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## **Review of studies concerning developmental theory-of-mind deficits in children with FASD**

### **Abstract**

Children exposed to alcohol in the prenatal period of development may experience various postnatal developmental problems. One of the competences that is impeded or delayed as a result of the teratogenic influence of alcohol drunk by the mother during pregnancy is the development of theory of mind. The presented article provides a literature review based on the existing research findings on fetal alcohol spectrum disorder (FASD) and outlines the developmental theory-of-mind deficits that are associated with it. The review of current research does not allow comprehensive outcome of the relationship between FASD and theory-of-mind deficits because the number of research carried out within this scope is scarce. Further research on developmental theory-of-mind deficits in children with FASD in the context of the model by Baron-Cohen is postulated.

**Keywords:** Fetal alcohol spectrum disorders, FASD, theory of mind, developmental deficits

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## Przegląd badań nad deficytami w rozwoju teorii umysłu u dzieci z FASD

### Streszczenie

U dzieci narażonych na szkodliwe działanie alkoholu w okresie prenatalnym często po urodzeniu występują różnego rodzaju zaburzenia. W wyniku teratogenicznego wpływu alkoholu wypijanego przez matkę w czasie ciąży przebieg rozwoju różnych kompetencji u dziecka jest zaburzony. Jedną z bardzo istotnych dla prawidłowego funkcjonowania społecznego jest teoria umysłu. Niniejszy artykuł prezentuje przegląd aktualnych wyników badań naukowych poświęconych występującym u dzieci z FASD deficytom w rozwoju teorii umysłu. Opracowany przegląd nie pozwala na wyprowadzenie spójnego modelu istniejącego związku, gdyż opublikowane w literaturze badania są nieliczne i mają pewne ograniczenia. Zatem postuluje się dalsze badania nad deficytami w rozwoju teorii umysłu występującymi u dzieci z FASD w kontekście modelu opracowanego przez Barona-Cohena, których wstępny projekt został zarysowany.

**Słowa kluczowe:** Spektrum Płodowych Zaburzeń Alkoholowych, FASD, teoria umysłu, zaburzenia rozwojowe

### Introduction

#### Fetal Alcoholic Spectrum Disorders – social and cognitive consequences

Epidemiological research conducted in the USA confirms that about 13% of babies experience differing degrees of alcohol exposure in connection with the mother's consumption of alcohol during pregnancy, while in 2–5% of American primary-school-age children, serious neurodevelopmental disorders appear for this very reason. However, a higher rate was found in schools in South Africa (4,6.4 %) in children aged 5 to 9 years (May et al., 2014; May et al., 2000). The prevalence of FASD in Poland was at least 2%, including 0.4% of FAS (Okulicz-Kozaryn, Borkowska, Brzózka, 2017). Because of the teratogenic effect of alcohol consumed by the mother in the prenatal period of the child's development, extensive deficits appear in physical, cognitive, emotional and social functioning (Chudley et al., 2005); however, there is also significant diversity of individual symptoms, which makes the scope of deficits very wide-ranging: from basic deficits of information processing (Kodituwakku, 2009), through general intellectual functioning, especially in terms of verbal intelligence (Jacobson et al., 2004), to significant deficits in spelling, reading, and arithmetic at 6 years of age (Goldschmidt et al., 1996). There are also deficits in learning, memory and executive functions in the preschool developmental stage (Rasmussen, 2005; Rasmussen, Bisanz, 2011). Later, deficits in adolescent achievements are seen in the manipulation of information and goal management in working memory

(Kodituwakku et al., 1995), in the ability to think logically, perform arithmetical operations, and use more advanced mathematical functions (Streissguth et al., 1994; Howell et al., 2006), as well as in performing phonological processing (Streissguth et al., 1994). Deficits are also found in the different neurocognitive and behavioral characteristics of children with ADHD (Coles et al., 1997) as well as in social-cognitive functioning and social communication (Whaley, O'Connor, Gunderson, 2001; Kodituwakku, 2009), as well as in school achievements (Howell et al., 2005).

