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**ZITA GÁL**

**AGE-RELATED DIFFERENCES OF THE THEORY OF MIND, AND  
IT'S RELATIONSHIP WITH WORKING MEMORY AND  
SOCIOMETRIC POSITION**

Summary of PhD Thesis

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## The theoretical background of the dissertation

Investigating the development of the theory of mind (ToM) is a core area of cognitive developmental psychology. In the recent decades the researches regarding theory of mind are diversified. The term theory of mind is first used by *Premack and Woodruff* (1978) in a study carried out with primates. In human researches the term theory of mind is often referred with other terms such as naive psychology, folk psychology, mind reading or mentalization (*Bíró*, 2002; *Kiss*, 2005). These terms refer to an ability to infer other people's mental states. Theory of mind helps us to explain and predict other person's behaviour, so this is a core ability in order to act effectively in social situations (*Baron-Cohen*, 2001; *Brüne és Brüne-Cohrs*, 2006).

Studies regarding theory of mind focus on developmental disorder, especially autism spectrum disorder, one of the first studies is linked to *Baron-Cohen, Leslie and Frith* (1985). Their results suggested "mindblindness", which means that there is a lack of mindreading in autism spectrum disorders (*Baron-Cohen*, 1997), this idea led to the naive theory of mind deficit hypothesis, which is a possible explaining theory of autism. Later researches suggest that the theory of mind deficit hypothesis is not the only explanation, but also an important part of a complex cognitive system (*Győri, Borsos and Stefanik*, 2014).

The focus of this dissertation is the typical development, including the success in school and in social interactions. Theory of mind impairments are often investigated regarding developmental disorders (such as autism: *Baron-Cohen et al.*, 1999; *Lombardo and Baron-Cohen*, 2011; *Senju*, 2013, *Győri, Borsos and Stefanik*, 2014; ADHD: *Uekermann et al.*, 2010), and psychiatric disorders (such as schizophrenia: *Shamay-Tsoory et al.*, 2007; *Varga, Tényi, Fekete and Herold*, 2008; borderline personality disorder: *Harari et al.*, 2010; *Choi-Kain and Gunderson*, 2008, anorexia nervosa: *Tchanturia et al.*, 2004; *Russel et al.*, 2009; *Gál, Egyed, Pászthy and Németh*, 2011) and neurological disorders (pl. Parkinson's disease: *Bodden et al.*, 2010; *Poletti et al.*, 2013; dementia: *Gregory et al.*, 2002; *Stone et al.*, 2003). In the typical development researchers found implicit theory of mind in toddlers and early childhood (eg. *Clements and Perner*, 1994; *Onishi and Baillargeon*, 2005; *Kovács, Téglás and Endress*, 2010). Four year old children have the ability to understand false beliefs (*Wimmer and Perner*, 1983; *Hogrefe, Wimmer and Perner*, 1986; *Baron-Cohen, Leslie and Frith*, 1985; *Brüne and Brüne-Cohrs*, 2006). Theory of mind - measured by false belief tests - is related to executive functions (eg. *Carlson and Moses*, 2001; *Carlson, Moses and Breton*, 2002; *Razza and Blair*, 2009), to several environmental factors (eg. *Dunn et al.*, 1991; *Cutting and Dunn*, 1999; *Pears and Moses*, 2003), and to social competence measured with different methods (eg. *Lalonde and Chandler*, 1995; *Razza and Blair*, 2009) among kindergarten children. From the beginning of school beyond the false belief understanding, children are able to understand embedded mental states, later they understand irony and humour (*Brüne and Brüne-Cohrs*, 2006; *Westby and Robinson*, 2014) and at 9-11 years they can recognize faux pas (*Baron-Cohen, O'Riordan, Stone, Jones and Plaisted*, 1999). Theory of mind ability changes until the end of adolescence and young adulthood (*Dumontheil et al.*, 2010; *Sebastian et al.*, 2012; *Altgassen et al.*, 2014), later it declines in old ages (*Maylor et al.*, 2002; *Duval et al.*, 2010). Most of the studies applied cross-sectional strategies comparing two or three age groups in order to investigate typical development of theory of mind, in our study we attempt to map the age-related differences in a wider age-range.

