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TOM PERFORMANCE IN NORMAL AGING: THE ROLE OF MOTIVATION

RELATORE:

Prof.ssa Serena Lecce

COORDINATORE:

Prof.ssa Gabriella Bottini

DOTTORANDA:

Irene Ceccato

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Abstract

A growing body of research supports the idea that Theory of Mind (ToM) declines during aging process. Recently, some intriguing studies has suggested that motivational factors could play an important role in explaining older adults' ToM performance (Zhang, Fung, Stanley, Isaacowitz, & Ho, 2013). Specifically, the authors reported that increased motivation positively impacted on older people's ToM, reducing or even filling the gap between young and older adults.

The present dissertation addresses this issue and aims to better understand the role of different types of manipulation in younger vs. older adults' ToM performance. After the review of the literature, it presents findings from three separate studies in which young and older people's motivation to perform ToM tasks was experimentally manipulated.

Study 1 aimed to replicate and extend Zhang and colleagues' research. Following the original procedure, motivation -operationalized as personal closeness- was manipulated in an Italian sample of young and older adults and ToM was measured with two tasks varying in complexity. Results did not show the expected positive role of increased motivation on older adults' ToM performance.

Study 2 aimed at investigating the effect of intergenerational knowledge transmission (i.e., generativity need), which is known to be relevant in occidental culture. Young and older Italian people's ToM was measured with verbal, video and autobiographical tasks. Results showed a mixed pattern of results, with some suggestions of a positive effect of motivation on older adults' ToM.

Finally, Study 3 manipulated motivation as ego-involvement in a New Zealander sample. Notably, cardiovascular reactivity was considered as a physiological indicator of motivation and measured several times through the experiment. Furthermore, emotion recognition ability was measured along with ToM. As in the first study, results showed no relation between motivation and socio-cognitive skills.

Finally, in Study 4 took a different perspective and examine older people's individual differences in social motivation. Results showed that in socially motivated older adults, but not in people with low level of social motivation, ToM was positively associated with quality and quantity of friendships. The finding suggests that ToM is important to social adjustment only when people are interested in having social relations.

Globally, in line with the literature, results showed an age-related decline in ToM ability which is task-independent. However the presented results suggested that motivation is not likely to play a major role in older adults' ToM performance, even if it could lead to minor improvements under certain conditions. Furthermore, a secondary aim of this thesis was to inspect social correlates of ToM abilities in older adults. Findings offered some suggestions of a positive relation between ToM and friendships; moreover, results indicated that social motivation played a role in explaining this association.

Introduction

The present dissertation aims to offer a qualitative review about Theory of Mind's changes during aging with a special focus on the interplay between (socio)cognition and motivation .

In the first chapter, a review of the literature on ToM in aging is presented, in particular ToM changes in normal aging are examined together with the correlates and the consequences of these changes.

In the second chapter, the focus moves towards the construct of motivation and its importance in older people. Current theoretical models are discussed and empirical findings on the impact of personal goals on cognitive performance are presented.

The literature review ends with the presentation of the very few works investigating the relation between motivation and socio-cognitive skills in young and older adults. Following, four empirical studies are presented.

Study 1 is a replication on an Italian sample of a previous study conducted by Zhang and colleagues on Chinese older people (2013). Motivation was manipulated in terms of personal closeness and its effects on ToM performance in two very different tasks were measured.

Study 2 considered and manipulated motivation in terms of intergenerational knowledge transmission need, a goal specific of older adults. ToM was measured through tasks with increasing levels of ecological validity. Additionally, we investigated social correlates of ToM, that is both quantity and quality of relationships with family members and friends. Also, we examined whether personality traits, as described by the Big Five model, were associated to socio-cognitive skills. Finally, we tested whether objective and subjective measures of social competence were related.

Study 3 examined ego-involvement, a type of motivation usually manipulated in young adults. Also, physiological indices (cardiovascular reactivity) were considered, in order to get a more genuine measure of motivation. Moreover, in addition to ToM also emotion recognition (ER) was analyzed.

Study 4 did not manipulate motivation, rather it investigated how normative individual differences in social motivation related with on both ToM and social relationships.

Finally, in the conclusion section findings are summarized and some conclusive remarks are given, together with suggestions for future works and practical implications.

Chapter 1 - Theory of Mind in Aging: a review of literature

1.1. *What's Theory of Mind and why it is important in aging.*

Theory of Mind (ToM) refers to the ability to reflect upon mental states - thoughts, beliefs, emotions, intentions- and use this knowledge to predict and explain people's behavior (Premack & Woodruff, 1978). It is a component of the socio-cognitive skills, like emotion recognition and gaze detection, and it is a crucial ability in social adjustment and relational success. Empirical evidence has confirmed this assumption, showing positive associations between ToM and peer-acceptance (Banerjee, Watling, & Caputi, 2011), friendship (Lecce, Ceccato, et al., 2015), social support (Bailey, Henry, & Von Hippel, 2008), social network (Stiller & Dunbar, 2007), communicative competence (Keysar, Barr, Balin, & Brauner, 2000), social functioning (Yeh, 2013), moral reasoning (Hayashi, 2007), and prosocial attitude (Caputi, Lecce, Pagnin, & Banerjee, 2012).

In the literature ToM has been labeled in very different way, creating some conceptual confusion. Notwithstanding different names - e.g., mind-reading, mentalizing, empathic accuracy, perspective taking, cognitive empathy among others- the core meaning is the same: the ability to consider what ourselves and others are thinking/feeling when interpreting behaviors and social situations. Hence, it is important to note that ToM is different from empathy, a related construct which refers to the (emotional) reaction to others' emotions (e.g., Kanske, Böckler, & Singer, 2012).

ToM is a high-order cognitive process, which lays on sensory inputs and stored knowledge in elaborating information (Bird & Viding, 2014). For this reason, is not unexpected to find it associated with other cognitive abilities, like working memory, inhibition and language knowledge (see paragraph 1.4.a and 1.4.b). However, ToM refers to a distinct construct, as confirmed by experimental (e.g., Bernstein, Thornton, & Sommerville, 2011) and clinical evidence (e.g., J. D. Henry, von Hippel, Molenberghs, Lee, & Sachdev, 2015).

Several authors pointed out the multi-componential nature of ToM, identifying a social-perceptual component (i.e., quick judgments without reasoning) and a social-cognitive component (i.e., a representational system, linked to language and general cognitive abilities) (Tager-Flusberg & Sullivan, 2000). In addition, a further distinction is between "hot" and "cold" components of ToM ability (Brothers & Ring, 1992). These two components appear to rely on different neural circuits, show different pattern of development and be selectively impaired in clinical populations (see paragraph 1.3 below).

ToM develops through all childhood, starting very early in its implicit forms (13 months, according to Surian, Caldi, & Sperber, 2007) and becoming progressively more explicit and complex. Most studies investigated pre-scholar and primary school children, focusing on the acquisition of the false-belief concept and on the increasing complexity in mental reasoning, linked to recursive thinking ability (2-order false belief and following). Nevertheless, a growing interest is now focusing on adolescents and adults' ToM ability, pointing out the existence of age-related changes and significant individual difference well beyond childhood (Apperly et al., 2010; Dumontheil, Apperly, & Blakemore, 2010).

Recently, interest has grown about what happens to ToM skill during typical aging. Literature strongly found a general decline in several facets of cognitive functioning in elderly population. Individual differences play a major role, but globally speaking aging is associated to difficulties in memory, executive functions, speed of processing, planning and decision making (Harada, Natelson Love, & Triebel, 2013; Mather, 2006; Salthouse, 2009). On the other side, crystallized ability seemed to be maintained until very old age (Horn & Cattell, 1967; Park et al., 2002) and some social skills, like emotional competence and wisdom, appeared to be enhanced in older people (Grossmann, Na, Varnum, Kitayama, & Nisbett, 2013; Leclerc & Hess, 2007; Scheibe & Carstensen, 2010). Therefore, it is both theoretically and practically interesting to investigate what happens to ToM, ability at the intersection between cognitive and social domain.

Understanding whether and how ToM changes during the typical aging process could have several important implications. As a crucial tool for successful social interactions, ToM ability could impact on social functioning and, in turn, on well-being and personal satisfaction. Aging is characterized for a reduction on social contacts and relationship (Charles & Carstensen, 2010) that can lead to lack of support and increased risk of social isolation (Shaw, Krause, Liang, & Bennett, 2007), as well as depression and loneliness (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006). Hence, ToM may play a role in explaining the changes in social functioning in aging. To understand how ToM changes in aging as well as the consequences in daily life of this change could help to create interventions aiming to decrease loneliness and social isolation through improving older adults' social skills.

1.2. *Age-related changes in Theory of Mind*

The first study on ToM in aging found that older adults performed better than young adults on an advanced task, the Strange Stories test (Happé, Winner, & Brownell, 1998). The authors explained this result in terms of social expertise and wisdom. Nevertheless, as the authors themselves stated, the study had several limitations, the main one being the absence of a measure of general cognitive functioning. Therefore, it is not surprising that following studies found quite different results. Both Maylor, Moulson, Muncer, and Taylor (2002) and Sullivan and Ruffman (2004b) tried to replicate and extend this pioneer result, using the same task but adding measures of fluid and crystallized abilities. Both studies found that older adults performed worse than young adults and this decline was partly related to the impairment in memory (Maylor et al., 2002) and fluid ability (Sullivan & Ruffman, 2004b). Starting from those contrasting findings, following studies contributed to the issue. Different tasks were used to measure ToM[1] (e.g., faux pas stories, MacPherson, Phillips, & Della Sala, 2002; false belief reasoning, German & Hehman, 2006;

[1] The Eye task has not been considered here and in following chapters. Indeed, even if is one of the most used task, recent evidence indicated that it is likely to be a task tapping emotion recognition rather than Theory of Mind (Oakley et al., 2016).

empathic accuracy, Blanke, Rauers, & Riediger, 2015; perspective taking in communication, Healey & Grossman, 2016; videos, Halberstadt, Ruffman, Murray, Taumoepeau, & Ryan, 2011; Bailey & Henry, 2008; see below for further discussion). Also, separation between cognitive and affective components showed a varied impact of age on ToM (Bottiroli, Cavallini, Ceccato, & Vecchi, 2016; Wang & Su, 2013; see paragraph 1.3). Moreover, the theoretical debate on the independence and dominion-specificity of ToM was investigated taking into account executive functions and more general cognitive abilities. Again, findings are contrasting, with some studies showing a specific impairment in ToM independent from executive functioning (e.g., Cavallini, Lecce, Bottiroli, Palladino, & Pagnin, 2013; Wang & Su, 2006) and others showing the executive functions fully mediate the relation between age and ToM (e.g., Charlton, Barrick, Markus, & Morris, 2009) (see paragraph 1.4.b).

A complete review of the studies investigating ToM in aging is beyond the scope of the present work (but see Moran, 2013). Hence, only some of the studies on this topic are presented in the following paragraphs. First those studies supporting the idea of stability in ToM ability in old age are discussed, and then the contrasting findings pointing out an age-related decline are examined.

1.2.a. *Stability in ToM*

In their study MacPherson and colleagues found that older and young adults did not differ in ToM performance, as measured through the Faux Pas task (MacPherson et al., 2002). The authors investigated age-related decline in tasks relying on different regions of the frontal lobe, namely the ventromedial and the dorsolateral prefrontal cortex. They considered the Faux Pas task associated to the first region -an assumption that more recent works investigating the neural correlates of ToM may possibly question (Abu-Akel & Shamay-Tsoory, 2011). However, some research suggested that affective ToM is related to the ventromedial prefrontal cortex (Shamay-Tsoory & Aharon-Peretz, 2007) and the Faux Pas test has been considered as tapping affective more than cognitive

component of ToM (Wang & Su, 2013). Beyond neuro-anatomical controversies, the fact remains that in this study people over 60 years old performed the same as young adults on the Faux Pas task.

More recently, in a study aiming to explain older adults' deficit in sarcasm understanding, the authors found that the performance on Faux Pas task was comparable between older and young adults (Phillips et al., 2015). The authors suggested that "[…] age effects on more complex and context dependent tasks such as sarcasm detection or belief reasoning might occur later in the life span. […] The trajectory of adult age effects on different aspects of social cognition may be highly task-specific, depending on perceptual and cognitive demands, the role of wisdom and experience, and social and emotional demands of different task conditions". (Phillips et al., 2015, p. 1847).

Using partly different tasks, Wang and Su (2006) tested 30 young (under 26 years old) and 30 older adults (over 62 years old) ToM, revealing quite contrasting results. They used 3 stories from the Faux Pas task and 3 stories from the Strange Stories task to measure ToM; addiotinally, they administer 3 neutral stories (i.e., with no mentalistic content) to control for general reading comprehension. Results showed that young and older adults did not differ in Strange Stories and neutral stories' performance, whereas young adults outperformed older adults in the Faux Pas stories. The authors explained the contrast with previous results which showed a selective decline in Strange Stories performance (Maylor et al., 2002; Sullivan & Ruffman, 2004b) claiming that their older adults were high in IQ and educational level, similarly to participants in Happé's study. On the other side, they considered the worse performance of older adults on Faux Pas stories as in line with previous results, thus identifying a decline in the ability to understand complex social situations. However, the ceiling effect on Strange Stories and neutral stories as well as the low number of items used partly limited the possibility to generalize results.

The role of education has been further explored by Li and colleagues (2013). They recruited older adults both high (about 16 years of education in average, $n = 28$) and low (about 10 years of education, $n = 24$) in educational attainment and compared them with a group of young students (about 15 years of education, $n = 28$). ToM was measured with both false belief stories, requiring

second-order ToM reasoning, and the Faux Pas task. Results showed that older adults with low education performed significantly worse in both tasks compared to both older adults high in educational level and young adults, with no differences between these latter two age-groups. Further supporting this result, no differences were found on the control task between the three groups. Hence, age-related differences in ToM appeared to be specific and exclusive only for older adults with low level of education. On the contrary, older adults with high level of educational performed as well as young adults. In explaining the results, the authors hypothesized that "the older adults' advantage in education may have counteracted age declines in extracting information in verbal tasks, in particular when these required mental state judgments" (Li et al., 2013, p. 723). Thus they suggested a potential protective effect of the educational attainment, an hypothesis in line with the idea of a cognitive reserve that acts against the brain aging (Stern, 2002).

In line with these results, Slessor, Phillips, and Bull (2007) found that vocabulary scores -a proxy for crystallized ability- masked age-related differences in ToM performance. Comparing 40 young (under 40 years old) and 40 older adults (over 60 years old) on 12 ToM stories (similar to the Strange Stories task), the authors found no significant differences between the age groups. Nevertheless, when they entered vocabulary score as a covariate, the main effect of age group appeared, showing that young adults performed higher than older adults in ToM. However, it is important to note that the emerged difference between age groups was not specific to ToM stories, but applied to control stories as well.

A partial support of preserved socio-cognitive skills in aging came also from a study investigating first- and second-order ToM in young and older adults (McKinnon & Moscovitch, 2007). In this study, 12 older adults and 12 young adults read 8 stories and were requested to answer 4 following questions tapping both cognitive and affective ToM. First-order questions concerned what one character did think /feel, whereas second-order asked what one character thought about the other character's thoughts/feelings. The authors found no age-related differences in first-order ToM, whereas young adults had better performance in second-order ToM. Results

were explained considering that the second-order questions "place high demands on domain-general resources, and in particular, on working memory, which is thought to mediate such performance demands" (McKinnon & Moscovitch, 2007, p. 186). Hence, the authors suggested that in aging ToM ability was not impaired per se, but rather was affected by the well-know decline in general cognitive functioning. Nevertheless, the small sample and the ceiling effect in first-order ToM task limited these conclusions.

Finally, a more recent work underlined the role of motivation in explaining ToM performance in older adults (Zhang et al., 2013). This study will be explained more in detail in Chapter 3, but in short the authors found that when older adults were highly motivated their performance on Faux Pas test was comparable to young adults' one. At the same time, older adults low in motivation showed a worse performance of both young adults and older adults highly motivated.

It is important to note that all these studies used verbal tasks of ToM[2]. Curiously, this modality could either facilitate older adults, who can rely on their preserved crystallized ability (Slessor et al., 2007), or hinder them, when it requires memory load and other general cognitive demands (Maylor et al., 2002).

1.2.b. *Decline in ToM*

With the few exceptions presented above, the majority of studies investigating ToM in aging found an age-related decline in this ability. The most used test is the Strange Stories task (Happé, 1994; White, Hill, Happé, & Frith, 2009), variously adapted. This task is considered an advanced test of ToM, because it tests the understanding of complex social situations, namely misunderstanding, bluff, persuasion, irony and white lie scenarios. Thus, it seems to be a task suitable to adults and to some extent near to daily life events. In contrast to previously reported

[2] Slessor and colleagues (2007) did use a video task, adapted by Sullivan and Ruffman (2004). Even if this task was considered as a measure of ToM, it actually measured attribution of emotion. Indeed, it is described as very similar to the Eye task, but it used videos depicting social interactions instead of static photos of faces. I preferred not to consider it in the present dissertation in order to maintain a stricter concept of ToM.

results (Happé et al., 1998; Wang & Su, 2006), older adults appeared generally impaired on this task compared to young adults (Castelli et al., 2010; Cavallini et al., 2013; Maylor et al., 2002; Rakoczy & Harder-Kasten, 2012; Sullivan & Ruffman, 2004; Wang & Su, 2013).

Similarly, the age-related decline was found also using different version of the false belief task, adapted to be suitable for adults, irrespective of the modality used, being either verbal (Moran, Jolly, & Mitchell, 2012) or visual (Bailey & Henry, 2008; Duval, Piolino, Bejanin, Eustache, & Desgranges, 2011; Phillips et al., 2011). For example, Bernstein and colleagues (2011) used the Sandbox task, a continuous measure of false-belief reasoning. In this task, participants stayed in front of a box filled with Styrofoam peanuts in which the experimenter hid and moved objects, following a plot (based on the classical false-location task; Wellman, Cross, & Watson, 2001). Participants were then required to indicate the position of the objects, according to three different conditions: where the character would search for the hidden object (false belief condition), where another object was (no false belief condition) or where the object was hidden originally (memory condition). Thus, a better performance corresponds to a smaller bias (measured in centimeters) in the location's decision. Notably, the within-subject design allowed a deeper comparison between age-group, controlling for individual differences in pointing. Results showed that older adults (over 60 years old, $n = 37$) performed significantly poorer compared to young adult (under 22 years old, $n = 37$) solely in the false belief condition.

Concerning the Faux Pas test, to date there are no published studies showing a declined performance in old adults on this test (considering it as a whole; but see Bottiroli et al., 2016 and paragraph 1.3 for differentiation between cognitive and affective components within the task). Some studies used this task to measure ToM in older adults, but they weren't interested in comparing performance with young adults performance (Ahmed & Miller, 2013; Yeh, 2013). Interestingly, some authors made an adapted version of this task which used video stimuli instead of verbal stories, and findings showed again an age-related decline in ToM performance (Halberstadt et al., 2011). However, the plot of the videos was quite different from the original stories; moreover,

participants were requested to rate inappropriateness (on scale from 0 to 100), rather than to detect and explain it. Thus possible comparison between these two conceptually similar tasks is limited.

Finally, on a relate note, several studies investigated age-related changes in irony understanding. Irony and sarcasm are related to ToM skills (Wang & Su, 2013; Winner, Brownell, Happé, Blum, & Pincus, 1998). Indeed, in order to understand that a sentence is ironic the person must take into account the intention of the speaker -that is, his/her thoughts and feelings. Research on this ability consistently showed an impaired ability in older adults (Phillips et al., 2015; Shammi & Stuss, 2003; Uekermann, Channon, & Daum, 2006).

1.2.c. *Conclusion*

A crucial contribute to solve this controversy in findings has been offered by a recent meta-analysis (J. D. Henry, Phillips, Ruffman, & Bailey, 2013). This quantitative review analyzed 23 datasets comparing young and older adults ToM. The potential effects of the task's modality (verbal, visual, static, dynamic) and the component investigated (cognitive, affective, mixed) were considered. Moreover, for those studies which used matched control tasks, also the specificity of the age effects on ToM was analyzed. Overall, findings showed that older adults performed worse than young adults, irrespective of the task used and the component investigated. The age-related impairment appeared to be stronger to ToM tasks compared to the matched control tasks, suggesting a specific decline in socio-cognitive skills.

It is important to note that the authors excluded from the analyses the Happé's study because it was an outlier (more than 3 *SD*), thus excluding the only study which found an increase in older adults ToM. Moreover, they considered those studies which used the Eye task, a task that has recently suggested to be measure of emotion recognition rather than ToM (Oakley, Brewer, Bird, & Catmur, 2016). Nevertheless, findings strongly indicated a pattern of age-related decline also in "purer" ToM tasks, like false-belief reasoning, and as the authors stated: "Because age-related ToM difficulties occur in tasks with no emotion recognition requirement, problem with mentalizing in

late adulthood are unlikely to be solely attributable to deficits in emotion recognition" (J. D. Henry et al., 2013, p. 833).

The authors did not directly investigate the role of other variables in explaining ToM deficit (e.g., educational level, executive functions, intelligence). However they pointed out that "executive control is now regarded by many as a critical component of ToM, and consequently it may not be possible to completely disentangle executive demands from ToM demands" (J. D. Henry et al., 2013, p. 833), thus suggesting a close relation between executive functioning and ToM abilities (see paragraph 1.4.b above).

On a relate note, the protective role of cognitive reserve proposed by Li and colleagues (2013) has been recently questioned by a study that directly investigated the relationship between cognitive reserve and ToM in a sample of older adults (Lavrencic, Kurylowicz, Valenzuela, Churches, & Keage, 2015). The authors measured cognitive reserve as comprising both education, and occupation and mental activities through the life. They also rerun the analyses considering only the effect of years of education. Regression analyses revealed that ToM was not predicted by either cognitive reserve or years of education. The authors concluded "social cognition may be less affected by cognitive reserve than other cognitive abilities. […] age-related declines in social cognition might not be offset in those with high cognitive reserve." (Lavrencic et al., 2015, p. 71).

To conclude, strong empirical evidences indicate that ToM decline in typical aging. This decline is supposed to be (partly) related to a deficit in general cognitive functioning. Nevertheless, the few studies which found preserved ToM ability seems to suggest that, under some conditions, is still possible for older adults to perform equally well as young adults. It is still not clear enough what are such conditions, but motivation as been suggested as one possible mediator (Zhang et al., 2013).

1.3. *Cognitive and affective components of ToM*

A useful distinction made within the construct of ToM is between cognitive and affective components (Bodden et al., 2013; Kalbe et al., 2010; Shamay-Tsoory & Aharon-Peretz, 2007). Cognitive ToM refers to the understanding of thoughts and beliefs, whereas affective ToM involves the reasoning about emotions. False belief is considered the prototypical task of cognitive ToM, but also attribution of intentions tasks and the Strange Stories task have been used to measure it. Affective ToM is commonly assessed through the Reading the Mind in the Eye task (RME), with the limitations that this entails, but the Faux Pas test is sometimes considered an affective ToM measure. The Faux Pas test is used also as a mixed task, that is to measure both cognitive and affective components separately. Neuroimaging studies usually used another mixed test, namely the Yoni task, wich discerns between cognitive and affective components using very matched items. Globally, the dissociation between the two components has been proven both in clinical and neuroanatomical studies and is now widely acknowledged, even if not deeply investigated.

Data from functional imaging consistently supported this distinction on the basis of the differential pattern of activation. Beyond a shared network, affective ToM appeared to rely mostly on ventromedial prefrontal cortex and orbitofrontal cortex (Hynes, Baird, & Grafton, 2006), whereas cognitive ToM usually activated dorsolateral prefrontal regions (Kalbe et al., 2010). To exclude the possibility that differences in the activated areas were just a consequence of the task used to measure cognitive and affective components, a recent fMRI study used a single task to investigate both components, thus using very matched stimuli (Bodden et al., 2013). Behavioral results found no differences in young adults' performance in cognitive and affective items. Nevertheless, confirming previous evidences, a dissociable pattern of activation emerged, with affective ToM showing a broader pattern of activation compared to cognitive ToM, even if the two components shared several neural correlates (medial prefrontal cortex- mPFC, superior temporal sulcus - STS, and tempo parietal junction - TPJ). Moreover, some studies suggested that cognitive ToM could be more cognitively demanding than affective ToM, because it activated areas involved

also in reasoning and planning (Hynes et al., 2006; Kalbe et al., 2010; Mahy et al., 2014; Torralva, Gleichgerrcht, Torres Ardila, Roca, & Manes, 2015). In support of this hypothesis, Hynes and colleagues (2006) found that the reading times were significantly reduced in affective perspective taking stories compared to cognitive perspective taking stories.

Similar evidence came from clinical and lesion studies. A specific impairment in affective ToM has been found in psychopathy (Blair, 2000; Shamay-Tsoory, Harari, Aharon-Peretz, & Levkovitz, 2010), children with conduct problems (Sebastian et al., 2012) and depression (Mattern et al., 2015; Wolkenstein, Schönenberg, Schirm, & Hautzinger, 2011). On the contrary, a specific impairment in cognitive ToM in presence of preserved affective ToM was found in multiple sclerosis (Roca et al., 2014), bipolar disorder (Montag et al., 2010) and with some controversy in the early stage of Alzheimer disease (Poletti, Enrici, & Adenzato, 2012).

Studies focused for the most on young adults and less is known about ToM components in aging. As anticipated, clinical studies suggested that some neurodegenerative diseases, e.g. the behavioural variant of frontotemporal dementia -bvFTD, may impact on both ToM components (Poletti et al., 2012), while others, e.g, Parkinson, may impact selectively on cognitive component (Roca et al., 2010).

Concerning typical aging literature, only few studies have directly tested the possible dissociation between the two components. Following the suggestion that cognitive ToM is related to areas associated also with general cognitive functioning, it has been hypothesized that this component could show an age-related decline. To date, three studies directly investigated this hypothesis, showing contrasting results (Bottiroli et al., 2016; Duval et al., 2011; Z. Wang & Su, 2013). Duval and colleagues (Duval et al., 2011) included three age groups (21-34, 45-59, 61-83 years old) and three objective visual ToM tasks, one for the affective component (an adapted RME task), one for the cognitive component (attribution of intention and false belief vignettes) and a composite task with required both components at the same time. Results indicated lower performance in all ToM tasks for older adults compared to both young and middle aged adults.

General cognitive functioning partly mediated the association between age and ToM tasks. Additionally, ToM tasks were not related to each other. Contrary to these results, a more recent study found preserved affective ToM, and only cognitive ToM showed an age-related decline (Wang & Su, 2013). Three age groups were recruited, but differently from the previous study which included middle aged participants Wang and Su divided older adults in two separate groups (20-35, 65-74, 75-85 years old). Moreover, while the use of very different tasks to measure ToM's component partly limited the Duval's results, Wang and Su investigated ToM components through 12 stories, equal in length and complexity, but requiring false belief, double bluff (cognitive ToM), white lie, faux pas (considered as affective ToM) and irony (considered as mixed); also two neutral stories, not requiring inference on mental states, were administered. Results revealed no differences between the three age groups in neutral and affective ToM stories; nevertheless, old-older adults performed worse than young adults in both cognitive and mixed ToM, with young-old adults showing an average position, that is decline in cognitive but not in mixed ToM compared to young adults. Additionally, authors found that executive functions were related selectively to cognitive ToM and not to affective ToM, further supporting the dissociation between the two components. The more recent study confirmed this pattern of results, revealing a selective age-related decline in cognitive ToM partly mediated by working memory ability (Bottiroli et al., 2016). Again, three age groups were compared (19-27, 60-70, 71-82 years old). Notably, the ToM components were measured through the same task, namely the Faux Pas test, considering separately the cognitive and affective questions of the task. In such a way, the authors excluded the alternative explanation that results depend on task used. Analyses on executive functioning impact on ToM revealed that cognitive, but not affective, component is associated with inhibition and working memory.

Summing up, available evidences suggested that there is a dissociation between cognitive and affective ToM, possibly explained in terms of differences in neural networks involved. In addition, cognitive ToM appeared to be associated with executive functions, while affective ToM seems to be less related to general cognitive functioning. Concerning older adults, available

evidence indicated a reduction in cognitive ToM, whereas affective ToM could possibly be preserved still very old age.

1.4. *Relation with other cognitive and socio-cognitive variables*

1.4.a. *Language and Intelligence*

Research on children consistently showed that language ability is strictly associated to ToM development. Notwithstanding the on-going debate about which linguistic component is more important (Milligan, Astington, & Dack, 2007), it is highly acknowledged that greater overall linguistic ability is positively associated with ToM skills (Astington & Baird, 2005).

Importantly, it has been suggested that language plays a role both in the development of ToM ability, and in the subsequently use of this ability (Apperly, Samson, Carroll, Hussain, & Humphreys, 2006). Thus, the relation between ToM and language may exist also beyond childhood. Notably, a recent finding revealed that the model of associations between ToM and other cognitive abilities (e.g., language, executive functions) was not constant across ages, but rather changed from childhood to early adolescence (Im-Bolter, Agostino, & Owens-Jaffray, 2016). This result opens the possibility that some changes in the pattern of associations may happen also in aging.

Available research on the ToM-language relationship beyond childhood revealed that adolescents' ToM skills are related to language ability and specifically to the semantic component (Ceccato, 2012; Im-Bolter et al., 2016). Moving on adulthood, studies on aphasic patients indicated that grammatical abilities may play a less important role in adults' ToM (Siegal, Varley, & Want, 2001). Therefore, it seems likely that growing older general language knowledge becomes more crucial for ToM ability compared to syntactic complexity. Further promising results came from investigations on non-literal language abilities, perhaps the domain representing the very intersection between ToM and language skills. Research investigating non-literal language comprehension (e.g., metaphor, proverb interpretation) in adults indicated a relation with ToM skills in both clinical and typical populations (Thoma & Daum, 2006).

Concerning the aging literature, it is worthy to note that older adults show preserved or even enhanced linguistic abilities (Harada et al., 2013). The different pattern of changes between language abilities and cognitive reasoning abilities is well explained by the distinction between crystallized and fluid abilities (Cattell, 1963; Horn & Cattell, 1967). That is, while general cognitive processing skills decline in older adults, language remains constant till very late age. Hence, it has been suggested that older adults may compensate impairments in general cognitive process relying on their preserved crystallized intelligence, that is general knowledge and experience (Bielak, 2016).

Language has been found as a significant contributor of older adults ToM in the vast majority of the studies (Cavallini, Lecce, et al., 2013; Mahy et al., 2014; Maylor et al., 2002; Hannes Rakoczy, Harder-Kasten, & Sturm, 2012; Sullivan & Ruffman, 2004b; Y. Wang & Su, 2006), even if not in all (Bernstein et al., 2011). More controversy exists on whether language could completely account for age-related differences, but findings generally indicated that -even controlling for linguistic ability- older adults do show a ToM decline (Cavallini, Lecce, et al., 2013). However, some authors claimed that, as in general cognitive field, also in socio-cognitive field crystallized ability may partly compensate the age-related decline (Moran, 2013; Slessor et al., 2007; but for contrasting findings see Lavrencic et al., 2015).

With regard to intelligence, less extensive investigation has been done on its association with ToM ability. Please, note that here we considered language ability as a distinct construct from verbal IQ. Indeed, verbal IQ usually comprises facets other than semantic knowledge, for instance verbal reasoning. Thus, we prefer to discuss language as a separate ability from IQ, even if the two constructs are clearly related.

Developmental research generally found that IQ is not related to ToM in typical developing children (Bauminger & Kasari, 1999; Rajkumar, Yovan, Raveendran, & Russell, 2008).

Similarly, Wang and Su (2006) measured IQ in older adults, examining the relation with ToM (Y. Wang & Su, 2006). Results showed that IQ -both components, namely performance and verbal- was not related to ToM performance (see also Ahmed & Miller, 2013). However, Charlton and colleagues found that performance IQ correlated with ToM and even fully mediated the relationship with age (Charlton et al., 2009). Given the paucity of available evidence, a firm conclusion cannot be reached, however findings seem to suggest that general intelligence is not so strongly related to ToM in aging, especially compared to other cognitive abilities.

Having said that, we decided in following studies to measure language. Indeed we want to control for age-related differences in crystallized ability. Instead, we did not examine IQ, because of the little evidence of relation with ToM ability.

1.4.b. ***Executive functions***

Executive functions (EF) encompass a rather heterogeneous collection of skills that includes inhibition, working memory, attentional flexibility, updating of information, and resistance to interference (Welsh, Pennington, & Groisser, 1991; Zelazo, Carter, Reznick, & Frye, 1997). Developmental research strongly demonstrated that EF are associated to ToM skills in preschooler and school-aged children (C. Hughes & Devine, 2015; Moses & Tahiroglu, 2010), playing a role independently from other important variables, for instance SES, language ability, and amount of sibling (Shahaeian, Henry, Razmjoee, Teymoori, & Wang, 2015).

As far as aging is concerned, two mains lines of evidence describe the possible association between ToM and EF: on the one side, the age-related decline in EF seems responsible of ToM impairment; on the other side, the ToM decline appears to be specific and independent from general cognitive functioning, even if EF deficit possibly worsen the situation.

In line with the first position, Charlton and colleagues investigating EFs, ToM and white matter integrity found that executive functioning, together with fluid intelligence and processing speed, fully mediated the relationship between age and ToM (Charlton et al., 2009). Analogous

results came from a number of studies, indicating that age effect on ToM was fully explained by inhibition and working memory (Li et al., 2013; Rakoczy, Harder-Kasten, & Sturm, 2012).

Supporting the second position, several studies found that age negatively affected ToM beyond the effect of cognitive decline (Bernstein et al., 2011; Cavallini, Lecce, et al., 2013; Maylor et al., 2002; Slessor et al., 2007; Z. Wang & Su, 2013). For instance, Bernstein and colleagues considered a wide range of executive and cognitive abilities, comprising memory, shifting, inhibition, processing speed, and fluency. Results revealed that age was the only significant predictor of false belief performance. Similarly, other works indicated that, even if EF were significant mediator, still age had direct effect on ToM (Phillips et al., 2011).

To summarize, notwithstanding some controversy about the underlying mechanisms, aging research consistently supports the idea of an association between ToM and executive functioning (Ahmed & Miller, 2013; German & Hehman, 2006; Shammi & Stuss, 2003; von Hippel & Dunlop, 2005; Yeh, 2013).

1.4.c. ***Emotion recognition***

Emotion recognition refers to the ability to accurately detect emotional cues expressed in faces, voices, bodies and movements (e.g. Mitchell & Phillips, 2015). It is a crucial ability in daily life, allowing to successfully move in our social world; empirical evidences demonstrated its association with social competence, communicative skills, political attitude and prejudices (Lima, Alves, Scott, & Castro, 2014; Ruffman et al., 2016; Ruffman, Murray, Halberstadt, & Taumoepeau, 2010).

The aging literature consistently showed a decline in emotion recognition ability (Isaacowitz et al., 2007; Phillips, Slessor, Bailey, & Henry, 2013; Ruffman, Henry, Livingstone, & Phillips, 2008). Several authors pointed out that negative emotions like anger and sadness appeared to be more impaired than positive emotions. This effect -usually labeled “positivity effect”- is considered a consequence of the change in future time perspective in older adults, which leads to a prioritization of socio-emotional goals (Charles & Carstensen, 2010). Accordingly, older people

prefer positive over negative affects. Nevertheless, a proposed alternative explanation is that aging is associated with change in face-processing mechanisms (Wong, Cronin-Golomb, & Neargarder, 2005): older adults look more at the mouth rather than the eyes' area and studies with young adults indicated that fear, sadness and anger are emotions more recognizable from the top half of the face region, compared to happiness and disgust which are more detectable from the bottom half of the face (Mather, 2015).

