How to Improve Social Communication in Aging: Pragmatic and Cognitive Interventions

Valentina Bambini[a*], Elisabetta Tonini[a*], Irene Ceccato[b], Serena Lecce[b], Eleonora Marocchini[c], Elena Cavallini[b]

[a] Center for Neurocognition, Epistemology and theoretical Syntax (NEtS), University School for Advanced Studies IUSS Pavia, Piazza della Vittoria 15, 27100 Pavia, Italy

[b] Department of Brain and Behavioral Sciences, University of Pavia, Piazza Botta 11, 27100 Pavia, Italy

[c] Laboratory of Language and Cognition, University of Genoa, Via Balbi 30, 16128 Genoa, Italy

[*] Joint first authors

Corresponding Author:

Valentina Bambini, Center for Neurocognition, Epistemology and theoretical Syntax (NEtS), University School for Advanced Studies IUSS Pavia, Piazza della Vittoria 15, 27100 Pavia, Italy, Email: valentina.bambini@iusspavia.it

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 elderly people. 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 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

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., 2016; Cummings, 2014; Jagoe, 2017).

Concerning the non-pathological aging population, the literature has shown that pragmatic abilities show a decline compared to young 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, Burke, Austin, & Hulme, 1998; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010). In addition, discourse coherence, measured in terms of links between utterances, was shown to be affected by age (Marini, Boewe, Caltagirone, & Carlomagno, 2005). Studies tackling receptive pragmatic abilities showed age-related changes in the domain of figurative language, including the comprehension of metaphors (Champagne-Lavau, Monetta, & Moreau, 2012; Mashal, Gavrieli, & Kavé, 2011), idioms (Grindrod & Raizen, 2019), and proverbs (Uekermann, Thoma, & Daum, 2008). Also, age affects the comprehension of jokes (Bischetti, Ceccato, Lecce, Cavallini, & Bambini, 2019; Mak &

Carpenter, 2007; Uekermann, Channon, & Daum, 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, pragmatic skills have *never* been a target of intervention in the elderly population. 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 in clinical populations; 2) previous cognitive training programs in elderly people; 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, Frymark, & Venedictov, 2013; and Lundgren & Brownell, 2016). Tompkins, Blake, Wambaugh and Meigh (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 Training, which targets the recognition of the speaker's communicative intention and speech act (sincere, ironic, deceitful) both in the linguistic and extra-linguistic modality, and 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, focusing on turn-taking and verbosity (Togher, McDonald, Tate, Power, & Rietdijk, 2009, 2013; Togher, Power, Rietdijk, McDonald, & Tate, 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, Brownell, Cayer-Meade, Milione, & Kearns, 2011) and traumatic brain injury (Brownell et al., 2013). Albeit often including a very limited sample 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 disorder of 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 senders 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 difficulty in maintaining the topic), the P.A.C.E. procedure does not specifically target inferential pragmatic skills, but rather functional communication, i.e., 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, Blasi, Labruna, & Santoro, 2000; Carlomagno, Losanno, Emanuelli, & Casadio, 1991).

More evidence on aging is available in the field cognitive training. Aging research shows the existence, also in the third and fourth ages, of the considerable potential of cognitive plasticity and the efficacy of cognitive and/or metacognitive interventions (Hertzog, Kramer, Wilson, & Lindenberger, 2008), targeting memory (Borella, Carretti, Riboldi, & De Beni, 2010; Bottiroli, Cavallini, Dunlosky, Vecchi, & Hertzog, 2013; Cavallini, Dunlosky,

Bottiroli, Hertzog, & Vecchi, 2010), reasoning (Anand et al., 2011), decision making (Rosi, Vecchi, & Cavallini, 2019), and even socio-cognitive abilities such as theory of mind (Cavallini et al., 2015). Moreover, the cognitive training field provides cumulating evidence for the role of individual differences, including age, baseline level, and cognitive profile, in training (Borella, Carbone, Pastore, De Beni, & Carretti, 2017; Cavallini et al., 2019; Lecce, Ceccato, et al., 2019; Lövdén, Brehmer, Li, & Lindenberger, 2012; Zinke et al., 2014), where 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 relationship between pragmatic skills and cognitive resources in older adults. For instance, in the study of Daniluk & Borkowska (2020), the most important factor predicting the scores in all tests 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, Declercq, Novella, & Besche, 2010). Verbal fluency is another language-based executive task which has been related to figurative language, for instance in the study of Grindrod & 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 & Gold, 1993), although for this aspect the literature hosts conflicting findings (Burke & Shafto, 2008). Indeed, recent works have emphasized that in older adults, the relationship with cognitive skills varies a lot across different pragmatic tasks (Bambini, Van Looy, Demiddele, & Schaeken, 2020).

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, Grimm, & McArdle, 2005; Bowles & Salthouse, 2008; Burke & Shafto, 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, since older adults have had more time to accumulate knowledge (either vocabulary or general information), we expect that they will consider more metaphoric expressions as familiar. Indeed, a study by Mashal et al. (2011) found that older adults judge novel metaphors as more familiar than young 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.

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 encompasses both expressive and receptive aspects, we argued that a training with a broad scope (i), targeting both comprehension and production, could be the most effective for the elderly to enhance their social communication. 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 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, i.e., 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, i.e., the assumption that people's behavior will be affected by their level of involvement (Clark, Lawlor-Savage, & Goghari, 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, Shipstead, Wiemers, Melby-Lervåg, & Hulme, 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 exercises, processing speed, and reasoning activities (Bottiroli et al., 2013; Bottiroli, Cavallini, Dunlosky, Vecchi, & Hertzog, 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, 2016), a standardized test used to evaluate pragmatics in clinical populations previously used in pathological aging (Bambini, Arcara, Martinelli, et al., 2016; Carotenuto, Arcara, et al., 2018; Montemurro et al., 2019). However, since APACS is a test for clinical populations and the effect of age in the norm-group are limited (Arcara & Bambini, 2016), 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, Del Sette, Bischetti, & Bambini, 2019), and the other evaluating expressive pragmatic skills and specifically the propensity to off-topic speech (Arbuckle & 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 are 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 the elderly is linked to vocabulary knowledge and fluency (Grindrod & Raizen, 2019; Mashal et al., 2011), we expected that the language-based cognitive index could be predictive of differences in training benefits. This investigation would also, on the practical side, indicate who can benefit most from which intervention.