The question of the relationship among theory of mind and other cognitive functions have motivated several studies. The results suggest that theory of mind is related to executive functions among kindergarten children (eg. *Carlson, Moses and Breton, 2002; Müller, Liebermann-Finestone, Carpendale, Hammond and Bibok, 2012*), young and old adults (pl. *German and Hehman, 2006; Duval et al., 2010*), and also related to working memory (*Lin, Keysar and Epley, 2010; Phillips et al., 2011*). In dual-task studies, memory load reduces theory of mind performance (eg. *McKinnon and Moscovitch, 2007*), so the approach of automatic theory of mind in adulthood is controversial. However social cognition can be implicit or explicit (*Frith and Frith, 2008*), also mindreading can be automatic, not flexible and not automatic process, and putting significant load on one's cognitive resources (e.g. *Apperly, 2011*). Most of the studies use explicit measures of theory of mind in order to investigate the relationship with working memory or executive functions (eg. *Razza and Blair, 2009*).

The relationship between theory of mind and social behaviour is another focus of the studies. The main question is high performance on theory of mind tests is related to more successful social behaviour and higher social competence. The results are controversial on the one hand because of the methodological questions of measuring theory of mind: several tests are not realistic enough to modellate real-life social interactions, because if a child can perform well on a theory of mind test, it is not necessarily predict the successful social behaviour (*Astington, 2003*). The other reason of the controversial results are the following: people may use their superior theory of mind ability to antisocial goals, such as studies about bullying are suggest this pattern (*Slaughter and Repacholi, 2003; Sutton, 2003*). Most of the results suggest that there are a relationship between social competence and theory of mind among kindergarten children (eg. *Watson, Nixon, Wilson and Capage, 1999; Walker, 2005*), school-aged children (eg. *Banerjee and Watling, 2005; Liddle and Nettle, 2006*), and also longitudinal studies found this relationship (eg. *Banerjee, Watling and Caputi, 2011*), but according these results the causality of how theory of mind affects social relationships, or how social relationship affects theory of mind, is controversial. Reviewing these studies, the examined relationships between social behavior and theory of mind are weak or modest. And the administered methods for measuring theory of mind and social behavior are various, so according to these results we can only say that the relationship is weak between these constructs.

The purpose of this dissertation is to investigate age-related differences in theory of mind, the relationship between cognitive functions, especially working memory and theory of mind, and also to find relationship between social position (measured with different tools) and theory of mind. We aim to investigate the above mentioned aims in a wide range of ages, and with the same theory of mind measurements. The dissertation focuses on examining explicit theory of mind, administering the Faux Pas Recognition Test child (*Baron-Cohen et al., 1999*) and adult versions (*Stone, Baron-Cohen and Knight, 1998*). The child version can measure school-aged children's (7-11 years) theory of mind, and the adult version was used in typical and atypical population in several studies (eg. *Banerjee and Watling, 2005; Harari et al., 2010*), this test was also used in modified versions (eg. *Banerjee, Watling and Caputi, 2011*) in order to measure theory of mind. According to these results, the Faux Pas Recognition Test contains situations from everyday life events, so that it can map theory of mind in a realistic way. It is important to provide the Hungarian translation of the test, we attempt to fill this gap with our study. In the dissertation, we administered the Faux Pas Recognition Test's child and adult

versions in our own translation, according to our previous results the test provides a good measure for explicit theory of mind (Gál, Egyed, Pászthy and Németh, 2011; Gál, Katona, Janacsek and Németh, 2014).