Children with FASD often show impulsiveness, emotional lability, lower general moral maturity, externalization and aggressive behaviors, as well as poor concentration and control of impulses, and a lowered sense of guilt. Limited social and moral development (Schonfeld, Mattson, Riley, 2005) connected with lack of efficient mechanisms of emotional and behavioral control and a lack of understanding the consequences of one's actions (cause and effect) (Larkby et al., 2011) constitute predictors of risky behaviors and criminal actions (Janzen, Nanson, Block, 1995; Roebuck, Mattson, Riley, 1999; Sood et al., 2001). 60% of young people and adults with FASD experience trouble with the law (Streissguth et al., 1996). Furthermore, a high percentage of secondary disorders occur in those with FAS, including educational problems, addictions, mental illnesses, improper sexual behaviors, violation of social standards, and suicide (Streissguth, Kanton, 1997; Streissguth, O'Malley, 2000; Temple et al., 2019).

### **Deficits in the development of theory of mind in children with FASD**

Many research reports provide data concerning the cognitive and emotional deficits that result from prenatal exposure to alcohol, but very few concern deficits related to the development of theory of mind. Yet, even on the basis of this scarce research, it is possible to conclude the existence of a causal link between the teratogenic effect of alcohol consumed by pregnant mothers and the extensiveness of the deficits in the development of theory of mind. Studies conducted so far in the field of FASD have focused more on the elements of the theory of mind than on a coherent concept of its development, therefore their results are of rather contributory value. Despite these limitations, we present an analysis of the deficits in ToM development in children with FASD from the developmental perspective. While referring to the universal model of the development of theory of mind created by Simon Baron-Cohen (2005), it should be emphasized that in the literature there are no reports about the development of the prerequisites of the theory of mind in the context of prenatal exposure to alcohol: *The Emotion Detector* (TED), *Intentionality Detector* (ID), *Eye Direction Detector* (EDD), and the

*Shared Attention Mechanism* (SAM). However, there are studies dedicated to make-believe play, which may be considered a manifestation of joint attention and imitation activities (Baron-Cohen, 2005).

#### *Pretend play*

Even though the consequences of fetal exposure to the teratogenic effects of alcohol are commonly known, many women still consume toxic substance while pregnant. Proper diagnosis of FASD in young babies is difficult because the symptoms tend to be ambiguous. Most frequently, the final diagnosis is not made until the pre-school period, especially in cases in which neurocognitive and behavioral symptoms are less evident, or when there appear to be no explicit craniofacial dysmorphism symptoms (ARND). A few studies analyzed the impact of anti-natal and perinatal socioenvironmental factors (i.e. socioeconomic status, level of mothers' education, quality of intellectual stimulation provided by parents, and the intellectual competence and level of stress and depression of the mother), on the performance of spontaneous and modelled pretend play in children whose mothers used alcohol while pregnant (Jacobson et al., 2004).

For the purpose of more effective early FASD diagnosis, an attempt to identify particular neurobehavioral biomarkers of the threat of fetal exposure to alcohol was undertaken. In longitudinal studies conducted by Jacobson's team (Jacobson et al., 1993) on a group of 382 black babies from an urban environment, severe delays were found in the development of make-believe play (drinking from a mug, feeding a doll) and in the ability to imitate pretend play when modelled by the researcher; also, significant delays were found in the development of motor abilities (standing and walking). The most considerable developmental deficits measured using the Bayley Mental Development Index scale appeared in children whose mothers drank on average no less than 0.5 oz. of pure alcohol per day. The results of the quoted studies demonstrated that the level of development of both spontaneous and modelled pretend play is inversely proportional to the degree of prenatal exposure to alcohol. This suggests that exposing a fetus to the influence of alcohol directly affects its ability to acquire the more complex forms of manual and symbolic activity that are stimulated by imitating an adult. As compared to spontaneous pretend play, the ability to be involved in pretend play (whether modelled or initiated by a researcher in babyhood) is an essential indicator of diagnosing FASD in the pre-school period. Modelled symbolic play constitutes a significant step in the development of theory of mind, but also has cardinal significance for predicting further developmental consequences in other areas. The level of realization of modelled play at the end of the first year of life constitutes

a strong predictor of the level of verbal intelligence reached after the age of 7.5 (Jacobson, Chiodo, Jacobson, 1996).