Mostly, empirical studies used facial expression recognition tasks, showing that elderly are specifically impaired in anger, sadness and fear recognition (Isaacowitz et al., 2007; Ruffman et al., 2008). Some controversy still exists about disgust, surprise and happiness (Phillips et al., 2013), with disgust possibly showing an improvement with age and happiness and surprise showing no or slight decline (Sullivan, Ruffman, & Hutton, 2007; Wong et al., 2005). Studies using different modalities are generally in line with results from facial expression detection, globally confirming the age-related impairment in emotion recognition (Hunter, Phillips, & MacPherson, 2010; Krendl & Ambady, 2010; Ruffman, Halberstadt, & Murray, 2009; Spencer, Sekuler, Bennett, Giese, & Pilz, 2016).

A major problem in emotion recognition literature often acknowledged is that happiness is the solely positive emotion investigated, greatly limiting the possibility to generalize the effect to other positive emotions. Recently, an intriguing study directly investigated this issue including triumph, amusement, pleasure and relief as positive emotions along with the more studied sadness, fear, anger and disgust (Lima et al., 2014). The authors used a voice task composed by 80 nonverbal vocalizations. Participants were required to rate how much each vocalization represented all the eight emotions. Results revealed that older adults were less accurate than young in all emotions, thus irrespective of emotion's valence, contrasting the existence of the positivity effect. Rather, this result was more in line within the neuro-anatomical framework. Authors also controlled for general cognitive functioning, personality and emotion regulation, further supporting the independence of emotion recognition's age-related decline.

In conclusion, research affirms that older adults have impairment in emotion recognition, irrespective of emotion expression's modality. Some emotions appeared to be more affected than others, but this issue is still controversial. Finally, the emotion recognition decline appeared to be independent from general cognitive functioning, as demonstrated by studies using very matched control tasks (Sullivan & Ruffman, 2004a) and directly testing the role of cognitive decline (Krendl & Ambady, 2010).

From a theoretical point of view, emotion recognition and ToM are distinct but related constructs. According to the Bird and Viding's model, emotion recognition -which the authors called "affective cue classification system"- is a source of input necessary for high-level processes, like ToM (Bird & Viding, 2014). Thus, ToM system relies on information obtained from emotion recognition system, together with information from other domain-general systems (e.g., knowledge about social situation scripts). In past, several models considered ToM and emotion recognition either totally independent from each other or compulsory related, thus a clear definition is still lacking (for a review see: Mitchell & Phillips, 2015). Accordingly with a broad range of models (Corrigan, 1997; Frith & Frith, 2006; Ochsner, 2008), we considered ToM and emotion recognition as two socio-cognitive skills partly related but different in terms of level of processing required (reasoning vs. perception). Based on these assumptions, a recent study directly investigated the relation between emotion recognition and (affective) ToM (Mier et al., 2010). Notably, the authors used the same stimuli to test both emotion recognition and ToM. Results revealed a significant association between the two constructs, but crucially reaction times analysis confirmed the distinction between ToM and emotion recognition in terms of complexity of process involved. Neuro-anatomical data identified an overlapping brain activation, and authors speculated that "emotion recognition preactivates the network necessary for emotional intention recognition and thus facilitates affective ToM" (Mier et al., 2010, p. 1035).

To conclude, ToM and emotion recognition are both important socio-cognitive skills, interrelated and with partly overlapping neuro-anatomical correlates. Nevertheless, they are

different constructs specifically because of ToM requires higher level of processing and reasoning, whereas emotion recognition is (mostly) a perceptual process. Both of them are negatively impacted by age, showing a progressive decline in elderly people. The mechanisms underlying this decline are still unclear, but possibly different.

Chapter 2 - Motivation in aging

2.1. *What is motivation and why it is important in aging*

On a general note, motivation refers to the reasons behind people's behaviors (Bargh, Gollwitzer, & Oettingen, 2010) and it is usually investigated in terms of goals, which are "cognitive representation[s] of a future object that the organism is committed to approach or avoid" (Elliot & Fryer, 2008, p. 244).

Within cognitive-aging research, the role of motivation has been theoretically explained by the Selective Engagement Theory (SET - Hess, 2006, 2014). According to this model, the cost to engage in cognitive activities increases with age. Therefore, older people, on the one side, reduce engagement in effortful activities (to preserve resources), on the other side select with great care where to put their resources. This selection is accomplished following personal goals, so that those activities which satisfy personal goals are preferred. For this reason, older people's cognitive performance is disproportionately affected by perceived significance and motivational factors. Several studies supported this model, showing that older people's performance on a wide range of tasks (e.g., memory, decision-making, judgment formation) is affected by experimental manipulation of motivation (for a review, see Hess, 2014). To be noted, the Selective Engagement Theory complements well two well-known models of life-span developmental theory: the Socioemotional Selectivity Theory (SST - Carstensen, Isaacowitz, & Charles, 1999) and the Selective Optimization with Compensation theory (SOC - Baltes & Baltes, 1990).

On the one hand, Selective Optimization with Compensation model affirms that development (or adaptation) throughout life requires three essential processes: selection, optimization, and compensation (Baltes & Carstensen, 1996; Baltes, 1997). Across adulthood, people become increasingly aware of age-related gains and losses. Because social, cognitive, and functional reserves are tend to diminish with age, resources are carefully allocated. As a result, people select goals that (a) are important and (b) can be realistically obtained in later life. These

goals are often selected at the cost of other, less important priorities that are eventually discarded. As goals are prioritized, people engage in behaviors that optimize their abilities to achieve these goals. If their goals cannot be met using their usual strategies, people may engage in compensatory activities.

On the other hand, Socioemotional Selectivity Theory (Carstensen et al., 1999) claims that personal goals change during the life-span in relation to time perception. Since young and older adults have different temporal horizons, they perceive different aspects of life as significant and consequently they are motivated toward different goals. Growing older, people's goals become more attuned toward the regulation of emotions. Therefore, old people increasingly prefer emotionally meaningful goals, such as maintaining close and positive social relationships and obtaining a sense of meaning in life. Conversely, young adults prefer future-oriented goals, related to the acquisition of knowledge. Therefore, young people are concerned to making new friends, exploring the unknown world and seeking information (Carstensen, 2006; Charles & Carstensen, 2010; Fung & Carstensen, 2003). A large amount of empirical evidences supported SST, specifically claiming for the existence of a shift toward positive valence stimuli in older adults, i.e. the previously discussed positivity effect (Carstensen & Mikels, 2005; Kellough & Knight, 2012; Mather & Carstensen, 2005). In other words, with increasing age people tend to avoid negative information in order to maintain or enhance emotional well-being. Crucially, this shift in motivation directly affects cognitive performance. For instance Mikels and colleagues have examined working memory for visual and emotional information in young and older adults and found that no age-related differences appeared for emotional vs. visual information. Moreover, older adults remembered significantly more positive stimuli compared to young adults (Mikels, Larkin, Reuter-Lorenz, & Cartensen, 2005).

As it can be noted, in Hess's model both allocation of resources and orientation toward specific age-related goals are integrated. Hence motivation appears to be essential in understanding aging process.

The importance to consider motivational aspects in studying cognitive functioning in aging has been demonstrated by several empirical evidence from very different research areas (Verhaeghen, Martin, & Sędek, 2012). Globally speaking, everyday-life and ecologically valid tasks were developed in order to better measure actual cognitive ability, disentangling performance from competence (e.g., Kliegel, Martin, McDaniel, & Phillips, 2007). Overall, findings in this area of research showed that older adults' level of intellectual functioning, as assessed with laboratory-type measures, and their functioning in everyday situations may be quite discrepant (Salthouse, 1990) in a variety of domains (source memory: Rahhal, May, & Hasher, 2002; emotional memory: Carstensen & Turk-Charles, 1994; social problem solving: Artistico, Cervone, & Pezzuti, 2003; Crawford & Channon, 2002). This difference is interesting and it reflects age-related changes in the emphasis placed on different aspects or attributes of the task itself.

Summing up, research affirms that personal goals -and consequently motivation- change during the life-span. Personal significance, positive social relationships, emotional well-being, and generativity are considered personal goals specific of elderly people (Labouvie-Vief, 1990; Mergler & Goldstein, 1983). At the same time, motivation and cognition are strictly linked; this is particularly true in aging, when cognitive functioning costs increase and there is a general decline in several cognitive abilities (Forgas, 2000). As a consequence, older people accurately select activities in which allocate resources. Manipulating motivation, therefore, could lead to a change in cognitive performance.

2.2. *Experimental manipulation of motivation in aging*

Concerning aging literature, motivation has been manipulated mostly in memory research. Typically, manipulation of motivation concerned either the type of materials to be learned or the instructions given to participants. Following, a short (and not exhaustive) summary of ways in which motivation has been previously manipulated in older adults is presented.

One of the most common ways to manipulate motivation is changing the self-relevance of the context or task (Hess, Follett, & McGee, 1998; Hess, Germain, Rosenberg, Leclerc, & Hodges,

2005). For instance, some studies presented items varying in contents to fit with young (e.g., budget cuts on campus) or older adults (e.g., rising health care cost) interests and experiences (Germain & Hess, 2007; Hess, Queen, & Ennis, 2013; Hess, Rosenberg, & Waters, 2001). Results consistently showed that higher self-relevance is associated with better performance. Crucially, this manipulation disproportionally affected older compared to young adults.

Partly related to the self-relevance construct, there is the own-age bias, that is the preference for stimuli coherent with one person's age (Rhodes & Anastasi, 2012). This method has been widely used in the research area of face recognition. Evidence indicated that this bias is present both in young and older people, but it possibly affects strongly elderly people. For instance, Riediger and colleagues investigated emotion attribution to either young or older target people. Results indicated that older participants showed a worse emotion attribution compared to young adults, but this age difference was reduced when the target person was an older adult (Riediger, Voelkle, Ebner, & Lindenberger, 2011; see also Campbell, Murray, Atkinson, & Ruffman, 2015).

Based on SST assumptions, another common manipulation of motivation used with older adults is changing future time perspective and accordingly personal goals (Fung & Carstensen, 2003; Fung, Carstensen, & Lutz, 1999; Hoppmann & Blanchard-Fields, 2010). For example, when their future time perspective was experimentally expanded, older adults' social preferences changed, resembling young adults' preferences (Fung et al., 1999). Similarly, Löckenhoff and Carstensen manipulated instructions given to participants, emphasizing either emotional goals or information-related goals. Results revealed that when information-related goals were prompted, age-related differences in decision making's strategies disappeared (Löckenhoff & Carstensen, 2004).

On a relate note, Cassidy and colleagues manipulated interpersonal meaningfulness in a source memory task and evidenced that presenting items within an interpersonal perspective increased older (but not young) adults' accuracy in traits recall (Cassidy & Gutchess, 2012).

Furthermore, several studies manipulated accountability, that is the feeling to be responsible of one's own answer because it will be publicly evaluated (Chen, 2004; Hess, Germain, Swaim, & Osowski, 2009; Hess et al., 2013, 2001). For instance, authors told participants to orally justified their decisions to the experimenter, or even to hand out their answers to the other (stranger) participants to be rated. The effect of accountability has been investigated mostly in memory field, and it is supposed to affect both young and older adults, even if with different magnitude.

Also giving feedback could be a fruitful way to improve older adults' performance in a range of cognitive abilities. Feedback can be declined in terms of economical payments (Harsay, Buitenweg, Wijnen, Guerreiro, & Ridderinkhof, 2010; Touron & Hertzog, 2009), other payoffs (Spaniol, Voss, Bowen, & Grady, 2011) or information about actual performance (Chen, 2004; Smith & Hess, 2015). For instance, West and colleagues compared young and older' memory performance in three conditions: positive-goal feedback, goal feedback and no feedback. Results showed that offering a goal feedback -especially a positive goal-feedback- significantly enhanced performance in both age groups. Furthermore, older adults receiving positive goal-feedback reached young adults in no feedback condition's performance (West, Bagwell, & Dark-Freudeman, 2005).

A quite different approach to shape motivation is offered by research in the communicative competence's field. In these studies the effect of having different listeners was tested on several facets of communicative ability. For instance, Adams and colleagues tested young and older people's memory performance comparing the amount of recalled information when the listener was the experimenter vs. a child. Results revealed that when recalling for a child, older adults' memory performance was at a comparable level to young participants' performance, whereas when recalling for an experimenter the well-know age-related impairment in episodic memory was evident (Adams, Smith, Pasupathi, & Vitolo, 2002). The authors claimed that the reason behind this effect is that different listeners are related to different personal goals, and specifically a child listener was a "good match" to older adults' need to transmit sociocultural knowledge to the next generations. Furthermore, the authors found that older adults were also more able to adjust their speech

depending on the person with whom they interact, thus reflecting greater sensibility to the context. Supporting this finding, Keller-Cohen (2015) investigated older adults' speech comparing three types of listener: a fictive listener, a child and a young adult. Results showed that older participants were indeed sensitive to the listener and adjusted their discourse specifically when talking with a child. This evidence seems particularly interesting, because the adjustment to the listener is likely to reflect the ability to understand others' needs, and so it could be considered a kind of perspective taking ability applied in conversational context.

Chapter 3 - Theory of Mind and Motivation

The literature presented above suggested that motivation plays a crucial role in older adults' cognitive performance. To be noted, previously reviewed works focused on cognitive abilities, but not on social skills. Thus is important to check if motivation can boost socio-cognitive performance as well as cognitive.

Generally speaking, it is assumed that high motivation affects people's inclination to engage in more systematic and elaborate cognitive processing; crucially, this should be true for both cognitive and social information (e.g., Chaiken, Liberman, & Eagly, 1989; Fazio, 1990; Petty & Cacioppo, 1986; Thompson, Kruglanski, & Spiegel, 2000).

To our best knowledge, only one study directly tested the role of motivation in ToM performance in elderly people (Zhang et al., 2013). In their first experiment the author manipulated motivation through an increase in perceived personal closeness both in young and older adults. Personal closeness was chosen because, according to SST, elderly people are specifically interested in maintaining and promoting close social relationships (Charles & Carstensen, 2010). ToM was measured through the Faux Pas task, requesting to identify and explain complex social situations. Results showed that older participants in the enhanced motivation condition performed better than their counterpart in the control condition, demonstrating that motivation positively impacted on ToM. Furthermore, findings revealed that when motivated older adults performed at the same level of young adults, suggesting that the positive effect of motivation could even wipe out the age-related differences. Notwithstanding the number of still open issues, this first study offered a compelling hypothesis, indicating that ToM's decline in aging can be counteracted by motivation. Globally speaking, the results also supported the notion that performance is a consequence not only of cognitive ability, but of motivational factors as well as.

However, being the first (and only) study investigating ToM and motivation, more evidence is required to confirm or reject this provocative result. Several interesting suggestions come from close fields, namely socio-emotional skills.

On a general note, partly supporting the idea of a positive effect of motivation also in social abilities, some findings indicated the manipulation of motivation significantly increased the amount and sophistication of reasoning in the domains of persuasion and person perception (see Pelham & Neter, 1995, for a review).

More related to mental contents understanding, studies investigating the impact of motivation on socio-cognitive performance examined this relation mostly through the empathic accuracy paradigm, which is a construct almost overlapping ToM. Indeed, according to the creators of this paradigm, empathic accuracy refers to the ability to understand what a target person is thinking/feeling in everyday interactions (Ickes, 2001). Data from young adults indicated that when given an economical incentive, men performed as well as women, wiping out the acknowledged female superiority (K. J. K. Klein & Hodges, 2001). Also women's performance showed an improvement, namely when payment was offered, thus further confirming a motivational explanation of gender differences. The authors concluded: "our results also suggest that differences in empathy are situationally dependent" (K. J. K. Klein & Hodges, 2001, p. 728).

Not only payment, but also belief about what the task is aimed to impacts on performance: in their meta-analysis, Ickes and colleagues (Ickes, Gesn, & Graham, 2000; K. J. K. Klein & Hodges, 2001) found that gender differences in empathic accuracy appeared only when participants were requested to self-evaluate their empathic skill, thus -suggested the authors- making success more salient for women, because empathy is considered a trait relevant to female gender role. Notably, the importance attributed to abilities under evaluation is a motivational factor extensively tested in the ego-involvement research (G. S. Klein & Schoenfeld, 1941; R. M. Ryan, Koestner, & Deci, 1991), which however investigated cognitive, but not socio-emotional, performance.

On a similar vein, Thomas and Maio (2008) manipulated motivation in two experiments, first threading personal competence and then increasing personal importance of the task. In line with previous results, they found that increased motivation led to better empathic accuracy.

Moving from empathic accuracy to the domain of emotional intelligence, a recent study investigated specifically the management of others' emotions. The authors manipulated social motivation: participants in the experimental condition were requested to describe a negative social experience, in order to prompt feelings of social exclusion. Following, they were requested to list all possible strategies to manage others' emotions (e.g., how to cheer up a sad friend). Results from four experiments consistently demonstrated that people who with social exclusion feelings performed better on several emotion intelligence tasks (Cheung & Gardner, 2015). Thus, this research demonstrated that people's emotional intelligence can vary as a function of their social motivation, questioning previously claimed stability of emotional intelligence.

A further intriguing study investigated emotion recognition ability manipulating in-group/out-group membership (Thibault, Bourgeois, & Hess, 2006). In the first experiment, the authors divided participants in two groups according to their reported level of identification with cats. Then, participants were shown photos representing cats showing emotional behaviours/postures (e.g., a cat with puffed up fur and widened eyes, representing fear). Participants were requested to describe each cat's behaviour, with no explicit prompt on emotions. Thus, spontaneous attribution of emotional states was measured. Results showed that people who declared to feel more identified with cats were also better in recognizing cats' emotions. Notably, neither experience with cats nor love toward cats accounted for this effect. In a following study authors replicated this result using photos of people and introducing them either as basketball players or non-basketball players and comparing participants who play or not basketball. The authors explained their results arguing that identification with a group implies greater motivation toward stimuli concerning that group.

Globally, presented empirical evidence supported the view that social understanding abilities may be affected by contextual and motivational factors. However, all the studies cited above involved young adults. The literature in aging is much more limited and, thus, we do not know

whether previous results can be generalized to older adults. In other words, we do not have direct evidence that the same happens also during aging.

The few studies involving elderly people focused on emotion recognition skill, rather than ToM or empathic accuracy. Specifically, two studies demonstrated that higher motivation positively impacted on emotion recognition skills of older adults (Stanley & Isaacowitz, 2015; Zhang et al., 2013). To anticipate, in line with SET assumptions, in both the studies the positive effect of motivation was greater for older than young people (Hess, 2014).

More in detail, Zhang and colleagues manipulated motivation in terms of perceived closeness. Notably, they both increased and decreased it and measured emotion recognition in terms of both performance and time spent in performing the task (Zhang et al., 2013- Experiment 2). Results showed that older adults benefitted by enhanced perceived closeness, reaching young adults in control condition's level of performance. Moreover, differences in emotion recognition accuracy in older adults were explained by the time spent in watching the items.

Differently, Stanley and Isaacowitz manipulated motivation in terms of accountability first, and familiarity then (Stanley & Isaacowitz, 2015). In the first experiment young and older people performed a traditional emotion recognition task, with participants in the high accountability condition being informed they would need to justify their answers later. Results showed that accountability did not significantly impact on older adults' performance (even if means were in the expected direction). Also, unexpectedly young adults in the high accountability condition performed significantly worse than their counterpart in the control condition. In the second experiment, the manipulation of familiarity seemed more effective: participants were asked to identify emotions expressed by either a stranger or a relative in short video clips. Results showed that older had a greater benefit in judging a familiar partner compared to young adults. Moreover, in the familiar condition the age-related differences were attenuated.

Having said that, it is crucial to acknowledge the existence of some contrasting findings, indicating that greater motivation does not improve or even impairs socio-cognitive performance

(Horgan & Smith, 2006; Koenig & Eagly, 2005). For instance, Horgan and Smith (2006) manipulated purpose goal in a social sensitivity task: in gender-congruent purpose condition, the instructions presented the task as in line with gender stereotypes (i.e, masculine purpose: used in military field; feminine purpose: used in social services). Authors found that the gender-congruent purpose condition and the control condition (no purpose) did not differ in accuracy. Thus, findings indicated that carrying on a task in line with personal (gender-oriented) goals did not enhance social sensitivity performance. A speculative explanation is that in tasks where verbal cues are less diagnostic than nonverbal cues - judging of affective states, detecting lies - motivation is not useful to improve performance (Thomas & Maio, 2008).

Globally, literature offers little and contrasting evidence concerning the impact of motivation on socio-cognitive skills. Specifically, ToM is the less investigated ability, with only one study claiming a positive impact of motivation on elderly people's performance.

To clarify this issue, following chapters present empirical studies in which ToM performance in young and older adults was measured following experimental manipulations of motivation.

Chapter 4 - Study 1: perceived closeness.

The literature presented above suggested that motivation could possibly improve elderly people cognitive performance. Greater motivation is supposed to be reflected in greater effort which, in turn, increases performance (Hess, 2014). As previously stated, this has been experimentally proved for memory, decision-making, and bias susceptibility abilities, among others (Hess, Germain, Rosenberg, Leclerc, & Hodges, 2005; Hess, Queen, & Ennis, 2013; Hess, Germain, Swaim, & Osowski, 2009). Recent findings further suggested that the same could be true in the socio-cognitive domain (Stanley & Isaacowitz, 2015; Zhang et al., 2013). The present study follows these very recent studies. It manipulated motivation in young and older adults and tested the effect of this manipulation on ToM performance.

Hence, the aim of this study was to replicate and extend Zhang and colleagues' results. The main question that arises from Zhang's work is whether findings could be generalized to the Western population. As anticipated, Zhang and colleagues focused on the effect of perceived closeness. However, this type of motivation is potentially culturally determined and thus different results are likely to be found in Western societies. Indeed, collectivistic cultures consider communality and affinity as high valued goals. On the contrary, individualistic societies generally prefer individual interests and uniqueness over social belonging (Oyserman, Coon, & Kemmelmeier, 2002). Clearly, perceived closeness appears to be a goal that is more in line with collectivistic, rather than individualistic, culture. Nevertheless, a strong body of research indicated that goals change throughout the life-span and growing older people move toward socio-emotional goals (Carstensen, Fung, & Charles, 2003; Carstensen & Turk-Charles, 1994) and this effect is similar across cultures (Fung, Stoeber, Yeung, & Lang, 2008). Thus, hypothetically, older adults in Western societies should be still sensible to perceived closeness, possibly more than their young counterpart. The present study addressed this issue manipulating perceived closeness in a Western society. Moreover, in order to replicate findings, the original procedure and materials were used,

with very little changes that were arranged directly with Prof. Zhang through personal communications.

In addition to replicate an existing research, the present study was also innovative as it: a) used a second, different ToM task; b) distinguished between cognitive and affective components of ToM.

Several studies have showed that performances on different ToM tasks did not always correlated. Researchers have interpreted this result as evidence of the multi-componentiality of ToM and suggested that different ToM tasks measure slightly different facets of ToM skill (Ahmed & Miller, 2013; Ahmed & Stephen, 2011; Saltzman, Strauss, Hunter, & Archibald, 2000). Moreover, as Devine and Hughes stated: "Reliable assessment of individual differences rests on having multiple measures of any given construct. Ideally, these measures should differ in modality" (Devine & Hughes, 2013, p. 990). For these reasons, using more tasks -especially if different in verbal/visual modality- seemed to be an advantageous procedure to get deeper insight onto the changes in socio-cognitive skills (Slessor et al., 2007). The task chosen by Zhang and colleagues - the Faux Pas task- is a complex ToM task, requiring explicit reasoning about social situations presented in a written format. This task has been successfully used both in clinical (e.g., A. Henry et al., 2015; Martín-Rodríguez & León-Carrión, 2010; Spek, Scholte, & Van Berckelaer-Onnes, 2010) and aging literature (e.g., Ahmed & Miller, 2013; Bottiroli, Cavallini, Ceccato, & Vecchi, 2016; Li et al., 2013; MacPherson, Phillips, & Della Sala, 2002; Phillips et al., 2015; Yeh, 2013). Along with the Faux Pas task, the present study introduced a visual and implicit task, namely the Animation task (Abell, Happé, & Frith, 2000; F. Castelli, Happé, Frith, & Frith, 2000). This test measures spontaneous mental states attribution to non-social stimuli presented as video clips. It could be considered a more complex task compared to the Faux Pas task: whereas the Faux Pas task presents several social situations and directly asked to reflect on characters' mental states, the Animation task doesn't offer clear social cues either in the stimuli (geometrical shapes) nor in the answer requested (a general description) (Lecce et al., 2016). Even if it usually used with children, a limited

range of studies has used it in aging population (Rosi, Cavallini, Bottiroli, Bianco, & Lecce, 2016; Weed, McGregor, Feldbæk Nielsen, Roepstorff, & Frith, 2010). The Animation task was chosen because it seemed a good candidate to accomplish the goal of a broader investigation of ToM skills. In such a way, ToM was measured through tasks which differed both in modality (verbal vs. visual) and elaboration (explicit vs. implicit).

As extensively described in paragraph 1.3., a further aspect of ToM complexity is the dissociation between cognitive and affective components. Briefly, several studies suggested that aging impacted on cognitive more than affective ToM and cognitive ToM appeared to be more related to general cognitive abilities, like executive functions (Bottiroli et al., 2016; Z. Wang & Su, 2013). Therefore, an intriguing possibility explored in this study was whether motivation could specifically enhance the ToM component more impaired in aging, namely the cognitive one. To this end, Bottiroli et al. (2016)'s procedure was followed, extracting the two components within the same test (Faux Pas task), instead of simply comparing performances of two different tasks.

To summarize, this study aimed to test the effect of motivation on older adults' ToM in a Western society: a) comparing two ToM tasks (Faux Pas and Animation) that differ in terms of modality and complexity, and b) considering age effect on cognitive and affective ToM components.

We hypothesized that, as in Zhang's study, older adults would show an improvement in ToM performance when highly motivated. No hypotheses are advanced concerning the generalization of the motivation effect on a complex ToM task. Finally, the benefic effect of motivation could possibly be greater for the cognitive comparing to the affective component of ToM, acting as a buffer against the pronounced age-related decline in the cognitive component.

4.1 *Method*

Participants

Original sample was composed by 211 participants (103 young, 108 older adults). Of those, 22 subjects were excluded from following analyses because of serious errors in tasks administration's procedure (n = 10), scores above the cut-off of the dementia screening test (n = 5), age outside the requested ranges (n = 2) or declared previous knowledge of the tasks (n =5). Further 11 participants were excluded because of incoherence between the two items of the motivation check scale (e.g., reporting both high closeness and high distance), rising question about their understanding of the scale. Hence, the final sample comprised 91 young adults (age: M = 23.26, SD = 2.79; range 19-31) and 87 older adults (age: M = 71.14, SD = 7.70; range 60-89). The 33 participants excluded did not differ from the final sample in terms of age, education, and general cognitive functioning; significant differences were found on crystallized intelligence ($t_{(23)}$ = 3.75, p = .012) and fluency ($t_{(24)}$ = 2.28, p = .025)[3]. This is easily explained by the fact that this group comprised participants with some degree of cognitive impairment, as indicated by the low scores on the MMSE.

The sample was unbalanced in older participants gender (Female = 75.9%) as a consequence of demographic features in the population. A similar percentage was recruit in young adults sample (Female = 67.0%). Thus young and older groups did not differ in gender distribution, t(176) =1.30, p = .194.

Materials[4]

ToM Tasks.

Faux Pas task. This test evaluates advanced ToM skills: false belief understanding, perspective taking and empathy (Gregory et al., 2002; Stone, Baron-Cohen, & Knight, 1998). Participants were asked to silently read 10 short stories, 5 of which contained a faux pas or social

[3] Homogeneity of variance assumption was violated, as indicated by the Levene's test. Therefore here and in following analyses adjusted *ts*, *Fs*, degrees of freedom and *ps* are reported.

[4] For each Study, examples of tasks and questionnaires are presented in Appendix A.

slip (faux pas stories) and 5 that did not (neutral stories). Stories were presented one at time and followed by oral questions. In both faux pas and neutral stories, only if subjects answered "yes" to the first question they were further questioned with five questions. In any case, two more control questions were always asked to test story comprehension (see Appendix A.1. for more details). There were not time limits, and participants were able to read the stories as many times as they required to fully understand them. The stories remained in front of the participants while the questions were asked, allowing participants to check their answers. Answers were audio recorded and experimenter/helper just took notes.

Following authors' indications, in faux pas stories answers were judged as correct if they indicated a clear understanding that the protagonist had unintentionally said something that would hurt or insult another character in the story; any response that inferred that the protagonist's utterance was intentional or responses that involved incorrect facts about the story were judged as incorrect. One point was given for each correct answer (range 0-30). In neutral stories, one point was assigned if the participant answered to the first question "no", indicating that no one committed a faux pas (range 0-5). These two sum scores (i.e., Faux Pas stories Global score and Neutral stories Global score) were then transformed in percentages. Notably, the correctness of answers to the control questions was the prerequisite to examine participant's other responses in both faux pas and neutral stories. If a control question was wrong, the whole story was discarded and percentage score were calculated adjusting for the remaining number of correctly understood stories.[5]

Moreover a second score was calculated following Zhang et al.'s procedure. For each faux pas story, one point was given if answers to the three first questions were all correct. Neutral stories

[5] E.g.: concerning the global score of faux pas stories: a subject scored 24 points on 4 faux pas stories without any error in control questions; in the last faux pas story he got 0 on a control question, thus all other answers in that story were not considered and the story discarded. Accordingly, in calculating his/her global score his/her maximum score was 24 instead of 30. Thus, even if only 4 stories were considered for this subject, he/she got a 100% score. The reasoning behind this choice is that in those stories that he/she correctly understood (that is, without errors in control questions), he/she got the maximum score. In such a way, ToM performance is not confounded with comprehension performance. Please, note that errors in control questions were minimal: 0.59% of errors in faux pas stories (7 subjects) and 0.68% in control stories (8 subjects).

were coded as before. Thus possible range for both faux pas and neutral stories was 0-5. These scores were used respectively as hit and false alarm rates in the calculation of A prime score (see results section above).

The A prime score (A') has the advantage to collapse both faux pas and neutral stories, thus it represents the global ability to recognize social situations, identifying both social gaffes and proper social behaviors. Conversely, to keep separated faux pas understanding from neutral stories understanding allows to investigate whether, as the literature suggests, the age-related impairments are selective for social gaffes detection.

Triangle task. Participants were shown 16 animations depicting two triangles moving about on a screen (F. Castelli, 2002; F. Castelli et al., 2000). Animations were of two typologies: Goal-directed (8 animations) in which triangles moved in a goal-directed fashion (chasing, fighting); and ToM (8 animations), in which triangles moved interactively with implied intentions (coaxing, tricking). The last typology of animations is defined ToM as it frequently elicited descriptions in terms of mental states that viewers attributed to the triangles. Each ToM animation had a really matched Goal-directed animation, as triangles' pattern of movements was very similar between the two corresponding videos. The 16 animations were presented in random order, with the only care to avoid that participant watched consecutively more than 5 animations of the same type (ToM or Goal-directed). At the end of each animation, participants were asked to orally describe what happened in the videos (i.e., "What was happening in this animation?"). Two examples were given before the task started. There were no time limits, but each video could be seen only once, repetition was not allowed. Participants' answers were audio-recorded and briefly write down by the experimenter/helper. According to authors' manual, answers were scored on two indexes: intentionality and appropriateness. Intentionality (range 0-5) reflected the degree to which the subject described complex, intentional mental state. Appropriateness evaluated how well the participant understood the underlying script of each animation and was rated from 0 (in the event of

no answer or a response of "don't know") to 3 (an appropriate, clear answer). Inter-rater reliability was assessed on a second rater s' scoring of 25% of the sample, and resulted good, Cohen's k = .86.

Intentionality and appropriateness scores were summed together in two global scores, separated for Goal-directed and ToM videos (range 0-64) (Devine, White, Ensor, & Hughes, 2016). Finally, scores were transformed in percentage. Please, refer to Appendix A.1. for videos' screenshots and examples of answers and scoring attribution.

Cognitive tasks.

Digit Span task (WAIS-R -Wechsler, 1981). This task was composed by two parts: forward and backward digit span. The forward digit span measured short term memory, whereas the backward digit span measured working memory. Both forward and backward parts consisted in participants' immediate repetition of progressively longer sequences of number that the experimenter read. Each sequence was composed by two item of the same length. The task was interrupted when the subject failed both the two items composing a sequence. In forward digit span the subject had to repeat the heard numbers in the same presentation's order. In backward digit span, the subject had to repeat numbers in the reversed order. The score attributed in each part of the task corresponded to the longer sequence of numbers the subject could repeat correctly. Range was 3-9 for forward task and 2-8 for backward task.

Digit-Symbol Substitution test (WAIS-R; Laicardi & Orsini, 1997). It measured processing speed, memory and visual scanning abilities. It consisted of nine digit-symbol pairs followed by a list of random digits, and the participants were asked to write down the corresponding symbol as fast as possible under each digit. During the task, subject could refer to the key (i.e., the table with the association between digits and symbols). The number of correct symbols within the allowed time (120 second in the present study) was measured (range 0-93).

Animal Naming task (Spreen & Benton, 1977). It evaluated verbal fluency, requesting to name as many members of the category "animal" as possible within 60 seconds. One point was given for each animal named (repetition was not allowed).

Vocabulary task. To test crystallized ability we used the verbal meaning subscale of the Primary Mental Ability test (Thurstone & Thurstone, 1963). It consisted of 50-items requesting to find the correct synonym of a given word between five choices. The subject had 8 minutes to complete the task. One point was given for each correctly identified synonym (range 0-50).

Mini Mental State Examination. The Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975) is a 10-minute measure assessing the level of cognitive functioning in older people, frequently used as a screening for signs of dementia. The MMSE consists of eleven questions inspecting orientation, registration, recall, calculation and attention, naming, repetition, comprehension, reading, writing and drawing. On the whole, it indicates whether the patient can follow instructions, read and write. Range score from 0 to 30 and a score of 24 was used as cut-off to exclude participants with possible cognitive impairment.

Other tasks.

Demographic questionnaire. Participants were requested information about age, sex, educational level, subjective health and religion.

Trust scale. This 9-item questionnaire was made selecting from the literature the most widely used items to measure trust in others (Delhey & Welzel, 2012; Siegrist, Earle, & Gutscher, 2003; Siegrist, Keller, & Kiers, 2005; Tokuda, Jimba, Yanai, Fujii, & Inoguchi, 2008). This allowed to cover several facets of trust feeling, obtaining a general outlook and a highly informative picture of participants' trust attitude. Items investigated both general trust in other and trust in specific groups of people. The first 8 items of the scale ranged each one from 0 to 4, with higher score indicating higher trust[6]. The last item ranged from 0 to 18. On the whole, the questionnaire showed a good reliability, Cronbach's $\alpha = .70$[7]. A global index of trust was computed (range 0-50). See Appendix A.1 for the whole scale.

Self-construal scale. A self-construal can be defined as a constellation of thoughts, feelings, and actions concerning the relationship of the self to others and the self as distinct from others

[6] Items 1, 2, 3, 4 and 6 were reversed.