The purpose of the dissertation is to examine the age-related differences in theory of mind, to map the relationship between theory of mind and working memory, and also to map the relationship between sociometric position and theory of mind. These purposes are examined in three experiments, the first study investigates the age-related differences in theory of mind from the age of 5 to 11, measured with the child version of Faux Pas Recognition Test, and from the age of 11 to 75 with the adult version of Faux Pas Recognition Test. Our first study's purpose is not only to map the age-related differences, but also to form a realistic measurement in order to investigate theory of mind in childhood and adulthood. In the second study our aim is to map the relationship between theory of mind and working memory capacity, in order to reveal how the Faux Pas Recognition Test is related to working memory capacity, and to improve the test for a more reliable and valid measurement of theory of mind. The third study's aim is to map the relationship between the sociometric status and theory of mind among school-aged children. The long-range purpose is to plan interventions in order to develop children's social skills and to plan prevention programmes for bullying, because if the results support the relationship between theory of mind and social behaviour, than it is worth to consider to build in theory of mind developing methods to a complex developing programme in the school. The education requires analytic thinking skills, but the brain among school-aged children, especially in adolescence naturally deals with the exploration of the world, using the mentalization network. According to this concept, it is worth to consider how developing methods of social cognition can be built in the classroom processes (Lieberman, 2012). The above mentioned purpose is far from our studies now, but in the interest of children's success in school and effective social behaviour it is worth to examine theory of mind functioning in school-aged children.

### **Conception of the experiments**

*The first experiment's* aim is to map the age-related differences of theory of mind, investigating the cognitive and the affective components, focusing on the Faux Pas Recognition Test (Stone, Baron-Cohen and Knight, 1998; Baron-Cohen et al., 1999), which is able to map the cognitive and affective theory of mind also (Harari et al., 2010). Mapping the age-related differences of cognitive and affective theory of mind following kindergarten years is a unique research in Hungary.

*The second experiment's* aim is to map the factors related to theory of mind, especially the associations between working memory capacity and the cognitive and affective components of theory of mind. The cross-sectional (eg. Carlson and Moses, 2001) and the longitudinal studies (eg. Carlson, Mandell and Williams, 2004; Müller et al., 2012) revealed, that cognitive functions (especially inhibitory control) and theory of mind is associated in childhood. In adulthood and in old age theory of mind is related to working memory capacity (German and Hehman, 2006; Lin, Keysar and Epley, 2010; Philips et al., 2011). These associations were examined in heterogeneous samples and with various measurements, so that our purpose is to

map the associations between working memory and theory of mind in a wide range of age with standard measurements of the examined constructs.

*In the third experiment* we aimed to examine the relationships between children's sociometric status and theory of mind, mapping the associations between these constructs in school-aged children is unique in Hungarian research. The main question is that in view of the modest relationships published in previous studies (*Banerjee and Watling, 2005; Banerjee, Watling and Caputi, 2011*) how these associations will reveal in our research.

### **Participants involved in the experiments**

#### *Participants in Experiment 1:*

A total of 299 subjects participated in the study, from 5 to 75 years, divided to two samples, based on methodological issues. The sample measured with the child version of the Faux Pas Recognition Test contains 172 subjects (range: 5-11 years of age; mean age: 8,93 years; 82 male, 90 female). The sample measured with the adult version of the Faux Pas Recognition Test contains 127 subjects (range: 11-75 years of age; mean age: 28,5 years; 61 male, 66 female). Subjects were also assigned to age groups, on the one hand based on literature data, and on the other hand in order to obtain groups of appropriately large size for the analysis.

#### *Participants in Experiment 2:*

A total of 240 subjects participated in the study, from 7 to 75 years, divided to two samples, based on methodological issues. The sample measured with the child version of the Faux Pas Recognition Test contains 113 subjects (range: 7-11 years of age; mean age: 9,41 years; 53 male, 60 female). The sample measured with the adult version of the Faux Pas Recognition Test contains 127 subjects (range: 11-75 years of age; mean age: 29,16 years; 59 male, 68 female).

#### *Participants in Experiment 3:*

A total of 137 subjects participated in the study, from 8 to 14 years, divided to two samples, based on methodological issues. The sample measured with the child version of the Faux Pas Recognition Test contains 100 subjects (range: 8-10 years of age; mean age: 8,83 years; 47 male, 53 female). The sample measured with the adult version of the Faux Pas Recognition Test contains 37 subjects (range: 12-14 years of age; mean age: 13 years; 12 male, 25 female).