The harmful effect of prenatal exposure to alcohol on the development of symbolic play was also confirmed in research conducted by Molteno's team (Molteno et al., 2010). Research was carried out on two groups: the children of mothers who drank excessively, and the children of mothers who drank considerably less. Abilities of spontaneous play and modelled play (imitating the researcher), verbal intelligence, verbal working memory, and symptoms of FAS were assessed at the age of 13 months, and then five years later. The research showed that 43.9% of the children of excessively drinking mothers met the FASD or PFAS criteria, while 37% did not have dysmorphic symptoms or growth disorders. Intensification of FASD symptoms was proportional to the amount of alcohol consumed by the mother during pregnancy and to the degree of development of symbolic play in babyhood; it was inversely proportional to the level of verbal intelligence in the pre-school period. The correlation between spontaneous play and prenatal exposure to alcohol was conditioned by worse socio-economic conditions and less-than-optimal intellectual stimulation on the part of drinking mothers. The level of development of modelled play in babyhood was related to the intensity of prenatal exposure to alcohol and to the quality of parenting. These results also confirmed that prenatal exposure to alcohol correlates considerably with the increasing probability of being involved in symbolic play, while the level of symbolic play in babyhood may constitute a predictor of the development of verbal competence, verbal working memory, and executive function at the age of 6. Although spontaneous symbolic play in babyhood was not correlated with the FASD diagnosis, the level of modelled play was lower in babies who were diagnosed with FASD at the age of 6.

Prenatal exposure to alcohol affects modelled symbolic play, thus reducing the development of this ability. Prenatal exposure to alcohol can also interfere not only with a child's ability to imitate the behaviors of a model, but also with a child's social learning, which plays an important role in the early stages of cognitive development.

#### *Adopting another person's perspective*

Perspective adopting is an important indicator of the development of theory of mind. Adopting the perspective of another person, termed *cognitive decentration* by Piaget (1972), is a cognitive ability which makes it possible to abandon the egocentric perception of the surrounding reality and view it from the point of view of another person. This is governed by the Theory of Mind Mechanism. On the other hand, *interpersonal decentration*

(adopting someone's emotional perspective) is examined through the analysis of picture stories described from the perspective of characters playing different roles (Feffer, 1970). Interpersonal Decentration concerns both emotional and social processes and becomes the basis for empathy and intuitive understanding of the emotional experiences of another person. It constitutes the basis of the development of the ability to empathize with others, which is governed by *the Empathizing System*. The ability of children with FASD to understand someone else's cognitive and emotional perspective was the subject of research conducted by the team led by Sara Stevens et al. (2015). The research was conducted on a group of children with FASD (37 persons) and included a control group (21 persons). Tools for measuring theory of mind, social cognition and empathy were applied. The research showed that children with FASD had considerable problems with understanding emotions and other people's beliefs, regardless of the form of reply (verbal, non-verbal). However, they scored as well in the Personalized Thoughts subtest (testing the simple ability to adopt perspective when recognizing where a hidden object was hidden) as normally developed children. Children with FASD showed more social problems and a lower level of development of complex social competences and empathy, as compared to children of typical development. Children with FASD have serious problems with processing complex information, and adopting the perspective of other persons requires the ability to process and integrate complex social information (Kodituwakku, 2007).

As compared to girls, boys with FASD display a lower level of development of theory of mind and more behavioral problems. Older children with FASD performed worse in theory of mind tasks than younger children due to problems with processing complex information. However, in a group of typical developmental level, younger children achieved lower results in ToM than older ones (Stevens et al., 2015).

### *Understanding emotions*

The process of understanding emotions concerns increasing knowledge of emotional processes and of their functioning (Southam-Gerow, Kendall, 2002); it involves recognizing one's own and other people's emotions, understanding the causes and consequence of emotions, and having knowledge of the situational regulation strategy for the control of emotions. Emotional and social functioning in childhood constitutes a predictor of mental health in adults, as has been well documented in standard and non-standard populations (Moffitt et al., 2011; Jones, Greenberg, Crowley, 2015). However, there is relatively little data concerning school-children with FASD.