[7] Removing the relative condition, Cronbach's $\alpha = .72$.

(Markus & Kitayama, 1991). The comparison of Western and Eastern conceptualizations of the self led to the identification of two styles of self-construal: the independent and the interdependent, respectively associated with Western and Eastern culture. In this study the 12-items Gudykunst's Self Construal Scale (Gudykunst & Lee, 2003) was used. Respondents answered on a 7-point Likert-type scale (1 = *strongly disagree*, 7 = *strongly agree*). A sample item is: "I prefer to be self-reliant rather than depend on others". This scale was administered in view of possible comparisons with Eastern samples. Thus, it will not further discussed in the present work.

Leisure activity questionnaire. It is a 15-item questionnaire investigating participants' interests and habits (Cornelissen, Dewitte, & Warlop, 2010; see Appendix A.1). In the primed closeness condition, this scale was used to manipulate perceived closeness. In order to enhance the priming effect in both ToM tasks, the scale was divided in two parts. Part one was composed by the first 8 items of the scale and part two by the 7 remaining items.

Manipulation check. It was composed by two opposite items. The first question asked participants to indicate on a 7-point Likert scale their perceived closeness toward the experimenter/helper (namely, the person who was administering the tasks), with a higher score indicating that the subject perceived the experimenter to be closer to him/her. The second question asked participants to indicate the distance between them and the experimenter drawing a cross on a continuous line (15 cm length); a shorter distance indicated that the subject perceived the experimenter to be closer to him/her (see Appendix A.1). The two items were strongly correlated, $r = .69$, $p \leq .001$[8] thus a global closeness score was computed collapsing the two items. First, the score of the second item (measuring distance) was reversed. Then both items were transformed in percentages and finally they were averaged.

[8] Excluding the relative condition did not change the result.

Procedure[9]

Two independent factors were investigated: Age group (young, older adults) and Condition (control, primed closeness, relative). Conditions differed in terms of implicated motivation, that is, perceived closeness.

Participants belonging to the control and primed closeness conditions were recruited through announcements in the University newsletter's system and via aging cultural associations and community centres. Young adults were undergraduates who received course credits following the participation to the study. Older participants were volunteers; at the end of the study they received a brief informative describing the main results of the project as a thank you. They all lived independently, and had active social and cognitive lives. Indeed, they were members of the University of the Third Age, a cultural association which offer both recreational and learning activities. Participants belonging to the relative condition were recruited through student helpers, who received course credits. Student helpers were asked to recruit one older member of their family (preferably grandparent) and/or one sibling (of similar age).

In both control and primed closeness conditions, the same experimenter (female, 27 years old) administered the tasks. The two conditions differed exclusively in that participants' perceived closeness with the experimenter was enhanced in the primed closeness condition. In order to do that, the experimenter declared herself to be very close to the participant with whom she shared interests and activities, as emerged from the participant's answers to the Leisure Activities questionnaire. Please note that closeness was primed twice, just before each one of the two ToM tasks.

In the relative condition, the student helpers were requested to administered to their family members (young participant: sibling; older participant: grandparent) the ToM and cognitive tasks, thus acting as experimenters. Student helpers received a short individual training before to

[9] This research and research presented in Chapter 5 and 7 were approved by the Ethics Committee of the Department of Brain and Behavioural Sciences, University of Pavia. Research presented in Chapter 6 was approved by the University of Otago Human Ethics Committee.

administer the tasks. Training consisted of the explanation of procedure's general rules (e.g., don't talk to the relative during the experiment, don't offer suggestions or judgments) and of an explanation of each task. The helper was instructed to strictly follow a given script, handing tasks in the indicated order and reading the instructions. During helper's administration the experimenter was in a different, but close, room and did not show up, unless requested by the student helper. The administrations were audio-recorded and later the experimenter checked the registrations for procedural errors.

The order of the tasks was fixed. First, participants were requested to complete the Demographic questionnaire, the Trust scale and the Self-Construal scale as a warm-up. Older people also completed Mini-Mental State Examination (MMSE)[10]. Participants then filled the first part of the Leisure activity questionnaire. In the primed closeness condition the manipulation of motivation occurred now. Then, participants were administered the ToM tasks in counterbalanced order, separated by the second part of the Leisure activity scale (and the reinforcement of manipulation in the primed closeness condition). The Manipulation check questionnaire followed. Finally, participants were asked to complete the cognitive tasks, presented in counterbalanced order. The administration was carried out individually in a quiet room and lasted between 1 hour ½ and 2 hours.

Statistical analysis[11]

Analyses were conducted with IBM SPSS Statistics Version 19. After *t*-tests comparing young and older adults' general cognitive functioning, preliminary analyses of variance (ANOVAs) were conducted on background variables to test the equivalence between the conditions. Notably, because the relative condition appeared to be significantly different on several background characteristic (see below), this condition was excluded and following analyses focused exclusively on the primed closeness and the control conditions. A univariate ANOVA tested the effectiveness

[10] The MMSE was always administered by the experimenter (and not by the student helpers).
[11] If not differently specified, parametric analyses were conducted even when data were not following normal distribution. The pattern of results did not change using non-parametric analyses.

of the experimental manipulation. Following, main analyses investigated the effect of motivation on ToM performance using ANCOVAs separately for the two ToM tasks. A further repeated ANCOVA was conducted to differentiate between cognitive and affective component in the Faux Pas task.

4.2 *Results*[12]

Preliminary analyses

Globally, comparisons between young and older adults across conditions are in line with aging literature, indicating a decline in all the tasks measuring fluid abilities ($t_{s(176)} \geq 5.45$, $p_s \leq .001$). Older adults had also a lower education compared to young adults ($t_{(136)=} 3.14$, $p = .002$). Young and older adults did not differ on crystallized intelligence, $t_{(141)} = .07$, $p = .941$).[13]

Then, we tested for unwanted differences in background variables between conditions, within each age group. Descriptive information are presented in Table 4.1. Separated ANOVAs were conducted on each dependent variable. Generally speaking, the relative condition performed significantly worse compared to the other conditions. More in detail, concerning young adults participants in the relative condition had less education ($p = .009$), lower vocabulary ($p = .047$) and lower fluency ($p = .017$) compared to participants in the primed closeness condition. Concerning older adults, participants in the relative condition are older and with less education ($p_s \leq .001$) compared to participants in the other two conditions; moreover, they showed also worse performances on vocabulary, fluency and digit-symbol substitution ($p_s \leq .001$) than they counterparts. Hence, the participants in the relative condition (irrespective of the age group) appeared to be a population significantly different from people in the other two conditions.

[12] If not differently specified, parametric analyses were conducted even when data were not following normal distribution. The pattern of results did not change using non-parametric analyses.

[13] Excluding participants in the relative condition, older adults had better vocabulary than young adults, $t_{(120)} = 2.29$, $p = .024$, in line with the literature showing better crystallized intelligence in older adults (Harada et al., 2013). Moreover, differences in education were reduced, $t_{(120)} = 1.95$, $p = .053$. All other results did not change.

Therefore, in order to obtain meaningful comparisons the relative condition was excluded from following analyses. Please, refer to the Discussion section for further details on this issue.

We rerun ANOVAs comparing control and primed closeness conditions on background variables. Results showed no significant differences in that young in any of the background variable ($F_s(1, 57) \leq 3.05$, $p_s \geq .086$, $\eta_p^2 \leq .05$). In older adults results showed that participants in the control condition had lower vocabulary ($F(1, 44) = 5.59$, $p = .022$, $\eta_p^2 = .08$) and digit-symbol ($F(1, 61) = 5.98$, $p = .017$, $\eta_p^2 = .09$) than participants in the primed closeness condition.

Following, we checked the effectiveness of the motivational manipulation. Self-reported closeness was compared across conditions. The global score of self-reported closeness was the dependent variable of the ANOVA, with Condition (control vs. primed closeness) as independent variable. The conditions significantly differed in the expected direction, $F(1, 120) = 6.59$, $p = .012$, $\eta_p^2 = .05$), with the primed closeness condition showing greater self-reported closeness ($M = 75.40$, $SD = 12.08$) than the control condition ($M = 68.74$, $SD = 16.28$).[14]

To further exclude that the obtained difference in closeness was an effect of individual differences in trust toward people rather, than a true effect of our manipulation, self-reported *trust* was entered as covariate in the previous ANOVA. The pattern of results did not change: conditions significantly differed in self-reported closeness ($F(2, 118) = 4.97$, $p = .028$, $\eta_p^2 = .04$) and *trust* appeared to be a significant covariate ($F(2, 118) = 4.02$, $p = .047$, $\eta_p^2 = .03$).[15] Further controlling for the coherence between the gender of participants and the gender of the experimenter (same vs. different gender) did not alter results: conditions still differed in self-reported closeness, $F(3, 117) = 5.27$, $p = .024$, $\eta_p^2 = .04$, and gender coherence had no impact on perceived closeness

[14] Entering vocabulary and digit-symbol as covariates did not change the result: $F_{(3, 118)} = 8.56$, $p = .004$, $\eta_p^2 = 07$.

[15] One item of the Trust scale directly investigated trust toward an unknown person: this item could precisely reflect the attitude toward the (unknown) experimenter. Entering this single item instead of the whole scale as a covariate did not change the pattern of results: condition significantly differed in self-reported closeness, $F_{(2, 119)} = 6.52$, $p = .012$, $\eta_p^2 = 05$ and trust toward an unknown person was a significant covariate, $F_{(2, 119)} = 6.32$, $p = .013$, $\eta_p^2 = 05$.

($F(3, 117) = .59$, $p = .443$), whereas *trust* was a marginally significant covariate, $F(3, 117) = 3.90$, $p = .051$, $\eta_p^2 = .03$.

The effect of motivation on ToM performance

First, performance on the Faux Pas task was investigated. Two different scores were computed. First, following Zhang and associates (2013), A prime score (A') was calculated. This score allowed to consider both correct (hit) and wrong (false alarm) detection, thus controlling for the "yes" bias in answers (Stanislaw & Todorov, 1999)[16]. Hence, performances on faux pas stories and neutral stories were collapsed into a single score. Second, in order to be consistent with the original scoring criteria and the available literature (Gregory et al., 2002; Li et al., 2013; Stone et al., 1998), we calculated, separately for faux pas stories and neutral stories, a global sum score. Descriptive information for ToM tasks are shown in Table 4.2.

First, a 2 x 2 ANCOVA on A' score with Age group (young, older) and Condition (control, primed closeness) as between-subjects factors was run. Because conditions significantly differed on vocabulary and digit-symbol, those variable were entered as covariates both here and in following analyses. Results are showed in Figure 4.1. The only significant effect was the role of crystallized ability as a covariate ($F(5, 112) = 3.93$, $p = .050$, $\eta_p^2 = .03$). However, univariate analyses revealed a marginally significant age difference in the control condition ($F(1, 112) = 3.91$, $p = .050$, $\eta_p^2 = .03$), whereas in the primed closeness condition young and older adults did not differ ($F(1, 112) = .30$, $p = .585$).

Then, a mixed-design 2 x 2 x 2 ANCOVA with Age Group (young, older) and Condition (control, primed closeness) as between-subjects factors and Story (faux pas, neutral) as within-subject factor was performed. Results showed a significant Age Group x Story interaction, $F(1, 112) = 4.51$, $p = .036$, $\eta_p^2 = .04$, indicating that older adults performed worse than young adults in faux pas stories, but not in neutral stories. The three-ways interaction was marginally significant,

[16] The formulas used were: 0.5+[(HIT-FA)*(1+HIT-FA)/4*HIT*(1-FA)] if HIT≥FA; and 0.5+[(FA-HIT)*(1+FA-HIT)/4*FA*(1-HIT)] if FA>HIT.

$F(1, 112) = 2.87$, $p = .093$, $\eta_p^2 = .03$. Further pairwise comparisons (Bonferroni adjusted) revealed that within the group of young adults, the performance on neutral stories was higher in control compared to primed closeness condition ($F(1, 112) = 4.42$, $p = .038$, $\eta_p^2 = .04$). Moreover, age differences on faux pas stories appeared in the primed closeness condition ($F(1, 112) = 6.42$, $p = .013$, $\eta_p^2 = .05$) and marginally in the control condition ($F(1, 112) = 3.65$, $p = .059$, $\eta_p^2 = .03$), globally indicating young adults' superiority. Results are graphically presented in Figure 4.2.

Finally, we focused on the comparison between cognitive and affective understanding of the faux pas stories.[17] A further ANCOVA with Age Group (young, older) and Condition (control, primed closeness) as between-subjects factors and Component (cognitive, affective) as within-subject factor was performed. Results showed neither significant main effects nor interaction effects, but the main effect of Age Group, $F(1, 112) = 6.14$, $p = .015$, $\eta_p^2 = .05$, indicating that overall young adults performed better than older adults. Thus, present findings did not confirmed the age-related decline specifically for cognitive ToM.

On the whole, findings from the Faux Pas task pointed out that higher motivation did not promote performance in older adults.

[17] Points obtained in the five faux pas stories at question 5 and 6 were separately summed. These scores were then corrected for the number of faux pas stories considered (excluding stories with errors in control questions -see footnote 15 above for further details) and transformed in percentage.

Table 4.1.

Means and Standard Deviations as Function of Age Group and Condition.

	Young					**Older**				
	Control n = 29	*Primed closeness n = 30*	*Relative n = 32*	*F*	*Pairwise comparisons*	*Control n = 32*	*Primed closeness n = 31*	*Relative n = 24*	*F*	*Pairwise comparisons*
Age	23.14 2.36	23.97 3.29	22.72 2.58	1.62		69.47 6.28	66.97 5.60	78.75 5.81	27.55***	C, PC < R
Educational level	3.45 .69	3.60 .93	3.03 .54	5.03**	R < PC	3.09 1.17	3.26 1.09	1.96 1.43	8.74***	R < PC, C
Vocabulary	43.34 3.81	44.27 3.94	41.44 5.52	3.17*	R < PC	44.34 4.62	46.48 2.17	36.38 10.87	17.75***	R < PC, C
DS Forward	6.79 1.18	6.72 1.33	6.66 .90	.11		5.88 .91	5.84 .74	5.67 .96	.43	
DS Backward	5.55 1.30	5.86 1.27	5.31 1.18	1.48		4.25 .92	4.58 1.06	4.00 1.02	2.35	
Animal naming task	25.69 4.95	28.37 6.67	24.00 5.96	4.28*	R < PC	21.47 5.06	23.81 4.85	17.17 5.01	11.22***	R < PC, C
Digit-symbol	82.17 11.03	82.37 11.4	79.26 13.30	.65		55.19 11.17	62.61 12.90	38.67 13.84	25.14***	R < PC, C

Note. Pairwise comparisons were Bonferroni adjusted. R = relative, PC = primed closeness, C = control.

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

Table 4.2.

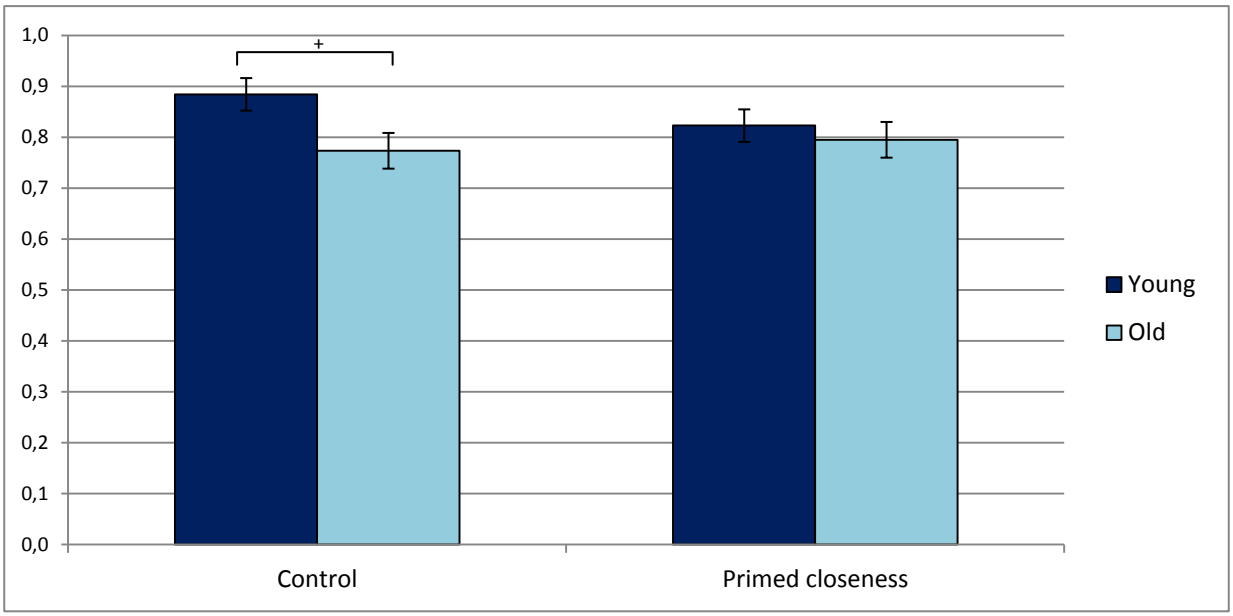
Means and Standard Deviations of Theory of Mind Tasks as a Function of Age Group and Condition.

	Young			**Old**		
	Control *n = 29*	*Primed closeness* *n = 30*	*Tot* *n = 59*	*Control* *n = 28*[18]	*Primed closeness* *n = 31*	*Tot* *n = 59*
Faux Pas						
A’	.88 .15	.82 .15	.85 .15	.77 .17	.81 .16	.79 .16
Faux Pas stories global score	86.90 12.94	89.56 10.75	88.25 11.85	81.58 13.84	82.31 16.52	81.97 15.18
Neutral stories global score	96.55 7.69	89.17 13.78	92.80 11.72	88.57 19.95	93.23 11.94	91.02 16.26
Cognitive ToM	82.41 15.90	84.00 16.94	83.22 16.31	72.86 22.04	77.90 22.13	75.51 22.04
Affective ToM	83.10 17.55	87.33 16.17	85.25 16.85	82.86 22.25	78.07 23.86	80.34 23.04
Animation task						
ToM videos	81.84 8.53	77.50 6.93	79.63 8.00	62.84 8.37	65.27 8.70	64.04 8.55
Goal-directed videos	70.64 6.54	68.18 7.28	69.39 6.98	61.13 9.07	63.86 6.13	62.48 7.83

[18] In Animation task, *n* = 32.

Figure 4.1.

Comparison of A' Performance as a Function of Age Group and Condition.

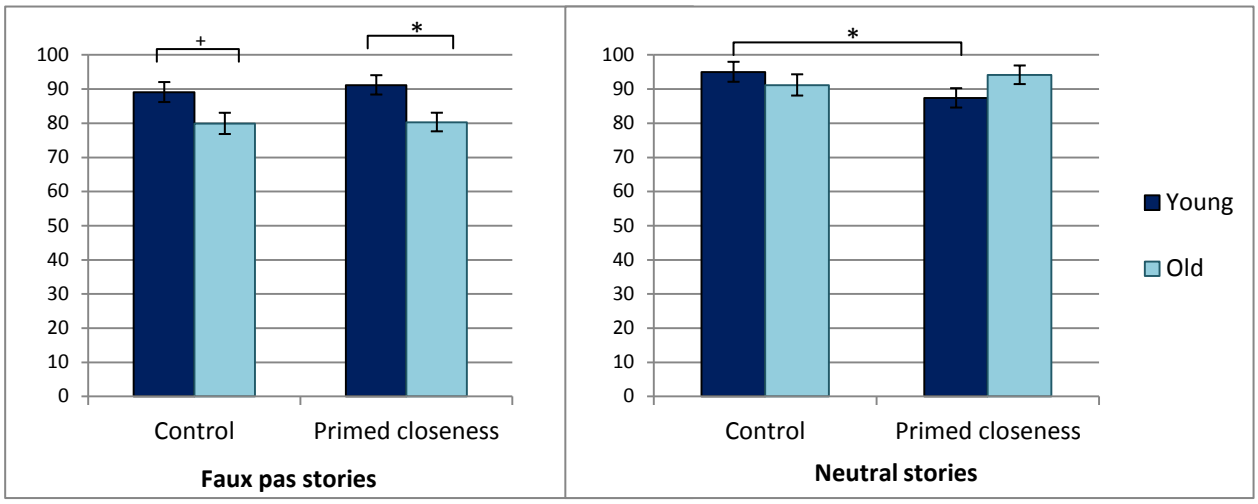


Note. Error bars represent standard errors. Covariates in the model: vocabulary = 44.70, digit-symbol = 70.64.

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4.2.

Comparisons on Faux Pas Global Scores as a Function of Age Group and Condition - Separately for Faux Pas Stories and Control Stories.



Note. Error bars represent standard errors. Results reported refer to univariate analyses. Covariates in the model: vocabulary = 44.70, digit-symbol = 70.64.

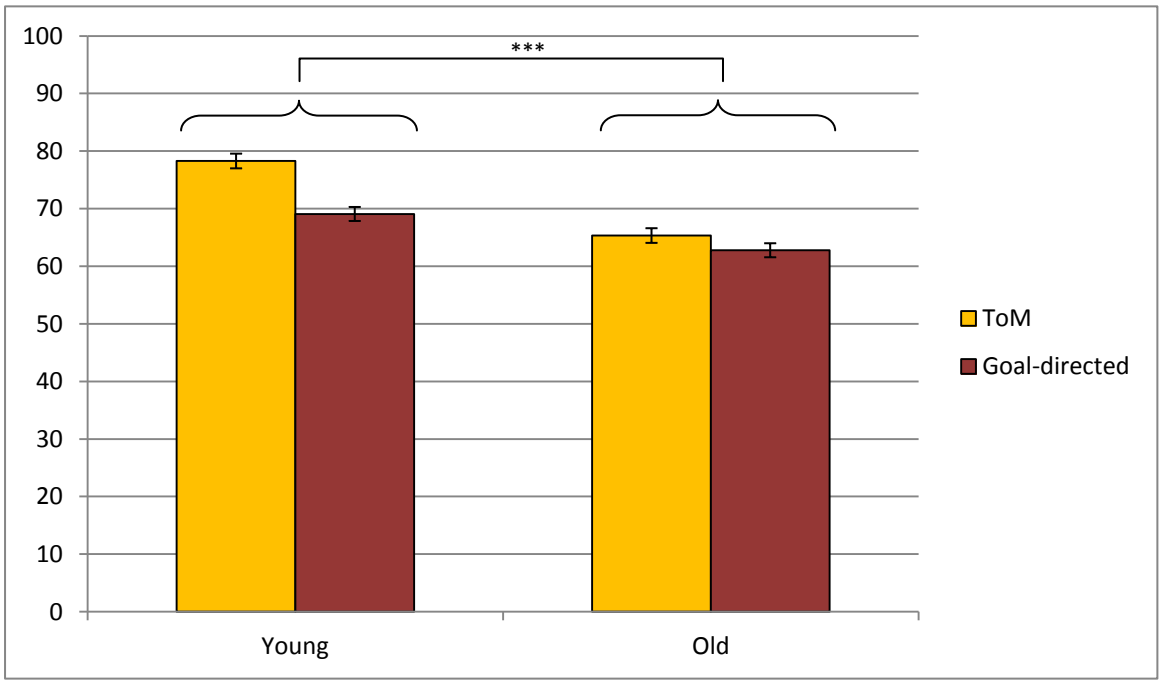
$^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001.

Concerning the Animation task, a mixed-design 2 x 2 x 2 ANCOVA with Age Group (young, older) and Condition (control, primed closeness) as between-subjects factors and Typology of video (ToM, Goal-directed) as within-subject factor was performed. A significant main effect of Age Group emerged, $F(1, 116) = 26.88$, $p < .001$, $\eta_p^2 = .19$, showing that young adults outperformed older adults. Also the Age Group x Typology of video interaction term was significant, $F(1, 116) = 12.84$, $p < .001$, $\eta_p^2 = .10$, indicating that young adults had a greater difference between the two typologies of videos compared to older adults (see Figure 4.3.). The hypothesized three way interaction did not reach statistical significance ($F(1, 116) = .17$, $p = .681$).

Again, results suggested that increased motivation did not improve older adults' performance in the Animation task.

Figure 4.3.

Animation Task Performance as a Function of Video and Age Group.



Note. Error bars represent standard errors. Results reported refer to univariate analyses. Covariates in the model: vocabulary = 44.63, digit-symbol = 70.17.

$^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001.

4.3. *Discussion*

This study aimed to test whether increased motivation improved ToM performance in older adults. Following Zhang and colleagues (2013), motivation was conceptualized as perceived closeness between the subject and the experimenter. Findings of the present study did not confirm previous results: motivation did not significantly impact on older adults' ToM, as indexed by both verbal explicit (Faux Pas task) and visual implicit (Animation task) tests. The same (not significant result) was obtained when cognitive and affective components of ToM within the Faux Pas task were considered.

The role of motivation on older adults' ToM

Motivation has been suggested as an important factor in explaining older adult cognitive performance (Hess, 2014) and recent findings confirmed its role in socio-cognitive skills (Stanley & Isaacowitz, 2015; Zhang et al., 2013). However, the present findings did not support these existing works. Replication of the Zhang and colleagues' study -using the same ToM measure (the A' score from Faux Pas task) and the same experimental procedure- showed that even if closeness was enhanced, this did not result in an improvement in older adults' performance. Rather, the well-known age-related decline in ToM was found (J. D. Henry et al., 2013), as indicated by the overall better performance of young adults compared to older adults' one.

The A' score used differed from what the creators of the task suggested (Gregory et al., 2002) and it is uncommonly used in literature (for an exception, see MacPherson et al., 2002), but it had the advantage of to collapse faux pas and neutral stories and to avoid the response bias, namely the general tendency to respond *yes* or *no* irrespective of the stimulus presented (Stanislaw & Todorov, 1999). Thus, in order to get results more comparable with the available literature and to directly test the age-related difference in faux pas compared to neutral stories we also calculated a more common score (sum scores). Analyses on those scores revealed that older adults performed worse than young adults in faux pas stories, but not in neutral stories, hence supporting the specificity of ToM decline in aging (Bernstein et al., 2011; Charlton et al., 2009; Hannes Rakoczy

et al., 2012). But, again, results showed no motivation-related differences in older adults' performance.

The contrast between these and Zhang and colleagues' results deserves some exaplanation. The most obvious is the impact of cultural differences. Chinese and Italian elderly populations are likely to differ in terms of both demographic and cognitive characteristics and motivation (namely, social goals). With regards to the way in which motivation was operationalized, it is possible that, even if was an effective way to improve motivation in Chinese population, the manipulation of personal closeness was not so useful in the Italian population. Indeed, as a collectivist culture, older Chinese could be specifically affected by improved closeness. Collectivism refers to a "social pattern consisting of closely linked individuals who see themselves as parts of one or more collectives (family, co-workers, tribe, nation)" (Triandis, 1995, p. 2). Perceiving oneself as close to someone else appears to be strongly in line with these social goals and thus it possibly improved interest and effort in doing the tasks, which turned into a better ToM performance. On the other hand, individualistic cultures, as Italian population (Lykes & Kemmelmeier, 2014), are characterized by "a social pattern that consists of loosely linked individuals who view themselves as independent of collectives [and] are primarily motivated by their own preferences, needs, rights" (Triandis, 1995, p. 2). Thus to feel close possibly was not so important for Italian older adults, because they would be more interested in be unique and different, rather than similar and belonging to the same "collective". In other words, even if they perceived themselves more or less close to the experimenter -as reflected in the manipulation check scores- this did not implicate an increase in motivation in doing the tasks and consequently improved performances.

It is important to note, however, that according to the Socioemotional Selectivity Theory (Carstensen, 2006) growing older people change their goals, becoming emotionally oriented and so preferring to deal with emotionally significant social partners. Also, some empirical findings suggested that this age-related goals preference exists across different cultures (Fung et al., 2016, 2008). Improved closeness with the experimenter was hypothesized to be in line with this goal and

for this reason the manipulation of closeness was used in the Italian sample. A cross-cultural study, directly comparing those two populations, would better clarify this issue.

Finally, it's important to note also that even if the task was the same, and the score A' was computed following authors' indications, some changes were made compared to the original procedure: oral instead of written answers were requested; the number of stories was reduced (from 20 to 10); moreover, in faux pas stories participants were requested to answer 8 questions instead of 3. The global amount of time spent on the task it is unlikely to be changed, because of the reduced numbers of stories used. Possibly, in the present study the Faux Pas task was shorter in time than in the original study. Accordingly, if the time spent on the task would have had an effect, it would be expected that shorter time would be related to overall improved performance, because of the reduction in cognitive effort requested. This was not the case: globally speaking, performance in this study was lower than what Zhang et al. reported (especially for older adults). Nevertheless, it's impossible to rule out the possibility that have to answers to more questions on the same story could have affected in some way the performance.

The Animation task was chosen as a more complex task, because of the request to elaborate implicit social stimuli on-line. Also, it involved a greater memory load, compared to the Faux Pas task, because videos could be watched only once. Therefore, in investigating the effect of motivation on this task the aim was to expand previous results, testing whether increased motivation could enhance performance also in more difficult tasks. Because motivation did not increased performance on the Faux Pas task, it is not surprising that the same result appeared in the Animation task. Present findings showed that young adults performed generally better than older adults and specifically they better discriminate the two typologies of video, showing higher score on ToM videos compared to Goal-directed videos. Study 2 and 3 further examine this issue.

Overall, the present findings are in contradiction with the study of Zhang and colleagues (2013). Enhanced closeness did not affect older adults' performance in two different ToM tasks.

Instead, present findings appeared to support the literature showing an age-related decline in ToM (Henry et al., 2013).

The role of motivation on young adults' ToM

It was hypothesized that young adults should not be affected by the manipulation of motivation. This for two reasons: first, the perceived closeness was supposed to be in line specifically with older adults socio-emotional goals and not with young adults' acquiring knowledge goals (Carstensen, 2006). Second, according to the Selective Engagement Theory motivation plays a role in older adults because of their limited cognitive resources and therefore they carefully select where to use them, in an adaptive process. Since young adults do not have this need, it seemed reasonable to suppose that motivation would have generally a lower effect on them (Hess, 2014). Nevertheless, present findings showed that participants in the primed closeness condition performed marginally worse that their counterpart on the neutral stories of Faux Pas task. This result was unexpected, and hard to be interpreted. A lower score on this task reflected a wrong detection of faux pas presence, that is, answering that someone has made a social gaffe when this was not true. To better explore this result, we investigated if anything similar happened also in the Animation task. Hence, we considered only young adults and run a repeated ANOVA[19] with the Typology of video (ToM, Goal-directed) as within-subject factor and Condition (control, primed closeness) as between-subjects factor. Results showed a main effect of Condition, $F(1, 57) = 4.12$, $p = .047$, $\eta_p^2 = .067$, indicating again that participants in the control condition performed better than their counterpart in the primed closeness condition, irrespective of the typology of video. This result seemed to further suggest that increased closeness -in young adults- could possibly lead to a worse ToM performance. To be noted, also Stanley and Isaacowitz (2015) in their first experiment did find that enhanced motivation led to lower performance in younger adults (Stanley & Isaacowitz, 2015). The authors suggested as a possible explanation that in younger adults the manipulation of motivation generated a change in the style of processing stimuli (i.e., emotional facial expressions),

[19] Covariates were not entered because within young adults the two conditions did not differed in terms of background variables.

from an intuitive to an analytic strategy. More analytic strategies, claimed the authors, were not advantageous for emotion recognition process, which relies on more automatic strategies. We do not believe that this explanation could be plausible concerning the Faux Pas understanding, but it is however possible that enhanced closeness provoked a change in decision making strategies. However, we do not have direct evidence to prove that, thus further investigations are needed to explain this unexpected result.

Analysis on ToM components and the relation with executive functions

Not being the main aim of the study, it was nevertheless interesting to investigate on the one hand the distinction between cognitive and affective components of ToM and on the other hand the relation between ToM and the executive functions. Concerning the first point, as previously stated, extensive evidence from clinical and neuro-anatomical works indicated the importance of considering separately these two components of ToM (see paragraph 1.3.). Additionally, notwithstanding some controversy on this issue (Henry et al., 2013), recent evidence suggested that older and young adults performed the same on affective ToM, whereas cognitive ToM showed an age-related decline, which could be partly explained by a deficit in executive functioning, specifically updating ability (Bottiroli et al., 2016). Therefore, similarly to Bottiroli and colleagues, in the present study ToM's components were investigated separately, comparing the two questions from the faux pas stories which directly tested the understanding of the thoughts (cognitive) and the emotions (affective) of the characters involved. Contrary to previous results, here we found a significant age-related difference in both components of ToM. Furthermore, motivation did not showed any component-specific effect.

Concerning the relation with executive functions, literature often pointed out a relation between ToM and general cognitive abilities (see paragraph 1.4). Correlational analyses in the present work (partly) supported this finding (see Table I and II in Appendix C): generally speaking, both ToM tasks correlated with working memory and verbal fluency and, to some extent, with education; moreover, the Animation task correlated also with short term memory and speed of

processing, possibly reflecting the memory load and the on-line nature of this task. Crystallized ability -measured through the vocabulary test- was not related to ToM performance. Interestingly, the affective ToM was not related to either education or crystallized ability or executive functioning.

Separated analyses on young and older adults showed a slightly different pattern, suggesting that in elderly people executive functions possibly play a major role in ToM, partly depending on the task used. In older adults, working memory seemed to be the construct more related to ToM. Furthermore, in elderly people also crystallized ability appeared to be associated to ToM, in line with the idea of some compensation mechanisms in aging (Barulli & Stern, 2013).

Overall, results speak in favor of a relation between ToM and general cognitive functioning. Nevertheless, the absence of a strong pattern of correlations in the older adults sample could possibly suggest that the ToM decline is unlikely to be accounted exclusively by the executive functioning impairment (Bernstein et al., 2011).

The exclusion of the relative condition

Finally, it is important to acknowledge a severe limit of this replication study: namely, the exclusion of the relative condition from main analyses. The relative condition was a major point in the original study. Contrary to Zhang and colleagues' work, in the present study the three conditions were not comparable in terms of background variables: participants in the relative condition had overall a lower cognitive functioning, irrespective of the age group.

A speculation is that the procedure itself produced these differences in participants. Indeed, while the assignment of participants either in the control or in the primed closeness conditions was made on a purely random basis, participants in the relative condition were either siblings (young adults) or grandparents (older adults) of the helpers. Because the helpers were mostly 20 years old students, this has likely set some constraints on the characteristics of the participants. Thus, concerning young participants, they were often younger siblings, not necessarily enrolled in University courses. This could explain the lower educational level and crystallized ability found in

this condition. Concerning older adults, having a 20-years grandchild meant often to be over 75 years old, in order to had "space" for three generations behind. This could explain the age difference found between this condition and the other two. Additionally, the greater age of older adults in relative condition in turn (partly) explained their lower cognitive functioning.

Secondarily, participants in the relative condition were recruited through the help of a young adult - and that means that people were "persuaded" to participate in order to help out their relative. This seems to be an important difference with participants on control and primed closeness conditions, who participated as volunteers.

For all these reasons, it seemed reasonable to assume that the relative condition was composed by a "different" population compared to the other two conditions. Therefore, any further comparison appeared to be potentially meaningless, because the fundamental assumption of drawing participants from the same population would not be met.

