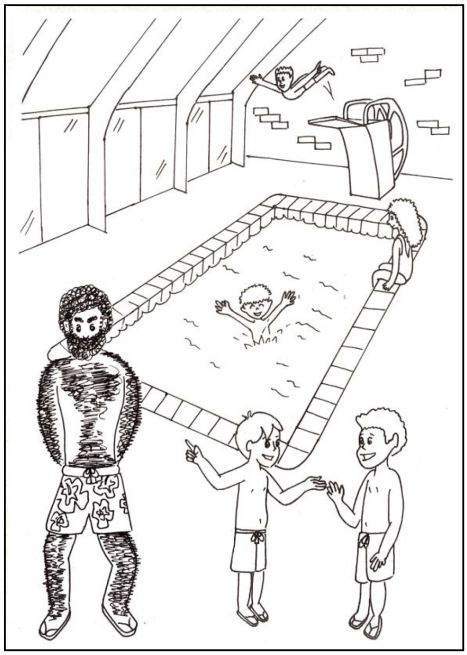
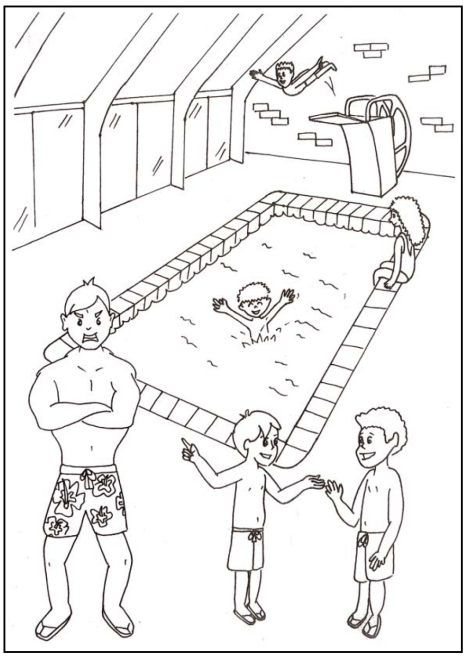
4. Look at the following pictures and choose the one that according to you is most suitable to represent the story you read.







5. Now you will read a series of 4 words, as for example:

   apple – pear – knife – cheek

   your task is to create metaphors combining these words and explain why the words you chose could create a metaphor, in this way:

   1) cheek 2) apple - because a cheek can be round and red like an apple.

   Now try to do the same thing with these words:

   bear – honey – highlander – bee

   Write down the metaphors you can create.

   1)_____ 2)_____ because_____
   _____
   1)_____ 2)_____ because_____
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   1)_____ 2)_____ because_____
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   1)_____ 2)_____ because_____
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6. Has it ever happened to you to use the bear metaphor to say that someone is hairy or to hear someone using it? If yes, tell us this episode. Otherwise, invent a story in which the characters use this metaphor.

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STORY B)

When Giovanni gets out from school, his mom tells him: “Giovanni, I have a surprise for you! I’ll take you to park and also your friend Greta will be there. You 2 can play together!”. Giovanni yells at her saying: “No, i don’t want to go to the park! I want to go home and finish my puzzle all by myself, in peace, without anybody disturbing me!”

“Oh Giovanni, you are a bear! Let’s go to the park to play with other children!” says again his mom.

1. What do Giovanni and a bear have in common?

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2. In the story, Giovanni’s mom tells him that he is a bear. What does it mean?

    a. That Giovanni is an animal which lives in mountains
    b. That Giovanni is grumpy and he prefers playing by himself
    c. That Giovanni should study more