At the age of two, children usually recognize basic emotions and begin to use verbal expressions to identify them. At pre-school age, they improve the ability to recognize and talk about their emotions. At that age, an understanding of the causes, signs and consequences of emotions also develops. In the school period, children start to understand that a single object can arouse diverse emotions simultaneously. They also learn the cultural and contextual principles of expressing emotions, as well as the strategy of changing and concealing emotions. Children's knowledge of the strategy of regulating emotions and dealing with them progresses from relying on external strategies (e.g. changing the external situation, seeking support of adults) to the growth of reflexive internal strategies (e.g. redirecting thoughts, reinterpreting the situation). It was stated that individual factors (e.g. verbal IQ, linguistic abilities) and family factors (e.g. attachment, socialization of emotions) constitute the cause of individual differences in the understanding of emotions in children with FASD (Pons et al., 2003). In children with developmental and behavioral disorders, the process of understanding emotions is underdeveloped as compared to their normally developed peers (Southam-Gerow, Kendall, 2002). The difficulties of children with FASD concern recognizing visual emotional expressions on faces presented in photographs and connecting visual symptoms of emotional expression to symptoms shown by another modality (prosody) and connecting them to verbal descriptions (Greenbaum et al., 2009). Recognizing emotions based on visual and prosodic signs in children with FASD depends on the age of the person expressing emotions in a photo. More mistakes were made in recognizing emotions in photographs and statements of adults than in those of children (Kerns et al., 2016). Delay in the development of the ability to recognize emotions based on visual premises is proportional to the intellectual deficits in children with FASD as compared to children from a control group of a comparable intellectual age (Way, Rojahn, 2012).

The ability to empathize, as subjectively assessed by parents, is inversely related to the intensity of behavioral disorders in children with FASD, which suggests more problems with understanding other people's emotions. Boys show a lower empathy level than girls (Stevens et al., 2015).

In children with FASD, deficits also appear in the more complex aspects of understanding emotions. Children with FASD demonstrate poorer knowledge of the principles of emotional expression than children of typical development or children with ADHD in tasks based on pictures consisting of reading and indicating the emotions experienced or concealed by a character in a story (Greenbaum et al., 2009).

Table 1. *Understanding of emotions by children with FASD*

Aspect of understanding emotions	Questions	Examples
Recognizing emotional signals in oneself	<ul style="list-style-type: none"> <li>How do you know when you feel sad/angry?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – when someone hits me</li> <li>Transitional level – when I am frowning and crying</li> <li>Specific operations level – my face is getting really red and I feel that I want to explode within</li> </ol>
Recognizing emotional signals in other people	<ul style="list-style-type: none"> <li>How do you know when other people feel sadness or anger?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – when someone is destroying their toys</li> <li>Transitional level – they stamp their feet and scream</li> <li>Specific operations level – when someone ridicules them, I know I would feel sad if it happened to me</li> </ol>
Sadness/joy simultaneous emotions	<ul style="list-style-type: none"> <li>Can someone feel sadness and happiness at the same time?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – sad when he damaged my plane, and later happy that he got into trouble</li> <li>Transitional level – for example, when I come second in a swimming competition</li> <li>Specific operations level – happy that I got a new dog, but sad that it was not the color I wanted</li> </ol>
Sadness / anger simultaneous emotions	<ul style="list-style-type: none"> <li>Can someone feel sadness and anger at the same time?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – sadness when I could not watch my favorite program, and then anger when mum sent me to my room</li> <li>Transitional level – yes, for example, when my friend pushed me</li> <li>Specific operations level – yes, I was sad and furious when she told other girls not to speak to me. And the sadder I am when upset, the more upset I get</li> </ol>
Emotions may be concealed	<ul style="list-style-type: none"> <li>Can you conceal your feelings?</li> <li>If yes, how can you do it?</li> <li>If not, why not?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – hiding under a table in order not to get in trouble</li> <li>Transitional level – stop so that no one can know; stop crying</li> <li>Specific operations level – when you may not laugh aloud, you may laugh inside</li> </ol>
Emotions may be changed	<ul style="list-style-type: none"> <li>Can feelings be changed?</li> <li>OK, let's assume you were nervous, could your feelings change?</li> <li>Please tell me, what has to happen to make your feelings change?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – someone spending the night away from home</li> <li>Transitional level – let's just forget about it</li> <li>If I am sad and I am doing something I like, my feelings change</li> </ol>
All emotions are good	<ul style="list-style-type: none"> <li>Are all feelings ok?</li> <li>If yes, why? How do you know that?</li> <li>If not, why not?</li> </ul>	<ol style="list-style-type: none"> <li>Preoperative level – they just are; my teacher told me</li> <li>Transitional level – if you have no feelings at all, you cannot share them with anyone</li> <li>Specific operations level – you have to have feelings, no matter what feelings they are</li> </ol>

Source: evidence based on Petrenko et al. (2017).