Moreover, the relative condition posed some doubts also from the point of the theoretical validity of the experimental procedure. Motivation -i.e., personal closeness- as independent variable was experimentally increased in the primed closeness condition and not manipulated in the control condition. This was a properly experimental manipulation. On the contrary, in the relative condition there was not any "manipulation" of motivation, rather motivation was selected to be high. Possibly, this could reflect more a "trait" motivation instead of the "state" motivation prompted with the manipulation of motivation, thus questioning the meaning of potential results.

Altogether, comparing exclusively control and primed closeness conditions appeared to be the more reasonable and safe solution to get interpretable results. In such a way, the study could be considered a proper experiment rather than a quasi-experimental design. Moreover, in Zhang and colleagues' work the relative and the primed closeness conditions showed the same pattern of increased ToM performance, not significantly differing from each other. Thus it seemed feasible to focus our analyses on the primed closeness condition, renouncing to the relative one.

One last consideration on the older adults in the relative condition: as previously said, in this study they were older, less educated and performed worse on cognitive functioning measures. An intriguing possibility is that with a more uniform sample original results would be possibly replicated; that is, if participants in all the three conditions would be recruited from that population with "lower" background characteristics. Indeed, it is possible that the Italian elderly in control and primed closeness conditions had a "higher" cognitive level compared to the "general" population, from which grandparents (i.e., participants in the relative condition) were drawn. Indeed, people in those two conditions were active members of a cultural centre, and this could reflect some cognitive skills or a general attitude toward cognitive activities.

Anyway, even if that would be the case, present results are not less meaningful: rather, the fact that an age-related decline in ToM was found in a "high cognitive level" older population further supported the importance of investigating socio-cognitive skills in typical aging.

Summary, limitations and future directions

To conclude, the present study did not confirm previous results indicating a motivation-related improvement in older adults' ToM. Nevertheless, it is possible that the manipulation of motivation used -perceived closeness- did not fit Western society's goals. Hence, present results do not rule out the possibility that other kinds of motivation could impact on socio-cognitive performance. To analyze this possibility, Study 2 used a different conceptualization of motivation, selecting the generativity need, an aging goal found in Western society and potentially culturally independent (Hofer et al., 2014; Hofer, Busch, Chasiotis, Kärtner, & Campos, 2008).

Further, the specificity of age effects on the cognitive component of ToM was not confirmed. We do not have a clear explanation for this finding. As previously stated, some works found an age-related decline in both components of ToM (Duval et al., 2011; Mahy et al., 2014; Hannes Rakoczy et al., 2012), but other suggested a preserved affective ToM (e.g., Bottiroli et al., 2016; Z. Wang & Su, 2013). Present result offered some support to the first position, finding that older people had lower performance on both components; nevertheless, correlational analyses were

in line with the general dissociation between the two components. Indeed, cognitive, but not affective, component was globally associated to executive functions, suggesting a difference in terms of underlying mechanisms.

An important issue not investigated in this study was how ToM would impact on daily life and social relationships. Present results told us that older adults were less able to detect social gaffe and to attribute intentionality in an appropriate way, but we don't know how and whether this decline actually impacts on their friendships, or on their satisfaction with their relationships, or on the way in which they react when meeting new people, or if other people like to spend time with them. That is, social correlates of ToM in aging are still not clear. Further studies should include some social functioning measures to directly test the assumption that ToM is important for social adjustment.

Chapter 5 - Study 2: intergenerational transmission of knowledge

In Study 2, as in Study 1, we manipulated the relevance of the tasks in terms of consistency with age-related social goals. Differently from Study 1 and from Zhang and colleagues' work (2013), which manipulated personal closeness, in Study 2 we focused on generativity goal, and specifically on the need to transmit personal knowledge to new generations (Blanchard-Fields, 1996; Chinen, 1989; Erikson, Erikson, & Kivnick, 1986; Hoppmann & Blanchard-Fields, 2010; Kotre, 1984; Lang & Baltes, 1997; McAdams, 2001). Empirical evidences showed that generativity is linked to psychosocial well-being in old age (Cheng, 2009; Gaggioli et al., 2014; Kessler & Staudinger, 2007) and several study used experimental procedures consistent to this social-cognitive goal specific of old age. For examples, both Pasupathi, Henry, and Carstensen, (2002) and Pratt, Boyes, Robins, and Manchester (1989) investigated older adults' discourse production (respectively, emotional valence and narrative competence) and requested participant to tell a story to a child, instead of using "classical" narrative production procedures. This because even if storytelling to a child and the production of a narrative both request to organize discourse, maintain referential coherence and so on, to present the task as related to a child made the task itself more relevant for older adults, because it is in line with both their personal goals and their daily experience.

To our knowledge, only one study explicitly manipulated the intergenerational knowledge transmission goal in an experimental context. Adams and colleagues (2002) in order to test memory performance requested young and older women to learn a story in order to repeat it to either a young child or to the experimenter. Crucially, they found no age differences in performance when the listener was the child, whereas young adults recalled more information than older adults when the listener was the experimenter, as expected based on traditional memory research in aging. The older women were also more likely to adjust the complexity of their recall when telling to a child compared to their young counterpart, therefore showing a greater sensibility to the listener. These

results suggest that older adults' recall is more sensitive to the retrieval context, with performance being enhanced when the testing context is consistent with the social-cognitive goals of later life (i.e., intergenerational knowledge transmission).

Therefore, in Study 2 we manipulated motivation increasing tasks salience for older adults. To do that, in the experimental condition participants were told that the tasks would be used to promote children development. In other words, the tasks were presented within an intergenerational transmission of knowledge's context.

Theory of Mind's social correlates

An important issue poorly investigated is how ToM ability is related to social adjustments in adulthood. Even if several studies claimed about the importance of ToM for social competence and interpersonal relationships (e.g., Paal & Bereczkei, 2007), very few studies directly tested these assumptions (Bailey et al., 2008; Shiri Cohen, Schulz, Weiss, & Waldinger, 2012; Lecce, Ceccato, et al., 2015; Lewis, Rezaie, Brown, Roberts, & Dunbar, 2011; Pezzuti et al., 2015; Stiller & Dunbar, 2007; Yeh, 2013). Data are often driven from developmental and clinical research (Banerjee et al., 2011; Devine et al., 2016; Mehl et al., 2010). Furthermore, findings from typical population are often contrasting. For example, a study on young adults found that the number of close friends is related to one's own perspective taking ability (Stiller & Dunbar, 2007); anatomical support for this result came from another study investigating gray matter volume (Lewis et al., 2011): authors found that both mentalizing competence and social network size were associated with the volume of the medial orbitofrontal cortex. However, other findings indicated that ToM and social relationships are not strongly related, especially in older adults. For instance, Pezzuti and colleagues found that older people's ToM was unrelated to social support (Pezzuti et al., 2015). Similarly, Blanke and colleagues using the empathic accuracy paradigm found that satisfaction with social relationships was mostly unrelated to the ability to attribute mental states; the authors hypothesized that "empathic accuracy may be necessary for positive relationship functioning at the beginning of a partnership. […] Age-related changes in social networks imply that older adults

preferably interact with close social partners with whom they have already developed relationship-specific interaction patterns. The importance of empathic accuracy for high relationship satisfaction might therefore be less than for young individuals who more frequently also interact with less familiar or emotionally close social partners." (Blanke, 2015, p. 82)

Therefore, given the little direct evidence, it is seems crucial to test what are the social correlates of ToM, especially in older people - a population characterized by a reduction in social network (Wrzus, Hänel, Wagner, & Neyer, 2013) and potential increased loneliness. Study 2 examined this issue, investigating the relationship between social networks and functioning and ToM ability in both young and older adults.

Objective and subjective measures of socio-cognitive skills

Another interesting issue is whether people are aware of their socio-cognitive skills. Duval and colleagues found that young and older people do not differ in self-reported ToM; not surprisingly, subjective assessment did not correlate with objective ToM measures (Duval et al., 2011). In line with this result, also Realo and colleagues found that adults' self-reported mindreading ability was not correlated to actual performance in an emotion recognition tasks (Realo et al., 2003).

Therefore, in present study along with ToM we assessed subjective evaluation of social skills. Specifically, we focused on two different but related aspects: mind-reading beliefs and social intelligence. Mind-reading beliefs refer to people's opinions about their ability to read others minds, and to anticipate people's thoughts based on facial/behavioral clues (Realo et al., 2003). Hence, it is a definition clearly overlapping with ToM. Social intelligence refers to a complex and a multi-faceted set of abilities and behaviors which globally explain the degree of success in social situations. Some authors highlighted the cognitive aspects (e.g., M. L. Barnes & Sternberg, 1989), while others considered mainly behavioral aspects (e.g., Ford & Tisak, 1983). Beyond the controversies, authors agree that it is a crucial ability to understand and interact with others.

In this study we want to better elucidate the relation between ToM and other social skills constructs, as well as possible changes in normative aging. Hence, we investigated both age-related differences self-evaluation of social skills and the congruence between subjective and objective measures of socio-cognitive competence.

Theory of Mind and personality

A further little investigated aspect is the relation between ToM and personality traits. Here, we refer to the Big Five structure of personality, thus including Agreeableness, Extroversion, Neuroticism, Conscientiousness and Openness to experience (McCrae & Costa, 2008). Theoretically, differences in personality are reflected in differences in cognitive and affective experiences to which people are exposed to; consequently, it is possible to hypothesize that some traits are generally more related to social competence.

Interestingly, some recent evidence in aging field suggested that there is a positive association between some personality traits and cognitive abilities into later life (Curtis, Windsor, & Soubelet, 2014). In their qualitative review, the authors found consistent evidence of a positive relation between Openness to experience and general cognitive functioning, e.g., fluid ability, episodic memory; moreover, Conscientiousness seemed to be associated to a slower rate of cognitive decline. Globally, results speak in favor of a link between personality and cognitive function in aging, even if the mechanisms explaining this link are not yet clear.

ToM is a socio-cognitive ability, and thus it may be related to personality traits, as other cognitive abilities are. Some limited evidences indicated that ToM is indeed related to Agreeableness in young adults (Ferguson & Austin, 2010; Graziano, Habashi, Sheese, & Tobin, 2007; Haas, Ishak, Denison, Anderson, & Filkowski, 2015; Nettle & Liddle, 2008). A speculation is that people high in Agreeableness trait may be generally more motivated to care about to the mental states of others; therefore, normative individual differences in ToM may be a reflection of differences in personality (Nettle & Liddle, 2008). With lower consensus, socio-cognitive skills

have been found related also to Neuroticism (Nettle & Liddle, 2008) and Openness to experience (Magalhães, Costa, & Costa, 2012).

To our best knowledge, only one study included personality measurement in investigating ToM in older adults. Keightley and colleagues found that personality was no related to ToM performance both for young and older adults (Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006). Given the limited evidence, we think that it is interesting to further investigate whether age-related differences exist in this association.

The present study

Summing up, this study had two main aims: 1) to investigate the role of motivation on ToM tasks performance; and 2) to test whether motivation has a specific impact on older adults' performance. Furthermore, secondary aims were to investigate the associations between ToM and several theoretically related construct: general cognitive functioning, social relationships, subjective evaluation of social skills, and personality.

Importantly, we decide to use a new task to measure ToM: the Describe-a-friend task (see the Method section). This task was selected as a more ecological way to test ToM. Indeed, it requires participants to briefly describe their best friend; the spontaneous use of mental state terms (MST) was measured. Indeed, the way in which people use mental attributes in describing a close person is supposed to be a significant proxy of their ability to understand other minds (Lecce & Pagnin, 2007; Meins & Fernyhough, 2010; Meins, Fernyhough, Johnson, & Lidstone, 2006; Ruffman, Slade, & Crowe, 2002). Moreover, it seemed that this task could be less "unusual" for older adults, compared to the more traditional ToM tasks. Indeed, both to read and answer questions (Faux Pas task) and to watch stimuli on a computer screen (Animation task) are activities which an older person could consider far from daily life. On the contrary, telling a story about an old good friend is a common activity -potentially more interesting and satisfying. Therefore, if results would show that older people have a lower performance compared to young adults also in such a age-friendly task, it would be a strong finding supporting the age-related decline in ToM.

As in Study 1, we controlled for age-related differences in general cognitive functioning. Indeed, we want to be sure that changes in ToM ability during aging were not just a reflection of the well-known cognitive decline. Therefore, we considered both experience-based characteristic - crystallized ability and educational attainment- and fluid ability -verbal fluency, short term memory, working memory- in our analyses.

On the basis of previous research, we expected: 1) the experimental group would show a greater self-reported level of motivation and engagement; and 2) older adults in the experimental group would perform better on ToM tasks than their counterpart in control group. No condition-related differences are expected for young adults.

To be noted, we do not make any specific hypothesis regarding the difference between young and older adults in the experimental condition. Previous findings suggested both that older adults could perform better (Happé et al., 1998) and at the same level (Zhang et al., 2013) of young adults. Nevertheless, we don't exclude that young adults could still outperform older adults regardless the enhanced motivation (Stanley & Isaacowitz, 2015).

5.1. *Method*

Participants

Original sample was composed by 131 participants (57 young, 74 older adults). Older adults (age range 60-92 years old) were recruited through the local branches of the University of the Third Age and aggregation centers located in the North of Italy. No tangible incentives (e.g., money or gifts) were given to them. Young adults (age range 19-26 years old) were undergraduate students recruited through the University newsletter system or word-of-mouth; they received course credits for their participation. Participants were randomly assigned to one of two conditions: either the manipulation of motivation condition (insofar, experimental condition) or the control condition. Additionally, older adults were administered the Mini-Mental State Examination (Folstein et al., 1975), as a first screening to exclude people at risk of cognitive impairment.

Of the initial sample, 10 subjects were excluded from following analyses because of: serious errors in administration procedure (n = 1), declared previous knowledge of the tasks (n = 4), scores above the cut-off of the dementia screening test (n = 2), declared pathologies (n =2), and age outside the requested ranges (n = 1). Therefore, final sample comprised 51 young adults (age: M = 21.65, SD = 1.68) and 70 older adults (age: M = 69.40, SD = 6.68). The 10 participants excluded did not differ from the final sample in terms of age, education, and general cognitive functioning (young: Fs(1, 5) ≤ 2.85, ps ≥ .148; older: Fs(1, 71) ≤ 2.67, p_s ≥ .107)[20].

The sample was unbalanced in gender distribution (the 80.0% in older and the 98.0% in young adults were female). Furthermore, the older people group had significantly more male participants than the young adults group.

Measures

ToM tasks.

Faux Pas task. The task was the same of Study 1, but in order to reduce the testing time we requested participants to read only 6 short stories, 4 containing a faux pas and 2 neutral stories (for further information about the task and administration procedure, please refer to Study 1 and Appendix A). Five scores were computed. Two sum scores -one for faux pas stories (range 0-24), the other for neutral stories (range 0-2)- were calculated summing up each correct answer. These scores were transformed in percentage to facilitate comparisons (in the Results section they are referred as Faux Pas score and Neutral score). Also, the A prime (A') score was computed, to allow comparison with Zhang and associates' study (2013). Finally, as in Study 1, cognitive and affective scores were calculated summing up the points earned in the two target questions (both range 0-4; then percentages were calculated).[21]

[20] Here and in following analyses, when homogeneity of variance assumption was violated, as indicated by the Levene's test, robust test were used instead (Welch's F). Values of significance reported, as well as F-ratio and degrees of freedom, refer to these adjusted tests.

[21] As in Study 1, only stories without comprehension errors were considered. Percentage scores allowed to control for individual differences in the number of valid stories. Frequency of comprehension errors was again very low: 0.93% (8 subjects) in faux pas stories and 0.62% (6 subjects) in neutral stories.

Importantly, in the experimental condition subjects were told that their answers would have been read to children at school, in order to foster children understanding of social situations and social norms.

Animation task. The task is the same used in Study 1, but in Study 2 we used only 6 videos, 3 ToM and 3 Goal-directed. The animations were presented in random order, with the only care to avoid showing 3 videos of the same typology consecutively. As in Study 1, two separate scores were calculated for ToM and Goal-directed of video, summing intentionality and appropriateness scores (each one ranging 0-24). Then, percentage scores were calculated.

Importantly, in experimental condition subjects were told that their descriptions would have been used to create a "guide" for teachers, aimed to promote child interpretation and narrative's skills.

Describe-a-friend task. Participants were asked to remember and orally describe their best friend. ToM was measured through the analysis of mental state terms (MST) used in the description. We selected this task in order to investigate the spontaneous use of socio-cognitive ability in the most ecological way. Indeed, referring to developmental age, Meins and colleagues (2006) argued that to have a ToM does not necessarily implies to use it: the knowledge of internal states is not always spontaneously used when representing and interpreting other people and their behaviors. Apperly (2012) has also recently discussed the potential discrepancy between competence and performance in children's mentalizing abilities. Hence, in this study we further analyzed this possibility, applying previous empirical suggestions to aging research. Crucially, MST measure is not affected by ceiling effect, therefore it appears to be particularly suitable to test ToM in adulthood (Lecce & Pagnin, 2007). This and similar tasks have been used both with children (Davis, Meins, & Fernyhough, 2014; Meins et al., 2002, 2006) and with young adults (Meins, Fernyhough, & Harris-Waller, 2014; Meins, Harris-Waller, & Lloyd, 2008). To our knowledge, no studies used this procedure with older adults, but some authors did investigate mental lexicon in aging (Pezzuti, Longobardi, Milletti, & Ovidi, 2011).

In our study, participants had 5 minutes to tell their story. Stories were audio-recorded and subsequently transcribed. Narratives were analyzed counting the amount of mental terms used. A total words score was also computed by summing all words that each participant used, in order to remove the effect of individual differences in verbal production. Therefore, we computed an adjusted index of MST, according to the following formula (Scopesi, Rosso, Delfante, & Pangallo, 2010):

$$\text{adjusted index} = \frac{\text{N mental state term}}{\sqrt{\text{N total}}\ \text{word}}$$

We also distinguished mental state terms in three exclusive and exhaustive categories, following findings from developmental field (Lecce & Pagnin, 2007; Ruffman et al., 2002). Specifically, we categorized cognitive terms (e.g., to think, to know, to remember), emotion terms (e.g., happiness, anger, to enjoy) and desire terms (e.g., to want, to hope). Again, to control for individual differences in volubility, each category score was divided by the square root of the amount of words used (Rosso, Viterbori, & Scopesi, 2015). A second coder scored a random 30% of descriptions and inter-rater agreement was good, k = .73.

In the experimental condition, subjects were told that their recollections would be used to create a book for children, aimed to promoting reflection and personal development (please, refer to Appendix B for further information).

Cognitive measures.

Vocabulary test, Animal Naming task, Digit span task, and Mini Mental State Examination were the same as in Study 1. They measured respectively: crystallized ability, verbal fluency, short term and working memory.

Other measures.

Lubben Social Network Scale-Revised (LSNS-R). We decide to measure social network because some evidences suggested that it could be associated to socio-cognitive abilities (Krause, 2006; Stiller & Dunbar, 2007). Indeed, it is possible that people who live alone may be engaged in fewer interactions and this in turn could reduce their practice and competence in understanding

other minds (D. Keller-Cohen, 2015). We used the 12-items version of the Lubben scale (Lubben & Gironda, 2003). It investigated both the frequency of contacts and the perceived quality of the relationships, separately for relatives and friends (6 items for each category). It was created to assess social support and social isolation risk. A sample item is: "How many relatives do you feel at ease with that you can talk about private matters?". Answers were rated on a 6-points Likert-type scale, ranging from 0 = *none/never* to 5 = *nine or more/always.* Two scores -family and friends- were calculated, each one ranging from 0 to 30.

Mind-reading beliefs scale. The Mind-reading belief scale (Realo et al., 2003) is a self-reported measure of perceived competence in socio-cognitive ability. It consists of 8 items concerning perceived ability in understanding others. A sample item is: "Usually, I know beforehand what my conversation partner is going to say". Answers were rated on a 5-point Likert-type scale, ranging from 0 = *strongly disagree* to 4 = *strongly agree*, thus score ranged from 0 to 32.

Tromsø Social Intelligence Scale. The Tromsø Social Intelligence Scale– TSIS (Silvera, Martinussen, & Dahl, 2001; Italian version adapted by Gini & Iotti, 2008) is a 21-items self-report questionnaire. Respondents were asked the degree to which each statement described them on a scale from 1 (*Describe me extremely poorly*) to 7 (*describe me extremely well*). Scores ranged from 21 to 147. A sample item is: "I can predict how others will react to my behavior". Three subscales -measuring different facets of social intelligence- are available: a) social information processing (SP), that is the ability to understand and predict other peoples' behaviors and feelings; b) social skills (SS), that stresses the behavioral aspects of the construct by assessing the ability to enter new social situations and social adaptation; and c) social awareness (SA), that measures the tendency to be unaware of or surprised by events in social situations.

Social desirability scale. To control for self-presentation bias, the "Marlowe–Crowne Social Desirability Scale" (Crowne & Marlowe, 1960) was administered in the Italian 9-item version (Manganelli Rattazzi, Canova, & Marcorin, 2000). Items were presented as statements and responses were made on a 6-point Likert-type scale, ranging from1 = *absolutely false*, to 6 =

absolutely true. A sample item is: "I have never been irked when people expressed ideas very different from my own". Total participant social desirability scores were calculated by summing single item scores (range 9-54).

Big Five Inventory. The Big Five Inventory (BFI - John, Donahue, & Kentle, 1991; Italian adaptation Ubbiali, Chiorri, & Hampton, 2013) is a short instrument designed to measure the Big Five dimensions (i.e., Agreeableness, Extroversion, Conscientiousness, Neuroticism, Openness to experience), consisting of 44 short-phrase items based on the trait adjectives known to be the prototypical markers of the Big Five. Each dimension is measured with 8 to 10 items. Responses are given on a 5-point Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*). Scores on each dimension are summed and averaged, therefore final scores ranged from 1 to 5.

Self-construal scale. As in Study 1, we measured self-construals to allow further comparisons with Chinese population. The same instrument was used in Study 2. Again, in the present study we were not interested in self-construal, thus it is not discussed any further.

Experience with children questionnaire. In order to take into account practice and expertise with children, we asked subjects to rate their experience, frequency and comfort with children. All ratings were made on 4-point Likert-type scales, with responses ranging from 1 (indicating low experience) to 4 (indicating high experience). A sample item is: "On the whole, how much experience do you feel in dealing with children?" (see Appendix A.2). The questionnaire was composed by 6 items and appeared to be satisfying reliable, Cronbach's $\alpha = .84$. Score ranged from 6 to 24.

Manipulation check. Globally, participants answered 12 questions concerning perceived motivation. The first question was raised before testing phase, being part of the demographic questionnaire. It requested participants to rate how much motivated they felt to participate in the experiment. The same question was asked again at the end of first session (i.e., after the three ToM tasks). These two items allowed us to compare initial with final motivation experienced (i.e, delta score).

Further 10 questions investigated motivation in a slightly more indirect way and were selected from previously used items found in the literature (Ennis, Hess, & Smith, 2013; Hess, Leclerc, Swaim, & Weatherbee, 2009; Hess et al., 2013; Kessler & Staudinger, 2007). Specifically, the facets investigated were: perceived utility, interest, effort, meaningfulness and feeling to transmit personal values (please refers to Appendix A.2 for more information). All answers were given on a 7-point Likert-type scale and were coded with higher scores indicating higher grade of personal motivation (1 = not at all, 7 =extremely). To assess reliability of the 10-items questionnaire inter-item correlations were run, revealing that all items but effort's ones were sufficiently correlated (r_{mean} = .35 without effort items; effort items' correlation with other items: r_{mean} = -.04). Therefore, the two items concerning effort were removed from the scale (for similar result, see Thomas & Maio, 2008). Cronbach's alpha of the 8-items questionnaire was .81. Scores on single items were summed up to create a global motivation score (range 7-56).

Procedure

All participants took part in two testing sessions with an interval of about a week, each one lasting about 45 minutes. The second session always occurred no less than 5 days after first session, in order to avoid interference between ToM tasks and self-report measures of social skills. Written consents were collected prior to the testing.

In the first test session, participants filled a demographic questionnaire, investigating chronological age, years of education. Older adults were administered the MMSE. Then, all participants performed the three ToM tasks. The order of the ToM task was randomized. In the experimental condition, motivation was manipulated introducing specific prompts both at the beginning of the test session and before each ToM tasks. Prompts consisted in explaining that the activities participants were about to carry out would be useful to children's education and development (please, refer to Appendix B for exact prompts). Moreover, also a reminder was introduced during Faux Pas task and Animation task, in order to assure that participants still remembered that their responses would be used for children's education. No additional instructions

were given to participants in the control condition. Finally, participants completed the Experience with children questionnaire and the Manipulation check questionnaire.

In second test session, no manipulation was introduced. Participants were requested to complete cognitive measures and to fill several questionnaires. The order of the tasks was randomized. At the end, participants were debriefed on research aims and thanked for their participation.

Statistical analysis

Analyses were conducted with IBM SPSS Statistics Version 19. First age-related differences in background variables were tested with a serie of analyses of variance (ANOVA). Then, ANOVAs were conducted on background variables separately for young and older adults to test for the equivalence between the experimental and the control condition. The effectiveness of the motivational manipulation was investigated through MANOVA on the two motivation scores (delta score and global score).

Main analyses investigated the effect of motivation separately on the three ToM tasks. Either univariate ANOVAs or repeated ANOVAs were used, according to each task's features, entering Condition and Age group as between-subjects factors. Finally, correlational analyses focused exclusively on the control group investigated the relationship between ToM and background variables first, and ToM and social and personality variables then.

5.2. *Results*[22]

Preliminary analyses

Differences in education, crystallized ability, verbal fluency and memory between young and older adults were analyzed with a series of ANOVAs. Results showed that older and young adults did not differ in terms of educational level ($F(1, 78) = .002$, $p = .964$), but older adults had greater crystallized ability than young adults, $F(1, 119) = 16.44$, $p < .001$, $\eta_p^2 = .12$; moreover older

[22] If not differently specified, parametric analyses were conducted even if data were not always normally distributed. The pattern of results did not change using non-parametric analyses.

adults had lower performance on verbal fluency, short memory and working memory (respectively: $F(1, 119) = 10.84$, $p = .001$, $\eta_p^2 = .08$; $F(1, 80) = 5.92$, $p < .017$, $\eta_p^2 = .05$; $F(1, 119) = 22.84$, $p < .001$, $\eta_p^2 = .09$). Means and standard deviations are presented in Table 5.1.

Following ANOVAs were run separately for young and older adults to assure that conditions did not differ in background variables. Results showed that globally conditions did not differ ($F(1, 49) \leq 2.26$, $p \geq .139$), but (marginally) for educational level of young adults, Mann-Whitney's $U = 273$, $z = -2.10$, $p = .051$; inspection of the means revealed that participants in the control condition had higher education. To avoid power reduction, following analyses did not include education as a covariate; moreover, because in theory greater education should be associated with higher ToM, the observed difference was against the research hypotheses. Please, note that analyses with education entered as a covariate showed the same pattern of significance.

Additionally, it is possible to hypothesize that previous experience with children could confound the effect of our manipulation: indeed, people with higher experience could also feel more comfortable with the idea to promote children development. Thus, in the experimental condition the potential enhancement in ToM performance may possibly reflect the effect of expertise rather than of the (generativity) manipulation. Similarly, older adults may report more experience than young adults. To exclude these possibilities, a further ANOVA was run with Age group and Condition as independent factors and self-reported expertise with children as dependent variable. Neither main effects nor interaction term were significant (Fs$(1, 117) \leq 1.93$, ps $\geq .168$), indicating that conditions and age group did not differ in (perceived) experience with children.

Table 5.1.

Means and Standard Deviations of Background Variables as a Function of Age Group and Condition.

	Young			**Older**		
	Control n = 25	*Experimental* n = 26	*Tot* n =51	*Control* n = 34	*Experimental* n = 36	*Tot* n =70
Age	21.84 1.70	21.46 1.68	21.65 1.68	70.44 6.79	68.42 6.51	69.40 6.68
MMSE	/	/	/	28.15 1.99	28.00 1.60	28.07 1.79
Educational level	3.16 .37	3.00 .00	3.08 .27	3.18 1.36	2.97 1.16	3.07 1.26
Vocabulary	42.08 4.26	40.19 4.69	41.12 4.54	44.03 5.99	45.44 4.06	44.76 5.10
Animal naming task	25.44 5.72	24.73 5.82	25.08 5.73	20.59 5.95	22.58 5.38	21.61 5.71
DS forward	6.40 1.14	6.35 1.02	6.37 1.22	5.88 .77	5.92 .81	5.90 .78
DS backward	5.00 1.23	5.50 1.21	5.25 1.23	4.15 .99	4.36 1.13	4.26 1.06

Note. DS = digit span task.

Manipulation check

To check the effectiveness of the generativity manipulation we investigated whether conditions significantly differed in terms of self-reported motivation. First, we computed a delta score between the two items directly concerning motivation. An ANOVA with delta score as dependent factor and Condition and Age group as independent factors showed that the two conditions did not differ in terms of change in self-reported motivation, (control: M = .16, SD = .82, experimental: M = .15, SD = .70; $F(1, 118) = .01$, p = .942). Similarly, neither the main effect of Age group nor the Age group x Condition interaction were significant. This indicated that the manipulation did not increase self-reported motivation selectively in the experimental condition, at least when investigated with a very direct question.

Analyses on the 8-items questionnaire revealed a different result. An ANOVA with the global motivation score as dependent factor and Condition and Age group as independent factors showed that participants in the experimental condition were more motivated than their counterparts in the control condition (control: M = 42.03, SD = 4.43, experimental: M = 44.65, SD = 5.38; $F(1, 117) = 8.51$, p = .004, η_p^2= .07). The interaction term was not significant ($F(1, 117) = .16$, p = .694), indicating that the manipulation of motivation was equally effective for young and older adults.

Therefore, we concluded that our manipulation was effective, but only when motivation was investigated in an indirect way.

The effect of motivation on ToM performance[23]

Main analyses aimed to test whether conditions differed on ToM performance and possibly if age additionally explained these differences. Means (and standard deviations) of ToM performance are presented in Table 5.2.

[23] To be noted, we re-run analyses investigating motivation's effect on ToM tasks adding general cognitive functioning as covariate. Entering education, verbal knowledge, verbal fluency, short term memory, and working memory as covariates in the following analyses did not change the presented pattern of results.

First, we investigated the Faux Pas task through a repeated ANOVA with Condition (experimental, control) and Age group (young, old) as between- subjects factors and Story (Faux pas score, Neutral score) as within-subject factor. Results showed significant main effects of Age group and Story ($F(1, 116) \geq 6.76$, $p \leq 0.11$, $\eta_p^2 \geq .06$), suggesting that young outperformed older adults and that faux pas stories were harder than neutral stories. Also a marginally significant Age group x Story interaction emerged, $F(1, 116) = 3.86$, $p = .052$, $\eta_p^2 = .03$, suggesting that older adults performed worse than young adults on faux pas stories ($F(1, 116) = 13.42$, $p < .001$, $\eta_p^2 = .10$) but not on neutral stories ($F(1, 116) = .16$, $p = .690$). Finally, the three way interaction was also significant, $F(1, 116) = 7.97$, $p = .006$, $\eta_p^2 = .06$. Following pairwise comparisons revealed that within the control condition young outperformed older adults in faux pas stories, whereas within the experimental condition age groups did not differ (see Figure 5.1).[24]

Analyses on A' score yielded different results. A univariate ANOVA with Age group and Conditions as independent factors showed only the main effect of Age group, $F(3, 117) = 6.05$, $p = .015$, $\eta_p^2 = .05$, confirming young adults' better performance.

Finally, ToM components were analyzed. A repeated ANOVA with Age Group and Condition as between-subjects factors and Component (cognitive, affective) as within-subjects factor was performed. Results showed the main effect of Age Group, $F(1, 115) = 14.34$, $p < .001$, $\eta_p^2 = .11$, and the Age group x Condition interaction $F(1, 115) = 5.62$, $p = .019$, $\eta_p^2 = .05$, again suggesting that in the control condition older adults performed (globally) worse than young adults, whereas in the experimental condition no age-related differences emerged. Also the main effect of

[24] Notably, within the older adults group the two conditions significantly differed on performance in the faux pas stories, $F(1, 116) = 7.25$, $p = .008$, $\eta_p^2 = .06$.

Because the homogeneity of covariance matrices and multivariate normality assumptions were violated, non-parametric analyses were performed. Globally results were in line with parametric results. Specifically, for what concerns the crucial three way interaction, Mann-Whitney tests separately for the two conditions showed that within the control condition young outperformed older adults in faux pas stories ($U = 182.50$, $z = 3.63$, $p < .001$), whereas within the experimental condition no significant age-related differences appeared ($U = 357{,}00$, $z = 1.60$, $p = .112$). In both conditions young and older adults did not differ in neutral stories ($U \geq 402.00$, $z \leq 1.47$, $p \geq .164$).

Component emerged, $F(1, 115) = 90.73$, $p < .001$, $\eta_p^2 = .44$, indicating that cognitive component was harder than affective component, irrespective of age group and condition[25]. No other interaction effects emerged, thus we found neither age- nor condition-related differences in the two components investigated. Nevertheless, as can be seen in Figure 5.2., means were in the expected direction.[26]

Globally, analyses on Faux Pas test suggested that older adults in the experimental condition -that is, with enhanced motivation- performed better than their counterpart in the control condition on faux pas stories, but only when the whole performance is considered (i.e., the sum score which considered all the 6 questions). Collapsing faux pas and neutral stories (A' score) or considering separately cognitive vs. affective component yielded non-significant results.

[25] When background variables (education, verbal knowledge, verbal fluency, short memory and working memory) where entered as covariates, the main effect of the component was not significant anymore, $F(1, 110) = .65$, $p = .423$. To be noted, no one of the covariate had a significant effect on the dependent variables. All other results did not change.

[26] Univariate ANOVAs separately for cognitive and affective components confirmed that young and older adults in control but not in experimental condition differed in both components.

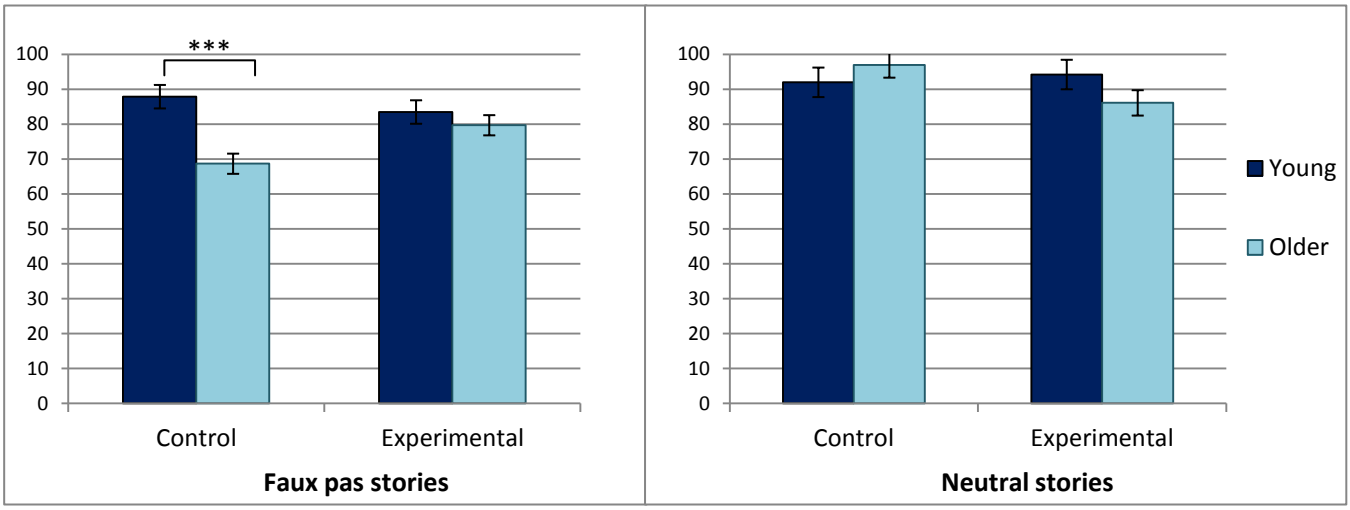
Table 5.2.

