

Changes of Meta-Representational Skills in Ageing: First Empirical Evidence on the Relation between Metalinguistic Competence and Attributions of Mental States

Federica Bianco¹, Ilaria Castelli¹, Carmen Belacchi²

¹ University of Bergamo, Bergamo, Italy

² University of Urbino Carlo Bo, Urbino, Italy

Abstract

Background. The present paper focuses on meta-representational changes occurring in ageing by studying the decline in Definitional Competence, an ability so far little studied in this period of life.

Purpose. The paper hypothesises a relation between Theory of Mind (ToM) and Definitional Competence, in a view that posits the former as a preparatory and facilitating competence for a more complex linguistic production, that is lexicographic definition. The effects of levels of education on the decline in ageing for Definitional Competence and ToM are also investigated.

Methods. We recruited 24 adults (age range 21–55), 25 young-old adults (age range 60–70) and 25 old-old adults (age range 71–85) and administered them the Eyes task to measure ToM and the Co.De. Scale to assess Definitional Competence.

Results. Results suggest that Definitional Competence declines earlier on than ToM, mirroring the well-known process according to which in semantic knowledge, during ageing, taxonomic relations are lost before thematic ones. Our results also show that better levels of education are associated with better performance in both our key constructs and that ToM predicts Definitional Competence, in line with our expectations.

Conclusion. The paper offers one of the first systematic studies on the changes in Definitional Competence during the last phase of life and it provides theoretical insights into the relation between ToM and Definitional Competence in ageing.

Implications. The paper is informative for future interventions aimed at enhancing linguistic and metalinguistic skills in ageing through the preservation of better levels of awareness and the assumption of a decentralised perspective in interpersonal communication.

KEYWORDS

definitional competence, theory of mind, meta-representation, ageing, levels of education

Citation: Bianco, F., Castelli, I., & Belacchi, C. (2022). Changes of Meta-Representational Skills in Ageing: First Empirical Evidence on the Relation between Metalinguistic Competence and Attributions of Mental States. *Journal of Language and Education*, 8(3), 41-53. <https://doi.org/10.17323/jle.2022.13868>

Correspondence:

Federica Bianco
federica.bianco@unibg.it

Received: February 12, 2022

Accepted: September 07, 2022

Published: September 30, 2022

INTRODUCTION

Meta-representation ability, the skill that permits one to implicitly and explicitly grasp and share one's own and other internal states, is a distinctive feature of the human species and finds its highest manifestation in language (Tomasello, Carpenter, Call, Behne, & Moll, 2005). Cognitively speaking, language is a powerful means of representation that organises world knowledge into perma-

nent and systematic mental structures and enables the sharing of this knowledge among all members of a given culture (Tomasello, 1999). Language also facilitates continual analytical reflection on experience and allows different hypothetical scenarios to be represented. From a communication point of view, language permits the negotiation of meanings, plans and solutions, as well as the explanation of individual mental states. In other ways, language and, crucially, the ability to define words allows us to



make explicit the implicit representations (both personal and cultural) according to the Representational Rewriting Model by Karmiloff-Smith (1992).

The prerequisite par excellence of language development consists in the ability to recognise that other individuals have minds that function in a similar way to ours (Tomasello, 2001) and in understanding other's intentions to pursue the "same" means for the "same" end (Tomasello, 2003, p.33). Other skills that seem particularly important for language acquisition involve various kinds of broadly defined pattern-finding categorisation (Rosh et al., 1976).

THEORETICAL BACKGROUND

The ability to understand others' internal representation behind manifest behaviour is called Theory of Mind (ToM) (Premack & Woodruff, 1978; Wimmer & Perner, 1983). Language and ToM share high-level cognitive and meta-representational components, and this common substrate is thought to explain how the acquisition of each of these competencies is closely linked to the acquisition of the other (Astington & Baird, 2005; Tomasello, 2001). In particular, among linguistic skills, the Definitional Competence, the ability to make verbally explicit the meaning of a given word (*definiendum*) by means of other words (*definiens*), implies metalinguistic and meta-representational capacities (Benelli et al., 2006), also crucial for ToM competence. Indeed, producing good lexicographic definitions demands not only the metalinguistic capacity to follow conventional rules for making word meanings explicit, the selection of relevant semantic content components, and the use of appropriate linguistic forms, but also the ability to take simultaneously into account one's own and others' information needs and goals. Despite the fact that the two skills studied here (namely *ToM* and *Definitional Competence*) seem to share the same underlying meta-representative process, they are also deeply different in their nature and thus can be studied as different constructs. ToM competence usually acts at an implicit (unless the subject is asked to verbally explicit the contents of their inferences upon mental states, such as in the second- and third-order false belief tasks or in some conversations) and contextualised level, while the Definitional Competence requires the mastering of explicit, de-contextualised and intersubjective forms of sharing mental representations. At a theoretical level, in order to provide the interlocutor with adequate definitions through a conventional and effective verbal exchange, the speaker needs to put themselves in the shoes of the interlocutor, assuming their cognitive and affective representation of the world (the core of ToM). However, few studies have investigated the meta-representational components of Definitional Competence (e.g. Belacchi & Benelli, 2021), requiring awareness of both the conventional value of definitions and shared meanings and no less of the interlocutors' informa-

tional needs and, more generally, of the ability to assume other perspectives.

From the literature in this domain, it is clear that, even if many previous empirical works examined the reciprocal links between language and ToM acquisition (see, for example, Astington & Baird, 2005; Tomasello, 2001), we still have little understanding of how the ability to define words and ToM are related in different phases of life. We already know that these kinds of meta-representational abilities are influenced by age, cognitive abilities and level of education (Benelli et al., 2006; Gini, Benelli and Belacchi, 2004; Li et al., 2013; Pardini e Nichelli 2009; Phillips et al., 2002; Slessor et al., 2007), but the relation between implicit (automatic and unconscious) and explicit (deliberate and conscious) levels/mechanisms that characterise the structure, functioning and specific manifestations of different meta-representational skills is still an open question. In particular, following both previous theoretical approaches (e.g., Malle, 2022) and preliminary evidence (Belacchi 2004; Belacchi, 2019; Roselli, Valentini, & Belacchi, 2019) on this issue, we are interested in testing whether the ability to implicitly represent one's own and others' psychic states (i.e., ToM as measured by tasks assessing automatic attribution of inner states) favours the mastery of language in its most advanced and explicit forms, as in the case of Definitional Competence.