A multifaceted study of understanding emotions by school children with FASD (aged 6–13) was carried out by a team led by Petrenko et al. (2017). Based on material gained from interviews, the developmental differentiation of understanding emotions was analyzed (e.g. identifying emotional signals in oneself and in others, simultaneously experiencing conflicted emotions, concealing emotions, changes in emotions) with reference to J. Piaget's stages of cognitive development. The research showed that as far as most analyzed aspects of understanding emotions were concerned, school children with FASD functioned on a preoperative or transitional level which was symptomatic of about 2–5 years of delay as compared to their peers (Table 1). As these complex issues require a higher level of linguistic and cognitive development, the most considerable problems children experienced were in understanding that it was possible to experience a lot of emotions at the same time, that emotions could be concealed, and that all emotions are good. However, they were relatively better at understanding that people could change their emotions by applying strategies of self-reflection that consist of thinking about or doing something else.

#### *Lying and the development of ToM*

To lie or deliberately mislead your interlocutor by providing false information constitutes a complex psychological issue. Providing information that does not correspond to reality may be considered a normative phenomenon that appears in the preoperative period (compare Piaget, 1972; is it a lie to tell your mum you saw a dog as large as a cow if you saw no dog?). It may also be a socially useful lie (e.g. a white lie in order to protect an individual against confusion in a situation of social exposure), or a lie purposefully masking and camouflaging one's deceptions. It seems that children with FASD tend to use such lies more often than their typically developing peers in order to hide deceptions, which may constitute a predictor of delinquent behaviors in adolescence or maturity, thus constituting a form of secondary disability resulting from prenatal exposure to alcohol. Research (Nash et al., 2006) concerning lies in children with FASD revealed that these children more frequently lied, cheated, stole, and demonstrated no sense of guilt, as compared to children with attention deficit hyperactivity disorder (ADHD). In order to determine the factors which may be related to the tendency of children with FASD to lie, experimental research was conducted in a group of 23 pre-school and younger school-children with FASD (Raumussen et al., 2008). The research was carried out in the framework of the modified paradigm of resistance to temptation (children were told not to look at a toy in the absence of the researcher, and on his return the researcher asked if the

children had glanced at the toy and what it was). Lewis, Stanger and Sullivan (1989) discovered that 38% of 3-year-olds who glanced at the forbidden toy did not admit it, while 38% of them admitted it; the remaining ones did not answer. However, Talwar and Lee (2002) found that most children of normative development aged between 4 and 7 lied in the same situation, while 64% of 3-year-olds admitted that they had cheated. Therefore, some children aged 3 and most children aged 4 will lie to hide a forbidden act and to avoid the potential penalty.

However, young children are poor liars (Polak, Harris, 1999; Talwar, Lee, 2002). In order to deceive another person effectively and to avoid being unmasked a liar not only has to make a false statement, but also to make sure that the statement and the signals conveyed via different communication channels are consistent with each other. The ability to lie develops with age. Thus, it seems that pre-school children have a limited ability to maintain semantic consistency between signals conveyed via different channels, while primary school children are already capable of justifying their lies verbally (Talwar, Lee, 2002; Talwar, Gordon, Lee, 2007; Talwar, Murphy, Lee, 2007). Developmental differences concerning the ability to lie result from the cognitive development of children (Carlson, Moses, Hix, 1998; Polak, Harris, 1999; Talwar, Lee, 2002), and in particular from the development of performing functions (impeding control) necessary in situations which require deception and cheating. Research on children with FASD that was conducted by Rasmussen, Talwar, Loomes, and Andrew (2008) did not show differences in the ability to lie between children with FASD (78%) and non-FASD children (75%). However, the detailed analysis of the reply to the question "Have you had a look at the toy?" proves that 94.4% of the 'glancing' group with FASD denied having done so, and only one child admitted guilt, while in the non-FASD group 72.2% of children who glanced lied, and 27.8% admitted having cheated. All children who refrained from glancing declared that they had not done so. Interesting results were also achieved by asking the question "What toy do you think it is?" The liars mentioned the real name of the toy (Mickey Mouse), or they lied, either pretending they did not know the name of the toy, or giving the toy a different name (e.g. a different mouse, not Mickey Mouse), while all non-glancing children gave incorrect answers because they did not know its name. A substantial difference was observed among the FASD and the non-FASD groups. In the FASD group, 58.8% of the liars answered "a mouse other than Mickey Mouse" as compared to only 38.5% in the non-FASD group. In the FASD group, a significant relation to age was discovered. Older children with FASD more often hid their forbidden acts (87.5%), pretending ignorance or providing a different answer, while only 33.3% of younger children with FASD cheated. However,

