



The Theory of Mind Performance in School-Age children with Down syndrome and autism spectrum disorder

La teoría de la mente en niños en edad escolar con síndrome de Down y trastorno del espectro autista

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Abstract

Theory of Mind (ToM) is ability in children and adolescents plays a key role to achieve the cognitive development, emotional and social cognition, which can enhance their communication ability. The study reported herein explored the comprehension of the ToM in Down syndrome (DS), Autism Spectrum Disorders (ASD), and typically development children (TD) during middle childhood and examined the role of IQ in the Theory of Mind. The participants were 74 Iranian school-aged between 6 and 12 years who participated in three groups: 24 ASD, 24 DS, and 26 TD. Children were compared to ToM tasks and first-, second-and third-order ToM tasks. Participants' IQs were measured using the Raven's Progressive Matrices (RPMs). We used SPSS 25 for analysis of variance (ANOVA), and correlation coefficient to assess the differences between the groups on ToM tasks. The level of significance was set at .05. These results show consistency with previous literature. TD group performed better than both clinical groups in all orders. ASD was competent to pass the first-order ToM tasks better than DS ($p < .001$). These findings suggest that second-order did not show statistically significant in clinical groups. It also finds statistically significant between the TD group than both other groups ($F = 55.13$, $p < .001$). For the third-order, children with DS did not perform statistically significant different ($F = 4.99$, $p = 0.010$) than children with ASD, and nor we found between ASD and TD groups. The IQ was significantly correlated with orders of false belief understanding. The significant consideration is required in further studies with more wide samples in other groups of neurodevelopment disorders.

Keywords: Theory of Mind; Down síndrome; Autism Spectrum disorder; Typically Development Individuals.

Resumen

La Teoría de la Mente (ToM) es la habilidad que juega un papel fundamental para lograr el desarrollo cognitivo, emocional y cognición social, que puede mejorar su capacidad de comunicación en los niños y adolescentes. Este estudio exploró la comprensión de la ToM en el síndrome de Down (SD), Trastornos del Espectro Autista (TEA), y niños con desarrollo típico (DT) durante la infancia media, y examinó el papel del CI en la ToM. Los participantes fueron 74 escolares iraníes con edades comprendidas entre los 6 y los 12 años que participaron en tres grupos: 24 TEA, 24 SD y 26 DT. Los niños se compararon con tareas de ToM y tareas de ToM de primer, segundo y tercer orden. Los coeficientes intelectuales de los participantes se midieron utilizando las Matrices progresivas de Raven (MPR). Utilizamos SPSS 25 para el análisis de varianza (ANOVA), y coeficiente de correlación para evaluar las diferencias entre los grupos en las tareas de ToM. El nivel de significancia se fijó en .05. Estos resultados muestran consistencia con la literatura previa. El grupo DT tuvo mejor rendimiento que ambos grupos clínicos en todas las tareas. El grupo TEA fue más competente en las tareas de ToM de primer orden que el grupo SD ($p < .001$). Estos hallazgos sugieren que las tareas de segundo orden no mostraban diferencias estadísticamente significativas entre los grupos clínicos. También se encontró una diferencia estadísticamente significativa entre el grupo DT y los otros dos grupos ($F = 55.13$, $p < .001$). Para las tareas de tercer orden, los niños con SD no tuvieron diferencias estadísticamente significativas ($F = 4.99$, $p = .010$) respecto a los niños con TEA, y tampoco se encontraron entre los grupos TEA y TD. El coeficiente intelectual se correlacionó significativamente con las órdenes de falsa creencia. Se requiere una consideración significativa de estudios posteriores con muestras más amplias en otros grupos de trastornos del neurodesarrollo.

Palabras clave: Teoría de la Mente; síndrome de Down; Trastorno del espectro autista; Personas con desarrollo típico.

1. INTRODUCTION

Prominent theories, such as Theory of Mind (ToM), originally advanced by two primatologists [1], have generated much research as an essential step for the cognitive control of behaviour. Gallagher & Frith [2] highlighted account ToM has a capacity in humans to predict people's mental states concerning our expectations and different emotions and cognitive states proposed by Hughes & Devine [3].

Whereas genetic cause of autism spectrum disorders (ASD) is still complex it defined base on behavioural cause. It leads to important insights in the evaluation of ToM with sharing an atypical number of cognitive and behavioural characteristics like wide into abnormal socialization, communication, and behaviour domains during early developmental period which persist throughout life [4, 5]. Down syndrome (DS) is lifelong condition disorder too, but an extra chromosome is the most common inherited cause of intellectual disability (ID).

Moreover, the role of higher intelligence has a compensatory effect on impairment of social cognition were highlighted [6]. Also, previously a study addressed to investigate whether these social abilities could be mediated by ToM ability [7]. Hence,

the effect of impairments in social skills and ToM abilities in the individuals with ASD when compared with typical developing children to assess differences were documented [8].