3. Why does Giovanni’s mom say that?

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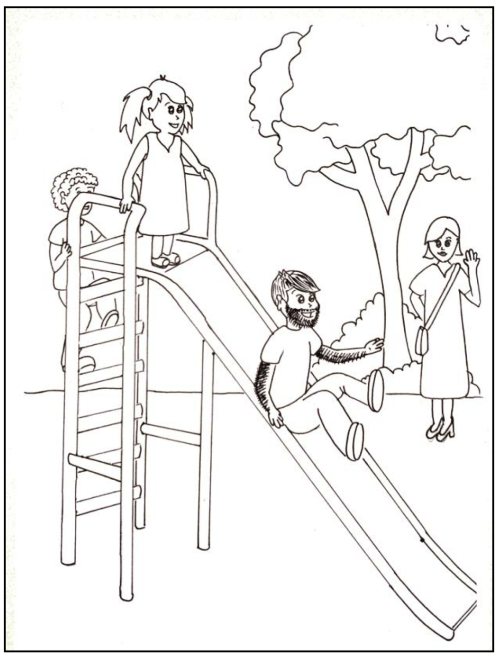
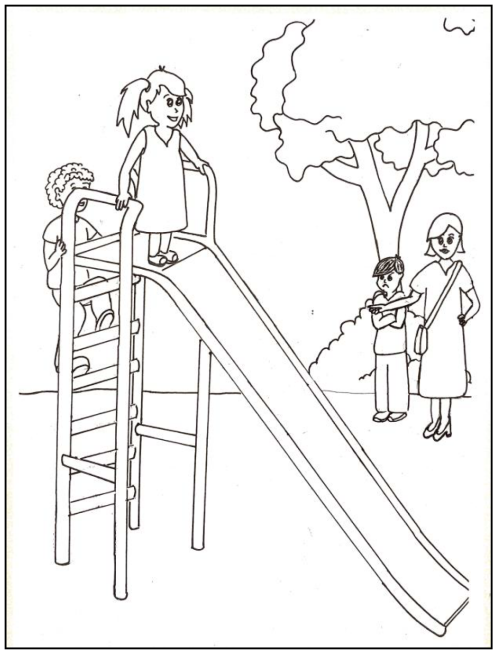
4. Look at the following pictures and choose the one that according to you is most suitable to represent the story you read.





5. Now you will read a series of 4 words, as for example:

   apple – pear – knife – cheek

   your task is to create metaphors combining these words and explain why the words you chose could create a metaphor, in this way:

   1) cheek 2) apple - because a cheek can be round and red like an apple.

   Now try to do the same thing with these words:

   bear – forest – boxer – flowers

   Write down the metaphors you can create.

   1)_____ 2)_____ because_____
   _____
   1)_____ 2)_____ because_____
   _____
   1)_____ 2)_____ because_____
   _____
   1)_____ 2)_____ because_____
   _____

6. Has it ever happened to you to use the bear metaphor to say that someone is grumpy or to hear someone using it? If yes, tell us this episode. Otherwise, invent a story in which the characters use this metaphor.

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B

Appendix B (Supplementary meterial for Chapter 4)

Table of contents: - B.1. Dropout/non-adherence/missing analysis (Table B.1) - B.2. Item characteristics of the Physical and Mental Metaphors task (Table B.2, Table B.3) - B.3. Example of off-topic and non-off-topic turns (Table B.4) - B.4. Additional analysis on memory performance in the control group (Table B.5, Table B.1)

B.1 Dropout/non-adherence/missing analysis

We distinguished three types of missing data: (i) dropout, when participants stopped coming to the sessions before completing the training (e.g., they missed the last session/s and the post-training assessment) and they never came back; (ii) non-adherence to the training, when participants missed more than one training session but they took part in both the pre-training and post-training assessment, demonstrating interest in the training by coming back after the missing sessions; (iii) missing assessment data, when participants missed the pre-training sessions or the post-training sessions. No statistically significant differences were observed between the PragmaCom group and the control group in the percentage of dropout/non-adherence/missing data (Table B.1).

Table B.1: Percentages for each level of missing data in each group

	Total	PragmaCom	Control	PragmaCom VS. Control		
	N(%)	N(%)	N(%)	*t*	*df*	*p*
Dropout	33(28%)	24(33%)	9(22%)	-1.49	114	0.14
Non-adherence	7(6%)	3(4%)	4(9%)	1.08	114	0.28
Missing assessment data	8(7%)	4(6%)	4(9%)	0.72	114	0.47

B.2 Item characteristics of the Physical and Mental Metaphors task

Table B.2 presents the psycholinguistic characteristics of the items used in the Physical and Mental Metaphors task. Items are reported in the original Italian version. Frequency characteristics were taken from the CoLFIS (Corpus e Lessico di Frequenza dell'Italiano Scritto, Bambini & Trevisan, 2012; Bertinetto et al., 2005), while all other characteristics were collected through an-online rating task. We asked 53 young adult volunteers (40 F Mage = 23,9, Age range = 21-32; Meducation = 15,9, education range = 13-18) to rate each metaphor on a 7-point Likert scale (1= not at all, 7= totally) in terms of: reference to physical/action features in its interpretation, reference to mental/psychological features in its interpretation, familiarity, and aptness. The two sets (Physical and Mental) do not differ for frequency, familiarity, and apteness, while –as expected– they differ for physical and mental score (Table B.3).