no significant differences in the non-FASD group were found with respect to age. Studies suggest that children with FASD lie more often and at a younger age than non-FASD children (Lewis Stranger, Sullivan, 1989; Polak, Harris, 1999; Talwar, Lee, 2002; Rasmussen et al., 2008). However, non-FASD children under 8 are not capable of maintaining semantic consistency (Polak, Harris, 1999; Talwar et al., 2002), and because of self-control problems it also seems rather unlikely that children with FASD are capable of maintaining consistency at this age.

Children with FASD who get into trouble with the law tend to lie more often and thereby implement the strategy of concealing their behaviour (Achenbach, Edelbrock, 1981; Stouthamer-Loeber, 1986; Gervais et al., 2000); therefore, at a young age they learn how to use a lie as a strategy for hiding their misdemeanours.

Children with FASD are unable to interpret the inner states of other people (desires) based on the direction of their gaze and on the situational context (Lindinger et al., 2016). At the age of 4 to 8 they also have difficulty in understanding the beliefs of other people that are incompatible with their directly observed reality (Rasmussen, Wyper, Talwar, 2009), and in their childhood and early adolescence they experience difficulties in recognizing their own and other people's emotions and intentions, as well as in predicting the behaviour of partners in social situations (Greenbaum et al., 2009). For this reason, they may behave inadequately in a given situation and may also experience abuse because of their naivety and literal understanding of statements.

The ToM developmental deficits in children with FASD is similar to that found in other clinical groups, but the scope of deficits correlates with the amount of alcohol consumed during pregnancy by the child's mother (Lindinger et al., 2016). Research conducted within a group of children aged 9–11 showed that excessive drinking during pregnancy results in the occurrence of fully symptomatic FAS, while less excessive drinking results in partial FAS (PFAS). Regarding simple ToM tasks, no difference was found in the relationship between the level of a mother's drinking during pregnancy and the development of FASD symptoms among the groups. However in the case of more advanced ToM tasks measured by the Reading the Mind in the Eyes (REM) test, substantial statistical differences between the groups appeared. Children with partial or fully symptomatic FAS performed less well in classic ToM tasks, and children with FAS achieved lower results in the Reading the Mind in the Eyes test than children from the control group (of non-drinking or occasionally drinking mothers). The degree of prenatal exposure to alcohol proved to be a very sensitive indicator of the deficits in advanced abilities in understanding the mental states of other people. In particular, this

concerns the ability to predict a person's mental state in either real situation or picture stories (Pillow, Henrichon, 1996). The only mediator between the degree of exposure and the scope of ToM deficits was the intelligence quotient (not the executive functions). A deficit in the highly organized ability to read other people's mental states by the Reading the Mind in the Eyes test was found to be a predictor of the amount of alcohol consumed by the mother during pregnancy (Rasmussen et al., 2013). A brief summary of the most representative studies in the field of FASD and ToM deficits is presented in Table 2 with their results and limitations.