However, children with Down syndrome which are much closer to the TD children to pass ToM skills as well, they can be overcome in difficulty than ASD individuals [9, 10]. Due to children with DS able to put themselves in other's place in different situations, but they still had difficulties to answer correctly to what they know about other people [11].

For the most part, theory of mind impairment linked with low IQ appears to be on par with cognitive expectations, and the evidence of pronounced ToM deficits come from the children with comorbidity of low IQ like autism and psychosis disorders [12]. Further, Kaland, MøllerNielsen et al. [13] suggests that children with ASD with the higher verbal IQ scores could pass first- second order of ToM understanding in older age [13]. Nevertheless, more research is still needed to have a better understanding and knowledge of how non-verbal IQ works to influence the development of ToM. This reason motivates us to use the nonverbal intelligence task for majority of the children with autism and children with intellec-

tual disability have the limitation narrative language skills, so, this could play an important role in the worse performance on the false belief understanding. However, some individuals with autism could even pass the second-order more advanced ToM tasks correctly proving the understanding of the mental state in other individuals [8, 30].

In the current study investigated several issues surrounding the differences in theory of Mind performances between TD, DS and ASD. Despite our relatively clear understanding of the ToM phenomenon, we aim to clarify differences in these specific disorders. We hypothesis that first, ASD have score lower than DS, as well as DS than TD in all orders of ToM. Secondly, with higher IQ perform better in ToM tasks.

2. OBJETIVE

To bridge a better knowledge of DS and ASD individuals of ToM understanding due to the children with

autism spectrum disorder and typically developed children has received enough attention; the same process for Down syndrome is considerable.

3. METHOD

3.1 Participants

The initial and final samples were 86 and 74(male: 43, females: 31) respectively, which were between 6 to 12 aged. We divided them into three groups: ASD 24 (M: 16, F: 8), DS 24 (M: 13, F: 11), and TD 26 (M: 14, F: 12). All participants spoke Persian (Farsi) and born in Iran. All ASD subjects had received a diagnosis of autism by a clinician according to DSM-5 criteria. In concern about a professional diagnosis of DS group, doctors used specific diagnosis like; Amniocentesis, Preimplantation Genetic Diagnosis, and Screening test. In addition, we present the IQ data for all three groups in table 1.

Table 1. Descriptive statistics of IQ and demographic data for the three groups.

| | ASD (N= 22) M(SD) | DS (N=21) M(SD) | TD (N=26) M(SD) |
|-----|--|---|---|
| Age | Male: 7.06 (.928) Female: 7.37 (1.685) Total= 7.16 | Male: 9.15 (2.086) Female: 8.72 (1.009) Total= 8.95 | Male: 9.38 (2.292) Female: 10.92 (1.255) Total= 10.15 |
| IQ | 74.30 (21.455) | 70.13 (8.941) | 103.15 (14.136) |

Note: ASD =Autism Spectrum Disorder; DS = Down syndrome; TD= Typically Development children; M = Mean; SD = Standard deviation; IQ =Intelligence Quotient

3.2 Instruments

Sally and Anne Task [14]: This standard first-order false belief task was designed by Baron-Cohen, Leslie, & Frith [14]. To assess the children understands of this task, at the beginning two characters are introduced as Sally and Anne (Naming Question). A girl doll comes into the room, puts her marble in a basket, and then leaves. While she is away, a boy doll, Ali, transfers the marble into the box. When the girl returns to the room, the experimenter asks; “Where does the girl doll, Maryam, think her marble is?” If children point to the previous location of the marble (in the basket), they have acknowledged false be-

lief and could pass the question (score = 1). After that, “Where is the marble?” (Reality question), and “Where was the marble in the beginning?” (Memory Question) were asked. In the present study, a Persian version of this test is used; we changed the names into well-known Iranian names as Ali and Maryam [15, in Persian]. To our knowledge, a study to address the reliability and validity tasks reported value.78 in terms of the Kuder-Richardson test (KR21) [28].

Smarties tube task [16]: The “Smarties test” was changed into a well-known Iranian Smarties brand with the same shape as a Smarties box which children were able to recognize very easily. A child is presented with a tube of Smarties which contains a

pen rather than the expected Smarties, and is asked two control questions, "What is this?" and "What is in it?" According to the children's beliefs, they replied "Smarties, "sweet" or "chocolate". They were then asked what other people (who have not seen inside the tube) will think is in there before it is opened (Belief Question). The child passes the task if it predicts what another person thinks the normal other person believes, and spontaneously says "Smarties" or "chocolate" because they think that that is what is inside the box before it is opened [16]. The total scores in this task are between "0" (failed), and "1" (passed) [18]. As mentioned earlier, in a similar study for reliability and validity in the Smarties task the reported value was .82 in terms of the Kuder-Richardson test (KR21) [28].