2. Material and Methods

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 (dropouts, 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 Supplementary Material (Table S1) for the detailed analysis of dropouts/non-adherence/missing assessment. Nineteen additional participants (13% of 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 (assessed with the Mini-Mental State Examination; Folstein, Folstein, & McHugh, 1975) or diagnosis of neurological disease. The final sample consisted of 49 participants: 32 in the PragmaCom group (24 F, *M*age = 68.75, age range = 60-78, *M*education = 12.42, education range = 8-18) and 17 in the Control group (15 F, *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 (n°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.

2.2. Design and Procedure

Participants took part in pre- and post-training assessment sessions. At both time-points 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 main 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 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.

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 the elderly population. 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, Sherman, & Spreen, 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 for 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 (2016) to assess pragmatic language disorder in Italian speaking individuals. APACS consists of 6 tasks devoted to assess different aspects of the pragmatics of communication, targeting both production and comprehension: Interview (consisting in a semi-structured interview which is evaluated for 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 orally given), 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 one ranging from 0 to 1.

Physical and Mental Metaphors task (collectively assessed): As a more fine-grained measures of pragmatic skills in comprehension than the APACS Pragmatic Comprehension score, we created a novel adult-appropriate version of the Physical and Mental Metaphors (PMM) task originally developed for children (Lecce, Ronchi, Del Sette, Bischetti, & Bambini; 2019). Fourteen novel nominal metaphors in the form X is Y were used, including physical metaphors (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 the written format, and participants needed to explain their meaning writing down their answers in a booklet. Answers were rated for the ability to articulate the 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: In order to obtained a more-fine grained measure of pragmatic production than the APACS Pragmatic Production score, we measured Off-Topic Verbosity (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 & 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 depends also on the number of questions asked by the interviewer, we calculated a measure of "OTV propensity", defined as a proportion between the number of times every single participant went off topic (i.e. the number of times their OTV value for the turn was 1) and the total number of answers given to the interviewer. 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.

2.2.2. Training programs.

2.2.2.1. 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 Quantity), as in the case of figurative language, the hearer is prompted to look for an implicated meaning on the bases 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 devoted to the comprehension of pragmatic meaning in figurative language (including different types such as nominal metaphors, transparent idioms, and proverbs), and the other type 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 unfolds through four phases, schematically represented in Figure 1. Phase 1 (Detection of a communicative 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 proposed context. Phase 3 (*Generalization of the rule to other contexts*) 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.

INSERT FIGURE 1

More specifically, in 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 an 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 article or videos featuring figurative expression 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.

2.2.2.2 Cognitive training.

This intervention was primarily based on a previous memory training (Bottiroli et al., 2013, 2017; Cavallini et al., 2010), which was adapted 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, i.e., 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 enhances organization of to-be-learned materials. Following the instructions, 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, Court, & Raven, 1983), adapting them to be collectively presented. Activities varied both within and between sessions and were of increasing difficulty. Activities in each session are described in Table 1.

INSERT TABLE 1

Past studies on the original memory training upon which the current cognitive training is based on showed reliable improvements in the target ability (Cohen's *d*s ranging from .60 to 1.10). For example, the first study examining the training effects 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 Supplementary Material, Table S4).

2.3. Data Analysis

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 main outcome measures, this preliminary step was especially important for the APACS test, since this test was designed to detect pragmatic impairments in clinical populations rather than typically aging population. To do this, we inspected the scores obtained at pre-training assessment (considered as baseline) and calculated the percentage of participants who had an accuracy higher than the 80% for all the main outcome measures (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% in Pragmatic Production, 91% in Pragmatic Comprehension and 100% in the APACS Total score), 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 the accuracy scores obtained in the metaphor comprehension task (PMM) and the scores obtained in the evaluation of off-topic verbosity propensity (OTV) were considered as main 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.

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 the elderly population), we first checked with independent sample t-test 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 main outcome

variables (PMM and OTV). Time (Pre 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.

2.3.3. Investigating the role of individual differences on the 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 hierarchical regression analysis for each group separately. For this analysis, and 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 correlations, we calculated Pearson's correlation coefficient between participant's age, language-based index, and the main outcome variables (accuracy in PMM and scores in OTV) assessed both at pre- and post-training for the whole sample, to investigate the relationship between age, cognitive abilities, and pragmatics. We also calculated the correlations between the pre- and post-training scores for each of the main outcome variables, to investigate the relationship between the baseline level and the post-training level.

Hierarchical regressions were performed to analyze the role of baseline, age, and the language-based index on pragmatic performance at post-training, separately for the two different training groups. The post-training scores for the two main outcome measures (PMM and OTV) were set as dependent variable in separate regression models. For each main outcome variable, the baseline score was entered in the first model (model 1), followed by age and the language-based index in the second model (model 2).

3. Results

Descriptive statistics are presented in Table 2.

INSERT TABLE 2

3.1. Effectiveness of the Training

The two groups did not differ at baseline for any of the assessed variables (see Table 3).

INSERT TABLE 3

3.1.1. Physical and Mental Metaphors task.

Repeated measures ANOVA on the PMM task showed only a main effect of Time [$F(1,47) = 19.68$, $p < .001$, $\eta^2p = 0.30$]. Post-hoc pairwise comparisons confirmed that both groups obtained a higher score at Post than at Pre training session, with the PragmaCom group leading the effect and showing a greater effect size compared to the Control group [PragmaCom: $t(47) = 4.23$, $p < .001$, Cohen's $d = 0.55$; Control: $t(47) = 2.40$, $p = .020$, Cohen's $d = 0.32$] (see Figure 2A).

INSERT FIGURE 2

3.1.2. Off-Topic Verbosity.

Repeated measures ANOVA on the OTV propensity measure showed only a main effect of Time [$F(1,22) = 5.23$, $p = .32$, $\eta^2p = 0.19$]. 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's difference in means [$t(22) = -1.18$, $p = .25$, Cohen's $d = 0.34$] (see Figure 2B).