### **Methods and procedure**

#### ***Measures of theory of mind***

We administered three types of theory of mind tests in order to map this ability from the age 5 to 75. In order to measure cognitive component of theory of mind at the age of 5-11 we administered the Hungarian version of *Baron-Cohen's* (1989) second-order verbal false belief test, used in autism spectrum disorder by *Stefanik* (2005) earlier. In order to map affective theory of mind we administered Faces Test, which measures the affective theory of mind by identifying emotional states from 20 photos (*Baron-Cohen, Weelwright and Jolliffe, 1997*). In order to measure the complex (cognitive and affective) theory of mind we administered the Faux Pas Recognition Test, which we translated to Hungarian. We used the child version of Faux Pas Recognition Test (*Baron-Cohen, Stone, Jones and Plaisted, 1999*) from the age 5 to 11, and the adult version of the test from the age 11-12 to old ages (*Stone, Baron-Cohen and Knight, 1998*).

### ***Measures of working memory***

In our second experiment in order to measure verbal working memory we administered Digit span test (*Racsmány et al., 2005*), complex working memory was measured with Backward digit span (*Conway, Kane, Bunting, Hambrick, Wilhelm és Engle, 2005; Hutton és Towse, 2001*) and Listening span tests (*Janacsek, Tánczos, Mészáros and Németh, 2009*). In the third study we administered Counting span test (*Case, Kurland és Goldberg, 1982*) in order to map complex working memory capacity.

### ***Measures of peer status***

The sociometric status was measured based on children's positive and negative nominations, and evaluated with three different way. With first evaluating method we formed popular rejected and controversial sociometric groups based on the rates of positive and negative peer nominations, we used only popular and rejected groups for the analysis. The second and third evaluation method was based on *Banerjee and Watling's (2005)* and *Banerjee, Watling and Caputi's (2011)* studies. The second evaluation method allowed us to form 5 sociometric groups (popular, rejected, neglected, controversial and average) based on the standardized variables of positive, negative nominations and the social impact and social preference (see *Banerjee and Watling, 2005*). The third evaluation method is based on the standardized variables of positive and negative nominations, forming variables named peer acceptance and rejection (see *Banerjee, Watling and Caputi, 2011*).

## **Results of Experiment 1**

### ***Age-related differences in theory of mind***

According to our results, the performance on the child version of the **Faux Pas Recognition Test** (administered from the age 5 to 11) was changed in accordance with age, but only in the younger age groups. Children at the age of 5-6 years performed worst on the test, from the age of 7-8 years of age children's performance did not significantly differ by age. In contrast with previous results (*Baron-Cohen et al., 1999*), we found that there are no significant differences between the ages of 7, 9 and 11. According to our results investigated on a larger sample, the faux pas performance at the age 7-8 years does not differ from the performance at the ages 9, 10 and 11 years old. On the adult version of the Faux Pas Recognition Test (administered from age 11 to 75 years), the performance significantly differs between the 11 and 12 years of age, 12 years old group performs better, than 11 years old group. From the 13-17 years age group, the faux pas performance shows a slight decrease, and theory of mind performance is the weakest in the 60-75 years of age, it is significantly weaker compared to all the younger age groups. We did not find difference on control stories among the age groups, thus age-related differences in faux pas stories mean that the differences are showed especially in stories requiring theory of mind.

The child version of the Faux Pas Recognition Test allows us to make more detailed evaluation based on the questions following each stories. Thus we evaluated three variables: the detection of the faux pas, the comprehension of the story and the false belief understanding regarding the faux pas. According to the results of faux pas detection we found that the youngest

age group (5-6 years old) performed above chance, thus they detect the faux pas not only based on trials, but the justification of the faux pas and attribution of the intentions could be difficult for them. According to the results of false belief understanding we found age-related increase of the performance from the age of 5-6 years to 9 years, this performance slightly decreases at the ages of 10 and 11 years. The possible explanation of the decrease could be that false belief understanding works automatically at the ages of 10 and 11, thus it does not differ sensitively or causes performance decrease. The lower performance of the 10-11 years of age could be explained in detail with the story comprehension questions, so we can evaluate how the children could understand and follow the story. The story comprehension was the highest at the 9 years of age, so the high performance of the false belief understanding at 9 years of age could be explained with the high story comprehension performance in our study. According to our results, the 10 and 11 years old children have better performance of story comprehension than the 5-6 years old children. Thus the lower false belief understanding performance of the 10 and 11 years old children could not be explained with lower story comprehension, but could be related to the automaticity of false belief understanding. In sum we found that according to story comprehension, the performance of the 9 years old are the highest, the faux pas detection is above chance at the age of 5-6 years (but it doesn't mean that they can understand the faux pas), and the false belief understanding performance is the highest at the age of 9 years. The second order mental state attribution appears earlier ages than the faux pas understanding in typical development, this is confirmed by our results, because the children who were successful in solving the second order false belief task, they had better performance on the Faux Pas Recognition Test child version (*Baron-Cohen et al., 1999*).