Mea*ns and Standard Deviations of ToM Tasks as a Function of Age Group and Condition*.

		Young			**Older**		
		Control *n* = 25	*Experimental* *n* = 26	*Tot* *n* =51	*Control* *n* = 34	*Experimental* *n* = 36	*Tot* *n* =70
Faux Pas							
	A’	.86 .17	.85 .19	.85 .18	.74 .19	.79 .21	.77 .20
	Faux Pas score	87.89 12.55	83.49 15.07	85.65 15.07	68.69 24.10	79.71 12.42	74.44 19.58
	Neutral score	92.00 18.71	94.23 21.57	93.14 20.05	96.97 12.12	86.11 28.31	91.30 22.62
	Cognitive ToM	77.00 19.58	68.67 21.95	72.83 21.02	53.03 24.01	62.50 17.08	57.97 21.07
	Affective ToM	88.67 15.00	88.67 15.00	88.67 14.85	72.73 28.20	85.65 16.74	79.47 23.68
Animation task							
	ToM video	78.50 13.75	78.53 10.85	78.51 12.23	63.01 12.62	69.33 10.96	66.30 12.12
	Gd video	68.33 8.07	70.03 7.17	69.20 7.60	63.38 9.92	67.59 6.69	65.58 8.59
Describe-a-friend task							
	global MST	1.12 .29	1.07 .39	1.09 .34	.68 .32	.80 .28	.75 .30
	cognitive MST	.40 .18	.43 .21	.42 .20	.25 .18	.37 .16	.32 .18
	emotion MST	.59 .26	.50 .23	.55 .25	.35 .25	.33 .16	.34 .21
	desire MST	.12 .11	.14 .10	.13 .11	.08 .07	.10 .08	.09 .08

Figure 5.1.

Performance on Faux Pas (Sum Scores) as a Function of Age, Condition and Story.

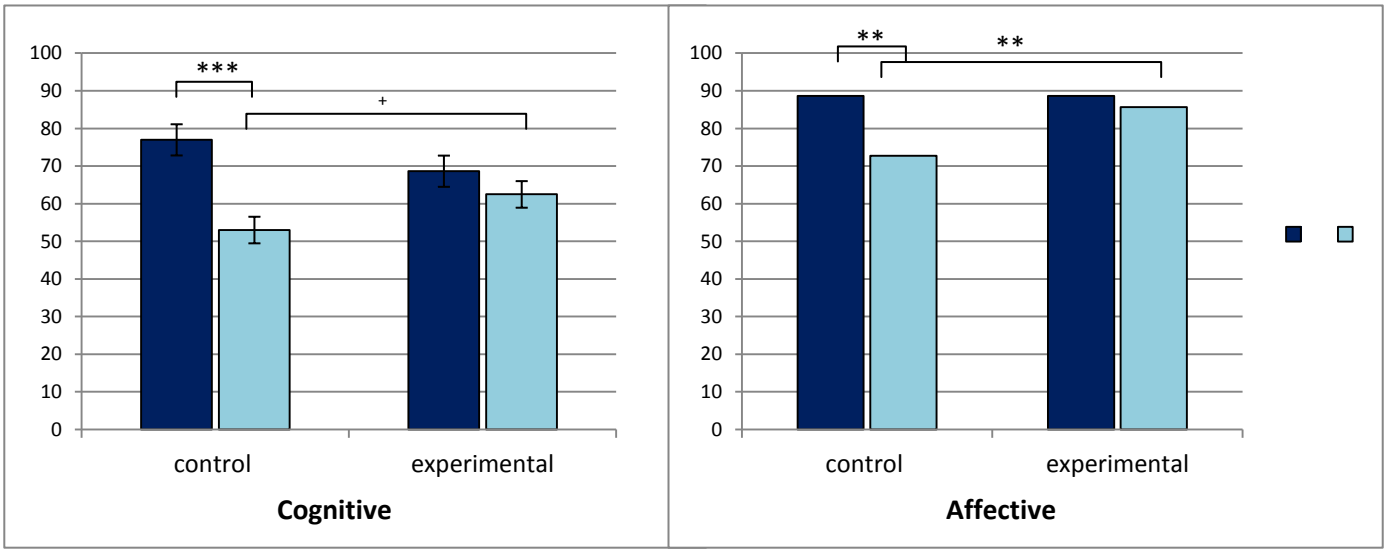


Note. Error bars represent standard errors. Results reported refer to univariate analyses.

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 5.2.

Performance on Faux Pas as a Function of Age, Condition and Component Investigated.



Note. Error bars represent standard errors. Results reported refer to univariate analyses.

$^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001.

Secondly, Animation task was investigated. A repeated ANOVA with Age Group and Condition as between-subjects factors and Typology of video (ToM, Goal-directed) as within-subject factor was performed. As expected, there was a main effect of Typology of video, $F(1, 116) = 21.30$, $p < .001$, $\eta_p^2 = .16$, reflecting the greater intentionality depicted in the ToM compared to the Goal-directed videos[27]. Furthermore, a significant main effect of Age group ($F(1, 116) = 26.73$, $p < .001$, $\eta_p^2 = .19$) was found indicating a the lower performance of older adults. Also, the Age group x Typology of video interaction was significant, $F(1, 116) = 15.91$, $p < .001$, $\eta_p^2 = .12$, suggesting -as in Study 1- that young adults were better able to differentiate the two typologies of video, that is ToM videos had significantly higher score compared to Goal-directed videos. Conversely, ToM and Goal-directed videos did not differ in older adults. Neither the Age group x Condition interaction nor the three way interaction were significant, thus Condition appeared to have no significant effect on Animation task's performance.

Finally, the Describe-a-friend task was considered. First, analyses on the frequency of use revealed that all participants got a MST global score over 0, thus reflecting that everyone used at least one mental state term. Few participants did not use either cognitive MST or affective MST at all, respectively 2.5% and 3.3%. A higher rate of participants did not use desire terms at all, namely the 27.5%.

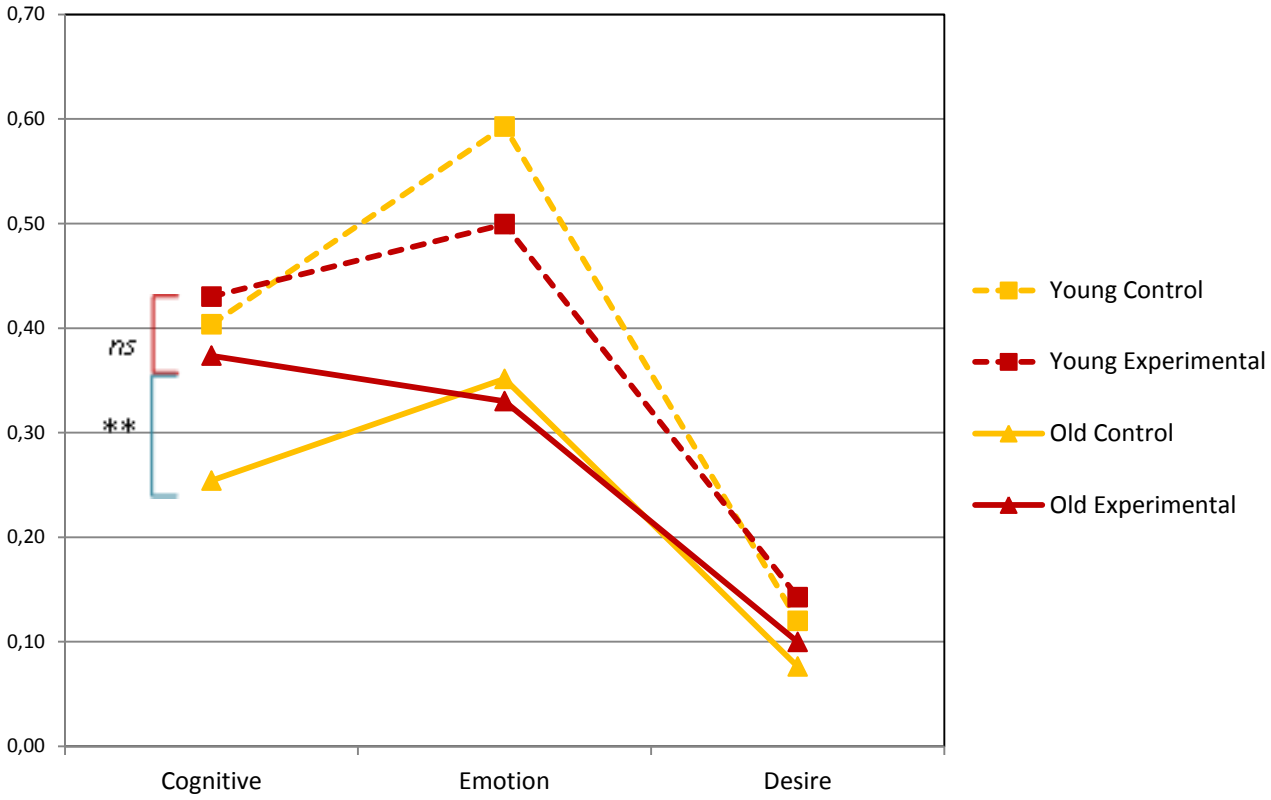
We investigated whether the manipulation of motivation had an effect on the spontaneous use of ToM in descriptions. To this end, the amount of all mental state terms used (global MST) was entered as dependent variable of an ANOVA with Condition and Age group as independent factor. Results indicated that young adults used more mental state terms, $F(1, 116) = 35.94$, $p < .001$, $\eta_p^2 = .24$, but Condition did not affect performance in any way.

[27] When background variables (education, verbal knowledge, verbal fluency, short memory and working memory) where entered as covariates, the main effect of the Typology of video was not significant anymore, $F(1, 111) = .19$, $p = .665$. To be noted, no one of the covariate had a significant effect on the dependent variables. All other results did not change.

Further investigations on the three categories were run through a repeated ANOVA with Category (cognitive, emotion, desire) as within-subject factor and Age group and Condition as between-subjects factors. Overall, emotion MST were the most used, followed by cognitive and desire MST ($F(2, 115) = 201.79$, $p < .001$, $\eta_p^2 = .78$). The main effect of Age group was qualified by an interaction with Category, $F(2, 115) = 8.37$, $p = < .001$, $\eta_p^2 = .13$, indicating that young adults not only used more MST than older adults irrispective of Category, but also that within age group older adults used a similar amount of cognitive and emotion terms, whereas young adults used significantly more emotion than cognitive terms. This result was unexpected, but means showed that it was lead by older adults in experimental condition's higher use of cognitive MST (please, refer to Figure 5.3.). Indeed, the Condition x Category interaction was marginally significant ($F(2, 115) = 2.99$, $p = .054$, $\eta_p^2 = .05$) and following univariate analyses revealed that in the experimental condition the frequency of cognitive terms was significantly higher than in the control group, whereas no differences between conditions were found on both emotion and desire terms. Nevertheless, the three way interaction was again non-significant ($F(2, 115) = 1.02$, $p = .365$), thus Condition did not differ in any of the categories of MST differently for young and older adults, even if means were in the expected direction.

Figure 5.3

Performance on the Three MST Categories as a Function of Age Group and Condition.



Note. Results reported refer to univariate analyses.

$^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001.

Correlations between ToM and background variables

To investigate the associations between ToM and general cognitive functioning, we decided to consider exclusively participants in the control group. Indeed, even if we did not find strong differences between the two conditions, we want to exclude the potential confounding role of the enhanced motivation. Because variables were mostly not normally distributed, Spearman's rho (ρ) was used instead of Pearson's *r* (please, refer to Table III in Appendix C).

Firstly, generally speaking the three ToM tasks presented positive inter-relations, confirming that even if different, they all measured the same underlying construct. Importantly, the control parts of the tasks (i.e., neutral stories in Faux Pas task and Goal-directed video in Animation task) were not related to the other ToM tasks.

Then we examined the relation between ToM and background variables. More in detail, we expected that age and executive functioning (i.e., verbal fluency, short term memory and working memory) negatively impacted on ToM. On the contrary, we hypothesized that those variables linked to life experiences may act as buffers against the socio-cognitive decline, therefore educational level, crystallized ability, and experience with children may be positively related to ToM. As expected, age group[28] was negatively correlated with all ToM tasks (ρs $\geq$ -.27, *p*s $\leq$ .042), but interestingly it did not correlate with control parts of the tasks (ρs $\leq$ -.25, *p*s $\geq$ .061). Crystallized intelligence was not significantly related to ToM, whereas education was (ρs $\geq$ .29, *p*s $\leq$ .026). Interestingly, education was not related to MST, thus suggesting that the more ecological task, based on spontaneous use of ToM, may also be less affected by difference in socio-economic features. Curiously, experience with children correlated with the Animation task (ρ = .26, *p* = .048) and partly with the Faux Pas task (Sum score: ρ = .22, *p* = .097; A' score: ρ = .30, *p* = .022. Regarding executive functioning, both working memory and verbal fluency were overall related to ToM, whereas short term memory appeared to be unrelated to ToM.

[28] Age group was coded 1 = young adults, 2 = older adults.

Further regression analyses were run separately for the three main ToM tasks (faux pas sum score, ToM videos and global MST); age group was entered at first step, and the correlated background variables were entered at second step (please, refer to Table 5.3.). Results revealed that age group was a significant predictor for all the three investigated tasks, even controlling for other background variables. In line with correlational results, experience with children appeared to be a significant predictor of Animation task and marginally of Faux Pas task. Fluency was a significant predictor only of Faux Pas.

Globally, findings revealed that age group is the main factor explaining differences in ToM performance, and executive functions played no or marginal role. Also, curiously experience with children seemed to facilitate the appropriate interpretation of moving shapes and social gaffes' understanding.

Table 5.3.

Regression Analyses on Main ToM Tasks.

	FP - Sum score				AT -ToM				MST			
		B	*SE B*	*β*		*B*	*SE B*	*β*		*B*	*SE B*	*β*
Step1	Age group	-19.20	.5.30	-.44**	Age group	-15.22	3.51	-.51***	Age group	-.43	.08	-.58***
Step2	Age group	-14.02	5.41	-.32*	Age group	-14.35	3.79	-.48**	Age group	-.38	.09	-.51***
	AN task	1.04	.46	.30*	AN task	.24	.32	.97	AN task	.01	.01	.14
	DS - Back	.68	2.40	.04	DS - Back	.18	1.68	.01	DS - Back	.02	.04	.06
	Education	1.86	2.48	.09	Education	1.30	1.74	.09				
	Expertise	1.13	.62	.22+	Expertise	.91	.43	.26*				
	R^2 = .19** for Step 1; ΔR^2 = .21** for Step 2.				R^2 = .25*** for Step 1; ΔR^2 = .12+ for Step 2.				R^2 = .33*** for Step 1; ΔR^2 = .03 for Step 2.			

Note. AN task = Animal naming task; DS - Back = Digit span backward; A - ToM = Animation task, ToM videos; MST = Mental state terms.

All models were significant, $Fs(1, 95) \geq 9.91$, $ps \leq .003$.

Correlations between ToM and social and personality variables

Following analyses investigated whether ToM ability was related to social network, self-reported social skills, and personality (see Table IV in Appendix C). Because in preliminary analysis we found that social desirability was related only with Agreeableness and Neuroticism traits of the Big Five, following analyses did not control for social desirability.

First, concerning social network results revealed that better ToM was associated to better friendships (ρs $\geq$ .35, ps $\leq$ .006), but did not correlate with relationships with family. Separate analyses on young and older adults showed a mixed pattern of results: marginally significant associations between friendship and the Animation task (ρ = .38, p = .063) for young adults; and significant association between friendship and MST in older adults, ρ = .35, p = .047.

Second, for what concerned perceived social skills (Mind-reading belief scale and Social intelligence scale) overall both measures correlated with the Faux Pas task and MST (ρs $\geq$ .26, ps $\leq$ .052), but not with the Animation task (ρs $\leq$.21, ps $\geq$ .122). Nevertheless, when correlations were run separately for young and older adults a clearer pattern of association between objective performance and self-reported ability emerged. Indeed, for young adults no correlations reached statistical significance, whereas for older adults only Social intelligence was related to both Faux Pas task and MST, ρs $\geq$ .37, ps $\leq$ .037.

Finally, personality traits were investigated. Globally, Openness was the trait more related to ToM, and Agreeableness specifically related to Faux Pas. No other relations were significant. Separating young and older adults, analyses revealed partly different results: no significant correlations for young adults emerged; nevertheless, for older adults Openness was marginally related to Faux Pas (ρ = .33, p = .058) and MST (ρ = .31, p = .081) and Extroversion was associated with MST, ρ = .42, p = .014.[29]

[29] Analyses investigating differences between age groups were run. Concerning social relationships, a repeated ANOVA with relationship (friend, family) as within-subject factor and Age group as between-subjects factor showed that older adults reported significant lower friendships that young adults, but no age-related differences emerged in familiar relationships (F(1, 57) = 8.29, p = .006, η_p^2 = .13). Concerning self-reported social skills, univariate ANOVAs

5.3. *Discussion*

The present study aimed to test whether improved motivation in older adults yielded to better performance in ToM, measured by very different tasks. Among all the way to operationalize motivation, we chose the intergenerational knowledge transmission need, which is related to the generativity goal, a personal goal central for late life. Motivation was manipulated during the first testing session: participants in the experimental condition received instructions focused on passing on one's own experience to the children. During the second testing session cognitive, social and personality variables were measured, to obtain more information about how ToM was related to these variables.

Overall, findings suggested that enhanced motivation could only slightly promote on older adults' ToM. Out of the three tasks used, only in the Faux Pas task the older adults in the experimental condition performed significantly better to their counterpart (to be noted, at a similar level of young adults). In the Animation task and in the Describe-a-friend task older adults did not differ between conditions and were repeatedly outperformed by young people.

In line with the aging literature, we found age-related differences in ToM. Contrary to our expectations, general cognitive functioning appeared not strongly related with ToM. Also, on the one hand interesting relationships between ToM and friendship and self-reported socio-cognitive skills were found. On the other hand, personality appeared to be mostly unrelated to ToM performance.

The effect of motivation on ToM performance

As emerged by the manipulation check analyses, the experimental manipulation of motivation appeared to be effective. That is, introducing the tasks as in line with personal goals actually improved self-reported motivation. To be note, to simply ask: "how much motivated

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showed that older adults had lower score on both Mind-reading belief scale and Social intelligence scale compared to young adults (respectively, $F(1, 57) = 4.03$, $p = .049$, $\eta_p^2 = .07$; $F(1, 57) = 5.02$, $p = .026$, $\eta_p^2 = .09$). Finally, with regard to personality, a 2 (Age group) x 5 (personality trait) repeated ANOVA revealed a marginal interaction between Age and Personality trait $F(4, 54) = 2.14$, $p = .088$. However, further univariate analyses showed no significant age-related differences in any trait, $Fs(1, 57) \leq 2.32$, $ps \geq .134$.

are/were you?" was not an effective way to measure motivation, in line with previous studies (Pelham & Neter, 1995). Indeed, self-reported motivation did not change before and after the manipulation, rather it remained almost the same, irrespective of age and condition. On the contrary, measuring motivation through its several facets (interest, perceived utility, personal significance, feeling of transmission of important values) yielded to a significant difference between the two conditions, confirming that participants who received the instructions in line with the generativity need felt globally more motivated.

Notably, once again the manipulation was effective for both older and young adults. This can be conflicting with the theoretical framework previously presented: the intergenerational knowledge transmission need is considered a goal pertinent to older adults (Adams et al., 2002; Hoppmann & Blanchard-Fields, 2010; Lang & Carstensen, 2002). However, it is important to acknowledge that young adults recruited here were Psychology students, mostly women. Hence, it is possible to hypothesize that this population -notwithstanding the young age- may be characterized by a marked interest in children's development promotion. Thus, for them, the manipulation could be in line with their personal goal -not generativity but perhaps personal/professional identity confirmation (Brunstein & Gollwitzer, 1996; Gendolla, 1998; Thomas & Maio, 2008). Supporting this hypothesis, we found no differences in self-reported experience with children between young and older adults: in theory, older adults should have greater expertise, being parents and possibly grand-parents. The findings that young students affirmed to have the same experience of older adults in dealing with children fit well the idea that they are a population with a specific focus on childhood and development.

Having said that, we expected that participants more motivated would perform better, and this would be specifically true for older adults who have compromised ToM. Partly confirming previous findings (Zhang et al., 2013), we found that motivation positively impacted on older adults Faux Pas performance. Indeed, the age-related differences in faux pas stories disappeared in the experimental condition, with young and older adults performing at the same level. However it is

important to note that differently from Zhang and colleagues we used a global score of faux pas stories performance, to be compared to a global score of neutral stories. Using two separate scores allowed us to confirm that older adults are less able not in deciding if a social gaffe is present or not, but rather in understand it in all its aspects- a result found also in Study 1.

We also calculated the A' score in order to compare the present result with Zhang and colleagues' one; however analysis on A' did not confirmed previous findings (MacPherson et al., 2002; Zhang et al., 2013). Indeed, collapsing together faux pas and neutral stories we found only the well-know age-related difference, and no motivation-related difference.

Finally, we investigated whether age and motivation selectively impacted on different ToM components. As expected, cognitive component was harder than affective component (Hynes et al., 2006). Contrary to previously cited literature (e.g., Bottiroli et al., 2016), present findings showed that older adults performed worse than young adults in both components. We found the same result also in Study 1 and this consistency makes stronger the evidence. Thus, present findings are in line with those studies indicating that aging negatively impacts on ToM as a whole (Duval et al., 2011; J. D. Henry et al., 2013).

Concerning the Animation task, we found the expected superiority of young adults over older adults, irrespective of the typology of video. Interesting, it appeared that older adults were not as good as young adults in differentiating between the two typologies of videos: that is, while young participants attributed less intentionality to the triangles in the Goal-directed videos compared to the ToM videos, older adults attributed intentionality similarly to both videos.[30] Curiously, Study 1 showed the same pattern of result, so we believe that this recurrent result is likely to indicate an important characteristic of ToM in aging. In a further investigation of this evidence, in Study 3 three typologies of video were used instead of two, to better elucidate the hypothesis of older adults' inaccuracy in intentionality attribution.

[30]Further analyses were conducted separately for the two scores: intentionality and appropriateness. Results revealed that young adults outperformed older adults in both videos irrespective of the score investigated, but for intentionality score of the goal-directed videos, were age groups performed similarly. Please, refer to Table V in Appendix C.

Notably, in the Animation task we found that motivation did not impact on older adults' performance, against our initial hypotheses. A possible explanation may involve the difference in complexity between the two tasks. That is, the Animation task is an implicit ToM task, which does not offer social clues or information, as the Faux Pas task does. Therefore, it could be considered as a more complex ToM task and consequently it is possible that enhanced motivation could not be enough to wipe out the age-related differences, as it can do in easier tasks (Lecce et al., 2016).

Finally, the investigation of spontaneous use of mental state terms during best friend's description once again showed that motivation did not improve older adults ToM. We consider both global MST and three separate categories, namely, cognitive, emotion and desire terms. In both cases, conditions did not clearly differ in MST frequency. Considering separately the three categories yielded to a marginal difference between conditions, and an inspection of the means suggested that older adults in the experimental condition used more cognitive terms than their counterpart in control condition; univariate ANOVAs supported this finding and further revealed that in the experimental condition young and older adults did not differ in cognitive MST. Nevertheless, the repeated ANOVA did not confirmed this result, thus further studies are needed to clarify this point.

To be note, the investigation of mental state terms used by people is quite common in developmental research, but not frequently used with adults. The existing literature often concerns clinical populations (J. L. Barnes, Lombardo, Wheelwright, & Baron-Cohen, 2009; Byom & Turkstra, 2012). To our best knowledge, only one study measured mental state terms in aging population (Pezzuti et al., 2011), but it did not compared young and older adults, rather it compared three age groups of older adults; the authors found that from 65 to 94 years old MST use did not change. Moreover, MST was not impaired in people with mild and moderate cognitive impairment. Unfortunately, the authors did not analyzed differences in terms of MST categories. Therefore, present results are highly informative, because they offer a new perspective on the spontaneous use

of ToM in adulthood, in a task highly ecological and independent from background characteristic - e.g., cognitive abilities, education and life experiences.

To summarize, present results pointed out that ToM declines in aging irrespective of task modality. We used three very different ToM tasks, from verbal to visual, from explicit to implicit, from far to daily experience to very ecological. Their inter-correlations confirmed that they all measured ToM, therefore the fact that older adults had lower performance in all of them supported the idea of an age-related ToM impairment (J. D. Henry et al., 2013).

Contrary to previous findings, present results did not strongly indicate an improvement in older adults ToM as a consequence of increased motivation. Even if globally means were in the hypothesized direction, only in the Faux Pas task enhanced motivation positively affected older adults' performance. The reason behind this is not clear, but a speculation may be that motivation can promote performance in easier task (Faux Pas) but not in more complex task (Animation task) (Lecce et al., 2016). However, this hypothesis does not explain why MST use did not improve: because of its high ecological validity, the Describe-a-friend task is a very easy task -possibly easier than the Faux Pas. Further studies are needed to clarify this point.

ToM's associations with general cognitive functioning

Apart from the role of motivation in socio-cognitive skills, we investigated also the relation between ToM and general cognitive functioning - that is, crystallized and fluid abilities. As previously stated, several evidence suggested a relation between these constructs (Charlton et al., 2009; Mahy et al., 2014; Sullivan & Ruffman, 2004b). Analyses on participants in the control condition globally revealed that both executive functioning and crystallized ability and educational attainment were generally not related to ToM performance. The mainly significant predictor was age group - that is, elderly people have lower in ToM compared to young adults independently of age-related differences in general cognitive functioning. Thus, present results are in line with those studies indicating that ToM's decline in aging can't be simply accounted by impairment in general

cognitive functioning (Bernstein et al., 2011; Cavallini, Lecce, et al., 2013; Slessor et al., 2007; Y. Wang & Su, 2006).

Unexpectedly, experience with children was a significant predictor, explaining additional variance other than age in the Animation task (and partly in the Faux Pas task). The association between experience with children and the Animation task can be hypothetically explained considering that this task consists of very short videos that may be similar to children's toons. However, no clear hypothesis can be proposed to explain the marginal association with the Faux Pas task.

ToM's associations with social and personality measures.

An important issue still open is whether ToM skills are actually related to social functioning in adulthood. To date, only few studies investigated this issue in aging, obtaining contrasting results (Bailey et al., 2008; Pezzuti et al., 2015). Present results supported the idea that ToM is associated to social relationships, both for young and older adults (Blanke, Rauers, & Riediger, 2016). Specifically, we found that socio-cognitive skills are related to interactions with friends, but not with family members (Lecce, Ceccato, et al., 2015); this is not surprising given the nature of these two kinds of relation: whereas family relationships are permanent and obligatory, friendships are temporary and voluntary. Accordingly, people are likely to put more energy to maintain their relationship with friends than with relatives (Roberts & Dunbar, 2011).

Furthermore, in line with a recent meta-analyses, we found no age-related differences in family relationships, whereas friendships decrease in older adults (Wrzus et al., 2013). Hence, given the relation between ToM and friendships, it appears that socio-cognitive skills are even more important for elderly people, in order to maintain friends and avoid social isolation and loneliness. To be noted, given the correlational nature of present results we do not know the direction of this relation: it could be that age-related impairments in ToM lead to a reduction in friendships, as well as that the reduction in friendships implies less occasions to use ToM ability. A longitudinal study could better solve this issue.

In this study we also investigated whether subjective and objective measures of social competence were related. Previous studies showed that ToM and self-reported social skills were mostly unrelated to each other (Duval et al., 2011; Ickes, Stinson, Bissonnette, & Garcia, 1990; Realo et al., 2003), and this lack of association has been found in several psychological domains (Zell & Krizan, 2014). Present results indicated that older adults' ToM was related to self-reported social intelligence, in line with previous study (Yeh, 2013); on the contrary, young adults' ToM was unrelated to our two self-reported measures of social competence. An interesting possibility is that growing older people become at least in part more aware of their social skills; possibly supporting this hypothesis, we found that overall older adults reported lower social competence than young adults.

Finally, this study investigated the potential relation between personality traits -as described by the Big Five model- and ToM. Very few works investigated this issue and only one considered elderly people (Keightley et al., 2006). Theoretically, one can suppose that some personality traits may be more related to socio-cognitive skills. For example, Extroversion -which reflects a sociable, friendly, and talkative attitude- and Agreeableness - people good natured, sympathetic, forgiving, and courteous- seems to be akin to ToM ability. Existing literature globally suggests that Agreeableness is the trait most likely correlated with ToM (Nettle & Liddle, 2008). Contrasting these limited findings, the present study indicated that ToM performance is globally not related to personality traits. However, separating young and older adults revealed that in the latter group Openness to experience was (partly) associated to socio-cognitive skills. Openness refers to the tendency to be creative, curious, sensitive to aesthetics, and open to new ideas and experiences; accordingly, it is positively related to better cognitive abilities, especially in older adults (Curtis et al., 2014). Therefore, it seems possible to hypothesize a similar relation with ToM. On a general note, ToM requires to be willing to consider others' point of view and to contemplate new perspectives, thus it seems plausible that people more interested in reflections are also more able in put themselves in others' shoes. Curiously, a recent study found that for older, but not for young

adults, higher score on Openness predicted being with friends at the present moment and in short-term future (Wrzus, Wagner, & Riediger, 2015). A speculation is that for older adults being more interested in intellectual activities and new experiences implies to meet people and engage in social activities - for example, recreational groups, cultural organization. Instead, for young adults higher openness may predict a greater preference for solitude. Hence, a compelling possibility is that ToM, Openness and friendships are all related constructs in older adults.

Summary, limitations and future directions.

Globally, this study demonstrated that: 1) ToM declines with aging, irrespective of the task used (i.e., verbal/visual stimuli, medium/high ecological validity); 2) motivation slightly promotes older adults' ToM; 3) the general cognitive functioning does not account for the age-related decline in ToM; 4) ToM is associated with friendships both for young and older adults; 5) subjective evaluation and objective performance in ToM are slightly related in older adults, but not in young adults; 6) personality is not related to ToM skills, with Openness to experience trait being a possible exception.

Some important limitations need to be acknowledged. First, we decided to use a reduced number of stories/videos to avoid too long testing sessions. However, this could have reduced the power of the tests. Nevertheless, we feel confident that this was not the case. Indeed, comparing means concerning both the Faux pas task and the Animation task between Study 1 and 2 showed that globally values are reasonably similar, notwithstanding that in Study 2 were used respectively 2 neutral stories instead of 5 and 6 videos instead of 16.

Second, the manipulation of motivation implied a difference in instructions given to participants in the two conditions. That is, people in the experimental condition received longer instructions compared to their counterpart in control condition. In these additional instructions, we carefully avoided to give any information which could help people in performing the task. Nevertheless, we cannot completely exclude that beside the content (enhancing motivation) the

length of instructions had an impact on performance as well. Given that, in Study 3 we directly excluded this possibility giving instructions extremely matched in length.

Third, we did not check whether people in the experimental condition trusted what instructions told them. Thus, we cannot be sure that participants in this condition simply did not believe that their answers would be actually used for children's development. This speculation could be partly ruled out considering that the reported motivation indeed reflected a difference between the two conditions. Hence, this difference would be puzzling if people did not trust what the experimenter told them. Nevertheless, future studies should directly ask participants if they had suspected the manipulation.

Related to the previous point, a possible enhancement in the procedure would be to involve a real child, as has been done in previous works (Adams et al., 2002), for instance, requesting people to describe the Animation task's videos to a child. In such a way, the increase in motivation would possibly be greater, exacerbating its effect on ToM performance.

Nevertheless these limitations, this study offer important contributions to the research. First, it clearly indicated that older people have a lower ToM compared to young adults, and this is true for a very heterogeneous set of ToM tasks. Literature often points out the need for more ecological tasks in the study of individual differences, casting some doubts on findings obtained with "lab" measures (Dziobek, 2012; Isaacowitz & Stanley, 2011). In the current work, we sought to answer this call, using a task both familiar and involving (Describe-a-friend task): results from this task were in line with those from less ecological tasks, indicating an age-related decline in ToM and an absent-to-slight effect of motivation.

Furthermore, we think that the suggestion that different stages of life may show differential association between socio-cognitive skills and social functioning is extremely compelling and deserves future investigations.

Chapter 6 - Study 3: ego-involvement

Globally speaking, the previous two studies showed an age-related decline in ToM, and motivation only slightly reduced it (i.e., Study 2, Faux Pas task). Empirical evidences showed that aging negatively affects not only ToM, but also emotion recognition (see Chapter 1, paragraph 4.c.). Therefore, the present study focused on both these two components of socio-cognitive skills, to test if motivation impacts differently on them.

As previously described, emotion recognition (ER) refers to the ability to detect emotions as they are conveyed through different social stimuli -facial expression, gaze direction, prosody of voices, bodily posture, and movements. Many studies have demonstrated an age-related decline in the ability to recognize emotions from facial, vocal and bodily stimuli (for a review, see Ruffman, Henry, Livingstone, & Phillips, 2008). This decay seems to be independent from task modality (Ruffman, 2011) and has important implications for a variety of dimensions of social functioning such as faux pas detection (Halberstadt et al., 2011), verbosity (Ruffman et al., 2010), lie detection ability (Ruffman, Murray, Halberstadt, & Vater, 2012) and social attitudes (Ruffman et al., 2016).

As anticipated, to date the role of motivation in age-related changes in the socio-cognitive domain has received very little attention with only two published studies to have directly investigated the impact of motivation on ER and ToM in older adults (Stanley & Isaacowitz, 2015; Zhang et al., 2013). Crucially, these studies operationalized motivation in three different ways: perceived closeness, familiarity, and accountability. According to the Socioemotional Selectivity theory, (Carstensen, 2006), given the reduced time-perspective, elderly people emphasize emotionally meaningful goals over acquisition of information; hence, perceived closeness was hypothesized to increase emotional meaningfulness and general motivation (Zhang et al., 2013). Similarly, familiarity is an important motivational factor for older adults because -again as explained by the SST - they prioritize close partners over acquaintances more than young adults (Fredrickson & Carstensen, 1990). Accountability refers to the feeling of being considered

responsible of one's answers, and having to justify them (Lerner & Tetlock, 1999). That is, accountability increases how much people care about an activity. Although accountability is not considered to be a motivational factor that is specific of older adults, empirical findings showed that it might be more relevant for older adults compared to young adults (e.g., Hess et al., 2001).

Overall, these findings suggested that when a task is perceived as personally relevant and/or in line with personal goals, older adults perform better, sometimes reaching the level of young adults. Yet, with only two studies thus far, and with findings being somewhat inconsistent, further research is clearly warranted.