Representational Change Test (Picture Task) [17]: A picture of animals is presented, whose bodies are hidden except for one part (The objects were similar to versions that children had seen before, except the last picture). Then the examiner asked three questions: What does the child think the object is? (Representational change), and the answer for this question is something like "the lion"; What will another child who comes in think the object is (who has not seen the last object, false belief)? The typical individuals' answer was "the lion"; and, what does the object really look like? (Appearance- reality distinction). Therefore, children's answer to the reality question was the sun. The total scores were from 0 to 3 [17]. We did not find any study on the reliability and validity for Representational Change Test.

The New Theory of Mind (ToM) Test [18]: We used the formatted version by Anderson KL [31], which contains nine stories (38 items). A drawing or reading story item is shown to a child with three subscales: 1) Precursors of ToM: (first-order; 20 items) the scores are rated between 0 to 20; 2) First Manifestations of a Real ToM: (second-order; 13 items) the range scores were between 0 to 13; 3) more advanced aspects of ToM (third-order; 5 items) the rates were 0 to 5. The total ToM scores range is either incorrect response (failed = 0) or correct response (passed = 1). The raw scores for every three areas' scores must be multiplied by specific numbers (ToM 1=1.4, ToM 2=2.5, and ToM 3=3.3), and then these three products are added to the total scores [18]. Total of all questions should be answered correctly for individuals with typical development, and it takes around 35 minutes to administer. In addition, previously, the Persian (Farsi) version (ToM test-38) with Iranian samples was documented. Ghamarani, Alborzi, & Khayer [19] have shown that the test has good reliability and va-

lidity for mentally retarded and non-retarded children between 7 to 9 years old in Iran. In a study by Muris et al. (1999), the reliability of the ToM test showed the internal consistency of the ToM test were $\alpha=.92$ for the total ToM-scale, $\alpha=.84$ for ToM 1, $\alpha=.86$ for ToM 2, and $\alpha=.85$ for ToM 3 [18].

The Raven's Progressive Matrices (RPMs) [20]: This IQ task is a nonverbal group test originally developed by John C. Raven [19]. There are three versions of the current test: Standard Progressive Matrices (SPM), Colored Progressive Matrices (CPM), and Advanced Progressive Matrices (APM), to access the intelligence and perceptual capacity, reasoning, problem-solving, and thinking skills in children and adults. Our findings focused on this nonverbal task because the majority of children with autism and with intellectual disability have limited verbal language skills with no spoken language or only a few words. The standardization of this non-verbal test has been frequently implemented on Iranian individuals by previous researchers [22]. Reliability results in some studies for the SPM Task, KR-20 value is from .60 to .98, with a median of .90 [29].

Ad hoc questionnaire: For both clinical disorders a questionnaire was used to obtain diagnostic information from the parents.

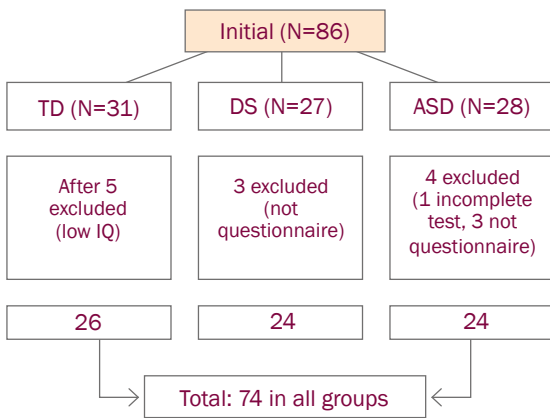
3.3 Procedure

After receiving permission from the ethical committee approval of the Education Department in Tehran, Iran, the invitation letters were sent to schools or institutes and after agreement to participate. The schools contacted all families, the consent forms were sent to the family's home with child and took it back to school one week later. The participants were informed that all data and information would be kept anonymous, and that personal information would be encoded, although the result of the children's IQ test would be sent to any parent who requested it. The author tested all children individually in their school or in the clinics in a quiet room: a single testing session lasting 45 to 60 minutes depending on children's diagnoses and conditions.

An analytic cross-section design was implemented. Furthermore, in this search, in totally 23 clinics, regular and special schools (private and public) provided the sample. Thus, we contacted to 3 regular schools to provide our typical group, who all agreed to cooperate with us. And also to employ the Down syndrome children from 9 special schools that we contacted. Finally, 9 clinical centers or Speech Therapy Center and 2 schools who their referral was the

children with ASD agreed to take part in the current study (see Figure 1).

Figure 1. Exclusion and number of participants in each group.