The adult version of the Faux Pas Recognition Test allows us also a more detailed evaluation method than the total points of the performance. According to explaining the faux pas, the false belief understanding and affective mental state attribution performance can be evaluated based on the questions following the faux pas stories in the test. In the old ages false belief understanding decreases, such as the affective mental state attribution performance is the lowest among all age groups. Thus in accordance with previous studies the cognitive and affective components of theory of mind decreases with age (*Maylor et al., 2002; Duval et al., 2010*), and specifically the performance on the Faux Pas Recognition Test also decreases with age (*Wang and Su, 2006*).

The affective theory of mind, measured with **Faces Test** shows age-related differences among the younger (5-11 years old) age groups. According to recognising basic emotions we found ceiling effect, such as the youngest age group performs above 80%, thus probably recognising basic emotions from photos appears in early years, before 5 years old (such as *Westby and Robinson, 2014*). Complex emotion recognition performance increases with age, 11 years old children's performance is the highest among all age groups. In our other sample (measured with adult version of Faux Pas Recognition Test) we did not find any age-related differences, the possible explanation is that basic and complex emotion recognition shows ceiling effect among the age groups. In the future age-related differences could be detected with more sensitive affective theory of mind measures (such as Reading the Mind in the Eyes Test, see *Duval et al., 2010; Gunther-Moor et al., 2011*).

The **relationship between theory of mind tests** (Faux Pas Recognition and Faces Tests) shows weak or moderate correlations. The total performance on the child version of the

Faux Pas Recognition Test, measured in 5-11 years of age correlates with Faces Test (total performance and both basic and complex emotion recognition). False belief understanding does not relate to any of the components on Faces Test. Detecting a faux pas and story comprehension correlate with basic and complex emotion recognition in the Faces Test. The total performance and the affective and cognitive components on the adult version of the Faux Pas Recognition Test, measured in 11-75 years of age correlates with the complex emotion recognition. Such as the cognitive component of faux pas understanding (false belief) correlates with the total performance on Faces Test. The background of these results could be that the adult version of Faux Pas Recognition Test contains questions referring affective mental state attribution, but in the child version it is absent. Thus the total performance of the adult version of the Faux Pas Test contains the affective mental state attribution, based on complex emotion understanding, which requires belief and intention attribution. The control stories (not containing a faux pas, not requiring theory of mind functioning) do not correlate with any other theory of mind tests, so the control stories and the tasks requiring theory of mind use different domains.

In sum the results suggest the at the age of 5-11 years if someone can detect and understand a faux pas, could be able to percept the negative emotions following the insult. Besides the complex emotion recognition requires understanding, so the subject has to understand well the word, that describes the emotion in the test, in order to perform well in complex emotion recognition. However, the false belief understanding and the affective theory of mind does not relate to each other, thus they are independent domains, so the child version of the Faux Pas Recognition Test maps the cognitive component of faux pas understanding. The adult version of the Faux Pas Recognition Test (measured in the age 11-75 years) shows less and weaker correlates with the Faces Test. In sum the relationships between the theory of mind tests suggest that the detection and the understanding of faux pas-s are not fully independent of affective theory of mind, thus the two administered explicit theory of mind tests do not measure independent domains. Performance on the Faces Test requires affective theory of mind functioning, according to the definition of the faux pas recognition, the Faux Pas Test requires both cognitive and affective theory of mind functioning, it means, that to understand completely a faux pas, we need to use the affective and cognitive theory of mind simultaneously (*Stone et al., 2003; Harari et al, 2010; Poletti et al., 2011*).