3.2. Individual Differences on the Training Benefits

3.2.1. Correlations.

The results of the correlation analysis are displayed in Figure 3. Age was significantly and negatively associated only with the PMM task, both at pre- and post-training assessment (pre: $r(47) = -.41$, $p = .004$; post: $r(47) = -.46$, $p = .001$). No significant correlations were found between age and the OTV propensity measure, neither between age and the language-based index. The language-based index correlated significantly only with the PMM task, in a positive fashion at both time points (pre: $r(47) = .70$, $p < 0.001$; post: $r(47) = .77$, $p < .001$), but not with the OTV propensity measure. Pre- and post-training scores correlated both for PMM and for OTV (PMM: $r(47) = .81$, $p < .001$, OTV: $r(22) = .50$, $p = .013$).

INSERT FIGURE 3

3.2.2. Regressions.

The results of the regression analysis are displayed in Table 4.

INSERT TABLE 4

3.2.2.1. Physical and Mental Metaphor task.

The regression models with the PMM scores at post-training as dependent variable

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, results showed a different pattern in the two groups. 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 PMM post-training scores ($p = .011$), reducing the predicting role of baseline performance ($p = .087$).

3.2.2.2. Off-Topic Verbosity.

Results showed that baseline performance was a significant predictor of post-training OTV propensity for the Control group [$F(1, 10) = 40.67$, $p < .001$], but not for 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 regression analyses were performed on 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 Supplementary Material, Table S5).

4. Discussion

This study is the first one in the literature to investigate the possibility of improving pragmatic skills in the healthy elderly people. 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' pragmatics 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, reasoning (Anand et al., 2011; Cavallini et al., 2010; Rosi et al., 2019). The novel finding stemming from our findings of a pragmatic improvement after training 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, e.g., 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 the existence of 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 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 & Shafto, 2008; Diaz, Rizio, & Zhuang, 2016; Zhang, Eppes, & Diaz, 2019). The greater difficulty of the pragmatic production task might thus in turn lead to a greater difficulty of 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 the Supplementary Material). Moreover, individuals who were stimulated cognitively generalized to pragmatics, obtaining also a gain

in 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 has been related to pragmatics in older adults (Daniluk & Borkowska, 2020) and also from studies on clinical populations where performance in pragmatic tasks was associated with the global 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 on 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, Pinto, & Di Filippo, 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 effects sizes comparing pragmatic performance at pre- and post-training were bigger in the PragmaCom than in the Control group, and we observed

different patterns of predictors. 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 run 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 et al., 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 the elderly people (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 et al., 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

& Shafto, 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, Kircher, Nagels, Strik, & Homan, 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, i.e., poor in conceptual association and formation (Bambini, Arcara, 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 in older compared to younger adults, i.e., the tendency to use broader categories and cluster information to fewer categories (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 on post-training metaphor accuracy and a predictive role of the baseline scores (in off-topic verbosity) on post-training off-topic verbosity. In the PragmaCom 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 such 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, Smith, & Baltes, 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 necessary for making use of new strategies and abilities successfully performing the tasks. Conversely, the compensation model postulates that it is actually lower-performing individuals who tend to benefit most 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, Lifshitz, & Mashal, 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 tells us something on 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 those skills. Conversely, the PragmaCom directly address 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, which might be useful to adopt tailored remediation decisions. Although both trainings are effective, by being less dependent from 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 that 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 one hundred sixteen subjects recruited), of which 34% were due to dropouts or non-adherence (see Supplementary Material). Although there is very little evidence of

dropout/non-adherence rate in cognitive training in healthy elderly subjects, 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, Walsh, Greenberg, & Priebe, 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 measures 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 be key in pragmatics. This would allow to clarify the role of the individual predictors in pragmatic intervention.

Finally, adding measures of brain's response to pragmatic and cognitive training would be highly informative to investigate if 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, relies on an extended network encompassing both hemispheres (Carotenuto, Cocozza, 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 modification 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, possibly supporting the behavioral improvements in pragmatic tasks (Gabbatore et al., 2017). Elucidating if pragmatic intervention is capable of inducing brain modifications in the complex, bilateral pattern supporting pragmatics would be of primary importance both for the study of aging and for the understanding the neural underpinning of pragmatics.

Despite its limitations, we believe that this study discloses promising evidence on 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 more suited for all individuals independently of the individual characteristics, might represent an effective treatment option to increase social communication and wellbeing in healthy and possibly pathological aging.

References

Agostoni, G., Tonini, E., Buonocore, M., Bechi, M., Silvestri, M. P., Sapienza, J., … Bosia, M. (2020). M51. Efficacy of "PragmaCom training" in schizophrenia: A RCT on a novel pragmatic intervention. *Schizophrenia Bulletin*, *46*(Suppl 1), S153. https://doi.org/10.1093/schbul/sbaa030.363

Anand, R., Chapman, S. B., Rackley, A., Keebler, M., Zientz, J., & Hart, J. (2011). Gist reasoning training in cognitively normal seniors. *International Journal of Geriatric Psychiatry*, *26*(9), 961–968. https://doi.org/10.1002/gps.2633

Arbuckle, T. Y., & Gold, D. P. (1993). Aging, inhibition, and verbosity. *Journal of Gerontology*, *48*(5), 225–232. https://doi.org/10.1093/geronj/48.5.P225

Arcara, G., & Bambini, V. (2016). A test for the Assessment of Pragmatic Abilities and Cognitive Substrates (APACS): Normative data and psychometric properties. *Frontiers in Psychology*, *7*, 70. https://doi.org/10.3389/fpsyg.2016.00070

Bambini, V., Arcara, G., Bechi, M., Buonocore, M., Cavallaro, R., & Bosia, M. (2016). The communicative impairment as a core feature of schizophrenia: Frequency of pragmatic deficit, cognitive substrates, and relation with quality of life. *Comprehensive Psychiatry*, *71*, 106–120. https://doi.org/10.1016/j.comppsych.2016.08.012

Bambini, V., Arcara, G., Bosinelli, F., Buonocore, M., Bechi, M., Cavallaro, R., & Bosia, M. (2020). A leopard cannot change its spots: A novel pragmatic account of concretism in schizophrenia. *Neuropsychologia*, *139*, 107332. https://doi.org/10.1016/j.neuropsychologia.2020.107332

Bambini, V., Arcara, G., Martinelli, I., Bernini, S., Alvisi, E., Moro, A., … Ceroni, M. (2016). Communication and pragmatic breakdowns in amyotrophic lateral sclerosis patients. *Brain and Language*, *153–154*, 1–12.

https://doi.org/10.1016/j.bandl.2015.12.002

Bambini, V., Van Looy, L., Demiddele, K., & Schaeken, W. (2020). What is the contribution of executive functions and inhibition to pragmatic skills? Insights from aging and different types of pragmatic inference. *Submitted*.