In the present paper we aim to provide one of the first contributions in this domain by focusing on aging. This period of the life-span can be particularly informative on the nature of the relation between ToM and Definitional Competence, as we know from a rich body of previous research that ToM undergoes deep transformations during the last phase of human life (Henry, Louis, Phillips, Ruffman, & Bailey, 2012; Hughes et al., 2019) and that crystallised knowledge tends to be maintained while fluid intelligence seems to decline in this period of life. On the other hand, recent literature on ageing has elucidated that some aspects of language skills decline across ageing while others are mainly preserved. In particular, it seems that productive aspects of language are more vulnerable to the effect of age (Burke & Shafto, 2008; Zhang, Eppes, & Diaz, 2019). Moreover, previous research suggests that the thematic memory organisation is better preserved in older adults than the taxonomic organisation (Belacchi & Artuso, 2018; Belacchi, Artuso, & Palladino, 2022), so it is plausible that those parts of language skills that use taxonomic categorisation are particularly impaired in the ageing process. Moreover, Artuso & Belacchi (2021) showed that the elderly seem to use thematic knowledge to support expository text comprehension and not the taxonomic one, which would work better in the light of similar common processes (such as abstract logical relationships and de-contextualisation). This confirms that hierarchically organised semantic structures (i.e., taxonomic ones) are not specifically useful in comprehending complex texts for older adults, conversely to what has been observed in adults.

In the following paragraph, we will better analyse each of our target skills and provide a framework to understand the main developmental changes from a life span perspective.

Definitional Competence: Its Nature and Developmental Trend

As stated above, language is a powerful means of representation that codes the most relevant knowledge about the world, allowing to share this knowledge among all members of a given culture. From a communicative point of view, language allows negotiation of meanings, plans and solutions, as well as an explanation of individual mental states such as notions, beliefs, emotions and needs (Nelson, 1996; Tomasello, 2001).

One of the most powerful ways to understand the most abstract, meta-linguistic and meta-representational aspects of language is to analyse the ability to define words: definitions require a well-established, conventionally shared semantic knowledge and linguistic expression rules, being part of the intersubjective “common ground” (Tomasello, 2008). The prototypical format of a lexicographic definition is the Aristotelian formula: “An X is a Y that Z”, which involves lexical, semantic and syntactic abilities to express the meanings of words (Belacchi & Benelli, 2007; Belacchi & Benelli, 2017; Benelli, Belacchi, Gini & Lucangeli, 2006). Traditional literature on conceptual and definitional development has shown that different definitional levels exist according to the kinds of answers children provide (Litowitz, 1977; Snow, 1990; Benelli & Belacchi, 2017). According to a developmental trend, prototypical definitional answers range from the so-called HAS structure (“a chair *has* four legs”), which simply describes the sensorial and experiential aspects of referents, to the so-called ISA structure (“a chair *is* a piece of furniture”), with a taxonomic organisation of conceptual knowledge. This syntagmatic to paradigmatic shift occurs around six to seven years of age.

Lexicographic definitions are an expression of explicit meta-linguistic competence: to define implies not only knowing *what to say* but also *how to say* it (McGee-Bidlack, 1991; Snow,

1990; Watson, 1995; Benelli et al., 2006). Producing good definitions also has meta-communicative and meta-representational components; it requires awareness of the conventional value of definitions and shared meanings and interlocutors’ informational needs.

Recently, a scale was developed (Benelli, et al. 2006; Belacchi & Benelli, 2017; Belacchi & Benelli, 2021) to assess Definitional Competence (Co.De. Scale). This scale identifies definitional levels, emphasising the formal aspect of the answers and analytically expanding the semantic content that is not directly evaluable. Specifically, the higher the scale levels, the better they represent the requirements of high-quality definitions. High-quality definitions (that are successful in making a reciprocal correspondence between *definiendum* e *definiens* at the semantic content level) have to respect the following formal rules: illustration of a meaning of a word by using other words (no-tautology rule); provision of more words than the stimulus item (phrasal extension rule); provision of a verbal expression to make explicit the semantic equivalence (copula rule); provision of a syntactically autonomous and correct linguistic structure (syntactic autonomy rule) (Belacchi & Benelli, 2021). See Table 1 for more details on the levels of the scale.

Previous research (e.g. Belacchi & Benelli, 2007; 2021; Benelli & Belacchi, 2017) has shown an increase in both formal correctness and completeness of the linguistic structures used to define words from preschool age to adulthood. The same age-related trends were found for nouns, verbs and adjectives, and concrete and abstract nouns. It was also demonstrated that there is a high concurrent validity of the Definitional Scale with traditional measures of intelligence, both in typical and atypical populations. In particular, mental and chronological age are predictors of Definitional Competence in children with intellectual disabilities (Belacchi & Benelli, 1999; 2007). Moreover, definitional skills, as a measure of de-contextualised language abilities, are closely related to school success and literacy (Artuso, Palladino, Valentini & Belacchi, 2022; Gini, Benelli & Belacchi, 2004; Gutierrez-Clellen & DeCurtis, 1999; Sinclair, 1986; Snow, 1990).

Table 1

Definitional Levels, Prototypical Answers and Scores for the Definition of the Word “Donkey”

Levels	Types of answers	Score
0. Non-definition	Non-verbal answers	0
I. Pre-definition	One-word answers, mostly associations (e.g. <i>donkey-> ears</i>)	1
II. Quasi-definition	Initial formulation of sentences without autonomous forms (e.g. <i>donkey-> with the long ears; when it brays</i>)	2
III. Narrative/descriptive definition	Formally correct and autonomous sentences with narrative/descriptive content (e.g. <i>donkey brays; donkey is mild</i>)	3
IV. Categorical definition	Formally correct and autonomous sentences in simply categorical/synonymic form (e.g. <i>The donkey is an animal</i>)	4
V Partial Aristotelian definition	Formal correctness without semantic equivalence (e.g. <i>The moon is a planet in the solar system</i>)	5
VI. Aristotelian, metalinguistic definition	Formal and semantic correctness and equivalence (e.g. <i>A donkey is an animal that brays</i>)	6

To our knowledge, this is the first complete study on Definitional Competence in ageing, although some preliminary results have also been presented at conferences (Belacchi, 2019).

Theory of Mind: Its Nature and Developmental Trend

In ToM reasoning, being able means being able to acknowledge the existence of mental states and to explain social actions in terms of inner states guiding the behaviour (Premack & Woodrooff, 1978; Wimmer & Perner, 1983). The more a person is competent in ToM, the more they are able to correctly ascribe a particular mental state (i.e., intention, emotion, desire, thought) to a focus agent, and the more they tend to adopt a mental-state lexicon to describe other people and their actions (Hughes, 2011). Studies on individual differences in ToM consistently show that this ability is fundamental for having a satisfying social life across an entire life span (Lecce et al., 2017; Slaughter, Imuta, Peterson, & Henry, 2015), and recent research has also demonstrated that ToM plays a role in the cognitive adjustment of the subject (Miller, 2012; Wellman, 2018).