B.3 Example of off-topic and non-off-topic turns

Table B.4 presents examples of off-topic and non-off-topic turns. Items are reported in the original Italian version with English translation on the left. A legend of the annotations (based on Savy, 2007) is provided: "P1" and "P2" stand for speaker 1 (interviewer) and speaker 2 (participant); "#1" and "#2" refer to the turn number for each speaker; "/" means that there is a change in the syntactic

Table B.2: Characteristics of the items of the Physical and Mental Metaphors task (adult version)

Metaphor	Frequency (vehicle)	Physical score	Mental score	Familiarity	Aptness
Physical set					
Quel pugile è un panda.	21	4.93	1.36	2.54	3.14
Certe ragazze sono spighe.	4	4.68	1.89	2.50	3.36
Quella sposa è una nuvola.	79	4.86	1.89	3.07	3.71
I neonati sono batuffoli.	4	6.00	2.25	5.04	5.29
I vecchi sono tartarughe.	32	5.54	3.71	4.29	4.61
Certi cantanti sono usignoli.	4	6.00	1.48	5.92	5.76
I bagnini sono lucertole.	7	5.28	1.60	3.16	4.16
Mental set					
I figli sono stampelle.	13	3.89	4.93	3.75	4.61
Certi amici sono ancore.	10	3.89	5.57	5.46	5.68
Gli adolescenti sono pendoli.	24	3.24	5.52	3.28	4.56
I filosofi sono aeroplani.	10	1.36	5.46	1.64	3.11
i nonni sono pilastri.	17	3.32	5.93	5.68	5.68
Certi politici sono pavoni.	6	4.11	4.48	4.32	4.76
Certi professori sono lanterne.	14	2.68	5.07	2.68	3.96

Table B.3: Summary of the characteristics of the two sets

	Frequency (vehicle)	Physical score	Mental score	Familiarity	Aptness
Physical metaphors	21.57 (27.53)	5.33 (0.54)	2.03 (0.80)	3.79 (1.72)	4.29 (0.98)
Mental metaphors	13.43 (5.83)	3.21 (0.95)	5.28 (0.48)	3.83 (1.46)	4.62 (0.91)
T-tests between the two sets	t= 0.77, p= .46	t= 5.09, p< .001	t= -9.19, p <.001	t= -0.06, p= .95	t= -0.65, p= .52

Note:
All tests had 12 degrees of freedom.

structure; "+" refers to an interruption during the pronunciation of a word; "" stands for short pause; letters repeated twice between the symbols "< >" refer to the sound extension of the last pronounced letter (these are reported only in the original Italian version). Example 1 contains two turns per speaker; the off-topic turn is P2#2.