The difficulties observed in children with FASD in their cognitive, social and communication competences are very close in nature to the criterial symptoms of autism (Singer et al., 2017). Children and adults with autism experience difficulties in initiating social interactions; also, like children and adults with FASD, they have deficits in social abilities and demonstrate a lack of response to social signals, difficulties in making friends and cooperating with their peers, as well as a lack of tact in social situations (Stevens et al., 2013). Children with FASD display the greatest problems with social and communicative functioning, but are less likely to undertake ritualistic and repetitive behaviors. FASD and ASD disorders have a number of similar symptoms in social and communicative functioning. However neither suffer from the deficits seen in the third affected category of autism: in imagination and stereotypical behaviors. The indicated similarities may be used to plan specific therapeutic interventions which are effective in the therapy of children with ASD.

Table 2. A brief summary of the most representative studies in the field of FASD and ToM deficits

Date	Author	Participants	Method	Results	Limitations
2005	Timler, G.R., Olswang, L.B., Coggins, T.E.	One school-age child with FASD case study	The intervention included group role play of social scripts and a checklist to elicit the child's statements about others' perspectives and strategies for completing the social script. Probe sessions consisting of theory-of-mind false-belief tasks were applied to examine mental state verb use. The participant's responses to the checklist questions were monitored.	The participant stated more strategies in response to checklist questions. Mental state verbs increased production during the treatment phase was observed. The intervention significantly improved the child's linguistic and social cognitive skills, specifically by increase of producing mental state words.	The presented intervention was addressed to mental state verbs production in child with FASD. Theory of mind is a complex ability, so other ToM development indicators should be also analyzed. The case study showed positive intervention effects however they are not authorizing to carry out results generalization. However, they are promising. Further studies are needed to determine the intervention components and the optimal duration time of the intervention procedure
2009	Rasmussen, C., Wyper, K., Talwar, V.	Fifty-three children (aged 4 to 8 years) participated: 25 children with FASD and 28 control children.	ToM measures, executive functioning, and receptive vocabulary	Children with FASD (44%) failed ToM measures compared to the control group (25%). Older children with FASD (but not in the control group) performed worse on ToM than younger children. For the FASD group (but not the control), ToM performance was correlated with deficits of inhibition and with visual-spatial working memory.	Children with FASD have difficulty on ToM tasks, and this difficulty may be related to underlying deficits in inhibition; however, future research should assess the other neurodevelopmental domains: EF deficits, including response inhibition, working memory and attention shifting as correlates of ToM and behavioral outcomes.

Date	Author	Participants	Method	Results	Limitations
2009	Greenbaum, R.L., Stevens, S.A., Nash, K., Korten, G., Rovet, J.	33 children with FASD, 30 with ADHD, and 34 normal controls (NC).	Measurements: social cognition and emotion-processing tasks, parents and teachers completed questionnaires assessing the child's behavioral problems and social skills	Parents and teachers reported more behavioral problems and poorer social skills in children in FASD and ADHD than NC groups. FASDs demonstrated significantly weaker social cognition and facial emotion-processing ability than ADHD and NC groups. Social cognition was found to be a significant predictor of behavioral problems and emotional and social skills.	Children with FASDs show a behavioral profile that is different than that of children with ADHD. Difficulties in social cognition and facial emotion processing in children with FASDs may contribute to their high level of social behavioral problems. The results suggest that neurologically conditioned facial emotion-processing ability might influence deficits in prerequisites of ToM development or social motivation.
2013	Rasmussen, C., Tamana, S., Baugh, L., [...], Tough, S., Zwaigenbaum, L.	32 children with FASD and 30 typically developing control children aged 6 to 16	NEPSY-II is a measure of children's neurocognitive processes across 6 domains: Attention and Executive Functioning, Language, Memory, Visual-Spatial Processing, Social Perception	Children with FASD were impaired (compared to control) on EF (sorting, auditory attention, inhibition), language (comprehension of instructions, speeded naming), memory (for names), social Perception (theory of mind). In the FASD group, IQ was not correlated with performance on NEPSY-II.	Because NEPSY-II is an effective and useful tool for assessing neuropsychological impairments among children with FASD, this test should be translated into other languages. One subset measures theory-of-mind ability, but this measure is not adequate due to its complex nature. This result should be compared with other theory-of-mind assessment tools