Bischetti, L., Ceccato, I., Lecce, S., Cavallini, E., & Bambini, V. (2019). Pragmatics and theory of mind in older adults ' humor comprehension. *Current Psychology*, 1–17. https://doi.org/10.1007/s12144-019-00295-w

Blake, M. L., Frymark, T., & Venedictov, R. (2013). Based systematic review on communication treatments for individuals with right hemisphere brain damage. *American Journal of Speech-Language Pathology*, *22*(1), 146–160. https://doi.org/10.1044/1058-0360(2012/12-0021)

Borella, E., Carbone, E., Pastore, M., De Beni, R., & Carretti, B. (2017). Working Memory Training for Healthy Older Adults: The Role of Individual Characteristics in Explaining Short- and Long-Term Gains. *Frontiers in Human Neuroscience*, *11*, 99. https://doi.org/10.3389/fnhum.2017.00099

Borella, E., Carretti, B., Riboldi, F., & De Beni, R. (2010). Working Memory Training in Older Adults: Evidence of Transfer and Maintenance Effects. *Psychology and Aging*, *25*(4), 767–778. https://doi.org/10.1037/a0020683

Bottiroli, S., Cavallini, E., Dunlosky, J., Vecchi, T., & Hertzog, C. (2013). The importance of training strategy adaptation: A learner-oriented approach for improving older adults' memory and transfer. *Journal of Experimental Psychology: Applied*, *19*(3), 205–218. https://doi.org/10.1037/a0034078

Bottiroli, S., Cavallini, E., Dunlosky, J., Vecchi, T., & Hertzog, C. (2017). Self-guided strategy-adaption training for older adults: Transfer effects to everyday tasks. *Archives of Gerontology and Geriatrics*, *72*, 91–98. https://doi.org/10.1016/j.archger.2017.05.015

Bowles, R. P., Grimm, K. J., & McArdle, J. J. (2005). A structural factor analysis of vocabulary knowledge and relations to age. *Journals of Gerontology - Series B Psychological Sciences and Social Sciences*, *60*(5), 234–241. https://doi.org/10.1093/geronb/60.5.P234

Bowles, R. P., & Salthouse, T. A. (2008). Vocabulary Test Format and Differential Relations to Age. *Psychology and Aging*, *23*(2), 366–376. https://doi.org/10.1037/0882-7974.23.2.366

Brownell, H., Lundgren, K., Cayer-Meade, C., Milione, J., Katz, D. I., & Kearns, K. (2013). Treatment of metaphor interpretation deficits subsequent to traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *28*(6), 446–452. https://doi.org/10.1097/HTR.0b013e31825b5e85

Burke, D. M., & Shafto, M. A. (2004). Aging and Language Production. *Current Directions in Psychological Science*, *13*(1), 21–24. https://doi.org/10.1111/j.0963-7214.2004.01301006.x

Burke, D. M., & Shafto, M. A. (2008). Language and aging. In F. I. M. Craik & T. A. Salthouse (Eds.), *The Handbook of Aging and Cognition* (pp. 373–443). https://doi.org/10.1016/B978-0-12-809324-5.01889-7

Carlomagno, S., Blasi, V., Labruna, L., & Santoro, A. (2000). The role of communication models in assessment and therapy of language disorders in aphasic adults. *Neuropsychological Rehabilitation*, *10*(3), 337–363. https://doi.org/10.1080/096020100389183

Carlomagno, S., Losanno, N., Emanuelli, S., & Casadio, P. (1991). Expressive language recovery or improved communicative skills: Effects of p.a.c.e. therapy on aphasies' referential communication and story retelling. *Aphasiology*, *5*(4–5), 419–424. https://doi.org/10.1080/02687039108248544

Carotenuto, A., Arcara, G., Orefice, G., Cerillo, I., Giannino, V., Rasulo, M., … Bambini, V. (2018). Communication in multiple sclerosis: Pragmatic deficit and its relation with cognition and social cognition. *Archives of Clinical Neuropsychology*, *33*(2), 194–205. https://doi.org/10.1093/arclin/acx061

Carotenuto, A., Cocozza, S., Quarantelli, M., Arcara, G., Lanzillo, R., Brescia Morra, V., … Iodice, R. (2018). Pragmatic abilities in multiple sclerosis: The contribution of the temporo-parietal junction. *Brain and Language*, *185*, 47–53. https://doi.org/10.1016/j.bandl.2018.08.003

Cavallini, E., Bianco, F., Bottiroli, S., Rosi, A., Vecchi, T., & Lecce, S. (2015). Training for generalization in theory of mind: A study with older adults. *Frontiers in Psychology*, *6*, 1123. https://doi.org/10.3389/fpsyg.2015.01123

Cavallini, E., Bottiroli, S., Dunlosky, J., Ambiel, E., Lux, A., & Hertzog, C. (2019). Strategy-adaptation memory training: predictors of older adults' training gains. *Open Psychology*, *1*(1), 255–272. https://doi.org/10.1515/psych-2018-0017

Cavallini, E., Dunlosky, J., Bottiroli, S., Hertzog, C., & Vecchi, T. (2010). Promoting transfer in memory training for older adults. *Aging Clinical and Experimental Research*, *22*(4), 314–323. https://doi.org/10.3275/6704

Cavelti, M., Kircher, T., Nagels, A., Strik, W., & Homan, P. (2018). Is formal thought disorder in schizophrenia related to structural and functional aberrations in the language network? A systematic review of neuroimaging findings. *Schizophrenia Research*, *199*, 2–16. https://doi.org/10.1016/j.schres.2018.02.051

Champagne-Lavau, M., Monetta, L., & Moreau, N. (2012). Impact of educational level on metaphor processing in older adults. *Revue Française de Linguistique Appliquée*, *17*(2), 89–100.