The heart of ToM competence is achieved around four years of age when the child becomes capable of reasoning on how a person may be guided in their actions by wrong thoughts on reality (Wellman, 2018). Then, the competence becomes more and more mature across middle childhood (Bianco, Lombardi, et al., 2019; Bianco et al., 2021; Lecce, Bianco, Devine, & Hughes, 2017), preadolescence (Devine & Hughes, 2013) and adolescence (Valle, Massaro, Castelli, & Marchetti, 2015). Interestingly, a meta-analysis of ToM studies in ageing showed that older adults score significantly poorer than their younger counterparts across a wide range of measures varying on the modality of assessment, with a mean effect size of the age-effect moderate in magnitude (Henry, Phillips, Ruffman, & Bailey, 2012). This ToM impairment begins at about 60 years of age and becomes more accentuated after 80 years of age (Charlton, Barrick, Markus, & Morris, 2009). Sometimes, the decline was observed at the level of brain activation (e.g., Castelli et al., 2010).

Notwithstanding these acknowledgements, our comprehension of how ToM changes during ageing is far from complete. In particular, we do not know how the decline observed after 60 years of age is bound to the functioning of other near cognitive domains and if sex differences may occur (the role of sex in the ability to reason on inner states remains an open question, for example, see Baron Cohen, 2001 vs Serafin & Surian, 2004).

Literature also showed an association between years of formal education and ToM competence (Li, Wang, Wang, Tao, Xie, & Cheng, 2013; Pezzuti, Longobardi, Milletti, & Ovidi, 2011).

Research Questions and Hypotheses

The present contribution aims to understand better the relationship between Definitional Competence and ToM ability in ageing, but also to add evidence on how these competencies unfold over time during the last phase of life and how they vary depending on levels of education. We expect to find an effect of age and education on the two competencies, in line with the literature reported above. Specifically, we hypothesise a decrease in the two sets of abilities related to age and an increase in the two sets of skills related to more years of formal education. As literature reports mix findings for the presence of sex differences in meta-representational skills (Astington & Jenkins, 1995; Baron-Cohen et al., 1999; Bosacki & Astington, 1999; O'Hare, Bremner, Nash, Happé, & Pettigrew, 2009), we checked for this potential effect without an a-priori hypothesis. Our final expectations concern the nature of the relationship between Definitional Competence and ToM. As our ToM measure mainly implies implicit representations, while Definitional Competence always involves explicit representations, we expected the former to act as a predictor of the latter, beyond the influence of age and schooling. To be more stringent, in analysing the relation between ToM and Definitional Competence, we also considered the type of words to be defined (words that do refer to vs words that do not refer to inner states).

METHODS

Participants

Seventy-four subjects (37 males) were recruited by local advertising (e.g., in recreational centres) in a region in the centre of Italy. Informed written consent for participation in the research was collected. All participants were treated in accordance with the ethical guidelines for research provided by the Declaration of Helsinki (World Medical Association, 2014), the American Psychological Association (APA, 2020) and the Italian Psychological Association (AIP, 2015).

None of them reported severe health problems of any kind (i.e. no anxiety, depression, sleep disturbances or other medical conditions). All participants were Italian native speakers and scored above the 24-point cut-off of the Mini-Mental State Examination (MMSE) (Folstein, Folstein, &

¹ APA American Psychological Association (2020). Publication Manual 7th Edition. American Psychological Association.

² AIP Italian Psychological Association (2015). Codice etico [Ethics code]. https://www.aipass.org/sites/default/files/codice%20etico%20AIP%20rev_.pdf

McHugh, 1975). The sample was composed of 24 adults (age range 21–55, $M = 38.29$, $SD = 11.53$), 25 young-old adults (age range 60–70, $M = 65.16$, $SD = 2.97$) and 25 old-old adults (age range 71–85, $M = 76.80$, $SD = 3.40$). In the group of adults, 18 out of 24 participants reported nine or more years of formal education; in the group of young-old adults, 11 out of 25 reported nine or more years of formal education; in the old-old group, only two participants reported nine or more years of formal education. All participants were unpaid volunteers.

Measures

Theory of Mind

To index ToM, we administered the Eyes Test Adult Version (Baron-Cohen et al., 1997, 2001). This test assesses the ability to attribute complex emotional and epistemic mental states from the eyes. For each item, participants are required to select which of four words best describes the thoughts or feelings expressed in a picture depicting a person's eye region. The test is made up of 36 items. For each correct answer, a score of 1 is given. The cut-off score is 13. The total score ranges from 0 to 36.

Definitional Competence

To assess Definitional Competence (Def), we used the Co.De. Scale (Belacchi & Benelli, 2021) articulated into seven definitional levels (while the previous one was articulated into five levels). This new version allows a more analytical assessment of Definitional Competence (see Table 1). The subject is presented with 32 target words (8 nouns, 8 verbs, 8 adjectives and 8 emotion terms) varying in terms of concreteness/abstraction and in being/not being words referring to mental states (ToM words). Items were presented in random order. For each item, participants are asked: "What does (stimulus word) mean?". Each definition, orally provided by participants, was rated on a 7-level scale (score range: 0-6). According to the scale, the more correct, syntactically articulated and organised a participant's definition was, the higher the definitional level attributed (see Table 1 for information about the scoring used). Given that the frequency in the use of nouns/verbs/adjectives that refer to one's own or others' mental states is an indicator of ToM competence (De Rosnay & Hughes, 2006), we separated words that refer to inner states (i.e., thoughts, desires, emotions) from other words. This allowed us to investigate if the hypothesised link between Definitional Competence and ToM is general or specific for words referring to mental states. We considered the following Italian items as ToM words: orgoglio, tristezza, rabbia, vergogna, invidia, senso di colpa, gioia, paura, premura, innocente, pensare, spionaggio, tollerare, costringere, rivalità, frustrare (in English: pride, sadness, anger, shame, envy, guilt, joy, fear, caring, innocent, to think, spying, to tol-

erate, to force, rivalry, to frustrate). We considered the following Italian items as non-ToM words: asino, battere, scot-tare, pagliaccio, magro, rotondo, rischioso. unire, arancia, educato, emigrare, biondo, abilità, liscio, ombrello, contagioso (in English: donkey, to beat, to burn, clown, thin, round, risky, to join, orange, polite, to emigrate, blond, skill, smooth, umbrella, contagious). Participants received mean definitional scores (range 0-6) for total, non-ToM, and ToM words.