Our results suggest that the ability to understand faux pas stories appears at the age 7, but not change radically until the age of 11. The adult test version of Faux Pas Recognition Test can show more differences between age groups, till the performance increases from the ages of 11 to 12, there is a decrease at the ages of 60-75, confirming previous results (*Wang and Su, 2006*). The Faces Test, measuring the affective component of theory of mind shows more differences among age groups in 5-11 years of age, but beyond 11 years of age it doesn't show any significant age-related differences, probably because of methodological issues, because Faces Test shows ceiling effect in our study. Regarding basic emotions, the performance in all age groups show ceiling effect, thus the basic emotion recognition appears before 5 years old, confirming previous results (*Westby and Robinson, 2014*). The relationships between the theory of mind tests administered in our study suggest that these tests do not measure different domains, thus the complex explicit theory of mind functioning (faux pas understanding) requires both affective and cognitive theory of mind component simultaneously in our study.



## Results of Experiment 2

### *Associations between working memory and theory of mind*

The aim of our second study was to map associations between working memory and theory of mind beyond the preschool years, which is a unique research in Hungary. Our purpose is to map the associations between especially the performance on the Faux Pas Recognition Test (child and adult version) and working memory capacity. We administered the child version (between the ages of 7 to 11 years) and the adult version (from the age 11 to 75 years) of the Faux Pas Recognition Test, thus we divided the sample to two age groups. The analysis was implemented with controlling the age, in order to avoid the direct effect of age-related differences, which was shown in our first experiment.

The total performance on the child version **Faux Pas Recognition Test** was related to the complex working memory, measured with Listening Span test. The correlation is positive, thus if one's performance is better on the Listening Span test, than the faux pas understanding will be better. The variables regarding faux pas understanding (see faux pas detection, false belief understanding and story comprehension) are also related to working memory. The story comprehension performance was related to verbal and complex working memory, thus in order to understand a faux pas story, the children have to use their working memory capacity. Likewise, the detection of the faux pas and the false belief understanding also related to complex working memory capacity, where all correlations are positive. The total performance on the adult version of the Faux Pas Recognition Test (measured in the age group 11-75 years) was positively related to the verbal working memory capacity, measured with the Digit Span test and the complex working memory. The correlations are weak or moderate, but we can see, that the control stories in the test (which do not require the theory mind functioning) are not related to any of the working memory tests, the positive correlations only showed specifically on the theory of mind stories. Thus these results suggest that the associations between working memory and theory of mind performance could be explained specifically with theory of mind and working memory relationship.

According to our results on the **Faces Test**, all of the components (total performance, basic and complex emotion recognition) is positively related to working memory capacity among 7-11 years of age. The association between the basic emotion recognition and working memory could be based on methodological issues, because in order to understand the words, describing emotions, the subject has to use working memory capacity. Besides this methodological issue regarding the complex emotion recognition, complex emotions are based on beliefs, so working memory could be important in being successful on this task. All of the components on the Faces Test (total performance, basic and complex emotion recognition) are significantly correlate with working memory in the 11-75 years of age. The strongest associations are between the Listening Span task and the Faces Test, so the better complex working memory capacity is related to a better performance on the Faces Test in our study, among the 11-75 years old. The above presented correlations (controlled for age) show that the explicit, cognitive and affective theory of mind performance and the working memory capacity

are positively associated. These correlations are weak or moderate, but we can see that the better working memory capacity is related to a better theory of mind performance.

According to our results the explicit theory of mind tasks we administrated are measuring theory of mind performance moderately correlated to working memory capacity. These results raise further methodological questions regarding how effectively theory of mind tests measure this ability, but in our study we measured such components, which are related to cognitive functions (*Frith and Frith, 2008; Apperly, 2011*). Thus our results reveal a further consideration, that the main question is not about how affective or cognitive theory of mind is related to cognitive function, because according to the results both theory of mind components need the cognitive efforts to a successful functioning. But the main question is if the mainly verbal theory of mind tests are moderately related to working memory, then how effectively could these tests measure the theory of mind performance. In addition the general working memory tests particularly based on non-social stimuli (e.g. numbers, words or sentences), but an open question for further research is how this relationship will change, if we will measure working memory with social stimuli (social working memory, *Meyer and Lieberman, 2012*). Our results will be specifiable with other working memory and theory of mind measures in further researches.