A fruitful way to investigate motivation is through physiological indices, and specifically cardiovascular values (CV). Indeed, high level of motivation implies greater engagement and effort (Wright, 1996), and therefore can be detected with cardiovascular measures (Gendolla & Richter, 2010). Specifically, the change in CV values from rest phase to testing phase (i.e., reactivity) has been demonstrated to be a reflection of mental effort, related to difficulty, ability and motivation (Hess & Ennis, 2014; Uchino, Birmingham, & Berg, 2010). Concerning older adults, the few studies investigating CV reactivity indicate that older adults are sensitive to task demands (Uchino et al., 2010) and are disproportionally affected by the importance attributed to the task (Ennis et al., 2013). That is, to perform a given task, older adults need to contribute more effort compared to young adults, and therefore they usually engage less (Hess 2014). To be engaged, the task should be perceived as important. According to the Selective Engagement Theory, if the importance given to a task is heightened (thereby increasing motivation), older adults' engagement and effort will increase significantly more than young adults', with this increase detectable through CV reactivity. Furthermore, if Isaacowitz and colleagues are correct in positing that differences in motivation underlie older adults' worse performance on tasks measuring social understanding, such an increase in motivation should also lead to an improvement in older adults' performance.

The present study

The present study examined the role of motivation in both ToM and ER of young and older adults. More precisely it addresses a number of open issues. The first aim was to examine the specificity of the motivation effect. No study has included control tasks not measuring ToM or ER, so that we do not know whether the positive effect of motivation is specific to social-cognitive skills or has a more general effect on concentration and task accomplishment. In Study 1 and 2 we did use tasks with control parts: the neutral stories in Faux Pas task, and the Goal-directed videos in Animation task. Nevertheless, they may be not enough well matched: the neutral stories requested to answer only 3 questions -against the 9 questions in the faux pas stories- and the target question was always a yes/no answer, thus not requiring to reason as much as in the faux pas stories. The Goal-directed videos, on the other side, are well matched to their ToM counterpart; however, to some extent they can elicit some mental states attribution, because the characters depicted are indeed characterized by some degree of intentionality. Hence, in present study we selected task with more matched control parts.

The second issue regards the way in which the effect of motivation was measured. In the studies cited above, the authors attempted to manipulate motivation and then examined its impact on ToM and ER, yet there was no direct measure of motivation. Therefore, the present study investigated not only participants' tasks performance, but also cardiovascular reactivity, i.e. CV-R (Gendolla, 1999; Smith & Hess, 2015). Physiological reactions to cognitive resource mobilization can be identified through changes in blood pressure (Wright & Kirby, 2001) with systolic blood pressure (SBP) the most useful index of effort and involvement in a task (Gendolla & Richter, 2010; Hess & Ennis, 2014).

The third issue regards the way in which motivation has been conceptualized. Previous studies have focused either on goals specific to aging, thus following SST assumptions (i.e., closeness, familiarity), or on goals shared by young and older people (i.e., accountability). The present study tried to merge these two approaches; we conceptualized and manipulated motivation

as “ego-involvement”, and we implemented it referring to socio-emotional goals typical of older adults. Ego-involvement -also called self-involvement- refers to the importance given to a task in terms of the subjective will to obtain the best possible performance (Gendolla & Richter, 2006). Previous research shows that ego-involvement manipulation successfully affects memory, concentration, and emotional bias susceptibility in adults (Brunstein & Gollwitzer, 1996; Gendolla, Brinkmann, & Scheder, 2008; Gendolla & Richter, 2006). Furthermore, ego-involvement manipulation effects have been detected also using physiological indices. In line with motivational intensity theory’s assumptions, the importance given to a task impacted on effort expenditure (Richter, 2013). Empirical evidence also showed significant correlations between self-reported motivation and CV changes following ego-involvement manipulation (Gendolla, 1998). To the best of our best knowledge, no studies have, so far, used ego-involvement manipulation in older adults. However, there are reasons to expect that ego-involvement manipulation would be effective for older adults. Indeed, the definition of ego-involvement seems to overlap, at least in part, with the ideas of self-relevance and socio-emotional goals, widely investigated in the aging literature (e.g., Germain & Hess, 2007; Hess, Germain, et al., 2005; Hess et al., 2001). Indeed, a high level of ego-involvement means that “important ego-factors (e.g., social prestige, self-esteem, fear of academic standing) are closely bound up in the tasks, and […], because of this, performance is of more vital consequence to the subjects” (Klein & Schoenfeld, 1941, p. 249). Additionally, we adapted previous manipulation of ego-involvement to be more in line with socio-emotional goals of older adults. Thus, instead of to refer to social prestige or school achievement -previously used with young adults (R. M. Ryan et al., 1991)- we associated their task success with social competence and positive relationships.

Summing up, the present study aimed to: 1) investigate the effect of motivation on two socio-cognitive skills, namely Theory of Mind and emotion recognition, in young and older adults; 2) examine whether motivation specifically improves socio-cognitive performance, rather than increasing the general level of concentration and, therefore equally affects target and control task

performance; and 3) measure increasing motivation following the self-involvement manipulation trough physiological indices.

To this end, we randomly assigned young and older participants to either a high ego-involvement condition in which participants were told that their performance was associated with a number of positive social outcomes, like positive relationships, better communicative skills and general success in life, or a control condition in which they were told general information about when and how the tasks were created. We gave participants a task measuring their emotion recognition (matching emotion sounds and faces) and a corresponding control task (matching non-emotion sounds and objects). We also gave participants a task measuring their ToM (describing the apparently intentional movement of two triangles) as well as control items (describing the random movement of two triangles). Because of the highly verbal nature of the ToM task, we tested also verbal reasoning and verbal knowledge. In addition, we measured blood pressure repeatedly throughout testing as a direct index of motivation. The rationale behind this was that blood pressure would increase to a greater extent in the self-involvement condition. If depressed motivation is the cause of older adults' difficulties, as hypothesised by others, then performance on the emotion and ToM tasks should be better in the high self-involvement condition relative to the control condition. A similar hypothesis was not made for young adults because, according to the SET, their performance should be less affected by motivational factors. A key question was whether the motivation manipulation also resulted in an increase in performance on the control tasks.

6.1. *Method*

Participants

The initial sample comprised 64 older and 66 young adults randomly assigned to either the high ego-involvement condition, in which motivation was manipulated (insofar, High Motivation condition), or to a control condition (Low Motivation condition). Three participants (two older, one young) were excluded from the analyses because the initial screening of systolic blood pressure

revealed values exceeding 160 mmHg (Smith & Hess, 2015). In addition, one young participant was excluded because of anomalous CV-R values (more than 3 *SD* above the average on SBP reactivity; more than 2 *SD* below the average on DBP reactivity; finally, more than 2 *SD* above the average on HR reactivity). One additional older participant was excluded because her self-reported motivation was more that 3 *SD* below the average. Five young adults were excluded because English was not their native language and two more were excluded due to procedural errors during the administration. Thus, the final sample was composed by 61 older adults (age: $M = 73.90$, $SD = 4.53$, range 65-85; male = 34.4 %, 29 in the Low Motivation condition and 32 in the High Motivation condition), and 57 young adults (age: $M = 20.61$, $SD = 3.22$, range 18-35; male = 24.6 %, 28 in the Low Motivation condition and 29 in the High Motivation condition).[31]

Older adults were recruited from the community through a university participant database. All participants scored above the 82 points cut-off for dementia screening on ACE-R ($M = 94.93$, $SD = 3.97$), were stroke-free and without cardiac diseases. Information about medications that affect blood pressure was collected: 52.5% of participants reported to be under treatment for hypertension. Participants were reimbursed $10 to cover their travel expenses.

Young adults were psychology students who received course credit for writing a report detailing their participation. Information about cardiac diseases and medications affecting blood pressure were collected. They reported neither cardiovascular anomalies nor were taking medications.

Measures

Socio-cognitive tasks.

Emotion recognition. It was measured via the Matching task (Ruffman, Sullivan, & Dittrich, 2009; Sullivan & Ruffman, 2004b) in which six images were presented on a computer screen, each one identified with a number. Participants listened to a sound and selected the corresponding image.

[31] Excluded participants did not differ from final sample in age, education, and verbal reasoning ($F(1,64) \leq 1.82$, $p \geq .182$). Obviously, excluded young adults had lower verbal knowledge than young in final sample, because they were not English native (Welch's $F(1,8.92) = 8.59$, $p = .017$).

This task was chosen instead of a standard facial expression test because (a) it tends to be more difficult and therefore a more sensitive measure of emotion recognition (Ruffman et al., 2008), and (b) it measures both facial and auditory emotion recognition rather than just faces. The Matching task was composed of two parts, emotion recognition and control. The emotion recognition part contained 12 emotional soundtracks that participants heard twice (though never consecutively). Soundtracks comprised both verbal (a sentence pronounced with different prosody) and non-verbal expressive sounds (like a happy humming sound or high-pitched gasps of fear). The participant's task was to match the soundtrack to a choice of six emotion pictures (all of "JJ," comprising happiness, sadness, anger, surprise, disgust, and fear; Ekman & Friesen, 1976). The control part contained 24 soundtracks comprising four categories of sounds (i.e., birds, vehicles, gardening, and household appliances). The participant's task was to match each soundtrack to the appropriate picture, when presented with six different pictures of the same category (e.g., the sound of a sewing machine to the image of a sewing machine, with distracters including a fridge, a washing machine, an electric shaver, a vacuum cleaner and a blender). Items belonging to both emotion recognition and control part were randomized within and held constant across participants. Total scores are created by summing separately emotion and non-emotion items, thus obtaining two different scores, both ranging from 0 to 24. Moreover, separated score for each of the six emotions investigated were also computed (range 0-4).

Theory of Mind. The Animation task was the same of Study 1 and 2. Notably, we included Random videos besides ToM and Goal-directed animations. Random animations depict simply movements with no intentionality (e.g., bouncing, rolling). As anticipated, we introduced this typology of animation to better investigate age-related differences in intentionality attribution. Indeed, attribution of mental state in Random videos would reflect a lack of sensibility and inappropriateness in ToM use. We used eight animations for each type for a total of 24 videos. As in previous studies, two examples were given (here a Random and a ToM) followed by an example of description. In this study we considered separately intentionality and appropriateness scores for

each type of video. The order of presentation of the videos was randomized and held constant across participants.

Cognitive functioning tasks.

Verbal reasoning. The Similarities subtest of the WAIS-IV (Wechsler, Coalson, & Raiford, 2008) requested participants to describe how two presented words (common objects or concepts) were similar; it is a measure of verbal concept formation and reasoning. The pair of words were presented one at time and answers were audio-recorded and later checked. Scores ranged from 0 to 36.

Crystallized ability. The Shipley vocabulary test (Shipley, 1940) was used to measured general knowledge and crystallized ability. It consisted of 40-items and requested participants to find the correct synonym of a given word between four choices. The subject had 10 minutes to complete the task. One point was given for each correctly identified synonym (range 0-40).

Other tasks.

Antonucci's circle diagram -adapted. This self-reported questionnaire (Antonucci, 1986; Blanke et al., 2016) investigated social network, both in terms of quantity and quality of social relationships. In the present work we were not interested in social relationships, thus this measure is not considered in subsequent analyses.

Manipulation check questionnaire. This self-report questionnaire included 5 items investigating motivation, interest and effort in performing the task. Answers are given on a Likert scale ranging from 1 (*not at all*) to 7 (*very much*). The questionnaire was created by adapting scales previously used in the literature (Brunstein & Gollwitzer, 1996; Gendolla & Richter, 2005; Ryan, 1982). A global Motivation score was computed summing up the five items separately for the two tasks. Internal consistency was α=.70 and α=.74 respectively for Matching and Animation tasks.

Cardiovascular measure.

We registered cardiovascular values (CV) with an automatic blood pressure monitor (Sanitas, model SBM 21) that uses oscillometry to determine systolic blood pressure (SBP -

millimetres of mercury [mmHg]), diastolic blood pressure (DBP -mmHg), and heart rate (HR - beats per minute). A blood pressure cuff was placed over the brachial artery above the elbow of participant's non-dominant arm throughout the experiment. The cuff inflated automatically when the experimenter pressed a button. Cardiovascular measures were taken in intervals of 5 minutes. Baseline values were collected during a 10-minute habituation period. Blood pressure readings were taken at minutes 0, 5 and 10 of this period (the first measurement was used only to acclimatise participants to the device, but did not contribute to the baseline value). One additional measurement was taken while participants filled the Social network questionnaire. Therefore, 3 CV readings were obtained during this rest phase, namely baseline systolic blood pressure, baseline diastolic blood pressure and baseline heart rate. Similarly, 3 CV readings were taken during each of the two task phases (ER, ToM), starting 30-60s after the task's onset (Jennings, Stiller, & Brock, 1998)[32]. CV values were measured only during focus tasks, and not throughout the experiment, in order to reduce participants' discomfort.

Finally, each participant had nine averaged CV values: SBP, DBP and HR during baseline phase; SBP, DBP and HR during Matching task; and SBP, DBP and HR during Animation task[33]. To control for individual differences in physiological indices, we computed cardiovascular change (delta) scores, as a measure of cardiovascular reactivity, i.e. CV-R (Gendolla & Richter, 2005; Llabre, Spitzer, Saab, & Ironson, 1991), by subtracting the baseline values from the values obtained during the Matching or the Animation task.

Procedure

Participants were tested individually in a quiet room in Psychology department. Written informed consent (asking also for age and educational level) was obtained before the texting

[32] For 23 participants (11 young, 12 older) during Animation task only two CV readings were collected instead of three, due to participants' rapidity in completing the task. Thus, for these participants, only two values contributed in the average scores of this task.

[33] Cronbach's alphas for the baseline measure were .82 (systolic blood pressure), .77 (diastolic blood pressure), and .90 (heart rate), respectively. the baseline measure were .82 (SBP), .77 (DBP), and .90 (HR), respectively. Alphas for measures during task performance were .91 (SBP), .80 (DBP), and .89 (HR).

session, which lasted approximately 1-$^{1}/_{2}$ hours. Firstly, participants were asked to relax during a 10-minute habituation period, during which baseline CV values were taken. Some magazines were available to kill the time. Participant then completed the task in the following fixed order: Social network questionnaire[34], Matching task, Similarities task, Animation task, and Shipley vocabulary test. The High Motivation and the Low Motivation conditions differed exclusively on the instructions given prior to performing the target tasks: Matching task and Animation task. Participants in the High Motivation condition read instructions which stressed that performing well in the task was related to social competence and interpersonal wellbeing. Moreover, they were informed that at the end of the experiment they would receive their results. Thus, this condition was designed to raise the level of ego-involved because the task was presented as a mean to demonstrate the possession of important social skills related to "success" in life. The expected feedback further motivated participants in doing as well as possible. Participants in the Low Motivation condition read instructions focused on the task itself, thus they received information concerning how the task was made. Instructions in both conditions were matched in length (for exact instructions see Appendix B). The manipulation check questionnaire was presented after both the Matching and the Animation task. Finally, participants completed the Shipley vocabulary test and were thanked and debriefed. Participants in the High Motivation condition were also informed that they would receive their results through email/mail as soon as data collection ended.

Statistical analysis

Analyses were conducted with IBM SPSS Statistics Version 19. First, age-related differences as well as equivalence between conditions in background variables were investigated with a series of analyses of variance (ANOVA). Following ANOVAs on CV indices at baseline examined once again age-related differences and tested for the equivalence between conditions. The potential effect of medication consumption in older adults was also investigated, to exclude the

[34] This task is not the relevant to the present study and thus will not be discussed any further.

possibility that people under medical treatment would present differences in CV reactivity during task performance.

Then, the effectiveness of the motivational manipulation was examined through ANOVAs on the motivation scores and the CV-R indices. Following analyses investigated differences between conditions separately on the Matching and the Animation task. Age-related differences were examined as well. Either univariate ANOVAs or mixed ANOVAs were used, according to each task's features, entering Condition and Age group as between-subjects factors. Finally, correlational analyses focused the whole sample investigated the relationship between socio-cognitive performance, self-reported motivation and CV reactivity.

6.2. *Results*

Preliminary analyses

We preliminary examined difference between older and young participants across conditions in background variables (i.e., age, education, verbal reasoning and crystallized ability) and physiological indices (SBP, DBP and HR at baseline). We then investigated the effect of medical treatments on CV-R in older adults.

Descriptives for age, gender, education, verbal synonyms, verbal Similarities, and CV values during baseline phase are presented in Table 6.1. We performed a series of 2 (Age group: young, older) x 2 (Condition: high motivation, low motivation) ANOVAs separately on each one of the background variables, (i.e., age, gender, education, crystallized ability, verbal reasoning). In line with the aging literature, a significant main effect of Age group appeared on both education and crystallized ability, with older adults having higher scores than young adults (respectively, $F(3, 114) = 17.02$, $p < .001$, $\eta_p^2 = .13$; and $F(3, 113) = 159.29$, $p < .001$, $\eta_p^2 = .59$).[35] No age differences emerged in verbal reasoning or gender. Additionally, neither the main effect of Condition nor the Age group x Condition interaction were significant for any of the dependent variables.

[35] Obviously, the main effect of Age group was significant also on age.

In a similar way, we investigated the potential age-related differences in cardiovascular values across conditions. A series of 2 (Age group: young, older) x 2 (Condition: high motivation, low motivation) ANOVAs were performed separately on SBP, DBP and HR values at baseline. Results showed a main effect of Age group on all CV indices; specifically, older adults had greater SBP ($F(3, 114) = 52.06$, $p < .001$, $\eta_p^2 = .32$) and DBP ($F(3, 114) = 13.20$, $p < .001$, $\eta_p^2 = .10$) compared to young adults. Conversely, HR was significantly lower in older adults compared to young adults ($F(3, 114) = 5.69$, $p = .019$, $\eta_p^2 = .05$). Furthermore, a main effect of Condition appeared on HR ($F(3, 114) = 7.51$, $p = .007$, $\eta_p^2 = .06$) indicating that participants in the High Motivation condition had higher heart rate at baseline compared to participant in the Low Motivation condition. No other effect reached statistical significance. This difference in baseline HR was unexpected, and in order to control for it in main analyses we used delta scores.

Finally, we examined the role of blood pressure medications in older participants. We considered four levels of medications: no medications; diuretic or statin; ACE-r or calcium-channel blocker; beta-blocker. Results showed that the two conditions did not differ in the frequency of medications' consumption, $\chi^2 (3) = 2.30$, $p = .550$. Additionally, we tested whether medication consumption impacted on cardiovascular reactivity, potentially preventing blood pressure changes. We performed three separated ANOVAs on each of the CV-R values (SBP, DBP, HR). Medication (4 levels: none, diuretic/statin, ace-r/calcium-channel blocker, beta-blocker) was the independent variable. Across the three CV-R values, we found that Medication had no significant effect on cardiovascular reactivity (respectively, SBP-R: $F(3, 57) = .50$, $p = .682$; DBP-R: $F(3, 57) = 1.02$, $p = .392$; HR-R: $F(3, 57) = 1.98$, $p = .127$).[36] Therefore, we concluded that medication did not impact on cardiovascular reactivity. For this reason, we did not exclude participants under treatment for hypertension.

[36] Separate analyses on Matching and Animation tasks showed the same results.

Table 6.1.

Means and Standard Deviations (below) of Background Variables and Cardiovascular Indices at Baseline as a Function of Age Group and Condition.

	Young			**Older**		
	Low Motivation	*High Motivation*	*Tot*	*Low Motivation*	*High Motivation*	*Tot*
Age	20.37	20.83	20.61	73.24	74.50	73.90
	2.75	3.64	3.22	3.84	5.06	4.53
Gender	1.75	1.76	1.75	1.66	1.66	1.66
	.44	.44	.43	.48	.48	.48
Education	3.14	3.14	3.14	3.79	3.81	3.80
	.37	.44	.40	1.05	1.23	1.14
Crystallized ability	27.25	26.28	26.75	26.14	26.50	26.33
	4.62	4.16	4.38	5.13	4.06	4.56
V. knowledge	28.82	30.00	29.42	36.66	36.74	36.70
	3.71	3.49	3.62	2.22	2.89	2.57
SBP - baseline	119.38	112.80	116.04	133.76	133.44	133.59
	10.17	11.83	11.44	14.47	14.99	14.63
DBP - baseline	73.90	70.63	72.24	78.60	77.64	78.10
	6.02	8.45	7.47	9.45	10.20	9.78
HR - baseline	75.27	77.94	76.63	68.05	75.96	72.20
	9.62	11.65	10.69	7.57	12.16	10.91

Note. Gender was coded: 1 = male, 2 = female. V. reasoning = verbal reasoning; Crystallized a. = crystallized ability; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

Table 6.2.

Means and Standard Deviations of Self-Reported Motivation and Cardiovascular Reactivity Values (CV-R) Concerning either ER or ToM Tasks as a Function of Age Group and Condition.

	Young		**Old**	
	Control	*Experimental*	*Control*	*Experimental*
ER - Motivation	24.15	24.45	26.79	28.19
	5.18	5.14	4.10	2.99
ToM - Motivation	23.65	23.20	26.23	27.26
	4.52	5.64	4.24	5.13
ER - SBP	-.93	-1.47	2.88	2.59
	7.80	7.12	8.97	9.86
ER - DBP	1.75	1.28	.69	2.54
	6.45	5.36	7.83	5.55
ER - HR	1.55	1.69	-1.20	-.86
	8.20	7.63	5.54	6.57
ToM - SBP	5.33	1.68	9.38	5.76
	11.85	7.32	11.58	12.12
ToM - DBP	3.64	3.16	6.06	3.52
	11.45	7.45	9.89	8.50
ToM -HR	3.01	1.24	-.72	-3.29
	7.46	9.08	5.32	6.75

Note. SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.

Manipulation check

We then tested the effectiveness of the motivation manipulation, comparing the level of self-reported motivation in the two conditions for both Matching and Animation tasks (means and standard deviations are presented in Table 6.2.). We performed a mixed ANOVA with Age group (2 levels: young, older) and Condition (2 levels: high motivation, low motivation) as between-subjects factors and Task (2 levels: matching, animation) as within-subject factor on participants' self-reported motivation. Results showed a non-significant main effect of Condition, $F(1, 114) = .73$, $p = .394$, as well as a non-significant Condition x Age Group interaction term, $F(1, 114) = .24$, $p = .627$, indicating that self-reported motivation did not differ between the two conditions. The tree-way interaction Condition x Age Group x Task was not significant as well, $F(1, 114) = .54$, $p = .462$. Therefore, findings indicated that the self-involvement manipulation did not significantly increase the level of self-reported motivation, neither in young nor in older participants. Notably, there was a significant main effect of the Age Group, indicating that overall older adults were more motivated than young adults, $F(1, 114) = 17.83$, $p < .001$, $\eta_p^2 = .14$.

Similar analysis conducted on the physiological indices investigated whether the two conditions differed in terms of cardiovascular reactivity during tasks performance. Concerning the Matching task, we ran a series of 2 (Condition: high motivation, low motivation) x 2 (Age group: young, older) ANOVA separately on the three CV-R values (SBP-R, DBP-R, HR-R). Both the main effect of Condition and the Age group x Condition interaction term were not significant across all the three CV-R. Therefore, conditions did not differ in term of physiological reactivity measured during the Matching task. Notably, a main effect of Age group emerged in both SBP-R ($F(3, 114) = 6.25$, $p = .014$, $\eta_p^2 = .05$) and HR-R ($F(3, 114) = 4.17$, $p = .043$, $\eta_p^2 = .04$). Inspections of the means revealed that compared to young adults, older adults, on the one hand, had higher systolic reactivity, on the other hand, they showed lower heart rate reactivity. Concerning the Animation task, similar analyses were performed: we run a series of 2 (Condition: high motivation, low motivation) x 2 (Age group: young, older) ANOVA on the three CV-R values (SBP-R, DBP-R, HR-R). Results

showed a marginally significant main effect of Condition on SBP-R, $F(3, 114) = 3.26$, $p = .074$, $\eta_p^2 = .03$, unexpectedly indicating that participants in the Low Motivation condition had higher systolic reactivity compared to participants in the High Motivation condition.[37] No other significant condition-related differences emerged. As in the Matching task, the main effect of Age emerged in both SBP-R and HR-R, again indicating greater systolic reactivity and lower heart rate reactivity of older adults compared to younger adults.

Overall, results on physiological indices indicated that participants in the High Motivation and in the Low Motivation conditions did not differ in CV reactivity.

To summarize, globally results indicated that the experimental manipulation of motivation was ineffective. Participants in the two conditions reported a comparable level of motivation and showed similar cardiovascular changes during tasks accomplishment.

To further confirm this conclusion, we also tested potential differences on socio-cognitive performance between conditions. Indeed, if the manipulation did not effectively enhance motivation in the High Motivation condition, it is expected that the two conditions would not differ in performance (means and standard deviation are presented in Table 6.3.). First, we analyzed the Matching task, comparing the emotion recognition part and the (non-emotion) control part of the task. A 2 (Condition: high motivation, low motivation) x 2 (Age group: young, older) x 2 (Part: emotion recognition, control) mixed ANOVA was performed, with Condition and Age group as between-subjects factors and Part as within-subject factor. The dependent variable was the obtained score. Results revealed a main effect of Age, $F(1, 112) = 14.98$, $p < .001$, $\eta_p^2 = .12$, further qualified by a significant Age x Part interaction, $F(1, 112) = 14.98$, $p < .001$, $\eta_p^2 = .12$. Univariate analyses showed that older adults performed significantly worse on the emotion recognition part, $F(1, 112) = 25.23$, $p < .001$, $\eta_p^2 = .18$, but not on the control part, $F(1, 112) = .55$, $p = .458$, compared to young adults. Also a significant main effect of Part emerged, $F(1, 112) = 35.86$, $p < .001$, $\eta_p^2 = .24$,

[37] Levene's test indicated a violation of the assumption of normality. However, robust test showed the same pattern of result: Welch's $F(1, 111) = 3.06$, $p = .083$.

indicating that the control part had higher score, possibly reflecting the fact that to recognize physical sounds is easier than to recognize emotions conveyed through sound. No other effects reached statistical significance.

We then examined performance on specific emotions, with a series of 2 (Condition: high motivation, low motivation) x 2 (Age group: young, older) ANOVAs, separately on each one of the six emotions investigated. Across emotions, results revealed that both the main effect of Condition, and the Condition x Age group interaction were not statistically significant. The main effect of Age group emerged on all emotions but fear, globally indicating that young adults outperformed older adults in emotion recognition (respectively: Happiness, $F(3, 113) = 11.66$, $p = .001$, $\eta_p^2 = .09$; Sadness, $F(3, 113) = 12.72$, $p = .001$, $\eta_p^2 = .10$; Fear, $F(3, 112) = .30$, $p = .582$; Anger, $F(3, 113) = 29.04$, $p < .001$, $\eta_p^2 = .20$; Disgust, $F(3, 113) = 4.48$, $p = .037\eta_p^2$, $= .04$; Surprise, $F(3, 114) = 5.69$, $p = .019$, $\eta_p^2 = .05$).[38] It is worth noting that results concerning Happiness need to be interpreted with caution, because of potential ceiling effect[39]. Globally, findings from the Matching task indicated that the two conditions did not differ in emotion recognition performance.

Second, we analyzed the Animation task, comparing the three types of videos. Two 2 (Condition: high motivation, low motivation) x 2 (Age group: young, older) x 3 (Type of video: ToM, Goal-directed, Random) mixed ANOVA were performed, with Condition and Age group as between-subjects factors and Type of video as within-subject factor. The dependent variables were intentionality score first and appropriateness score then. With regard to the intentionality score, as expected a main effect of Type of video emerged, $F(2, 107) = .711.75$, $p < .001$, $\eta_p^2 = .93$, indicating that intentionality significantly increased according to the animations' type (ToM > Goal-directed >

[38] Entering the performance on the control part of the task as covariate globally did not change the pattern of the result. The only exception was recognition of disgust: the main effect of Age group became marginally significant, $F(4, 111) = 3.35$, $p = .70$, $\eta_p^2 = .03$.

[39] Percentages of maximum score respectively for young and older adults for each emotion were the following: Happiness: 89.5% and 63.3%; Sadness: 52.6% and 23.3%; Fear: 24.6% and 30.5%; Anger: 10.5% and 10.0%; Disgust: 22.8% and 5%; Surprise: 15.8% and 1.6%.

Random). Neither the main effect, nor any interaction effect of Condition was significant.[40] Curiously, the main effect of Age group indicated that older adults had significantly higher intentionality score than young adults, $F(1, 108) = 11.85$, $p = .001$, $\eta_p^2 = .10$. However, further investigations taking into account the type of video revealed a significant Age group x Type of video interaction term, $F(2, 107) = 77.22$, $p < .001$, $\eta_p^2 = .59$. Pairwise comparisons showed that young adults had a greater intentionality score on ToM animations ($F(1, 108) = 25.21$, $p < .001$, $\eta_p^2 = .19$), while older adults had a greater intentionality score on both Goal-directed and Random animations, (respectively $F(1, 108) = 6.50$, $p = .012$, $\eta_p^2 = .06$; and $F(1, 108) = 98.99$, $p < .001$, $\eta_p^2 = .48$). Hence, results suggested that older adults had a lower level of intentionality's attribution when required (i.e., in the ToM videos), but a greater level when this is not supposed to be the case (please, refer to Figure 6.1.). With regards to appropriateness score, again neither the main effect of Condition nor the interaction effects reached statistical significance. A main effect of Age group emerged, indicating that young adults were more appropriate in describing the videos compared to older adults, $F(1, 108) = 125.70$, $p < .001$, $\eta_p^2 = .54$. Also, a significant main effect of Type of video appeared, $F(2, 107) = 16.18$, $p < .001$, $\eta_p^2 = .23$. Pairwise comparisons indicated that the Random videos had the higher appropriateness score compared to both ToM and Goal-directed video, which did not significantly differ. To summarize, findings from the Animation task indicated that older adults not only had a decline in ToM (as reflected by their lower intentionality score in the ToM animations), but they also used their ToM ability in a more indiscriminate way compared to young adults (as reflected by older adults' greater intentionality score in the Goal-directed and Random animations). These age differences in intentionality may be partly explained by older adults' overall lower appropriateness score, possibly reflecting older adults' general difficulty in understanding the videos.

Correlational analyses

[40] A marginally significant Age group x Condition effect emerged, $F(1, 108) = 2.91$, $p < .091$, $\eta_p^2 = .03$. Univariate analyses indicated that in the Low Motivation condition, but not in the High Motivation condition, older adults had higher intentionality score.

Because participants in the two conditions did not differ in any variable, we decided to consider our sample as a single population. An inspection of the means showed that there were important individual differences in self-reported motivation. Indeed, only the 0.8% of participants reported the maximum score of motivation and just the 11.7% reported a motivation over 90% of possible score. Therefore, it seemed interesting to investigate whether reported motivation was related to socio-cognitive skills. The relation between self-reported motivation and the performance on Matching and Animation tasks was investigated through correlations run separately for young and older adults. We separated young and older adults because they not only differed in terms of motivation reported, with older adults reporting overall greater motivation, but also because according to previously presented theoretical frameworks motivation could play different roles in different stages of life, thus being differently related to socio-cognitive skills. Spearman's rank correlations were used instead of Pearson's *r* due to violation of normality of self-reported motivation scores (please refer to Tables 6.4. and 6.5.).

Results showed that ER and ToM performances did not correlate to each other across age groups (with few exceptions). Moreover, self-reported motivation was associated to neither the Matching task nor the Animation task in both age groups.

Similar results came from analyses on CV-R, indicating that physiological reactivity was related to neither self-reported motivation nor socio-cognitive performance.

Overall, results showed that self-reported motivation was not related to socio-cognitive performance. Moreover, neither self-reported motivation nor performance were associated to physiological responses.

Table 6.3.

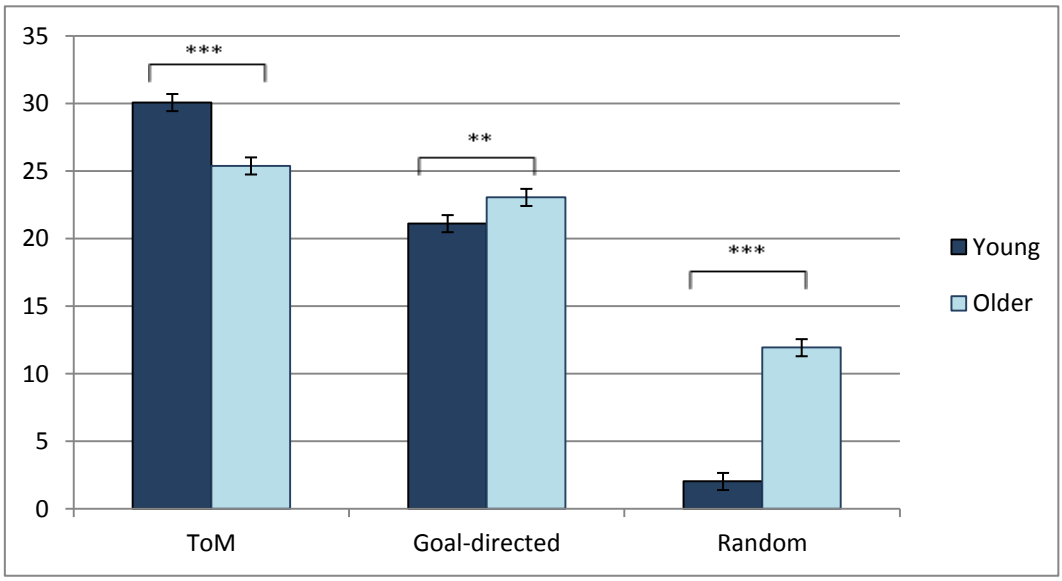
Means and Standard Deviations (below) of ToM and ER Tasks Separately for Young and Older Adults.

	Young	**Old**
EM - ER	16.54 2.96	13.49 3.51
EM - ctrl	17.28 2.34	16.86 3.14
T - Int	30.07 4.79	25.33 4.91
Gd - Int	21.04 3.53	23.10 4.80
R - Int	2.26 3.15	11.83 6.48
T - App	18.57 2.58	14.00 3.78
Gd - App	18.82 2.87	14.55 3.71
R - App	22.07 2.44	15.62 4.41

Note. EM - ER = Emotion matching task, Emotion Recognition part; EM - ctrl = Emotion matching task, Control part; T = ToM animations; Gd = Goal-directed animations; R = Random animations; Int = Intentionality score; App = Appropriateness score.

Fig.6.1.

Intentionality Score as a Function of Age Group and Type of Video.



Note. Error bars represent standard errors. Results reported refer to univariate analyses.

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 6.4.

Correlations Between Matching task, Animation task and Self-Reported Motivation.

	EM - ER	EM - ctrl	T - Int	Gd - Int	R - Int	T - App	Gd - App	R - App	EM -Motivation	ToM - Motivation
EM - ER		.16	.14	.09	-.03	.37**	.25+	.02	.03	-.02
EM - ctrl	.35**		-.21	-.02	.13	-.03	.11	-.12	-.05	-.01
T - Int	.15	.32*		.39**	.06	.61***	.44**	-.14	-.03	-.01
Gd - Int	.26+	.24+	.49***		.17	.26+	.14	-.26+	-.04	-.04
R - Int	-.10	-.04	.35**	.42**		.11	.33*	-.89***	.35**	.16
T - App	.11	.25+	.66***	.13	-.08		.63***	-.10	-.02	-.06
Gd - App	.33*	.42**	.41**	.38**	-.09	.52***		-.30*	-.05	.09
R - App	.12	.06	-.27*	-.33*	-.86***	.12	.25+		-.33*	-.14
EM - Motivation	.06	-.01	.02	.02	.17	-.11	-.11	-.06		.62***
ToM - Motivation	.02	.23+	.15	.01	-.04	.04	-.04	.12	.55***	

Note. Young adults are on the upper diagonal, older adults in the lower.