Analysis

Statistical analyses were performed with SPSS version 19. We started by running preliminary analyses on the distribution of scores on the Co.De. Scale; we then checked if sex affected our key measures in order to know if including sex (as control variable) in the following analysis or excluding it. We conducted univariate ANOVAs to examine effects of age and years of education on both Definitional Competence and theory of mind. Pairwise comparisons, corrected for Bonferroni indices, were performed in order to break down significant effects. To investigate the possible relations between definitional skills and ToM, we first conducted correlational analyses. Then, to better understand the impact of ToM on Definitional Competence, we run a hierarchical regression analysis entering, at Step 1, age and years of education, and, at Step 2, ToM scores. To be more stringent, we conducted analyses considering firstly all the items of the Co.De Scale and then separating words concerning mental states (ToM words) and words not concerning mental states (non-ToM words).

As our sample was not balanced concerning years of education, we could not test for age X education interaction.

Procedure

At the first stage we collected Informed written consent for participation in the research. At the beginning of the study subjects were administered the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) and asked for information about years of education and potential medical issues.

The focus tasks were administered in a fixed order: the Eyes task, then the Co.De Scale. The evaluation took place during a single session lasting about one hour at the homes of participants.

RESULTS

The results section is organised into four sections: a section focused on preliminary analyses to provide information on the distribution of Definitional Competence scores across

³ The data that support the findings of this study are available from the corresponding author, [FB], upon reasonable request.

age-groups and to check the potential effect of sex on our key measures via ANOVA; a section devoted to understand the effect of age and education on Definitional Competence via ANOVAs; a section devoted to understand the effect of age and education on theory of mind with ANOVAs; a final section where assessing relations between performance on Co.De. Scale and performance on ToM task through correlational and regression analysis.

Preliminary Analyses

From a preliminary analysis of non-verbal answers (Level 0 of the Co.De. Scale), we found 0.4% of answers of this type in the adult group, 1.13% in the young-old group, and 3.13% in the old-old group. Figures 1 and 2 show, for each age group, the proportions and distribution of responses for each verbal level of the Co.De. Scale.

Analyses showed that neither did sex have an effect on ToM, $F = 0.29, p = .60$, nor on Definitional Competence (total words/ToM words/non-ToM words), $0.002 < F_s < 0.42, .52 < p_s < .96$. For this reason, we did not have a control for sex in the next analyses.

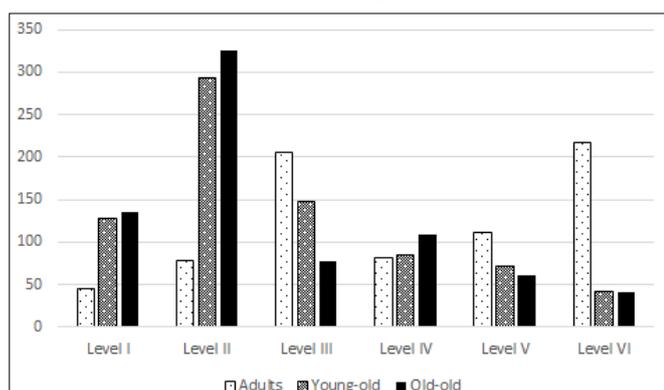
Differences in Definitional Competence scores as a function of age and education

Please note that the following analyses were conducted only on verbal answers (from Level 1 of the Co.De. Scale). Descriptive statistics for Definitional Competence in each age group and each level of education are shown in Table 3.

Analyses revealed the presence of age differences, $F(2, .71) = 24.03, p < .001$, partial $\eta^2 = .40$, with the group of adults outperforming both the young-old adult one, $p < .001$, 95% CI [0.76, 1.89], and the old-old one, $p < .001$, 95% CI [0.89, 2.02]. No differences emerged between the two groups of aged people, $p = 1.0$. The same age group effect was retrieved when we analysed effects on non-ToM words only, $F(2, 71) = 14.58, p < .001$, partial $\eta^2 = .29$, or on ToM-words only, $F(2, 71) = 28.51, p < .001$, partial

Figure 1

Frequency Distribution of Verbal Answers Across the Levels of the Co.De. Scale as a Function of Age



$\eta^2 = .45$. Analyses showed an effect of years of education, $F(1, 72) = 29.03, p < .001$, partial $\eta^2 = .29$. Pairwise comparisons with the Bonferroni method also showed that people with “higher levels of education” (calculated as more than 8 years of education) outperformed people with “lower levels of education” on Definitional Competence, $p < .001$, 95% CI [0.70, 1.53].

Differences in ToM scores as a function of age and education

Descriptive statistics for ToM scores in each age group and each level of education are shown in Table 3. Analyses revealed the presence of age differences, $F(2, 71) = 6.05, p = .004$, partial $\eta^2 = .15$. Pairwise comparisons, corrected for Bonferroni indices, showed significant differences only between the adult and old-old groups, $p = .003$, 95% CI [0.46, 0.27].

In a further ANOVA, the main effect of education was significant, $F(1, 72) = 16.62, p < .001$, partial $\eta^2 = .19$, with more formally educated people performing better than those less educated as shown by pairwise comparisons adopting the Bonferroni method, $p < .001$, 95% CI [0.08, 0.22].

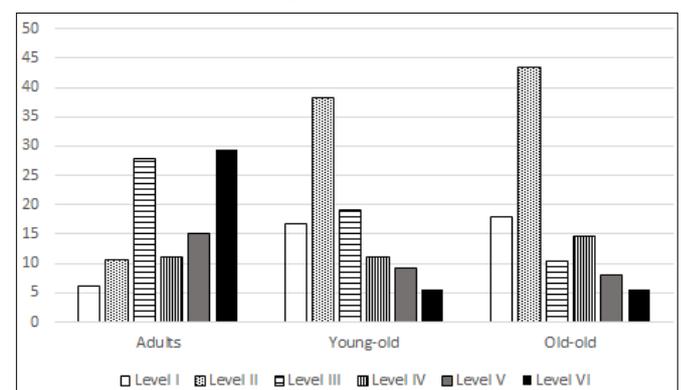
Relationship between performance on Co.De. Scale and performance on ToM task

Please note that the following analyses were conducted only on verbal answers (from Level 1 of the Co.De. Scale). We found a bivariate correlation (see Table 4) between the two skills, $r(74) = .51, p < .001$. Crucially, this relation is still significant, when we consider only non-ToM words, $r(74) = .46, p < .001$

In our first regression analysis on the Co.De Scale scores, at Step 1, we entered age and years of education, at Step 2, ToM scores. Step 1 was significant, $F(2, .71) = 51.61, p < .001$. Age resulted as a significant predictor, $\beta = -0.52, t = -4.65, p < .001$, and also the level of education, $\beta = 0.30, t = 2.68, p = .009$. Interestingly, Step 2 led to a significant increase

Figure 2

Percentage Distribution of Verbal Answers Across the Levels of the Co.De. Scale in Each Age Group



in the variance explained, $\Delta F(1, 70) = 5.15, p = .026$, with ToM uniquely predicting 2.8% of the variance in Definitional Competence scores. When we investigated the impact of ToM on Definitional Competence, separating non-ToM and

ToM words, the pattern of results was similar, even if for non-ToM words, the effect of ToM was marginally significant (please see Table 5, Table 6, and Table 7 for further details on regression analyses).