### **Results of Experiment 3**

#### ***Mapping the associations between theory of mind and sociometric status***

The aim of our second study was to map associations between school-aged children's sociometric status and theory of mind beyond the preschool years, which is a unique research in Hungary. The sociometric status was assessed with the method based on peer nominations used in previous results and evaluated in three ways (*Banerjee and Watling, 2005; Banerjee, Watling and Caputi, 2011*). Theory of mind was measured with the child version (among 8-10 years old children) and the adult version (among 12-14 years old children) of the Faux Pas Recognition Test and the Faces Test, working memory capacity was also assessed with the Counting Span task.

The first evaluation method of sociometric status formed three groups: popular, rejected and controversial, the final analysis was carried out with popular and rejected groups because of the low number of controversial children. According to the results none of the theory of mind test performance differed between the popular and rejected children neither in the 8-10 years of age nor in the 12-14 years of age. Only working memory capacity differed by sociometric position but only at the ages of 8-10 years, popular children have better working memory capacity than the rejected ones. The first evaluation method is very simple, because it forms groups only by the rate of positive and negative nominations and does not count with the number of the nominations, so this is not the most adequate assessment.

The second evaluation method is based on four aspects and standardized variables, it can form five sociometric groups: popular, rejected, neglected, controversial and average (based on *Banerjee and Watling, 2005*). The final analysis was carried out with popular and rejected groups because of the low number of controversial children. According to the results none of the theory of mind test performance differed between the sociometric groups neither in the 8-10 years of age nor in the 12-14 years of age. Thus we could not show any associations between

better theory of mind performance and popularity. Working memory differed among the sociometric groups, the popular and average children had better working memory capacity, but this only shows up in the younger age group (8-10 years). Therefore our results suggest that the working memory capacity differs between the sociometric groups, using second evaluation method.

The third evaluation method is based on the standardized positive and negative nominations, and the analysis was focused on correlational strategy. We found weak or moderate associations between theory of mind and peer acceptance/rejection, social impact and preference. In the younger age group (8-10 years old) we found a weak, but positive correlation between faux pas detection and social preference, thus if the child can successfully detect a social faux pas, then he or she have a higher social preference of the peers. In the older age group (12-14 years old) peer acceptance and social impact are positively related to affective theory of mind. Thus children who are accepted by their peers and have numerous peer nominations perform better on affective theory of mind task.

Our results confirm previous results, such as relationship between theory of mind and social position are weak. According to previous results the relationships were shown only in older age groups (*Banerjee and Watling, 2005*), even as in our study. Previous studies mainly focused on the faux pas understanding (*Banerjee and Watling, 2005; Banerjee, Watling and Caputi, 2011*), but our correlations are very weak with the faux pas understanding. This is probably based on methodological issues, because the previous studies used a modified version of the test, we administered the original Faux Pas Recognition Test. The former studies did not examined specifically affective theory of mind, as we assessed affective theory mind with Faces Test, so our results are noticeable in this area of research. Certainly our studies analysed only with correlational strategies, so we can't conclude any causal relations between theory of mind and peer acceptance or rejection.

In sum, theory of mind does not differ by sociometric status, but working memory shows differences in the younger age group by sociometric position. Thus we assume that the cognitive functions are important factors in peer nominations in the younger age group, but this relationship does not appear at the age of 12-14 years old. It suggest that the positive and negative nominations could be determined by other factors, which have to be examined in further research.

### **Summary and suggestions for further research**

The relevance of the dissertation is providing and piloting a new Hungarian method for assessing theory of mind beyond the preschool years. The age-related differences are clear in our studies, but the specificity of the Faux Pas Recognition Test is the separate adult and child versions. Further research can provide a new unified faux pas test fitting the ages of the subjects. Our results show the adult version of the Faux Pas Recognition Test can differ better between the age groups, and also because it contains more questions following each stories it can measure more aspects (e.g. there is no question regarding the emotional consequences of the faux pas in the child version, but there is in the adult version). Further researches can provide a modified child version of the Faux Pas Recognition Test which is based on the adult version,

or provide a unified test in order to effectively measure theory of mind among school-aged children.