Date	Author	Participants	Method	Results	Limitations
2015	Stevens, S.A., Dudek, J., Nash, K., Koren, G., Rovet, J.	Thirty-seven children with FASD and 21 TDC (typically developing controls)	Parent-rated CBCL (Child Behavior Checklist for identifying problem behavior in children) and SSIS (The Social Skills Improvement System) for evaluating social skills, problem behaviors, and academic competence.	Parents rated children with FASD higher than those with TDC on indices of behaviour problems and lower on indices of social skills. Children with FASD show impaired socio-behavioral functioning and social cognition, but the effects were influenced by sex and age. Females with FASD expressed less behaviour difficulties than males, whereas TDC females displayed higher empathy than males. In both FASD and TDC groups, females scored higher on theory-of-mind and empathy indices. On theory-of-mind tasks, older children with FASD performed worse than younger ones, whereas in the TDC group the relation between age and theory-of-mind indices was the opposite.	The research results showed the opposite developmental pattern of theory of mind in children with FASD in comparison to TDC children. This means that theory-of-mind progress is inversely proportional to age. The limitation of the study is the lack of developmental regression explanation. It might be useful to find the conditions of this developmental specificity and its behavioral and functional outcomes.
2016	Lindinger, N.M., Malcolm-Smith, S., Dodge, N.C., [..] Jacobson, J.L., Jacobson, S.W.	Children (aged from 9 to 11); FAS; n = 8, PFAS; n = 19; nonsyndromal heavily exposed children (n = 17; compared to children born to abstinent light drinkers (n = 9).	The Reading the Mind in the Eyes (RME) test. IQ and executive function (EF) were assessed as potential mediating variables.	Children with FAS and PFAS performed more poorly than controls on an advanced ToM task (RME test). Attribution of mental states assessed on RME was more sensitive to the level of prenatal alcohol exposure than FASD diagnosis. The data suggest that the RME test taps into a specific alcohol-related social-cognitive deficit.	Higher-order deficits in, advanced ToM tasks may play a significant role in the impairment of social-cognitive behavioral functioning in children with FASD. The limitations of the study is the lack of a longitudinal analysis that takes into account the qualitative and stadial nature of the ToM development process, and the lack of consideration of the relationship between qualitative changes in ToM and behavioral changes in children with FASD functioning.

### Prospects for further research

Children with FASD face difficulties in socio-emotional adjustment and school achievements that stem from mindreading processes. However, although not much research has been conducted to describe the specificity of theory-of-mind development in the context of FASD (see Table 2 for summary), it has been found that children with FASD exhibit deficits in emotion recognition, prediction of others' mental states and behaviors, as well as in understanding false beliefs and decoding the meaning of metaphors. These basic and advanced mindreading processes are followed by preliminary ability of seeing-leads-to-knowing and gaze-based desires recognition, which are the prerequisites of Theory-of-Mind development model by Baron-Cohen (2005), such as: *The Emotion Detector*, *Intentionality Detector* and *Eye Direction Detector*. It is very important to identify the relationship between FASD and ToM against the background of a positively verified this complex theory. However, such verification process requires the use of brain-imaging techniques, which is beyond the scope of the planned research. However, using a battery of experimental tasks and the Theory of Mind Inventory (ToMI-2, Hutchins, Prelock, Bonazinga, 2012) completed by caregivers, it might also be fruitful to compare the mindreading abilities of children with FASD against the same age control group without neurodevelopmental or neuropsychiatric diseases. Mindreading tasks would be composed of picture stories related to gaze-based desire, gaze-based behaviour, seeing-leads-to-knowing tasks, and true and false beliefs of first- and second-order representation tasks. The Theory of Mind Inventory (ToMI-2) by Hutchins, Prelock, and Bonazinga assesses three general developmental levels of mindreading ability (termed Early, Basic, and Advanced), as well as three others related to psychological processes such as emotional recognition, mental states comprehension, pragmatic ability requiring complex recursion, and the metapragmatic and metalinguistic skills of an active interpreter. Both assessment methods (the caregivers-reported inventory and the battery of experimental theory of mind tasks) seem to be equivalent measures of obtaining deeper insight and comprehensive evaluation of deficits in the mindreading abilities of children with FASD. The assumed results of the research project proposal will give the experimental background with which to plan a practical workshop for improving theory of mind in children with FASD, based on the teaching mindreading program by Hadwin, Howlin, and Baron-Cohen (2015) to support the children and their parents.



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