Table 3

Descriptive Statistics on Definitional Competence and ToM Scores Across Age Groups and Levels of Education

	Adult Group M (SD)	Young-old Group M (SD)	Old-old Group M (SD)	High Level of Education M (SD)	Low Level of Education M (SD)
Definitional Competence (total words)	4.07 (1.09)	2.74 (0.63)	2.62 (0.64)	3.78 (1.20)	2.66 (0.54)
Definitional Competence (non-ToM words)	4.05 (1.02)	3.01 (0.70)	2.97 (0.59)	3.79 /1.14)	3.0 (0.54)
Definitional Competence (ToM words)	4.09 (1.25)	2.47 (0.64)	2.26 (0.77)	3.76 (1.34)	2.32 (0.65)
ToM	0.61 (0.16)	0.53 (0.16)	0.46 (0.15)	0.62 (0.14)	0.47 (0.16)

Note: We considered nine or more years of education as a “high level of education” and all other values as a “low level of education”

Table 4

Correlations Among Focus and Control Variables

	Age	Education	ToM	Def.Comp. Total words	Def.Comp. non-TOM	Def. Comp. ToM
Age	1	-.74***	-.42***	-.74***	-.66***	-.75***
Education		1	.49***	.68***	.60***	.71***
ToM			1	.51***	.46***	.52***
Def.Comp. - Total words				1	.95***	.97***
Def.Comp. - non-TOM					1	.85***
Def. Comp. - ToM						1

*Note: + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$*

Table 5

Hierarchical Regression Predicting Definitional Competence (Total words)

		B	SE	β	p
Step 1	Age	-.03	.007	-.52	<.001
	Education	.07	.03	.30	.009
Step 2	Age	-.03	.006	-.50	<.001
	Education	.05	.03	.22	.054
	ToM	1.18	.52	.19	.026

R² = .59 for Step 1; $\Delta R^2 = .03$ for Step 2

Table 6

Hierarchical Regression Predicting Definitional Competence (non-ToM words)

		B	SE	β	p
Step 1	Age	-.03	.007	-.50	<.001
	Education	.05	.03	.22	.086
Step 2	Age	-.03	.007	-.48	<.001
	Education	.03	.03	.15	.262
	ToM	1.03	.54	.19	.062

R² = .46 for Step 1; $\Delta R^2 = .03$ for Step 2

Table 7

Hierarchical Regression Predicting Definitional Competence (ToM words)

		B	SE	β	p
Step 1	Age	-.04	.008	-.51	<.001
	Education	.10	.03	.34	.003
Step 2	Age	-.03	.007	-.48	<.001
	Education	.08	.03	.27	.019
	ToM	1.34	.59	.19	.027

R² = .62 for Step 1; $\Delta R^2 = .03$ for Step 2

DISCUSSION

The present study aimed to analyse for the first time in literature the relationship between two meta-representational skills, namely Definitional Competence and ToM, in ageing and to explore the possible analogous or different trends of developmental changes in different age groups.

Our results on the Co.De. Scale for our youngest group are in line with the mean normative scores obtained by adult people in the standardisation study conducted on 2262 Italian subjects. However, we also found a decline associated with ageing, which is worth further discussion. Even if literature consistently claims that crystallised knowledge is basically maintained across ageing (Bowles & Salthouse, 2008; Burke & Shafto, 2008; Wang & Kaufman, 1993), our results suggest that specific aspects of language, such as Definitional Competence, may be impaired. This pattern of findings can be explained considering that Definitional Competence requires a taxonomic organisation of representations, which tends to decline in the elderly, compared with better maintenance of thematic organisation (Belacchi & Artuso, 2018). A similar decline was also detected for ToM, although less marked and delayed in the age groups considered.

Our first proposal of explanation is that the decline in Definitional Competence could be due to the skills that underlie a competent use of such knowledge. Our work goes in this direction, confirming a relationship between Definitional Competence and ToM, and we already know from a large body of previous research that ToM seems to decline after 60 years of age (for a review, see Henry et al., 2013). A second possibility, not addressed here, is that the observed impairment is due to the well-known scarce executive functioning and the changes in brain connectivity (Cabinio et al., 2015.; Hughes et al., 2019) occurring in ageing. A third explanation concerns the possibility that the concurrent decline in ToM and definitional skills may reflect a more general decline in the shared underlying meta-representational domain, and indeed, we retrieved a significant association between performance on both the ToM and Definitional Competence tests, though they required quite different language skills: the Eyes Test simply requires activation of the correct name of the emotion observed, while the Co.De. Scale demands to recover and make analytically explicit the components of meaning of the terms through complex and more de-contextualised linguistic structures.

Finally, the decline in Definitional Competence might mirror a more generable vulnerability in language production during ageing. This vulnerability has been previously detected for word retrieval and off-topic speech (Burke & Shafto, 2008; Zhang, Eppes, & Diaz, 2019). However, we should note that our work reports a significant difference between the adult group and the group of aged people that for Defini-

tional Competence emerges from the beginning of ageing, while for ToM is evident only for the group of old-old people. If we look at the developmental literature, there is consensus that basic ToM skills are mastered before Definitional Competence, which is a more complex and specialised ability. Indeed, if the core of ToM competence is achieved around three to four years of age (Wellman & Liu, 2004), it is not until seven years of age that children are able to provide canonical definitions by superordinating categorical terms (Benelli & Belacchi, 2017). This symmetric temporally reciprocal loss could be a phenomenon similar to what previous studies have observed in the case of the deterioration of semantic knowledge, in which taxonomic relations (that are acquired later on) are lost before thematic ones (Rogers & McClelland, 2004). An intriguing explanation that can make sense of this evidence is the possibility that Definitional Competence may decline earlier, as it is a more sovraordinate ability, while ToM, a more basic skill, declines later, as it is crucially linked to survival needs.

To resume, while sex does not affect the meta-representative abilities investigated here, in regards to the effect of age, it can be said that the ability to recognise emotions by reading gaze is relatively preserved in ageing, compared to the ability to define words in general, and emotions in particular. With regards to the effect of education, higher levels of education are associated with better performance on both ToM and Definitional Competence, suggesting that education can preserve a decline in different areas of cognitive processing.