Our purpose was to map the associations between working memory and theory of mind, but in later research it is necessary to examine which cognitive functions are related to theory of mind in school-aged children and. Previous studies mapped the relationship with executive functions, according to the result inhibitory control is related to theory of mind (e.g. *Carlson and Moses, 2001; Razza and Blair, 2009; Müller et al., 2012*), we plan to map these relationships also in further research. In addition we can get more obvious evidence about the associations with working memory capacity in further researches using dual-task strategy (see *McKinnon and Moscovitch, 2007*) in a wide range of ages. Further researches can focus on how between theory of mind relates to social working memory besides the general working memory capacity (see *Meyer and Lieberman, 2012*).

The purpose of this dissertation was also to map the associations between theory of mind and sociometric position, in which our results show moderate correlations between these constructs. In our study, following other previous research (*Banerjee and Watling, 2005; Banerjee, Watling and Caputi, 2011*) we evaluated social behaviour with sociometry. According to our results none of the theory of mind measures differed in relation with the sociometric status, but working memory capacity showed differences at the age of 8-10 years. This result suggest, that several factors can be related to peer acceptance and rejection, such as cognitive functions, socio-economic status, anxiety or factors regarding the pedagogical situations. Thus it is worth to consider to apply sociometry based on multiple aspects, or to complete this measures with observations in the further researches. In previous studies social competence was measured by various methods (e.g. *Liddle and Nettle, 2006; Newton, Reddy and Bull, 2000*), thus later researches can map other components of social competence which are important in managing social situations in the school and examine how these components are related to theory of mind. One of these components of social competence could be the social problem solving (*Chang et al., 2004; Kasik and Gál, 2014b*). In one of our studies we examined the relationship between theory of mind and social problem solving among preschool children (*Gál and Kasik, 2015a; Gál and Kasik, 2015b*), our purpose to map these associations in school-aged children. Regarding social problem solving we found more subtle relationships in contrast with the results according to the sociometric measure. Furthermore other measures can reveal new aspects of social competence, besides peer nominations it is worth to apply self-reporting measures and external raters in order to map social competence more objectively (e.g. *Kasik and Gál, 2014a*). Critics regarding the studies measured social behaviour (e.g. *Astington, 2003; Banerjee, Watling and Caputi, 2011*) revealed that theory of mind tests are not realistic enough to modellate real life social interactions, but the faux pas stories are probably more realistic than earlier applied laboratory measures. According to our results working memory is more or less related to faux pas recognition, so it is worth to consider applying implicit methods besides the explicit theory of mind tests in order to map the associations with social competence. This could be a relevant aspect, because implicit cognition, especially implicit learning underlies social skills (*Lieberman, 2000*). Applying explicit theory of mind tests raise the question that we can measure the time elapsed until the subject's answer. And besides measuring the performance on visual theory of mind tasks it is worth to track the gaze direction of the subject, while one is

watching the photos of the test. A similar explicit-implicit research strategy could be unique to map school-aged children's theory of mind and the relationship with social competence.

The researches regarding theory of mind and social competence could be key elements in order to help children's school success, such as building theory of mind development into programmes, developing social skills. Mentalization based therapy is widely used in the clinical practice, for example in the treatment of borderline personality disorder (Bateman and Fonagy, 2004; Allen, Fonagy and Bateman, 2011), and eating disorders (e.g. Tcahnturia et al., 2007; Money et al., 2011). It is worth to evaluate the effectiveness of clinical techniques in typical development. The intervention methods suggest techniques developing mentalization: we can form reflective situations, in which we consistently answer and name the emotions, or facilitate the subject to examine an interaction from new aspects (Allen, Fonagy and Bateman, 2011). The above mentioned techniques could be used in social skills training, bullying prevention or development programmes in the classrooms among typically developing children. Development programmes could be used successfully on history or English lessons, because these subjects (because of the content) are able to develop the "social brain", to activate the mentalizing network, in addition educating methods (such as tutoring peers) are recommended in order to activate mentalizing network (Lieberman, 2012).

The heterogeneity of the theory of mind researches allows to map the age-related differences of theory of mind, the relationship with cognitive functions and social competence among school-aged children and according to the results we can recommend methods to be used in or out of the classroom, in order to be able to develop children's school success.

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