Table B.4: Examples of off-topic and non-off-topic items

Original transcription	English translation
Example 1: Off-topic turn	
P1#1: lei vive con la sua famiglia<aa>?	P1#1: do you live with your family?
P2#1: certo <sp> da<aa> mio marito e mio figlio, ho un figlio di cinquant'anni<ii> è ancora in casa, è in casa, sta in casa	P2#1: of course <sp> of my husband and my son, I have a fifty-year-old son, he is still in our house, he is in our house, he lives in our house.
P1#2: okay	P1#2: okay
P2#2: e niente<ee> mio marito è pensionato<oo> è un paio d'anni che <sp> lavorava, poi è andato in pensione, poi va be' io sono <sp> vent'anni che sono a casa <sp> perché la ditta lavora+ / è molto lontano, a [place1] <sp> e<eee> c'erano <sp> non si / nel senso che in poco tempo hanno licenziato un mare di persone, diciamo, no <sp> da mille che eravamo in tre / in tre anni / tre quattro anni son rimasti in trecento quindi <sp> secondo me nel tempo l'ho capita, c'era anche una <sp> selezione di tagliar le gambe a chi abitava lontano<oo> perché ci venivano a prendere col pullman<nn> da [place2] eccetera <sp> certi servizi, di conseguenza, che sul <sp> non te ne accorgi, al momento, sembra un sopruso e invece <sp> tagliare un po' le gambe per chi<ii> / per chi poi è lontano, poi davano degli incentivi <sp> di conseguenza<aa>	P2#2: and nothing, my husband is retired, it has been a couple of years he used to work, then he got retired, then, ok, I have been <sp> home for 20 years <sp> because the company works+ / it is very far, in [place1] <sp> and there were <sp> they dont / in the sense that they fired a lot of people in a very short period of time, lets say, no <sp> we were a thousand people and in three/ in three years/ three four years only 300 people remained <sp> in my opinion with time I understood, there was also a <sp> selection to get rid of those people who were living far from the company because they came to pick us up with the bus from [place2] etcetera <sp> this services, consequently, that <sp> you dont realize, at that moment, it seems something unfair, but <sp> to take the wind out of the sails of those/ of those who live far away, then they gave some incentives <sp> consequently
Example 2: Non-off-topic turn	
P1#1: lei vive con la sua famiglia?	P1#1: do you live with your family?
P2#1: adesso con mio marito, perché i miei tre figli hanno la loro vita	P2#1: now with my husband, because my three children have their own life

B.4 Additional analysis on memory performance in the control group

Here we present the additional analysis (t-test and regressions) performed on the memory tests in the control group. The following memory tests, based on previous studies (Bottiroli et al., 2013; Cavallini et al., 2010), were performed by participants at the beginning and at the end of the cognitive training: Cued recall task: participants were asked to study a list of 30 pairs of associated words for eight minutes. Then, one word of each pair was individually presented, and participants were asked to write the word that was previously associated with the one presented; Free recall task: participants were given eight minutes to study a list of 30 words. Right after, participants were asked to write down as many words as they could remember (in any order) on an answer sheet. For both tasks, we administered parallel versions at pre- and post-test to avoid potential familiarity with the stimuli.

B.4.0.1 T-tests

In order to test whether the cognitive training was effective in improving participants' memory abilities, we calculated the mean percentage of accuracy of the two memory tests assessed in the first session (the pre-training phase) and in the last session (the post-training phase). Thus, we obtained a composite memory score for each assessment phase (Memory_Pre and Memory_Post). The results of the paired samples t-test showed that there was a significant improvement from the pre-training phase to the post-training phase, proving that the training was effective (see Table B.5).

Table B.5: T-test on the memory measures collected in the control group at pre- and post-training

Memory_Pre $M(SE)$	Memory_Post $M(SE)$	t	df	p
48.63 (4.86)	57.50 (5.85)	-3.24	15	0.006

B.4.0.2 Regressions

In order to understand whether the improvement in memory skills influenced the improvement in pragmatic abilities, we performed a hierarchical regression. The post-training scores for the two outcome measures (PMM and OTV) were set as dependent variable. For each outcome measure, the baseline score was entered first (model 1), followed by age and the memory gain (ΔMemory, calculated as difference between Memory_Post and Memory_Pre scores) in the second step (model 2). Results showed that the only significant predictor was the baseline score, for both outcome variable. The second model did not explain additional variance (PMM: $\Delta F(2, 12) = 0.51$, $p = .61$; OTV: $\Delta F(2, 8) = 2.62$, $p = .13$), suggesting that memory gain did not explain the improvement in pragmatic abilities (see Table B.6).

Table B.6: Hierarchical regressions on PMM and OTV scores at post-training in the Control group with memory gain as predictor

		Model 1		Model 2		
	Independent variable	Baseline		Baseline	Age	ΔMemory
PMM	B	0.82		0.93	1.28	0.05
	SE B	0.12		0.20	1.43	0.07
	β	0.87	***	0.98 ***	0.19	0.10
	R^2 model 1 = .76					
	R^2 model 1 = .78					
OTV	B	0.70		0.85	0.02	-0.01
	SE B	0.11		0.15	0.04	0.00
	β	0.90	***	1.08 ***	0.07	-0.35
	R^2 model 1 = .80					
	R^2 model 2 = .88					

Note:
$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$.

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