We found that performance on the Eyes Test predicted performance on the Co.De. Scale over and above that is explained by education and age (please note, as a limit of our work, that these last factors explained a bigger variance than ToM). This was in line with our expectations, based on the assumption that the ability to name and recognise internal states is a preparatory and facilitating competence for a more complex meta-linguistic and meta-representational word production, i.e. lexicographic definition. The latter requires, indeed, the evocation and phrasal articulation of the meanings of words and, specifically, of terms that designate inner states (in the parts of the task that refer to ToM words). An explanation for this result is that the Eyes task measures a meta-representative ability of an implicit type, while the Co.De. Scale requires a capacity of an explicit, more evolved type, according to the representational rewriting model of Karmiloff-Smith (1992). This model considers psychological development in different domains of knowledge as a progressive, continuous transformation of the information already stored (by innate or acquired ways), recoding them in different formats that are gradually more complex, articulated and conventional – in other words, more and more explicit. On the basis of these findings, it seems that the better one's ToM capacity, the better one correctly attributes mental states and uses an adequate emotional lexicon

to describe people and their actions (Hughes, 2001), confirming and strengthening the strong association found in previous studies between performance on ToM and simple vocabulary measures (Peterson & Miller, 2012). In the light of our results, we can add that the perspectives of others, as measured by the ToM task, enable us to define mental representations, such as the meanings of words. Therefore, our results confirm that in ageing, the implicit understanding of the intentions of others can be a determining requirement for maintaining Definitional Competence as it is, reciprocally, for learning words in the early stages of development (Baldwin, 1993; Tomasello & Farrar, 1986).

There are some limitations in our work which warrant further mentioning, as they imply guidance for further research. The first limit was the lack of other ToM measures, beyond the Eyes test that requires subjects to give a verbal answer, i.e. naming an inner state. Future studies should adopt various measures of ToM tasks employing different modalities of answers to provide more reliable estimates of the relation between the two constructs, ruling out the possibility that we are observing an artifactual association due to the specific choice of instruments. The second one regards the design of our work and the conclusions we can formulate based on this. Our work is indeed cross-sectional, and even if we found that ToM performance predicts variance in Definitional Competence scores, future longitudinal designs or experimental manipulations in a training design are required to confirm the pattern of influences. A final limitation of the current work regards the lack of balance in our groups for years of education and, therefore, the impossibility to fully shed light on the interplay among age, education and ToM in determining levels of Definitional Competence in ageing. Future research should better consider this aspect and adopt a more stringent approach to this issue.

REFERENCES

- Agha, A. (2006). *Language and social relations*. Cambridge University Press.
- Artuso, C., & Belacchi, C. (2021). *Semantic memory and reading comprehension: the relationship through adulthood and aging*. *Aging Clinical and Experimental Research*, 33(8), 2261-2271. <https://doi.org/10.1007/s40520-020-01771-1>
- Artuso, C., Palladino, P., Valentini, P. & Belacchi C. (2022). Definitional skills as a bridge towards school achievement. *Sustainability*, 14, 286. <https://doi.org/10.3390/su14010286>
- Astington, J. W., & Baird, J. A. (Eds.). (2005). *Why language matters for theory of mind*. Oxford University Press.
- Astington, J. W., & Jenkins, J. M. (1995). *Theory of mind development and social understanding*. *Cognition and Emotion*, 9, 151-165. <https://doi.org/10.1080/02699939508409006>
- Baldwin D. A. (1993). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language*, 20, 395-418. <https://doi.org/10.1017/S0305000900008345>
- Bambini, V., Tonini, E., Ceccato, I., Lecce, S., Marocchini, E., & Cavallini, E. (2020). How to improve social communication in ageing: Pragmatic and cognitive interventions. *Brain and Language*, 211, 104864. <https://doi.org/10.1016/j.bandl.2020.104864>
- Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high functioning adults with autism or Asperger syndrome. *Journal of Child Psychology and Psychiatry*, 38, 813-822. <https://doi.org/10.1111/j.1469-7610.1997.tb01599.x>

Given the importance of language in social relations (Agha, 2006), future research should study how the decline we observed in Definitional Competence may impact the quality of life of older adults, especially regarding social exchanges. In this respect, it is worth mentioning that previous studies showed that it is possible to intervene in order to help older adults maintain their competence in socio-cognitive skills (Lecce, Bottiroli, Bianco, Rosi, & Cavallini, 2015; Rosi, Bottiroli, Cavallini, Bianco, & Lecce, 2016; Rossetto et al., 2020) and in pragmatics (Bambini et al., 2020).

CONCLUSION

To conclude, the current paper offers one of the first systematic studies on the changes in Definitional Competence during the last phase of life and provides theoretical insights into the relation between ToM and Definitional Competence. Specifically, these results suggest that Definitional Competence declines earlier than ToM, that better levels of education are associated with better performance in both our key constructs and that ToM predicts Definitional Competence, in line with our view that posits ToM as a preparatory skill for lexicographic definition. In an applicative view, our work is informative for future interventions aimed at enhancing linguistic and metalinguistic skills in ageing through the preservation of better levels of awareness and the assumption of a decentralised perspective in interpersonal communication.

DECLARATION OF COMPETING INTEREST

None declared.