Clark, C. M., Lawlor-Savage, L., & Goghari, V. M. (2017). Working memory training in

healthy young adults: Support for the null from a randomized comparison to active and passive control groups. *PLoS ONE*, *12*(5), 1–25. https://doi.org/10.1371/journal.pone.0177707

Cummings, L. (2014). *Pragmatic Disorders*. Dordrecht: Springer.

Daniluk, B., & Borkowska, A. R. (2020). Pragmatic aspects of verbal communication in elderly people: A study of Polish seniors. *International Journal of Language and Communication Disorders*, *55*(4), 493–505. https://doi.org/10.1111/1460-6984.12532

Davis, G. A. (2005). PACE revisited. *Aphasiology*, *19*(1), 21–38. https://doi.org/10.1080/02687030444000598

Diaz, M. T., & Eppes, A. (2018). Factors influencing right hemisphere engagement during metaphor comprehension. *Frontiers in Psychology*, *9*, 414. https://doi.org/10.3389/fpsyg.2018.00414

Diaz, M. T., Rizio, A. A., & Zhuang, J. (2016). The Neural Language Systems That Support Healthy Aging: Integrating Function, Structure, and Behavior. *Language and Linguistics Compass*, *10*(7), 314–334. https://doi.org/10.1111/lnc3.12199

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Gabbatore, I., Bosco, F. M., Geda, E., Gastaldo, L., Duca, S., Costa, T., … Sacco, K. (2017). Cognitive Pragmatic rehabilitation program In schizophrenia: A single case fMRI study. *Neural Plasticity*, *2017*, 1612078. https://doi.org/10.1155/2017/1612078

Gabbatore, I., Sacco, K., Angeleri, R., Zettin, M., Bara, B. G., & Bosco, F. M. (2015). Cognitive Pragmatic Treatment: A rehabilitative program for Traumatic Brain Injury individuals. *The Journal of Head Trauma Rehabilitation*, *30*(5), E14-28. https://doi.org/10.1097/HTR.0000000000000087

Greenwood, P. M. (2007). Functional Plasticity in Cognitive Aging: Review and Hypothesis. *Neuropsychology*, *21*(6), 657–673. https://doi.org/10.1037/0894-4105.21.6.657

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and Semantics, Vol. 3, Speech Acts* (pp. 41–58). New York: Academic Press.

Grindrod, C. M., & Raizen, A. L. (2019). Age-related changes in processing speed modulate context use during idiomatic ambiguity resolution. *Aging, Neuropsychology, and Cognition*, *26*(6), 842–864. https://doi.org/10.1080/13825585.2018.1537437

Hagoort, P., & Levinson, S. C. (2014). Neuropragmatics. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (5th ed., pp. 667–674). Cambridge, Mass: MIT Press.

Hertzog, C., Kramer, A. F., Wilson, R. S., & Lindenberger, U. (2008). Enrichment Effects on Adult Cognitive Development: Can the Functional Capacity of Older Adults Be Preserved and Enhanced? *Psychological Science in the Public Interest : A Journal of the American Psychological Society*, *9*(1), 1–65. https://doi.org/10.1111/j.1539-6053.2009.01034.x

Hyter, Y. D. (2017). Pragmatic assessment and intervention in children. In L. Cummings (Ed.), *Research in Clinical Pragmatics* (pp. 493–526). https://doi.org/10.1007/978-3-319-47489-2_19

Jagoe, C. (2017). Disruption of Pragmatics in Adulthood. In L. Cummings (Ed.), *Research in Clinical Pragmatics* (pp. 181–210). https://doi.org/10.1007/978-3-319-47489-2_8

James, L. E., Burke, D. M., Austin, A., & Hulme, E. (1998). Production and perception of "verbosity" in younger and older adults. *Psychology and Aging*, *13*(3), 355–367. https://doi.org/10.1037/0882-7974.13.3.355

Kliegl, R., Smith, J., & Baltes, P. B. (1990). On the Locus and Process of Magnification of Age Differences During Mnemonic Training. *Developmental Psychology*, *26*(6), 894–904. https://doi.org/10.1037/0012-1649.26.6.894

Lecce, S., Ceccato, I., Rosi, A., Bianco, F., Bottiroli, S., & Cavallini, E. (2019). Theory of mind plasticity in aging: The role of baseline, verbal knowledge, and executive functions. *Neuropsychological Rehabilitation*, *29*(3), 440–455. https://doi.org/10.1080/09602011.2017.1308871

Lecce, S., Ronchi, L., Del Sette, P., Bischetti, L., & Bambini, V. (2019). Interpreting physical and mental metaphors: Is Theory of Mind associated with pragmatics in middle childhood? *Journal of Child Language*, *46*(2), 393–407. https://doi.org/10.1017/S030500091800048X

Lövdén, M., Brehmer, Y., Li, S. C., & Lindenberger, U. (2012). Training-induced compensation versus magnification of individual differences in memory performance. *Frontiers in Human Neuroscience*, *6*, 141. https://doi.org/10.3389/fnhum.2012.00141

Lundgren, K., & Brownell, H. (2016). Figurative Language Deficits Associated With Right Hemisphere Disorder. *Perspectives of the ASHA Special Interest Groups*, *1*(2), 66–81. https://doi.org/10.1044/persp1.SIG2.66

Lundgren, K., Brownell, H., Cayer-Meade, C., Milione, J., & Kearns, K. (2011). Treating metaphor interpretation deficits subsequent to right hemisphere brain damage: Preliminary results. *Aphasiology*, *25*(4), 456–474. https://doi.org/10.1080/02687038.2010.500809

Mahncke, H. W., Kim, S. J., Rose, A., Stasio, C., Buckley, P., Caroff, S., … Keefe, R. S. E. (2019). Evaluation of a plasticity-based cognitive training program in schizophrenia: Results from the eCaesar trial. *Schizophrenia Research*, *208*, 182–189. https://doi.org/10.1016/j.schres.2019.03.006