EM - ER = Emotion matching task, Emotion Recognition part; EM - ctrl = Emotion matching task, Control part; T = ToM animations; Gd = Goal-directed animations; R = Random animations; Int = Intentionality score; App = Appropriateness score.

Rho di Spearman is reported.

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

Table 6.5.

Correlations Between CV-R and Socio-Cognitive Performance and Self-Reported Motivation.

	Young						Old					
	ER - SBP	ER - DBP	ER - HR	TOM - SBP	TOM - DBP	TOM - HR	ER - SBP	ER - DBP	ER - HR	TOM - SBP	TOM - DBP	TOM - HR
EM - ER	.06	.08	-.05	.03	.15	.00	.00	-.09	-.35**	.04	.02	-.15
EM - ctrl	-.01	.22	.12	.08	.01	.03	-.09	.09	-.10	.04	.16	.11
T - Int	-.01	-.17	-.13	.11	.03	-.14	.21	.12	-.13	.09	.23+	-.08
Gd - Int	.08	-.26*	-.10	-.18	-.28*	-.21	.20	.06	-.06	.14	.24+	-.13
R - Int	.18	-.03	-.12	.08	-.14	.05	.21	.02	-.01	.02	.09	-.21
T - App	.05	-.03	-.02	.08	.14	-.02	.07	.06	-.08	.06	.06	-.02
Gd - App	.08	.07	.10	-.04	.01	.08	-.10	.04	-.09	-.05	.14	-.03
R - App	-.13	.04	.22+	.05	.05	.05	-.27*	-.07	-.02	-.14	-.08	.19
EM - Motivation	.07	-.03	-.11	.06	.01	-.13	.25+	.14	-.20	.09	.08	-.05
ToM - Motivation	.13	-.13	-.15	.06	-.05	-.19	.25+	.16	-.07	.17	.17	.02

Note. EM - ER = Emotion matching task, Emotion Recognition part; EM - ctrl = Emotion matching task, Control part; T = ToM animations; Gd = Goal-directed animations; R = Random animations; Int = Intentionality score; App = Appropriateness score.

Rho di Spearman is reported.

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

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6.3. *Discussion*

In this study we investigated whether increased ego-involvement positively impacted on social-cognitive performance in older adults. Given the acknowledged decline in ToM and ER in older people, we considered both these social skills, hypothesizing that motivation could impact differently on them, possibly reflecting different mechanisms involved in the age-related impairments. Results showed that motivation was not related to social-cognitive performance neither in young nor in older adults. These findings need to be considered with caution, partly because the experimental manipulation was not effective, partly because physiological indices appeared to be unrelated to both self-reported motivation and performance. Nevertheless, overall results pointed out that self-reported motivation was not related to social-cognitive performance, thus contrasting previous findings indicating a positive relation between motivation and ToM/ER specifically for older adults.

Manipulation of motivation's ineffectiveness

The present study used ego-involvement induction as a way to increase personal motivation in performing the tasks. Ego-involvement refers to the attributed personal importance to the task, the performance on which reflects abilities considered valuable by the subject. Ego-involvement induction has been previously used with young adults, showing positive effects on cognitive performance, e.g., memory and task concentration (Gendolla & Richter, 2010). To the best of our knowledge, no studies applied ego-involvement induction in older adults. Nevertheless, based on the available studies which used a motivation's induction in older adults, ego-involvement seemed a construct adequate also to older people (Hess, 2014). In the present study participants in the High Motivation condition were informed that task performance was related to social abilities, e.g. reflecting lie detection ability or positive friendships. That is, here ego-involvement focused on social functioning, rather than intelligence or cognitive skills, in order to be in line with socio-emotional goals characteristic of older adults (Löckenhoff & Carstensen, 2004).

Notwithstanding that, results showed that both young and older adults were not affected by the manipulation of ego-involvement. Indeed, participants in the High Motivation condition did not differ in self-reported motivation from participants in the Low Motivation condition. That is, irrespective of our motivational manipulation, participants in the two conditions reported to be equally involved, interested, and worried, to consider the tasks worthwhile and to have put the same amount of effort in carrying on them. Hence, ego-involvement manipulation failed to generate differences in self-reported motivation. Even if unexpected this result is not unique: also Gendolla and colleagues (Gendolla & Richter, 2006) reported a similar result, with ego-involvement not impacting on importance given to success (i.e., how much worthwhile the task was) in young adults. The authors pointed out that, even if differences were not significant, means were in the expected direction. The same is true in this study, where participants in the High Motivation condition showed a greater (but not significant) motivation compared to their counterpart in the Low Motivation condition. Also, Ennis and colleagues (Ennis et al., 2013) manipulating motivation in a different way, i.e. accountability, reported that manipulation was unsuccessful, and thus excluded this factor from their following analyses (see also Koenig & Eagly, 2005).

Analyses on cardiovascular indices further confirmed the ineffectiveness of manipulation of motivation. It could be hypothesized that self-reported motivation did not reflect actual effort and engagement, because of the common limitations of subjective measures (Pelham & Neter, 1995). That is, people could report to be highly motivated just because this was supposedly what the questionnaire (and the experiment) was aimed to (Hess & Ennis, 2012). Investigation of physiological indices overcomes this issue: in the present study cardiovascular reactivity was used as a direct way to measure engagement and effort (i.e., motivation). However, once again findings revealed that the two conditions did not differ in terms of cardiovascular reactivity, thus supporting previous result that the ego-involvement manipulation failed to increase motivation.

In further confirmation of this pattern of results, analyses on performance globally indicated no condition-related effects. In other words, participants in the High and the Low Motivation

condition did not differ both in emotion recognition and in ToM performances. Hence, our manipulation did impact on neither self-reported motivation, nor physiological indices, nor socio-cognitive performance.

Globally, results are in contrast with the literature indicating a positive effect of high ego-involvement, at least in young adults. Our manipulation did not exactly replicate the procedures previously used, but differences do not seem great enough to explain the contrasting results. Indeed, previous studies used written bogus instructions similar to those used in the present work (please, refer to Appendix B.2.b.). For example, Gendolla and colleagues told participants that "the study would be a test of perceptual abilities, ostensibly a predictor of individuals' fast and efficient adaptation to situational changes and of important social competencies" (Gendolla et al., 2008, p. 215); similarly, Ryan and colleagues told participants: "this task is a test of social intelligence; it will show how well you are able to see through social situations. This particular form of social intelligence puts people in a better position to influence or manage others. In fact, preliminary research with this instrument suggests that effective leaders generally tend to do better at it." (R. M. Ryan et al., 1991, p. 195). Therefore, we feel confident in excluding the possibility that presents results could be explained exclusively in terms of procedural differences.

From a theoretical point of view, ego-involvement importance is explained within the motivational intensity theory (Richter, 2013; Wright, 1996). According to this framework, effort is mobilized as a result of both motivation and perceived difficult of the task. As the authors stated, "engagement rises with task difficulty until a task is too difficult or does not merit the necessary resources" (Gendolla & Richter, 2006, p. 1189). Several empirical evidences showed that ego-involvement enhanced cardiovascular reactivity and performance only if task is considered hard but not impossible (Gendolla, 1999; Gendolla & Richter, 2006; Silvia, McCord, & Gendolla, 2010). If task is either too easy or too hard, ego-involvement did not impact on cardiovascular reactivity or performance. Therefore, one could hypothesize that the lack of difference between conditions in CV reactivity (and possibly also in performance) could be attributed to the tasks we used. In the present

study task difficulty was neither manipulated nor investigated. We assumed that both social cognitive tasks were not too easy; support for this assumption came from inspection of success rate: only 1.8% of participants got the maximum score, both in ToM and ER task. Moreover, both tasks can be considered requiring an "unfixed" performance, that is participants did not know what a good/bad performance was, because feedback was not immediately given and tasks were made in such a way that people can't be sure about how well they performed. Accordingly to the authors, "ego-involvement leads to the mobilization of high effort when task difficulty is high or unfixed", thus task difficulty's issue it is unlikely to be responsible of the lack of ego-involvement effects.

Overall, findings were contrary to our expectations and severely limited the possibility to further investigate differences between the two conditions. Therefore, we collapsed them and analyzed motivation and social cognitive performance in the whole sample.

The relation between motivation and social-cognitive performance

For the most, available studies investigated the effect of motivation on performance through groups' comparison. Nevertheless, individual differences in self-reported motivation could be associated to social-cognitive performance. In other words, people more motivated may be "better" in performing social-cognitive tasks. Here, motivation refers to the "baseline" level of engagement and interest in the task, without any experimental manipulation over it. Possibly, this relation can be different in young and older adults: accordingly to previously reviewed theoretical frameworks, older people who report to be less motivated should also engage less resources in carrying on the task and consequently perform worse on it (e.g., Hess, 2014). To test this hypothesis, we run correlational analyses, separately for young and older adults. Results showed that self-reported motivation was not related to both ToM and ER performance. Hence, present findings did not confirm the notion that greater motivation promotes older adults' social cognitive performance. Motivation and performance appeared to be two unrelated constructs, in both young and older adults. Partly supporting this result, a compelling work in memory field found that motivation had minimal impact on performance (Ngaosuvan & Mäntylä, 2005). Manipulating extrinsic motivation

in young adults through competition induction, the authors found that performance was independent from the amount of motivation reported. The authors concluded that "people who consider themselves more motivated do not perform better than those who experience less motivation" (Ngaosuvan & Mäntylä, 2005, p. 328). Present results seemed in line with this position, expanding it to social-cognitive domain. Nevertheless, further research is needed to reach conclusive evidence.

Age-related differences in cardiovascular indices

Previous studies used physiological indices to measure effort and motivation specifically in older adults, showing that blood pressure and heart rate are reliable measures of task engagement (Ennis et al., 2013; Hess & Ennis, 2012; Smith & Hess, 2015; Uchino et al., 2010). Specifically, systolic blood pressure (SBP) has been suggested as the more adequate index of motivation (Hess & Ennis, 2014). In line with literature, we found that older adults had higher systolic and diastolic blood pressure (Pinto, 2007) and lower heart rate compared to young adults (Hess & Ennis, 2014). More interesting, analyses on cardiovascular reactivity showed a pattern of results in line with previous studies: older adults showed higher SBP and lower HR reactivity during task performance compared to young adults (Uchino et al., 2010). This result confirmed that older adults, notwithstanding their greater baseline SBP, are still sensitive to task requirements, as young adults are (Uchino et al., 2010).

Age-related differences in socio-cognitive performance

Globally speaking, results investigating age-related differences in ToM and ER abilities were in line with literature, indicating a lower social-cognitive performance of older adults compared to young adults. More specifically, present findings confirmed the age-related decline in ToM. We chose the Animation task to measure ToM because we wanted to use social-cognitive tasks with no (or minimal) linguistic requirements. Indeed, as previously stated developmental evidences strongly showed the relation between language and ToM (Milligan et al., 2007) and it has been suggested that ToM is relate to linguistic abilities also in older age, possibly play a compensational role which could mask the ToM impairment (Slessor et al., 2007). Therefore, we

looked for a task with the lower verbal requirements in order to measure ToM ability as pure as possible. Findings revealed that older adults had a lesser degree of intentionality attribution to the target animations (i.e., ToM videos) compared to young adults. On the contrary, older adults attributed more intentionality than young to the control animations, that is, where a lower degree of intentionality is required (i.e., Goal-directed and Random videos). This result, together with the lower appropriateness of descriptions, suggests that older adults use their ToM indiscriminately, possibly being less aware of when actions are actually intentional. Notably, this result is in line both with findings from Study 1 and 2. Transposing this result in daily life, it is possible that growing older people had difficulties in dealing with other minds both because do not attribute enough intentionality (i.e., thoughts, emotions) when necessary, and do attribute intentions (and emotions) when it is not the case. Interestingly, similar results came from atypical population (Abell et al., 2000; Weed et al., 2010). Furthermore, the difference between absence, insufficient and exceeding use of ToM has been recently pointed out with an ecological video task (Dziobek et al., 2006) and growing clinical evidence showed that different pathologies were related to specific errors in ToM usage (e.g., Sharp & Venta, 2006). To the best of our knowledge, no studies investigated these differences in older adults. Therefore, it seems a very promising way to investigate in more detail whether aging is associated with a global losing of ToM, or rather with an increase in inaccurateness of mental state attribution.

Present results are also consistent with literature pointing out an age-related decline in emotion recognition (Ruffman et al., 2008). Impairments appeared to be at least partly related to general listening ability, as showed by the strong correlation between the two parts of the Matching task (emotion recognition and sound recognition) in older but not young adults. Nevertheless, young and older adults did not differ in sound recognition ability, thus confirming the independence of emotion recognition deficit in aging. Investigations on specific emotion are consistent with the pattern usually identified (Phillips et al., 2013), with the exception of fear recognition. Some piece of research showed that age effects on fear are less strong than on other emotion like sadness and

anger (Ruffman et al., 2008). Indeed, studies using different set of stimuli (i.e. bodies, faces) found that recognition of fear did not show an age-related decline (Ruffman, Sullivan, et al., 2009). Also, studies using the Matching task found contrasting results concerning fear recognition (M. Ryan, Murray, & Ruffman, 2010; Sullivan & Ruffman, 2004a).

Summary, limitations and future directions

To conclude, the study confirmed the age-related decline in both ToM and emotion recognition abilities. More interesting, contrary to what recent findings suggested (Stanley & Isaacowitz, 2015; Zhang et al., 2013) we found that motivation was not associated to socio-cognitive performance in older adults. Also, physiological indices appeared to be unrelated to both performance and motivation, thus cautions is needed in results interpretation. Moreover, because the manipulation of motivation was not effective, we could not use groups' comparison, rather we simply investigated the pattern of correlations.

Several limitations should be acknowledged: first, the failure in manipulating motivation raises some doubts about the possibility to experimentally increase motivation. Previous works showed clear effects of ego-involvement manipulation on self-reported motivation, at least in young adults (Gendolla & Richter, 2005). Thus, it is unclear and deserves future investigation why the manipulation was ineffective in our experiment. One speculation is that participants in the experimental condition did realize that the instructions were "manipulated" to increase motivation and thus did not believe in what instructions told, hence impacting on motivation. Unfortunately, we did not check if participants were aware of the experimental manipulation, nor if they trusted what the instructions said. Further studies should test for this eventuality, asking to participants at the end of the administration phase if they "guessed" the aim of the study and changed their behaviors/feelings accordingly.

Another interesting future direction would be to try to replicate the findings reversing the manipulation: instead of to increase, try to decrease motivation -that is, creating a condition of lower ego-involvement, to be compared both with higher and baseline level of motivation (Zhang et

al., 2013). Indeed, we noticed that self-reported motivation was positively skewed: only the 5% (Emotion Matching task) and the 13% (ToM task) of participants reported scores of motivation below the half of possible range.

Furthermore, in this study personality was not investigated. It is possible that some personality trait related to motivation have played a role in manipulation effectiveness. For instance, achievement orientation -defined as a personal trait comprising the search for feedback on abilities, interest in assess personal skills, and greater involvement in evaluative activities (Harackiewicz, Abrahams, & Wageman, 1987)- seems to be a good candidate able to hinder the efficacy of the ego-involvement manipulation. That is, we can't exclude that people with low level of achievement orientation simply were not affected by our ego-involvement manipulation. Similarly, other individual differences in personality could have an impact when trying to manipulate motivation. Further studies should include personality measures and/or select motivations which are likely to be unrelated to personality traits.

We believe that a significant step forward to solve some of previous issues and to get deeper understanding motivation would be to manipulate motivation within subject, and not between participants. In such a way individual differences in CV-R, perceived motivation and personality would be taken into account. Moreover, changes in socio-cognitive performance within the same subject would be directly attributed to changes in motivation.

To conclude, results from Study 3 revealed that the level of motivation did not impact on socio-cognitive skills. Also, surprisingly, greater physiological reactivity was not related to better performance on both ToM and ER tasks. Finally, older adults showed a significant decline in both the investigated socio-cognitive skills. Notably, this decline was specific to mental contents and did not generalize on control parts of the tasks.

Chapter 7 - Study 4: individual differences in social motivation[41]

Previous studies experimentally manipulated participants' motivation in order to examine its effect on socio-cognitive skills. With little exceptions, results indicated that greater level of motivation did not impact on ToM performance, contrasting literature's findings. Therefore, the emerging picture is that aging is associated with a decline in socio-cognitive skills, and motivational factors cannot change this process.

Given that, in Study 4 we changed approach and instead of examine how motivation was directly related to ToM, we investigated whether motivation was associated with ToM's social correlates. As previously stated, little is known about how ToM skills are actually reflected in older people's social lives. Some aging research suggested the existence of a "paradox": older adults demonstrate significant impairments in socio-cognitive skills, however they maintain good level of social adjustment, sometimes even higher than young adults (Blanke et al., 2016; Luong, Charles, & Fingerman, 2011). Therefore, it seems paramount to investigate if and how ToM is related to older adults social functioning. More specifically, in this study we investigated the link between older adults' ToM and their social relationships. Crucially, we examined the role of social motivation in explaining that association.

Social relationships represent a universal human need (Maslow, 1943); across ones' life span, individuals search for social contact (Baumeister & Leary, 1995) and suffer due to social isolation (L. F. Berkman, Glass, Brissette, & Seeman, 2000). The term "social relationship" is very general and encompasses at least two dimensions: the structure and the function (Sheldon Cohen & Wills, 1985; Lubben & Gironda, 2003). The structure refers to objective traits, such as size and frequency of contacts. The function reflects the quality of the relationship and refers to closeness and social support. A considerable body of research has documented the benefits of both these

[41] This chapter is based on the following original article: Lecce, S. Ceccato, I., Bianco, F., Rosi, A., Bottiroli, S., & Cavallini, E. (2015). Theory of Mind and social relationships in older adults: the role of social motivation. *Aging & Mental Health,19,* 1-6. doi:10.1080/13607863.2015.1114586

aspects on elderly people's physical health and cognitive functioning (Beland, Zunzunegui, Alvarado, Otero, & del Ser, 2005; Holt-Lunstad, Smith, & Layton, 2010). On the other side, it is widely acknowledged that age negatively affects social networks' width and the frequency of social contacts (Wrzus et al., 2013) and loneliness is a major issue for elderly people's well being (Victor, Scambler, Bond, & Bowling, 2001). Therefore, from a practical point of view, knowing the antecedents of social relationships in aging -for instance, ToM- would help researchers to design effective programs to promote adequate social functioning, that is vital for wellbeing (Pinquart & Sörensen, 2000). In the present study, we focused on two specific social relationships: those with relatives and friends. We decided to investigate relationships with friends and relatives as, with increasing age, people carefully select activities that are emotionally meaningful (Hendricks & Cutler, 2004). As a result of this change, older adults tend to interact with close friends and relatives to a greater extent than do young adults (Fung et al., 1999) and relationships with relatives and close friends are crucial for successful aging (Hertzog, Kramer, Wilson, & Lindenberger, 2008). Because both the quantity and the quality of social relationships play a specific role in predicting wellbeing and quality of life in elderly population (Rafnsson, Shankar, & Steptoe, 2015), we considered both these aspects in order to have a comprehensive measure of relationships with friends and relatives.

On a general note, two hypotheses can be suggested regarding the role of ToM skills in older people's social relationships. On the one hand, it is possible that the association between ToM and social relationships is constant across life span. As previously stated, some empirical findings supported this position, indicating a positive association between ToM and social functioning in older adults (Bailey et al., 2008; Yeh, 2013). Also findings from Study 2 indicated that higher ToM was associated with more positive friendships in older adults. On the other hand, it is also plausible that the link between social relationships and ToM is attenuated during life (Blanke et al., 2016; Pezzuti et al., 2015) and that social relationships in aging rely on learned behavioral strategies (Ickes & Simpson, 2007; Blanchard-Fields, 2007), acquired social knowledge (i.e., appreciation of

contexts and goals), and greater social expertise (Hess, Osowski, & Leclerc, 2005) rather than on mental states understanding. Globally, just cited studies showed a considerable variability in the strength of association between social relationships and ToM. Thus, possibly this link can be moderated by other variables. In this study we focused on social motivation.

Specifically, we measured a peculiar aspect of social motivation, namely the importance of being liked by others. We chose this aspect because being liked by others is a crucial aspect of social motivation (Bergsieker, Shelton, & Richeson, 2010). Sociological studies have, indeed, shown how the human need to be involved in social relationships makes people constantly worried about how they are perceived about others (Baumeister & Leary, 1995) and motivates them to act in order to minimize the possibility of being refused (Leary, Terdal, Tambor, & Downs, 1995). Given this, we expected that people who think that being liked by others is important were more likely to use their ToM to build and maintain positive social relationships. This hypothesis is based on formerly reviewed studies, which suggest that what is important may be not only to possess a good understanding of others' mental states, but also to be motivated to use this understanding in everyday social relationships (Ickes & Simpson, 2007; Zhang et al., 2013).

To summarize, the main aim of the present study was to examine the association between older adults' ToM and their relationships with relatives and friends, considering the moderating role of social motivation. In doing that we also controlled for individual differences in fluid and crystallized intelligence. Indeed evidence indicated that both crystallized and fluid intelligence are related not only with ToM (Charlton et al., 2009; Moran, 2013), but also with social functioning (T. F. Hughes, Andel, Small, Borenstein, & Mortimer, 2008; Deborah Keller-Cohen, Fiori, Toler, & Bybee, 2006). We expected ToM to be significantly related with the relationships that people have with both relatives and friends. In addition, we hypothesize that the link between ToM and social relationships held up as significant only for those people with high social motivation.

7.1 *Method*

Participants

Participants were 53 older adults (28% men; age: *M* = 67.91, *SD* = 6.93, range 60-85; years of education: *M* = 13.28, *SD* = 3.75, range5-20) recruited through the local branch of the University of Third Age in northern Italy. All subjects were volunteers and lived independently, were reasonably fit and healthy, and had active social and cognitive lifestyles. Italian was the first language of all participants. Prior to testing, participants filled out a general demographic questionnaire to exclude diagnosis of dementia or neurological disorders. We administered also the CES-D (Fava, 1983) to make sure no participants had depression. None of the participants was excluded on the basis of the above criteria. The participants' demographic characteristics are reported in Table 7.1. All participants provided written informed consent to participate in the study.

Measures

Control variables. Verbal reasoning was assessed with the same Vocabulary task used in Studies 1 and 2. Differently, verbal fluency was assessed with a Word Fluency subtest (Dahlin, Nyberg, Bäckman, & Neely, 2008). Participants were requested to generate as many words as possible according to a phonemic rule (i.e., words beginning with "s") during a 90 second period for each trial; three trials were presented.

Social Motivation. It was measured via the following item from the Social Sensitivity subscale of the Social Skills Inventory (SSI - Riggio, 1986): "It is very important that other people like me". Participants were asked to indicate on a 5-point-Likert scale the extent to which the description given in the item applied to them.

Theory of Mind. We selected 4 ToM stories from the Strange Stories task (White et al., 2009). The stories consisted of two double bluffs and two misunderstandings. According to the scoring procedure, participants' answers to each story were scored as a 2 for full and explicit answer consisting in a mental state explanation, 1 for partially correct answer, and 0 for an incorrect answer. Hence, the possible score range was 0-8.Two raters independently coded 25% of the

responses at pre-and post-test. The degree of accordance, established with Cohen's Kappa, was good, $k = .87$).

Social relationships. They were assessed with the revised version of the Lubben Social Network Scale-Revised (Lubben & Gironda, 2003; please, refer to Study 2 for further information).

Procedure

Participants were tested collectively during a 2-hour session in which they completed a demographic questionnaire and a battery of tests assessing vocabulary, word fluency, social motivation, ToM, and social relationships.

7.2 *Results*

The pattern of associations between variables is reported in Table 7.1. As it can be seen, crystallized ability and verbal fluency were significantly associated with one another. In addition, crystallized ability significantly correlated with ToM, whereas word fluency was correlated with friendships. Regarding the associations between focus variables, our data showed that older people's ToM was significantly associated with friendships but not with relationships with relatives. Crucially, the association between friendships and ToM remained significant when crystallized ability and verbal fluency were taken under control, $r(48) = .32$, $p = .024$. Social motivation was not significantly related with either ToM or social relationships.

Table 7.1.

Means (and Standard Deviation) of Investigated Variables and Correlations Between Control and Focus Variables.

	Vocabulary	Animal Naming task	ToM	Relatives Relationships	Friendships	Social Motivation
Vocabulary		.57***	.29*	-.07	.06	-.18
Animal Naming task		-	.16	.06	.29*	-.09
ToM			-	-.04	.30*	.13
Relatives Relationships				-	.51**	-.02
Friendships					-	-.02
Social Motivation						-
Means (SD)	45.49 (4.87)	40.98 (10.96)	5.58 (1.64)	19.21 (4.64)	16.68 (4.17)	3.12 (1.32)
Actual range	25-50	15-59	2-8	9-29	5-24	1-5

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

In order to test whether social motivation moderates the association between ToM and friendships, we run a three-step multiple linear regression analysis with friendships as dependent variable. We entered crystallized ability and verbal fluency at first step, as control variables. At the second step we entered ToM and social motivation. Finally, we added the interaction term ToM x social motivation. Results indicated that Step 1 and 2 were only marginally significant models (Fs(2, 48) $\leq$ 2.70, ps $\geq$ .078); instead, at Step 3 the equation was significant, R^2 = .25, F(5, 45) = 2.95, p = .022. Crucially, the interaction term explained a significant amount of unique variance in friendships, ΔR^2 = .07, p = .046 (see Table 7.2.).

Table 7.2.

Hierarchical Multiple Regression Analysis Investigating the Interaction Effect of ToM and Social Motivation on Friendships.

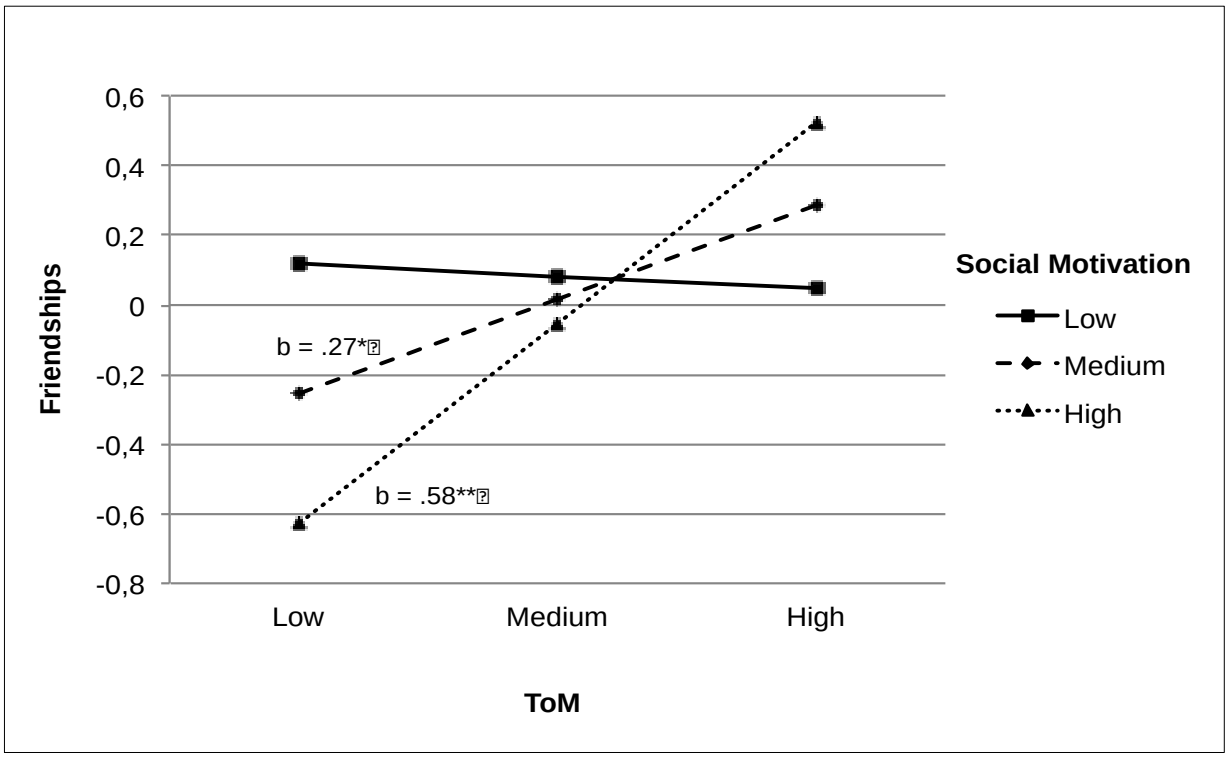
	Step 1			**Step 2**			**Step 3**		
Predictor	*B*	*SE*	*β*	*B*	*SE*	*β*	*B*	*SE*	*β*
Vocabulary	-.13	.16	-.14	-.22	.16	-.24	-.27	.16	-.29^{+}
Animal Naming task	.36	.16	.38*	.36	.15	.38*	.35	.15	.37*
ToM				.28	.14	.29*	.28	.13	.29*
Social Motivation				-.05	.13	-.05	-.07	.13	-.08
ToM x Social motivation							.31	.15	.27*
R^2		.10			.18			.25	
F for change in R^2		2.70^{+}			2.10			4.22*	

Note. $^{+}p < .10$; * $p < .05$.

Following, simple slopes analysis indicated that ToM was positively related to friendships at a high (at exactly +1 SD above the mean), $p = .005$, and medium, $p = .049$, levels of social motivation. No relations between ToM and friendships were found for low level (at exactly -1 SD below the mean) of social motivation, $b = .04$, *n.s.* (see Figure 7.1.).

Figure 7.1.

Simple Slopes of Tom at Low (-1 SD), Medium, and High (+1 SD) Level of Social Motivation.



Note. Unstandardized beta coefficients are reported for simple slopes.

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$

7.3. *Discussion*

Our first important finding is that individual differences in older people's ToM are significantly associated with those in relationships with friends, but not relatives. This result, in line with results from Study 2, is particularly interesting as it shows that the link between ToM and the social sphere is specific, and not general. Again, we argue that this result can be explained by taking into account the nature of the two relationships considered. Indeed, despite their comparable role, relationships between friends and relatives differ on many dimensions (Laursen & Bukowski, 1997). Perhaps, the most important is that while family ties are predetermined, friendships are created and maintained on a voluntary basis (Antonucci & Akiyama, 1995). Consequently, older adults may have generally less opportunities to use their social skills in their family relations, because these relationships have a strong normative component (Litwak, 1981). On the contrary, people are likely to exert more energy to maintain their relationships with friends than relatives (Roberts & Dunbar, 2011).

The second important result of this study is the moderating role of social motivation. Here, our data showed that individual differences in ToM were related to those in friendships only for people who had a high or medium level of social motivation. This suggests that, in order to have good and supportive friendships, older people need both to have ToM skills and to be motivated to put these skills into use for social purposes. This result fits with the view of ToM as a socially neutral tool that can or cannot be used. Accordingly, having an ability (marked by scores on experimental tasks) is not sufficient per se, as one also needs to have the motivation to use this understanding to guide everyday interactions with others (Begeer, Malle, Nieuwland, & Keysar, 2010; K. J. K. Klein & Hodges, 2001).

On a broad note, our finding that ToM has to be supported by high social motivation to guarantee positive relationships fits the Selective Engagement Hypothesis (Hess, 2006). It does not argue for stability of deliberative skills with age, but rather claims that these skills are put into action in a flexible way to support adequate functioning in real life.

The present study can be considered as a pioneering investigation that, we believe, has important implications in the field of intervention programs. Our results suggest that, in order to have positive effects on real life, researchers should improve ToM abilities and, at the same time, social motivation. Some researchers have shown that it is possible to enhance ToM in healthy aging people (Cavallini et al., 2015; Lecce, Bottiroli, Bianco, Rosi, & Cavallini, 2015; Rosi et al., 2016). These training programs should be revised in the light of the present results.

Although the present study examined an important issue from an innovative angle, it has some limitations that deserve attention. First, social motivation was investigated with only one item from a questionnaire. We chose this item as it reflects particular attention towards other people and an inclination to perform socially competent behaviours. However, a more comprehensive and robust measure is needed. Second, the number of participants is relatively low and replication with a bigger sample is required. It would also be useful to expand results using more objective assessment of social functioning. Further research is also needed to investigate whether there are any (and which) factors that may moderate the link between ToM and social factors, such as cultural background. For instance, Cavallini and colleagues (Cavallini, Bottiroli, Fastame, & Hertzog, 2013) have demonstrated how other metacognitive components (i.e., cognitive beliefs) may change across cultures and differently affect cognitive performance. Finally, longitudinal design could yield a deeper understanding of the causal link between ToM and social relationships in aging.

Chapter 8 - General discussion and Conclusions

The present dissertation focused on the changes in social understanding in normal aging. Specifically, the potential role of motivation was investigated in four studies. Indeed, the recent literature suggested that is crucial to take into account motivation in studying older adults' cognitive and social abilities. From a theoretical point of view (Selective Engagement Theory, Hess, 2014), growing older people need an increasing amount of resources to carry out cognitive demanding activities. For this reason, older adults: 1) tend to reduce activities that put demands on cognitive resources; and 2) carefully select activities in which they engage, on the basis of personal goals. These mechanisms reflect an adaptive process, aiming to preserve resources and to maximize performance in the most personally relevant situations. Accordingly, motivational factors become more and more pivotal in affecting older adults' cognitive performance. This does not mean that motivation is not important for young people, but rather that it has a disproportionate impact on older adults. As the authors stated: "under normal circumstances, the costs of cognitive engagement are greater for older adults, increasing the salience of such costs. In other circumstances in which the costs of cognitive activity are accentuated (e.g., fatigue), young adults should exhibit similar responses to task importance" (Ennis et al., 2013, p. 502). Empirical findings from disparate fields consistently supported the SET, offering compelling demonstrations of how experimental manipulations of motivation can lead to significant improvements in older adults' performance (e.g., Hess, 2005; Hess, Leclerc, et al., 2009; Hess et al., 2013; Hoppmann & Blanchard-Fields, 2010). To date, only one study directly investigated the impact of motivation on ToM performance in older adults (Zhang et al., 2013), showing that when motivated older adults not only performed better compared to older participants not motivated, but even performed as well as young adults did, thus wiping out the widely acknowledged age-related decline in ToM. To some extent, support for this result comes also from studies in close fields (Stanley & Isaacowitz, 2015). However, with such a limited number of studies thus far, and with findings being somewhat inconsistent, further

research is clearly warranted. In an attempt to answer this call, the present dissertation presented three studies in which motivation was manipulated and ToM ability was measured in both young and older adults (Study from 1 to 3).