- Baron-Cohen, S., O’Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children with Asperger syndrome or high-functioning autism. *Journal of Autism and Development Disorders*, 29, 407-418. <https://doi.org/10.1023/a:1023035012436>
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The “Reading the Mind in the Eyes” Test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child and Psychology Psychiatry*, 42, 241-251. <https://doi.org/10.1111/1469-7610.00715>
- Belacchi C. (2004, September 20-23). *Sviluppo della competenza definitoria e teoria della mente* [Development of definitional competence and theory of mind]. XVIII Congresso Nazionale di Psicologia AIP, Sezione di Psicologia dello Sviluppo, Sciacca, Italy. <http://www.psicologia.unipa.it/sciacca2004.htm>
- Belacchi, C. (2019, May 31-June 1). *Abilità metarappresentive nell’età adulta e negli anziani: confronto tra teoria della mente e competenza definitoria* [Meta-representational skill in adult life and in ageing: comparison between theory of mind and definitional competence]. XII Convegno Nazionale di Psicologia dell’invecchiamento, Chieti, Italy. https://www.sipinvecchiamento.it/Convegni/SIPI_12_ATTI_PESCARA_2019_web.pdf
- Belacchi, C., & Artuso, C. (2018). How taxonomic and thematic associations in semantic memory modulate recall in young through old-old adults. *Psychology and Aging*, 33, 1060-1069. <https://doi.org/10.1037/pag0000297>
- Belacchi, C., Artuso, C., & Palladino, P. (2022). Semantic long-term memory and verbal working memory performance: How does their relationship change with age? *Cognitive Development*, 62, 101185. <https://doi.org/10.1016/j.cogdev.2022.101185>
- Belacchi, C., & Benelli, B. (1999). Lo sviluppo della competenza definitoria in soggetti insufficienti mentali e normodotati [Definitional Competence development in low I.Q and typically developing subjects]. *Psicologia Clinica Dello Sviluppo*, 3, 385-420. <https://doi.org/10.1449/574>
- Belacchi C., Benelli, B. (2007), *Il significato delle parole. La competenza definitoria nello sviluppo tipico e atipico* [The meaning of words. Definitional competence in typical and atypical development]. Il Mulino
- Belacchi, C. & Benelli, B. (2017). “A mosaic is not a place where you go to see pictures”: On the nature of definitions and the development of definitional skills. *Journal of Applied Psycholinguistics*, XVII, 71-91. <https://www.torrossa.com/en/resources/an/4202276>
- Belacchi, C., Benelli, B. (2021). *Valutare la competenza definitoria. La Scala Co. De. In ambito clinico e nello sviluppo tipico* [Measuring the Definitional Competence. The Co.De Scale in typical and atypical development]. Franco Angeli.
- Benelli, B., Belacchi, C., Gini, G., & Lucangeli, D. (2006). ‘To define means to say what you know about things’: the development of definitional skills as metalinguistic acquisition. *Journal of Child Language*, 33, 71-97. <https://doi.org/10.1017/S0305000905007312>
- Bianco, F., Lombardi, E., Lecce, S., Marchetti, A., Massaro, D., Valle, A., & Castelli, I. (2021). Supporting children’s second-order recursive thinking and advanced ToM abilities: A training study. *Journal of Cognition and Development*, 22(4), 1-24. <https://doi.org/10.1080/15248372.2021.1901712>
- Bianco, F., Lombardi, E., Massaro, D., Castelli, I., Valle, A., Marchetti, A., & Lecce, S. (2019). Enhancing advanced theory of mind skills in primary school: A training study with 7□to 8□year□olds. *Infant and Child Development*, 28, e2155, 1-16. <https://doi.org/10.1002/icd.2155>
- Bosacki, S. L., & Astington, J. W. (1999). Theory of mind in preadolescence: Relations between social understanding and social competence. *Social Development*, 8, 237-255. <https://doi.org/10.1111/1467-9507.00093>
- Bowles, R. P., & Salthouse, T. A. (2008). Vocabulary test format and differential relations to age. *Psychology and Aging*, 23, 366-376. <https://doi.org/10.1037/0882-7974.23.2.366>
- 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). Psychology Press. <https://doi.org/10.1016/B978-0-12-809324-5.01889-7>
- Cabinio, M., Rossetto, F., Blasi, V., Savazzi, F., Castelli, I., Massaro, D., Valle, A., Nemni, R., Clerici, M., Marchetti, A., & Baglio, F. (2015). Mind-reading ability and structural connectivity changes in aging. *Frontiers*, 6, 1808. <https://doi.org/10.3389/fpsyg.2015.01808>
- Castelli, I., Baglio, F., Blasi, V., Alberoni, M., Falini, A., Sempio, O., Nemni, R., & Marchetti, A. (2010). Effects of aging on mind-reading ability through the eyes: An fMRI study. *Neuropsychologia*, 48, 2586-2594. <https://doi.org/10.1016/j.neuropsychologia.2010.05.005>

- Charlton, R. A., Barrick, T. R., Markus, H. S., & Morris, R. G. (2009). Theory of mind associations with other cognitive functions and brain imaging in normal aging. *Psychology and Aging, 24*, 338-348. <https://doi.org/10.1037/a0015225>
- De Rosnay, M., & Hughes, C. (2006). Conversation and theory of mind: Do children talk their way to socio-cognitive understanding? *British Journal of Developmental Psychology, 24*, 7-37. <https://doi.org/10.1348/026151005X82901>
- Devine, R. T., & Hughes, C. (2013). Silent films and strange stories: Theory of mind, gender and social experiences in middle childhood. *Child Development, 84*, 989-1003. <https://doi.org/10.1111/cdev.12017>
- 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](https://doi.org/10.1016/0022-3956(75)90026-6)
- Gini, G., Benelli, B., & Belacchi, C. (2004). Children's definitional skills and their relations with metalinguistic awareness and school achievement. *School Psychology, 2*, 239-267.
- Gutierrez-Clellen, V. F. & De Curtis, L. (1999). Word definition skills in Spanish-speaking children with language impairment. *Communication Disorders Quarterly, 21*, 23-31. <https://doi.org/10.1177/152574019902100104>
- Henry, J. D., Phillips, L. H., Ruffman, T., & Bailey, P. E. (2013). A meta-analytic review of age differences in theory of mind. *Psychology and Aging, 28*, 826-839. <https://doi.org/10.1037/a0030677>
- Hughes, C. (2001). Executive dysfunction in autism: Its nature and implications for the everyday problems experienced by individuals with autism. In J. A. Burack, T. Charman, N. Yirmiya & P. R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research* (pp. 255-275). Lawrence Erlbaum Associates Publishers.
- Hughes, C. (2011). *Social understanding and social lives: From toddlerhood through to the transition to school*. Psychology Press.
- Hughes, C., Cassidy, B. S., Faskowitz, J., Avena-Koenigsberger, A., Sporns, O., & Krendl, A. C. (2019). Age differences in specific neural connections within the default mode network underlie theory of mind. *NeuroImage, 191*, 269-277. <https://doi.org/10.1016/j.neuroimage.2019.02.024>
- Karmiloff-Smith A. (1992), *Beyond modularity. A developmental perspective on cognitive development*. The MIT Press.
- Lecce, S., Bianco, F., Devine, R. T., & Hughes, C. (2017). Relations between theory of mind and executive function in middle childhood: A short-term longitudinal study. *Journal of Experimental Child Psychology, 163*, 69-86. <https://doi.org/10.1016/j.jecp.2017.06.011>
- Lecce, S., Bottiroli, S., Bianco, F., Rosi, A., & Cavallini, E. (2015). Training older adults on theory of mind: Transfer on metamemory. *Archives of Gerontology and Geriatrics, 60*, 217-226. <https://doi.org/10.1016/j.archger.2014.10.001>
- Lecce, S., Ceccato, I., Bianco, F., Rosi, A., Bottiroli, S., & Cavallini, E. (2017). Theory of Mind and social relationships in older adults: The role of social motivation. *Aging & Mental Health, 21*, 253-258. <https://doi.org/10.1080/13607863.2015.1114586>
- Li, X., Wang, K., Wang, F., Tao, Q., Xie, Y., & Cheng, Q. (2013). Aging of theory of mind: The influence of educational level and cognitive processing. *International Journal of Psychology, 48*, 715-727. <https://doi.org/10.1080/00207594.2012.673724>
- Litowitz, B. (1977). Learning to make definitions. *Journal of Child Language 4*, 289-304. <https://doi.org/10.1017/S0305000900001665>
- MacPherson, S. E., Phillips, L. H., & Della Sala, S. (2002). Age, executive function, and social decision making: A dorsolateral prefrontal theory of cognitive aging. *Psychology and Aging, 17*, 598-609. <https://doi.org/10.1037/0882-7974.17.4.598>
- Malle B. F (2002), The relation between language and theory of mind in development and evolution. In T. Givón & B. F. Malle (Eds.), *The evolution of language out of pre-language* (p.265-284). Benjamins.
- McGhee-Bidlack, B. (1991). The development of noun definitions: A metalinguistic analysis. *Journal of Child Language, 18*, 417-34. <https://doi.org/10.1017/S0305000900011132>
- Miller, S. A. (2012). *Theory of mind: Beyond the preschool years*. Psychology Press.
- Nelson K. (1996), *Language in cognitive development. The emergence of mediated mind*. Cambridge University Press.
- O'Hare, A. E., Bremner, L., Nash, M. Happé, F., & Pettigrew, L. M. (2009). A clinical assessment tool for advanced theory of mind performance in 5 to 12 years old. *Journal of Autism and Developmental Disorders, 39*, 916-928. <https://doi.org/10.1007/s10803-009-0699-2>
- Pardini, M., & Nichelli, P. F. (2009). Age-related decline in mentalizing skills across adult life span. *Experimental Aging Research, 35*, 98-106. <https://doi.org/10.1080/03610730802545259>