Mak, W., & Carpenter, B. D. (2007). Humor comprehension in older adults. *Journal of the International Neuropsychological Society : JINS*, *13*(4), 606–614. https://doi.org/10.1017/S1355617707070750

Marini, A., Boewe, A., Caltagirone, C., & Carlomagno, S. (2005). Age-related differences in the production of textual descriptions. *Journal of Psycholinguistic Research*, *34*(5), 439–463. https://doi.org/10.1007/s10936-005-6203-z

Mashal, N., & Coblentz, S. (2014). Creative Interpretations of Novel Conceptual Combinations in Aging. *Creativity Research Journal*, *26*(2), 158–164. https://doi.org/10.1080/10400419.2014.901071

Mashal, N., Gavrieli, R., & Kavé, G. (2011). Age-related changes in the appreciation of novel metaphoric semantic relations. *Aging, Neuropsychology, and Cognition*, *18*(5), 527–543. https://doi.org/10.1080/13825585.2011.575202

Mejía-Constaín, B., Monchi, O., Walter, N., Arsenault, M., Senhadji, N., & Joanette, Y. (2010). When metaphors go literally beyond their territories: The impact of age on figurative language. *Italian Journal of Linguistics*, *22*(1), 41–60.

Melogno, S., Pinto, M. A., & Di Filippo, G. (2017). Sensory and physico-psychological metaphor comprehension in children with ASD: A preliminary study on the outcomes of a treatment. *Brain Sciences*, *7*(7). https://doi.org/10.3390/brainsci7070085

Messer, R. (2015). Pragmatic language changes during normal aging: Implications for health care. *Healthy Aging & Clinical Care in the Elderly*, *7*, 1–7. https://doi.org/10.4137/HaCCe.S22981

Montemurro, S., Mondini, S., Signorini, M., Marchetto, A., Bambini, V., & Arcara, G. (2019). Pragmatic language disorder in Parkinson's disease and the potential effect of cognitive reserve. *Frontiers in Psychology*, *10*, 1220. https://doi.org/10.3389/fpsyg.2019.01220

Morrone, I., Declercq, C., Novella, J.-L., & Besche, C. (2010). Aging and inhibition processes: The case of metaphor treatment. *Psychology and Aging*, *25*(3), 697–701. https://doi.org/10.1037/a0019578

Parola, A., Bosco, F. M., Gabbatore, I., Galetto, V., Zettin, M., & Marini, A. (2019). The impact of the Cognitive Pragmatic Treatment on the pragmatic and informative skills of individuals with traumatic brain injury (TBI). *Journal of Neurolinguistics*, *51*, 53–62. https://doi.org/10.1016/j.jneuroling.2018.12.003

Pushkar, D., Basevitz, P., Arbuckle, T., Nohara-LeClair, M., Lapidus, S., & Peled, M. (2000). Social behavior and off-target verbosity in elderly people. *Psychology and Aging*, *15*(2), 361–374. https://doi.org/10.1037/0882-7974.15.2.361

Raven, J., Court, J. H., & Raven, J. C. (1983). *Manual for Raven's Progressive Matrices and Vocabulary Scales (Section 3)– Standard Progressive Matrices*. London: H. K. Lewis.

Redick, T. S., Shipstead, Z., Wiemers, E. A., Melby-Lervåg, M., & Hulme, C. (2015). What's Working in Working Memory Training? An Educational Perspective. *Educational Psychology Review*, *27*(4), 617–633. https://doi.org/10.1007/s10648-015-9314-6

Rosi, A., Vecchi, T., & Cavallini, E. (2019). Metacognitive-strategy training promotes decision-making ability in older adults. *Open Psychology*, *1*(1), 200–214. https://doi.org/10.1515/psych-2018-0014

Ruffman, T., Murray, J., Halberstadt, J., & Taumoepeau, M. (2010). Verbosity and emotion recognition in older adults. *Psychology and Aging*, *25*(2), 492–497. https://doi.org/10.1037/a0018247

Salthouse, T. A., & Babcock, R. L. (1991). Decomposing Adult Age Differences in Working Memory. *Developmental Psychology*, *27*(5), 763–776. https://doi.org/10.1037/0012-1649.27.5.763

Savy, R. (2007). Specifiche per la trascrizione ortografica annotata dei testi. Retrieved from http://www.clips.unina.it/it/documenti/11_specifiche_trascrizione_ortografica.pdf

Seron, X., & de Partz, M.-P. (1993). The Re-education of Aphasics: Between theory and Practice. In A. L. Holland & M. M. Forbes (Eds.), *Aphasia Treatment: World*

Perspectives (pp. 131–144). San Diego: Singular Publishing Group.

Shammi, P., & Stuss, D. T. (2003). The effects of normal aging on humor appreciation. *Journal of the International Neuropsychological Society : JINS*, *9*, 855–863. https://doi.org/10.1017/S135561770396005X

Shnitzer-Meirovich, S., Lifshitz, H., & Mashal, N. (2018). Enhancing the comprehension of visual metaphors in individuals with intellectual disability with or without down syndrome. *Research in Developmental Disabilities*, *74*, 113–123. https://doi.org/10.1016/j.ridd.2018.01.010

Sperber, D., & Wilson, D. (1995). *Relevance: Communication and Cognition* (2nd ed.). Oxford: Blackwell.

Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary.* New York: Oxford University Press.

Szücs, M., & Babarczy, A. (2017). The role of Theory of Mind, grammatical competence and metapragmatic awareness in irony comprehension. In S. Assimakopoulos (Ed.), *Pragmatics at Its Interfaces* (pp. 129–147). Boston: Mouton de Gruyter.

Szymczynska, P., Walsh, S., Greenberg, L., & Priebe, S. (2017). Attrition in trials evaluating complex interventions for schizophrenia: Systematic review and meta-analysis. *Journal of Psychiatric Research*, *90*, 67–77. https://doi.org/10.1016/j.jpsychires.2017.02.009

Thurstone, T. G., & Thurstone, L. L. (1963). *Primary mental ability*. Chicago, IL: Science Research Associates.