Theory of Mind is known to be negatively affected by age (J. D. Henry et al., 2013), as well as other social understanding abilities, like emotion recognition (Ruffman et al., 2008). However, testing whether higher motivation can promote ToM is interesting issue not only from a theoretical point of view. Indeed, ToM is usually described to be a crucial "tool" to successfully move in interpersonal situations, to create and maintain positive relationships and, globally, to reach social adjustment (C. Hughes & Leekam, 2004; Paal & Bereczkei, 2007). Given the fact that aging is associated with a reduction in social networks and a higher risk of social isolation, ToM appears to be one of the most important skills for older adults' well-being. Accordingly, introducing motivation in the age-ToM relation may help research both to better understand those studies reporting preserved (or even improved) socio-emotional functioning in older people, and to create more effective intervention programs.

However, it is also important to acknowledge that so far there are little and contrasting findings on the association between ToM and social functioning in aging (Bailey et al., 2008; Blanke et al., 2016). Evidence mostly comes from the developmental field and literature on adulthood often just assumed that what is true for children is also true for older adults. Therefore, in this work two studies directly tested this assumption (Study 2 and 4).

In the following paragraphs the main results of the presented studies are explained: common points are elucidated and further implications are suggested.

Theory of Mind's decline in aging

Overall, all three presented studies (Study from 1 to 3) showed a significant decline in older adults' ToM. In line with the literature, the impairment appeared to be independent from task-dependent features. Specifically, we used three very different ToM measures, varying in terms of stimuli used, answers format, cognitive demand, and degree of ecological validity.

The Faux Pas task was a verbal test, requiring to answers predetermined questions, with no or little load on memory; it was a task partly ecological, in the sense that it presented daily situations.

The Animation task requested to produce a verbal description based on simple visual stimuli; it heavily relied on executive functions, implying attention, visual perceptions, and working memory skills, beyond basic linguistic ability. The stimuli themselves were quite far from daily life, but what was measured was the spontaneous use of mental state terms, thus a very ecological way to test the use of ToM.

The Describe-a-friend task asked people a short description of a close friend; hence, it was the most ecological measure, mimicking what people do daily. Again, spontaneous use of mental state terms was measured, reflecting the actual use rather than the competence in ToM. It possibly relied on episodic memory and basic linguistic ability.

Notwithstanding the differences, older adult performed worse than young adults in all the three tasks, strongly demonstrating the deficit in ToM.

Notably, the fact that the impairments were apparent also in very ecological measures speaks against the hypothesis that the age-related decline in socio-cognitive skills is just a matter of how the tasks are designed. Hence the paradox provided by older adults' good interpersonal functioning and reported satisfaction with relationships despite their impaired social understanding skills cannot be explained just as a consequence of a lack in ecological validity of the tasks used to measure socio-cognitive skills.

Contrary to recent research suggestions (e.g., Z. Wang & Su, 2013), we found that the impact of age on ToM was not component specific. Indeed, Study 1 and 2 indicated that both cognitive and affective components declined in older adults.

In addition, Study 3 confirmed that not only ToM but also emotion recognition skill is impaired in older adults. Interestingly, ToM and emotion recognition did not strongly correlate, supporting the notion that, in spite of being both important social skills, they however refer to different abilities and possibly rely on different mechanisms (Bird & Viding, 2014; Oakley et al., 2016).

An unexpected but compelling result emerging from present studies is the increasing inappropriateness in older adults' attribution of mental states. Through three studies, we repeatedly found that in the Animation task older participants, along with a lower global performance in target (ToM) animations compared to young adults, had greater intentionality attribution and lower appropriateness in the other typologies of animations. The coherence of this result across three studies varying in the number and typology of items presented (Study 1: 16 videos, two typologies; Study 2: 8 videos, two typologies; Study 3: 24 videos, three typologies) strengthens its reliability. A speculative explanation is that the widely acknowledged impairment in older adults' ToM is indeed related to two different mechanisms: on the one side, a genuine decrease in mental states attribution; on the other side, a decrease in the appropriate use of the (reduced) mental states attribution.

As anticipated in the Discussion section of Study 3, to some extent research on clinical populations identified a similar pattern of results. For instance, using the Animation task, investigations on adults with right hemisphere damage (RHD- age range 46-73 years old) showed that, compared to control participants, the clinical group displayed a reduced ability in discriminating between ToM and Random animations (Study 1 and 2 found the same result with regards to ToM and Goal-directed animations), as well as reduced attribution of mental states in the ToM videos (Weed et al., 2010). Furthermore, in line with our finding that older adults used too much intentionality (in Random and Goal-directed animations), some suggestions of an over-

attribution of mental states in people with RHD came also from a study using a story task (Champagne-Lavau & Joanette, 2007). Also research on people with autism using the Animation task seems partly in line with our results. For instance, Abell and colleagues found that children with autism attributed more intentionality than normally developing children in Random videos, suggesting an inappropriate use of ToM (Abell et al., 2000). Similarly, Salter and colleagues in explaining the differences found between children with and without autism suggested that: "the fundamental difference between the groups lies only in their interpretation of interactions that are designed to evoke theory-of-mind-related responses. Their [children with autism] inappropriate interpretations of such interactions may translate, in everyday life, into difficulties making sense of complex social situations in an appropriate way" (Salter, Seigal, Claxton, Lawrence, & Skuse, 2008, p. 365). Concerning adults with autism, Klin (2000) investigated both MST used (thus, partly overlapping to intentionality score) and appropriateness of its usage in a task similar to the Animation task. Participants were showed some geometrical shapes and were requested to describe them in terms of people's activities. Results showed that compared to control group participants with autism did use MST, but in an irrelevant way, that was completely dissociated with what animations actually depicted (Klin, 2000). Globally, presented research findings indicate that ToM deficit may be not only a matter of "lack" of ability, but also a question of appropriate use. An advantageous way to investigate this issue has been proposed by Dziobek and colleagues (Dziobek et al., 2006; Montag et al., 2011), who not only compared clinical and typical populations' ToM performance, but also described the nature of the mistakes made. Specifically, three kinds of errors are examined: absence, insufficiency and excess of mentalizing. In relation to present result, the pattern of deficit evidenced in older adults' mentalizing skill (too much ToM when not required together with too less ToM when required) is partly similar to what has been identified in some clinical populations. For instance, people with schizophrenia showed more over-mentalizing and under-mentalizing compared to control group (Montag et al., 2011). To the best of our knowledge, no studies examined ToM in terms of error categories in older adults. Therefore, globally present

and previous results open the way to consider ToM's decline in aging under a promising perspective, with potentially strong implications in daily life.

Motivation's effect on Theory of Mind

Taking at premise both theoretical frameworks (M. M. Baltes & Carstensen, 2003; Carstensen et al., 1999; Hess, 2014) and empirical findings (Stanley & Isaacowitz, 2015; Zhang et al., 2013), three studies directly investigated whether experimentally manipulating motivation lead to improved ToM performance in older adults. Notably, three different conceptualizations of motivation were proposed: closeness, intergenerational knowledge transmission, and ego-involvement. Globally, results indicated that to be more motivated doesn't imply to show better ToM, neither for older, nor for young adults.

The only clear exception to this pattern appeared in Study 2, where older adults (but not young adults) in the enhanced motivation condition: 1) performed better than their counterpart in control condition, and 2) reached young adults' level of performance in the Faux Pas task. Furthermore, concerning the Describe-friend task it seems important to acknowledge that -even if not statistically significant- means suggested a positive effect of motivation on performance, specifically on the use of cognitive mental state terms.

Therefore, out of three ways to connote motivation, only intergenerational knowledge transmission appeared to have a (partial) positive effect on socio-cognitive performance, selectively for older adults.

Crucially, in Study 3 the manipulation of motivation was not effective, that is, ego-involvement instructions did not affect self-reported motivation or physiological indices. For this reason, motivation has been considered as a trait-like quality, instead of as a state-like quality. That is, individual differences in (baseline) motivation were investigated in relation to both social understanding skills and cardiovascular responses. Results supported previous findings from group comparison analyses, indicating that motivation and socio-cognitive performance are unrelated in older (and young) adults.

Also Study 4 examined individual differences in motivation, but with two fundamental differences: 1) motivation was investigated as a potential moderator of the relationship between ToM and social networks (and not as directly impacting on ToM); 2) contrary to what we did in Study 2 and 3, which manipulated motivation to carry out the tasks, in Study 4 we examined social motivation.

Theory of Mind's correlates

Not being the main aim of the work, some of the correlates of ToM were investigated in older adults. Studies 1 and 2 measured executive functions. Also, crystallized intelligence and educational attainment were considered in Studies 1, 2 and 3. Social relationships were investigated in Study 2 and 4. Finally, Study 2 offered some initial suggestions concerning personality and self-perceived social competence.

Regarding executive functions, globally our two studies indicated that even if present, the pattern of correlations is not strong or clear. One can hypothesize that different tasks can differently rely on executive abilities, thus for instance the Animation task may be more associated with working memory compared to the Describe-a-friend task, which possibly relies more on crystallized ability. However, we did not obtain a clear support for this hypothesis. To be fair, we did not investigate all executive functions, but just working memory, verbal fluency and speed of processing. Therefore, a wider set of tasks considering also inhibition and shifting could possibly show different pattern. In any case, results from regression analyses consistently suggested that ToM's decline is explained mostly (when not fully) by age, with executive functions not being significant predictors. Thus, present results overall are in line with those literature suggesting the independence of ToM age-related decline from the effects other cognitive variables (e.g., Bernstein et al., 2011; Cavallini, Lecce, et al., 2013).

On a relate note, investigation on language and education association with social understanding showed that both these variables are to some extent correlated to ToM tasks.

However, regression analyses again indicated that they did not play a major role in explaining age-related differences.

Concerning social relationships, findings from Study 2 offered some (weak) indications that older adults' socio-cognitive skills are positively associated with friendships. Additionally, Study 4 better clarified this result indicating that this association occurred only for those people who were socially motivated.

With regards to personality, individual differences in Big Five traits were found mostly unrelated to older adults' socio-cognitive skills, in line with the limited literature (Keightley et al., 2006). The only exception may be Openness to experience, which seemed partly related to both the Faux Pas task and the Describe-a-friend task. Further studies should better clarify whether the attitude toward cognitive and aesthetic activities/materials may be genuinely related to socio-cognitive skills in older adults.

Finally, concerning self-evaluated social competence, we found that older, but not young, adults are partly aware of their objective ability. This result seems particularly intriguing, as it fit well with these works suggesting an improvement in social competence in later life. Indeed, some studies revealed that growing older people show more "wisdom" in social context (Grossmann et al., 2010; Hess, Osowski, & Leclerc, 2005). Notably, contrasting results came from research on memory: studies consistently showed that older adults possess beliefs unrelated to actual performance (Schmidt, Berg, & Deelman, 2001).

Limitations and Conclusion

Some important limitations need to be acknowledged. First, even if the use of three different conceptualizations of motivation allowed us to investigate the construct of motivation in a broader way and offered important hints, it also limited the possibility to generalize results. It is also important to acknowledge that the construct of motivation encompasses a very heterogeneous range of aspects (Braver et al., 2014). This complexity is reflected in the way in which motivation has been operationalized in both present and previous studies. As a consequence, a great deal of studies

is still needed in order to get the "whole story" about the interplay between cognition and motivation. For instance, an intriguing possibility for future works would be to investigate motivation in terms of goals achievement (Elliot, 1999). Indeed, some evidence seems to indicate that learning and mastery-oriented goals may positively impact on older adults' cognitive performance (Fairfield, Mammarella, & Di Domenico, 2015; Hastings & West, 2011). Second, longitudinal studies would offer deeper insight into age-related changes in socio-cognitive skills. Cross-sectional studies cannot account for historical/cultural differences between age groups and they only partly control for individual differences. Especially in examining the relation between ToM and social relationships and interpersonal functioning, investigating age-related changes on an individual level would be a more profitable way. Third, the present examination explicitly focused on typical aging processes; however, recruited older adults were not only without cognitive and physical impairments, but they also belonged to a specific population possibly characterized by high interest in cognitive activities. The importance of this issue was highlighted in Study 1, were older adults in the relative condition were recruited from the "actual" aging population. Here, we found that those older adults who were "forced" to participate -but who had never thought to participate to psychology research and who would likely refuse to do it if they were not required by a close relative- had significant lower cognitive and socio-cognitive performances than older volunteers in the other two conditions. Finally, generally speaking, greater samples are required to reach firmer conclusions; we considered groups with no less than 25 participants and thus we feel that our results are indeed meaningful, but further studies are needed to confirm present results.

Notwithstanding these limitations, this dissertation offers some important advancing in the field. First, it consistently demonstrated the existence of an age-related decline in ToM, irrespective of the task used and the component investigated.

Second, it indicated that -generally speaking- motivation is not a major factor able to fully explain the age-related decline in socio-cognitive abilities.

Third, it pointed out that ToM is indeed related to social functioning under certain circumstances - i.e., when people is motivated to have social contacts; and with regards to relationships with friends, rather than with relatives. As a consequence, we believe that an important future direction is to better investigate how the decrease in socio-cognitive skills in older adults impacts on actual social adjustment.

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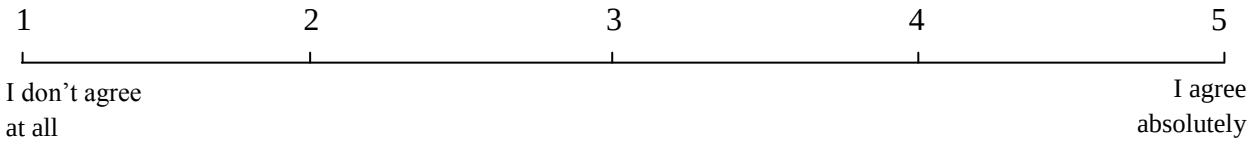
Appendix A - Tasks

A.1. Study 1

A.1.a. *Trust scale*

Please, read the following sentences and attribute a score to each one, ranking from 1, "I don't agree at all", to 5, "I agree absolutely". Chose the number which better represents what you think.



1. If given a chance, most people try to take advantage of you.*
2. Most people are too busy looking out for themselves to be helpful.*
3. You can't trust stranger anymore*
4. I never rely on other people.*
5. Most people can be trusted.°
6. You can't be too careful in dealing with people.°
7. People would try to be fair.°
8. Most of the time people try to be helpful.°
9. How much do you trust the following group of people?#

   Completely /somewhat /not very much/ not at all

   a. family
   b. neighborhood
   c. people you know personally
   d. people you meet for the first time
   e. people of another religion
   f. people of another nationality

* Item adapted from Siegrist, Keller, & Kiers (2005) and Siegrist, Earle, & Gutscher (2003).

° Item adapted from Tokuda, Jimba, Yanai, Fujii, Inoguchi (2008).

Item adapted from Delhey & Welzel (2012).

A.1.b. ***Leisure activity questionnaire***

Sample items:

1. How often do you go to the movies?
   - Never
   - Less than, or about, once a year
   - Once every 6 months
   - Every 2 months
   - Every month
   - Every week
   - More than once a week

2. How often do you eat junk food?
   - Never
   - Less than once a month
   - Less than once a week
   - Once a week
   - Twice a week
   - More than twice a week
   - Every day

6. How much do you spend a month using your mobile phone?
   - I don't have a mobile phone
   - 0-5€
   - 5-10€
   - 10-20€
   - 20-50€
   - 50-100€
   - More than 100€

9. How often do you do sports?
   - Never
   - Less than once a month
   - Less than once a week
   - Once a week
   - Twice a week
   - More than twice a week
   - Every day

12. How often do you go to concerts or theatre?
   - Never
   - About once a year
   - Two to four times a year
   - Every month
   - Twice a month
   - Every week
   - Multiple times a week

13. How often do you purchase new clothes?
   - Never
   - About once a year
   - Two to four times a year
   - Every month
   - Twice a month
   - Every week
   - Multiple times a week

A.1.c. *Manipulation check*

1. How much close do you feel to the experimenter?
(*Please choose a number*).

Not at all Very much

1 --------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6 ---------- 7

2. Please indicate where you think the experimenter should be placed putting a cross on the following line.

I Stranger

A.1.c. *Faux Pas task*

Example of faux pas story:

Helen's husband was throwing a surprise party for her birthday. He invited Sarah, a friend of Helen's, and said, "Don't tell anyone, especially Helen." The day before the party, Helen was over at Sarah's and Sarah spilled some coffee on a new dress that was hanging over her chair. "Oh!" said Sarah, "I was going to wear this to your party!" "What party?" said Helen. "Come on," said Sarah, "Let's go see if we can get the stain out."

Questions:

1. Did anyone say something they shouldn't have said or something awkward?

If yes, ask:

2. Who said something they shouldn't have said or something awkward?
3. Why shouldn't he/she have said it or why was it awkward?
4. Why do you think he/she said it?
5. *Cognitive question:*
   Did Sarah remember that the party was a surprise party?
6. *Affective question:*
   How do you think Helen felt?

Control question:

7. In the story, who was the surprise party for?
8. What got spilled on the dress?

Example of control story:

Joan took her dog, Zack, out to the park. She threw a stick for him to chase. When they had been there a while, Pam, a neighbour of hers, passed by. They chatted for a few minutes. Then Pam asked, "Are you heading home? Would you like to walk together?" "Sure," Joan said. She called Zack, but he was busy chasing pigeons and didn't come. "It looks like he's not ready to go," she said. "I think we'll stay." "OK," Pam said. "I'll see you later."

Questions:

1. Did anyone say something they shouldn't have said or something awkward?

If yes, ask:

2. Who said something they shouldn't have said or something awkward?
3. Why shouldn't he/she have said it or why was it awkward?
4. Why do you think he/she said it?
5. *Cognitive question:*
   When she invited her, did Pam know that Joan wouldn’t be able to walk home with her?
6. *Affective question:*
   How do you think Pam felt?

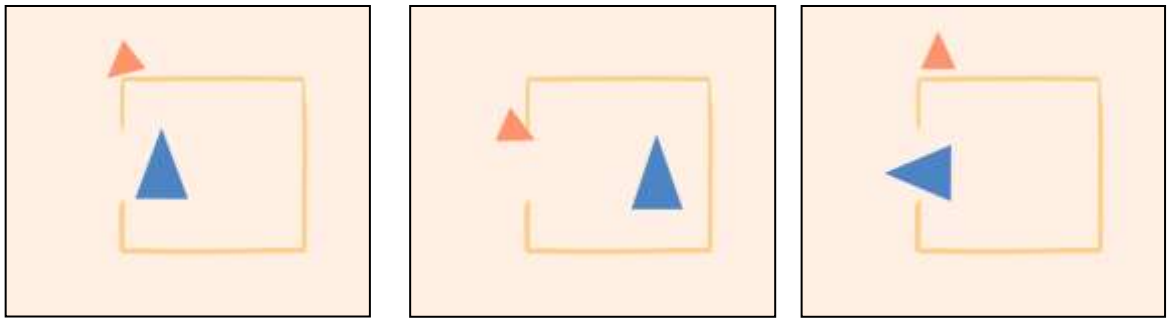
Control question:

7. In the story, where had Joan taken Zack?
8. Why didn’t she walk with her friend Pam?

A.1.d. *Animation tasks*

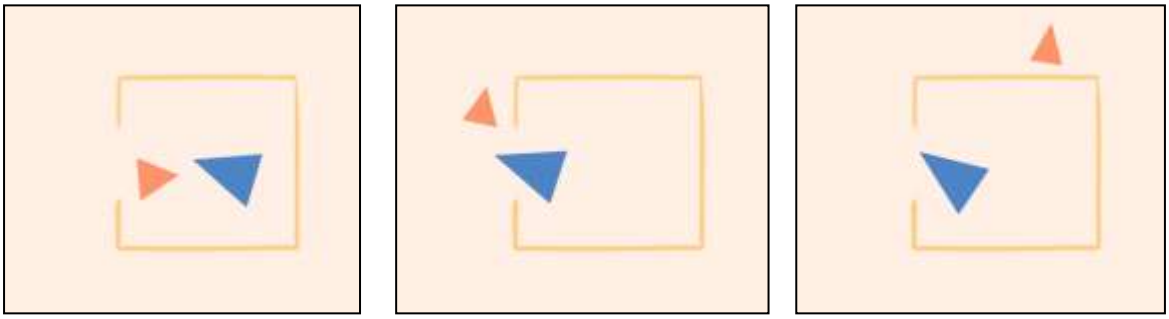
Example of ToM video:

T 3c: The little triangle spies on the big one and hides to not be noticed.



Example of Goal-directed video:

A 3c: The little triangle enters the space and the big one chases it out.



Samples answers and attributed scores:

T 3c:

- "The little triangle peeks at what the big one is doing in the house. When the big triangle turns itself, the little one hides itself in order to not be discovered."
  Intentionality = 5; Appropriateness = 3
- "They are playing hide-and- seek".
  Intentionality = 2; Appropriateness = 2
- "The big triangle is dancing".
  Intentionality = 1; Appropriateness = 1
- "The little triangle wants to enter but it is too afraid to do it".
  Intentionality = 3; Appropriateness = 1

A3c:

- "The little triangle is walking and sees the big one which is doing something. They talk for a while, then the little goes back and the big continues to do what it was doing."
  Intentionality = 2; Appropriateness = 3
- "The little one notices the big one doing something and stops (to watch/talk), but the big one drives away it."
  Intentionality = 3; Appropriateness = 3
- "The big triangle doesn't want the little one inside the box".
  Intentionality = 3; Appropriateness = 2
- "The little triangle want to steal something"
  Intentionality = 3; Appropriateness = 1

A.2. Study 2

A.2.a. *Experience with child questionnaire*

a - Thinking about the present, how often do you tell stories to children?

b - Thinking about the present, how often do you have to do with children?

c - Thinking about the present, how comfortable do you feel when you deal with children?

d - Thinking about the past, how often did you tell stories to children?

e - Thinking about the past, how often did you deal with children?

f - On the whole, how much experience do you feel in dealing with children?

Possible answers

- *questions a-e:*

1- Never 2-Rarely 3- Sometimes 4-Often

- *question f:*

1- Slightly 2-Somewhat 3- Moderate 6- Very

A.2.b. ***Manipulation check questionnaire***

The first question was asked within the demographic questionnaire.

The second question was asked after all ToM tasks.

a - How much do you feel motivated in participate in this study?

b - How much did you feel motivated in carrying on the previous activities?

Possible answers:

1- Not at all 2-Very slightly 3- Slightly 4-Somewhat 5- Moderately 6- Very much 7- Extremely

Answers on the following questions were summed into a global motivation score (effort items were removed because of low inter-correlation with other items).

a - I found it a bit difficult to do these activities. [effort]

b - I think I transmitted my personal values in doing these activities. [trasmission]

c - It was fun participating to this research. [interest]

d - I think these activities are not very meaningful for me. (R) [meaningfulness]

e - I think the information collected during these activities could be very helpful in practical context. [utility]

f - I felt personally engaged in this project. [meaningfulness]

g - I think this project will turn out to be very helpful. [utility]

h - It has been easy to accomplish all these activities. (R) [effort]

i - I think the activities I have just carried out were interesting. [interest]

j - On the whole, I think I give my personal contribute in carrying out these activities. [trasmission]

Possible answers:

1- Strongly disagree 2-Disagree 3- Somewhat disagree 4- Neither agree or disagree

5- Somewhat agree 6- Agree 7- Strongly agree

A.3. Study 3

A.3.a. *Manipulation check questionnaire*

1. To what extent was it worthwhile to succeed on the task?
2. How much did you feel involved in the task?
3. How interesting do you think this task was?
4. How much effort did you put in doing this task?
5. How worried did you feel about your performance in the task?

Possible answers:

1 (not at all) 2 3 4 5 6 7 (very much)

Appendix B - Procedures

B.1. Study 2

B.1.a. *Task order*

In session 1 ToM tasks were randomized.

In session 2 all tasks were randomized.

Session 1	*Session 2*
Demographic questionnaire + MMSE	Vocabulary test *(Crystallized ability)*
ToM - Faux Pas task *(ToM)*	Animal naming task *(Verbal fluency)*
ToM - Animation task *(ToM)*	Digit span test *(Short term & working memory)*
ToM - Describe-a-friend task *(ToM)*	Lubben social network scale-revised
Experience with children scale	Mind-reading belief scale *(subjective social competence)*
Manipulation check questionnaire *(Motivation)*	Tromsø social intelligence scale *(subjective social competence)*
	Self-construal scale
	Big Five Inventory *(personality)*
	Marlowe-Crowne social desirability scale

B.1.b. ***Manipulation of generativity***

Introduction to the first session:

Experimental Condition	*Control Condition*
We are working on a project in collaboration with elementary school teachers. Specifically, we work with children aged from 9 to 11. This project aims to encourage transmission of knowledge and experiences between children generation and adults/grand-parents generation. Indeed, a number of studies has demonstrated that knowledge transmission between generations is an important factor to promote children's development. For this reason, I will need your help and I will ask you to perform a number of activities/tasks.	I will ask you to perform several activities. They will be rather various.

Faux Pas task:

Experimental Condition
Please, remember that your answers will be read to children at school, in order to promote children ability to understand different social situations, and to teach them how people should behave. *at the end of third story, the experimenter gave the prompt:* Good, remember that your answers will be used to promote children development.

Animation task:

Experimental Condition
Please consider that, again, your answers will be used in our project on children's development. In particular, we will use your answers to promote children interpretation and narrative's skills. Indeed, your descriptions will be used to create a "manual" for teachers and they will use it at school. *at the end of third story, the experimenter gave the prompt:* Good, remember that your answers will be used to promote children development.

Describe-a-friend task:

Experimental Condition
[Think of a person you regard as a very close friend. I will ask you to tell me a little about this person.] This because we will create a children book about best friends. This book aims to promote children reflections about friendship. This book will be made up of several friendship stories, included your one. Please consider that your experience is important to help children in understanding what means to have a best friend.

B.2. Study 3

B.2.a. *Task order*

Older adults were sent by email/mail the Consent form and it was collected before the experiment begins. Young adults filled the Consent form before starting the testing session.

Task (construct)	*CV readings*
Resting phase	Baseline *at minute 0, 5 and 10*
Antonucci's Circle diagram (*social network*)	Baseline *5 minutes after the last measuring*
Matching task (*emotion recognition*)	Emotion recognition *first reading after the first item (30-60s from the onset of the task), following at 5 minutes intervals.*
Manipulation check questionnaire (*motivation*)	
Reasoning task (*verbal knowledge and reasoning*)	
Animation task (*ToM*)	ToM *first reading after the first item (30-60s from the onset of the task), following at 5 minutes intervals*
Manipulation check questionnaire (*motivation*)	
Shipley vocabulary test (*crystallized ability*)	

B.2.b. *Manipulation of ego-involvement*

Emotion Recognition task:

High Motivation Condition	*Low Motivation Condition*
"In this task you will hear some soundtracks, and you have to match each soundtrack to the most appropriate picture choosing within the given options. Previous research has shown that people who have a high score in this task usually are also highly socially competent. For example, they are able to discriminate a lie from a truth, they are better and more enjoyable communicators, and they are better at recognizing when someone has made a social gaffe. At the end of the experiment, I will give you your results so you can check your skill."	"In this task you will hear some soundtracks, and you have to match each soundtrack to the most appropriate picture choosing within the given options. Previous research using this task are been carried out in a very wide range of countries. The voices and the sounds were recorded in this laboratory from volunteers who helped us or were retrieved on the internet. The faces were drawn from an international set of faces and they are commonly used in psychology research. At the end of the experiment, I will give you another kind of task."

ToM task:

High Motivation Condition	*Low Motivation Condition*
In this task you will see some videos. In each one, you will see two triangles, one big, the other little, which are moving and doing things. Sometimes, it seems they are moving quite randomly, for example they could bounce; other times it seems they do things together, interacting; for example, they could dance. You have to watch carefully and at the end of each video you have to answer out loud to the following question: "What was happening in this animation?", so you have to describe what you have seen in the video. According to several researchers, high scores in this task are related to better relations between people and to the ability to make and keep good	In this task you will see some videos. In each one, you will see two triangles, one big, the other little, which are moving and doing things. Sometimes, it seems they are moving quite randomly, for example they could bounce; other times it seems they do things together, interacting; for example, they could dance. You have to watch carefully and at the end of each video you have to answer out loud to the following question: "What was happening in this animation?", so you have to describe what you have seen in the video. This task has been first used in 1944 by Heider and Simmel in the USA. Years later, other researchers rediscovered and adapted it and now it is used in

friendships. High scores are also associated with social competence and altruistic attitudes and are considered markers of wisdom. At the end of the experiment, I will give you your results, so you can check your skills.”	research worldwide. This task has been adapted from a previous version with different geometrical shapes, like circles and squares. At the end of the experiment, I will give you another kind of task.”

Appendix C - Supplementary analyses

Table C.I. Study 1. Correlation between ToM tasks, age group, education, crystallized intelligence and executive functioning.

	Age group	Education	Vocabulary	DS Forward	DS Backward	Fluency	Digit-symbol
Faux Pas							
A'	-.168^{+}	.157^{+}	.113	.143	.263**	.173^{+}	.159^{+}
Faux Pas stories global score	-.251**	.162^{+}	.105	.147	.234*	.319***	.147
Cognitive ToM	-.172^{+}	.121	-.028	.068	.175^{+}	.285**	.098
Affective ToM	-.086	.021	.103	.101	.106	.146	-.018
Animation task							
ToM videos	-.734***	.262**	-.103	.313***	.457***	.345***	.625***

Note: Age group was coded: 1 = young adults, 2 = older adults.

$^{+}$ $p < .10$, * $p < .05$, ** $p < .01$, *** $p \leq .001$.

Rho di Spearman is reported.

Table C.II. Study 1. Correlation between ToM tasks, age group, education, crystallized intelligence and executive functioning separated by Age group.

Young						
	Education	Vocabulary	DS Forward	DS Backward	Fluency	Digit-symbol
Faux Pas						
A’	.168	.029	-.073	.113	.075	.058
Faux Pas stories global score	.094	.131	.003	.044	.283**	-.115
Cognitive ToM	.202	-.079	-.157	.037	.298**	-.019
Affective ToM	-.007	.263*	.176	.138	.208	-.135
Animation task						
ToM videos	-.092	-.111	.018	.043	.176	-.011
Old						
	Education	Vocabulary	DS Forward	DS Backward	Fluency	Digit-symbol
Faux Pas						
A’	.094	.333*	.309*	.351**	.134	.032
Faux Pas stories global score	.103	.255^{+}	.134	.300*	.197	-.034
Cognitive ToM	.-.019	.150	.157	.288*	.204	-.089
Affective ToM	-.005	.040	-.031	-.066	.028	-.092
Animation task						
ToM videos	.363**	.337**	.116	.323*	.255*	.214^{+}

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

Rho di Spearman is reported.

Table C.III. Study 2. Correlation between ToM tasks, age group, education, crystallized intelligence, experience with children and executive functioning (only Control condition, $n = 58$).

	FP -sum	FP - neutral	FP - A'	FP -cognitive	FP - affective	A - ToM	A - Gd	MST - global	MST - cognitive	MST - emotion	MST - desire	Age group
FP -sum	-	-.18	.73***	.81***	.79***	.34**	.22	.35**	.24+	.24+	.13	-.48***
FP - neutral		-	.37**	-.12	-.23+	-.12	-.13	.01	.22+	-.11	-.13	.17
FP - A'			-	.55***	.61***	.22+	.18	.37**	.39**	.18	.09	-.31*
FP -cognitive				-	.48***	.36**	.26+	.35**	.32*	.22+	-.05	-.49***
FP - affective					-	.20	.19	.32*	.14	.22	.30*	-.27*
A - ToM						-	.50***	.46***	.25+	.44***	-.07	-.52***
A - Gd							-	.15	.02	.13	.10	-.25+
MST - global								-	.56***	.81***	.25+	-.59***
MST - cognitive									-	.08	-.06	-.39**
MST - emotion										-	.06	-.43**
MST - desire											-	-.16
Age group												-
Education												
CA												
Expertise												
STM												
WM												
Fluency												

Note. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. A = Animation task; CA = crystallized ability; STM = short term memory; WM = working memory.

Rho di Spearman is reported.

Table C.III. *(Continued)*

	Education	CA	Expertise	STM	WM	Fluency
FP -sum	.34**	.11	.22+	.11	.37**	.49***
FP - neutral	-.21	-.11	.13	.08	-.01	-.22+
FP - A'	.22	.13	.30*	.15	.37**	.40**
FP -cognitive	.23+	-.05	.21	-.05	.23+	.35**
FP - affective	.37**	.31*	.22+	.08	.34**	.50***
A - ToM	.29*	-.06	.26*	.01	.30*	.39**
A - Gd	.43**	.00	.20	-.04	.05	.40**
MST - global	.16	-.15	.20	.07	.30*	.38**
MST - cognitive	.15	-.04	.15	-.03	.26*	.27*
MST - emotion	.12	-.15	.13	.12	.17	.27*
MST - desire	.10	-.05	.12	-.05	.25+	.15
Age group	-.09	.33*	.02	-.14	-.36**	-.40**
Education	-	.48***	.31*	.11	.26*	.43**
CA		-	.09	.12	.15	.26*
Expertise			-	.00	.27*	.23+
STM				-	.41**	.35**
WM					-	.42**
Fluency						-

Note. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. A = Animation task; CA = crystallized ability; STM = short term memory; WM = working memory.

Table C.IV. Study 2. Correlation between ToM tasks, social network, perceived socio-cognitive skills and personality.

	Friends	Family	MRBs	TSIS	Ag	Co	Ne	Ex	Op
FP -sum	.53***	.16	.33*	.48***	.37**	-.00	-.03	.17	.30*
FP - neutral sum	-.13	.16	-.06	-.07	-.09	.08	-.05	.12	-.15
FP - A’	.40**	.30*	.19	.36**	.29*	.02	.02	.23+	.24+
FP -cognitive	.39**	.11	.19	.41**	.22+	.00	.07	.20	.37**
FP - affective	.48***	.12	.31*	.38**	.30*	.04	-.12	.09	.16
A - ToM	.35**	.16	-.01	.21	.16	-.12	.18	.04	.25+
A - Gd	.13	.01	.06	.03	-.07	-.21	.10	.04	.24+
MST - global	.51***	.05	.26+	.38**	.01	.00	.08	.16	.25+
MST - cognitive	.23+	.22+	.06	.28*	-.11	.09	-.01	.21	.28*
MST - emotion	.42***	-.01	.23+	.33	.06	-.02	.07	.13	.18
MST - desire	.28*	-.08	.09	-.05	.05	-.02	.10	-.21	-.12

Note. A = Animation task; MRBs = mind reading belief scale; TSIS = tromso intelligence scale; Ag = agreeableness; Co = conscientiousness; Ne = neuroticism; Ex = extroversion; Op = openness to experience.

Rho di Spearman is reported.

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

Table C.V. Study 2. Repeated ANOVA with Score (Intentionality, Appropriateness) and Video (ToM, Goal-directed) as within-subject factor and Age group (young, old) as between-subjects factor. Descriptives are presented first.

	young	**old**	*F*	η_p^2
T - Intentionality	11.78 20.02	10.48 1.92	12.95***	.10
T- appropriateness	7.06 1.33	5.43 1.41	40.78***	.26
Gd - Intentionality	9.12 1.44	9.28 1.63	.30	.00
Gd- appropriateness	7.49 1.24	6.46 1.28	19.40***	.14

Multivariate analysis:

Effect	*F*	η_p^2
Age group	25.02***	.18
Video	21.66***	.16
Score	628.07***	.84
Age group x Video	15.86***	.12
Age group x Score	7.02**	.06
Video x Score	173.43***	.60
Age group x Video x Score	4.58*	.04