- Pezzuti, L., Longobardi, E., Milletti, K., & Ovidi, A. (2011). A study about the theory of mind in primary and secondary aging. *Life Span and Disability*, 14, 31-44.
- Phillips, L. H., MacLean, R. D., & Allen, R. (2002). Age and the understanding of emotions: Neuropsychological and sociocognitive perspectives. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 57, 526-530. <https://doi.org/10.1093/geronb/57.6.P526>
- Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind. *Behavioral and Brain Sciences*, 1, 515-526. <https://doi.org/10.1017/S0140525X00076512>.
- Rogers, T. T., & McClelland, J. L. (2004). *Semantic cognition: A parallel distributed processing approach*. MIT Press.
- Rosch, E., Mervis, C., Gray, W., Johnson, P.M., & Boyes-Bream, P. (1976). Basic objects in natural categories, *Cognitive Psychology*, 8, 382 – 439. [https://doi.org/10.1016/0010-0285\(76\)90013-X](https://doi.org/10.1016/0010-0285(76)90013-X)
- Roselli, I., Valentini, P., Belacchi, C. (2019, May 10-11). *Abilità metarappresentative e metalinguistiche in adolescenti* [Meta-representational and meta-linguistic skills in adolescents] [Poster presentation]. Giornate Clasta X edizione, Verona, Italy. https://www.univr.it/it/iniziativa/-/evento/8488?p_auth=QU5sly09
- Rosi, A., Bottiroli, S., Cavallini, E., Bianco, F., & Lecce, S. (2016). Promoting theory of mind in older adults: Does age play a role? *Aging & Mental Health*, 20, 22-28. <https://doi.org/10.1080/13607863.2015.1049118>
- Rossetto, F., Baglio, F., Massaro, D., Alberoni, M., Nemni, R., Marchetti, A., & Castelli, I. (2020). Social cognition in rehabilitation context: Different evolution of affective and cognitive theory of mind in mild cognitive impairment. *Behavioural Neurology*, 2020, 1-9. <https://doi.org/10.1155/2020/5204927>
- Serafin, M., & Surian, L. (2004). Il Test degli Occhi: Uno strumento per valutare la "teoria della mente" [The Eyes Test: An instrument to evaluate "theory of mind"]. *Giornale Italiano di Psicologia*, 31, 839-862. <https://doi.org/10.1421/18849>
- Sinclair, A. (1986). Metalinguistic knowledge and language development. In I. Kurcz, G. W. Shugar & J. H. Danks (Eds.), *Knowledge and language*. NorthHolland.
- Slaughter, V., Imuta, K., Peterson, C. C., & Henry, J. D. (2015). Meta-analysis of theory of mind and peer popularity in the preschool and early school years. *Child Development*, 86, 1159-1174. <https://doi.org/10.1111/cdev.12372>
- Slessor, G., Phillips, L. H., & Bull, R. (2007). Exploring the specificity of age-related differences in theory of mind tasks. *Psychology and Aging*, 22, 639-643. <https://doi.org/10.1037/0882-7974.22.3.639>
- Snow, C. E. (1990). The development of definitional skill. *Journal of Child Language*, 17, 697-710. <https://doi.org/10.1017/S0305000900010953>
- Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience*, 10, 640-656. <https://doi.org/10.1162/089892998562942>
- Tomasello, M. (1999). *The cultural origins of human cognition*. University Press
- Tomasello, M. (2001). *Perceiving intentions and learning words in the second year of life*. In M. Tomasello & E. Bates (Eds.), *Language development: The essential readings* (p. 111-128). Blackwell Publishing.
- Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*. Harvard University Press.
- Tomasello, M. (2008). *Origins of human communication*. MIT Press
- Tomasello, M., Carpenter, M., Call, J., Behne, T., Moll, H. (2005) *Understanding and sharing intentions: The origins of human social cognition*. *Behavioral and Brain Sciences*, 28, 675-735. <https://doi.org/10.1017/S0140525X05000129>
- Tomasello M, Farrar J. (1986). Joint attention and early language. *Child Development*, 57, 1454-1463. <https://doi.org/10.2307/1130423>
- Valle, A., Massaro, D., Castelli, I., & Marchetti, A. (2015). Theory of mind development in adolescence and early adulthood: the growing complexity of recursive thinking ability. *Europe's Journal of Psychology*, 11, 112-124. <https://doi.org/10.5964/ejop.v11i1.829>
- Wang, J.-j., & Kaufman, A. S. (1993). Changes in fluid and crystallized intelligence across the 20- to 90-year age range on the K-BIT. *Journal of Psychoeducational Assessment*, 11(1), 29-37. <https://doi.org/10.1177/073428299301100104>
- Watson R. (1995). *Relevance and definition*, *Journal of Child Language*, 22, 211-222. <https://doi.org/10.1017/S0305000900009703>

-
- Wellman, H. M. (2018). Theory of mind: The state of the art. *European Journal of Developmental Psychology, 15*, 728-755. <https://doi.org/10.1080/17405629.2018.1435413>
- Wellman, H. M., Liu, D. (2004). Scaling of theory-of-mind tasks. *Child Development, 75*(2), 523-541. <https://doi.org/10.1111/j.1467-8624.2004.00691.x>.
- Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*, 103-128. [https://doi.org/10.1016/0010-0277\(83\)90004-5](https://doi.org/10.1016/0010-0277(83)90004-5)
- World Medical Association. (2014). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *The Journal of the American College of Dentists, 81*, 14-18. <https://doi.org/10.1001/jama.2013.281053>
- 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>