Togher, L., McDonald, S., Tate, R., Power, E., & Rietdijk, R. (2009). Training communication partners of people with traumatic brain injury: Reporting the protocol for a clinical trial. *Brain Impairment*, *10*(2), 188–204. https://doi.org/10.1375/brim.10.2.188

Togher, L., McDonald, S., Tate, R., Power, E., & Rietdijk, R. (2013). Training

communication partners of people with severe traumatic brain injury improves everyday conversations: A multicenter single blind clinical trial. *Journal of Rehabilitation Medicine*, *45*(7), 637–645. https://doi.org/10.2340/16501977-1173

Togher, L., Power, E., Rietdijk, R., McDonald, S., & Tate, R. (2012). An exploration of participant experience of a communication training program for people with traumatic brain injury and their communication partners. *Disability and Rehabilitation*, *34*(18), 1562–1574. https://doi.org/10.3109/09638288.2012.656788

Tompkins, C. A., Blake, M. T., Wambaugh, J., & Meigh, K. (2011). A novel, implicit treatment for language comprehension processes in right hemisphere brain damage: Phase I data. *Aphasiology*, *25*(6–7), 789–799. https://doi.org/10.1080/02687038.2010.539784

Uekermann, J., Channon, S., & Daum, I. (2006). Humor processing, mentalizing, and executive function in normal aging. *Journal of the International Neuropsychological Society : JINS*, *12*(2), 184–191. https://doi.org/10.1017/S1355617706060280

Uekermann, J., Thoma, P., & Daum, I. (2008). Proverb interpretation changes in aging. *Brain and Cognition*, *67*(1), 51–57. https://doi.org/10.1016/j.bandc.2007.11.003

Verhaeghen, P., & Marcoen, A. (1996). On the mechanisms of plasticity in young and older adults after instruction in the method of loci: evidence for an amplification model. *Psychology and Aging*, *11*(1), 164–178. https://doi.org/10.1037//0882-7974.11.1.164

Zacks, J. M., & Ferstl, E. C. (2016). Discourse comprehension. In G. Hickock & S. L. Small (Eds.), *Neurobiology of Language* (pp. 661–673). https://doi.org/10.1016/B978-0-12-407794-2.00053-5

Zhang, H., Eppes, A., & Diaz, M. T. (2019). Task difficulty modulates age-related differences in the behavioral and neural bases of language production. *Neuropsychologia*, *124*, 254–273.

https://doi.org/10.1016/j.neuropsychologia.2018.11.017

Zinke, K., Zeintl, M., Rose, N. S., Putzmann, J., Pydde, A., & Kliegel, M. (2014). Working memory training and transfer in older adults: Effects of age, baseline performance, and training gains. *Developmental Psychology*, *50*(1), 304–315. https://doi.org/10.1037/a0032982

Tables

Table 1

Activities in the Cognitive training

Session	• 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 face-name task, with commented examples • Memory task: face-name task (16 items) (followed by group discussion and feedback) • Speed of processing: letter comparison (60 items within 3 minutes)

Table 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)
Phonological 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)

Table 3

Independent sample t-tests comparing the PragmaCom group and the Control group for the control and the main outcome measures at pre-training

Variable	*df*	*t*	*p*	*M* diff	*SE* diff
Age	47	-0.37	.72	-0.63	1.72
Education	23.30	-1.24	.23	-1.30	1.05
Fluency	46	-0.28	.78	-0.97	3.41
Vocabulary knowledge	17.08	-1.31	.21	-3.92	3.00
APACS Total	40	1.26	.21	0.02	0.01
Phonological and Mental Metaphors	47	-0.42	.68	-0.72	1.73
Off-Topic Verbosity	22	-0.99	.335	-0.07	0.08

Table 4

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

		PMM						OTV					
		PragmaCom			Control			PragmaCom			Control		
	Independent variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Model 1	Baseline	0.56	0.09	0.77***	0.75	0.13	0.85***	0.01	0.23	0.02	0.70	0.11	0.90***
Model 2	Baseline	0.44	0.11	0.60***	0.34	0.18	0.37	0.17	0.24	0.23	0.72	0.13	0.92***
	Age	-0.90	0.58	-0.18	0.15	0.89	0.02	0.17	0.24	0.23	-0.01	0.04	-0.05
	Language-based index	0.72	0.58	0.18	1.70	0.56	0.60*	0.018	0.05	-0.13	0.017	0.02	0.12

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

Figure Captions

Figure 1. Schematic representation of the phases and items in the PragmaCom training.

Figure 2. Scatterplots showing the performance across time of the two groups (PragmaCom and Control) in the two main outcome measures.

The performance of the two groups in the Phonological 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 observed scores for each participant.

Figure 3. Correlogram displaying the relationship between age, language-based index and the main outcomes measured 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 main 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.

Figure 1

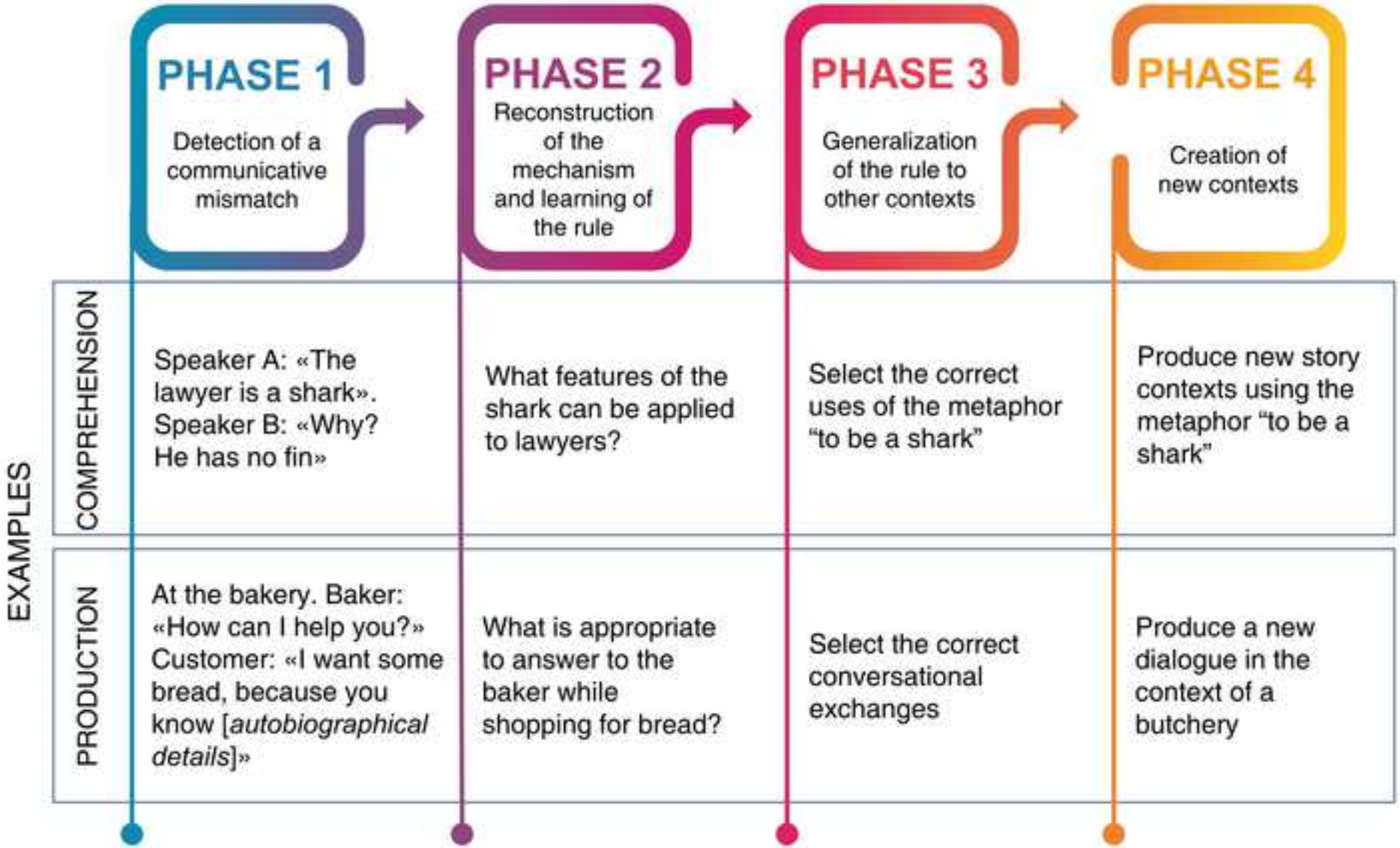

Figure 2

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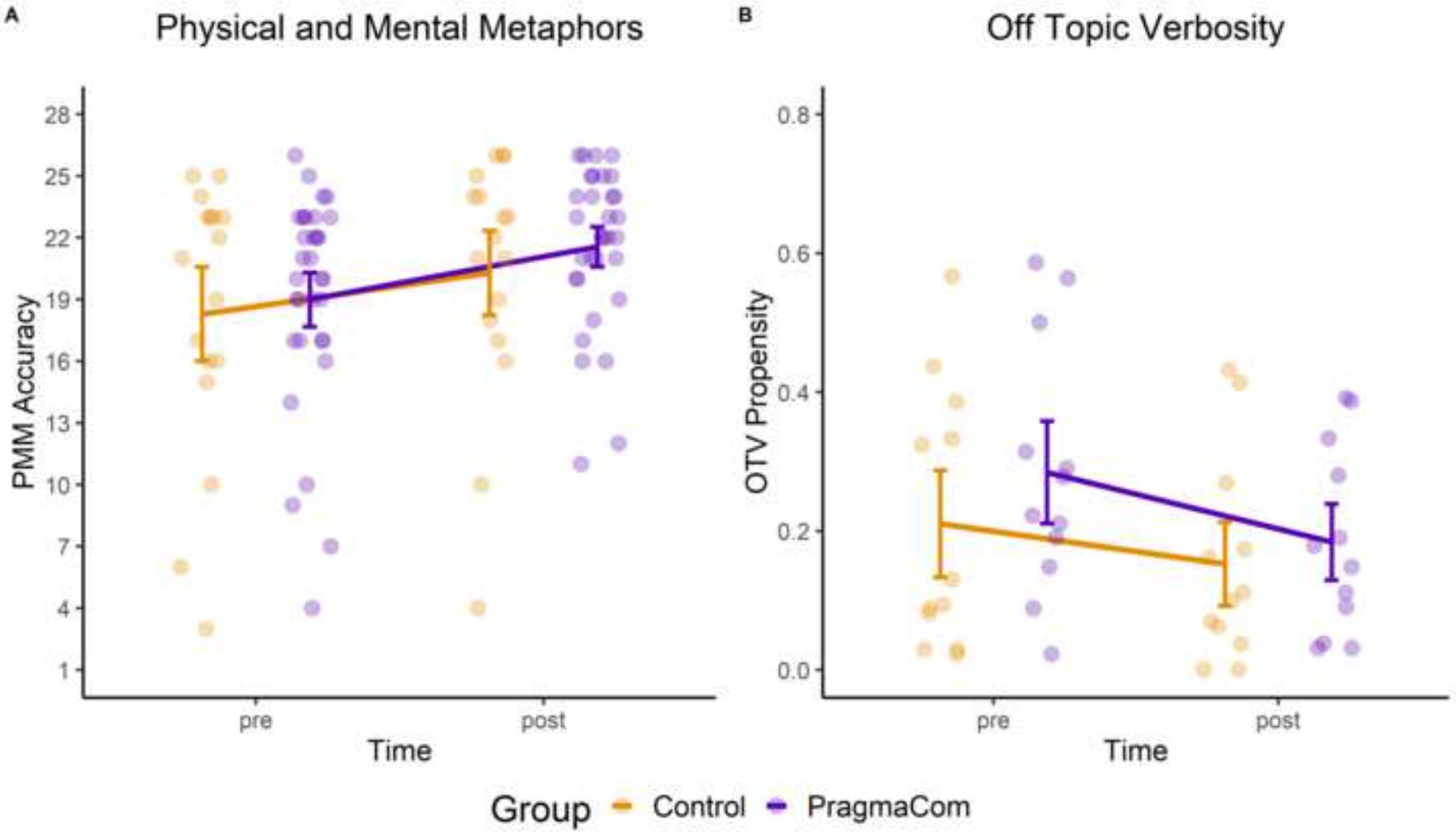

Figure 3

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