3.4 Data Analysis

The statistical analysis was performed using SPSS 25. Analysis of variance was used to assess the differences between the groups on ToM tasks. Scores on the measures were analyzed through ANOVA method. The level of significance was set at .05, to

describe method of reporting this estimate, 95% confidence intervals were documented.

4. RESULTS

Analysis indicated that there were statistically significant between the ToM tasks development and the different groups of children. The first order of ToM was included of 1; “Sally and Anne-false belie” (SAC-FB) which was statistically significant correlated with the performance on the groups ($X^2_{(2)} = 26.468, p < .001$). 2; in the Smarties False belie (smart_FT) the typically children who were statistically significant better than the other groups ($X^2_{(2)} = 9.676, p = 0.008$), 3; the representational change (False Belief) tasks ($X^2_{(2)} = 14.263, p < .001$) and also, the Repr_ Question task ($X^2_{(2)} = 11.225, p = .004$) shows a statistically significant relationship on the groups. And 4; There was a statistically significant higher difference on the performance of first-order task new ToM task (NTT_1) ($F = 27.02, p < .001$), the corresponding 95% confidence intervals was calculated: the lower limit of the confidence interval (LL): 13.2907, and is the upper limit (UL): 16.1296. Indeed, ASD was competent to pass the first order ToM tasks better than DS.

Table 2. The Number and Children Who Passed Each Task in groups

| Tasks | ASD (N=24) passed % | DS (N=24) passed % | TD (N=26) passed % | χ^2 | p |
|----------|---------------------|--------------------|--------------------|----------|--------|
| SAC_F | 43.5% | 13.6% | 88% | 26.468 | < .001 |
| Smart_FT | 57.1% | 20.8% | 61.5% | 9.676 | .008 |
| Repr-FB | 30.4% | 8.7% | 60.0% | 14.263 | < .001 |
| Repr_Q | 43.5% | 34.8% | 80.0% | 11.225 | .004 |

Note: SAC-F (Sally and Anne test, False belief), Smart_FT (Smarties tube task, False belief), Repr-FB (Representational change task, False Belief), Repr_Q (Representational change task, Question)

To measure second order of ToM used the new ToM test-second order (NTT_2), so, TD group was better than both clinical ASD and DS group ($F = 55.13, p < .001$), with the corresponding 95% confidence intervals were between (9.1540 - 12.4402), while in ASD and DS groups there is no statistically signifi-

cant difference. However, the third (NTT_3) ($F = 4.99, p = 0.010$) task indicated no statistically significance between DS and ASD groups, nor between TD and ASD groups, this confidence for the current order was (1.0337- 2.4097) (see tables 2 and 3).

Table 3. Differences in the ToM orders between groups

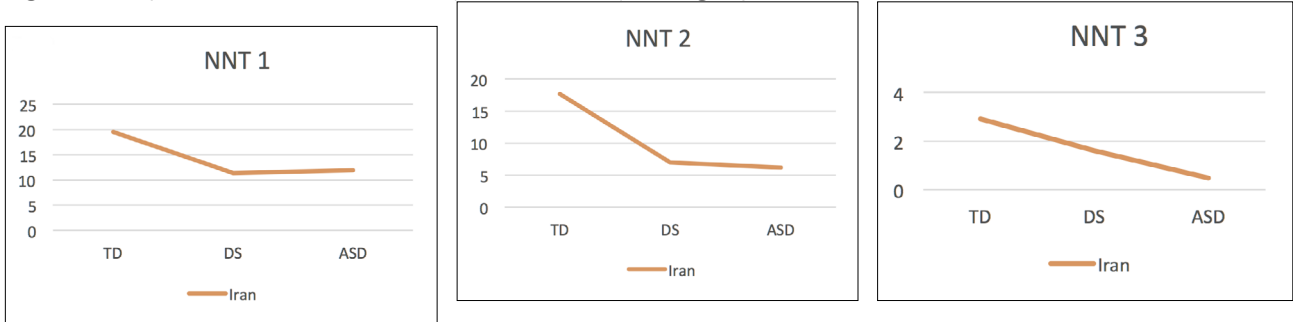
| | | ASD (N=22) M(SD) | DS (N=21) M(SD) | TD (N=26) M (SD) |
|-----|-------|---------------------|--------------------|---------------------|
| ToM | NTT_1 | 11.96 (4.35) | 11.33 (5.00) | 19.76 (4.02)** |
| | NTT_2 | 6.25 (4.80) | 7.02 (3.50) | 17.69 (4.29)** |
| | NTT_3 | 0.45 (1.54) | 1.57 (2.24) | 2.91 (3.65) |

Note: N=Number of samples in each groups; M= Mean; SD= Standard Deviation; * p ≤.05, ** p ≤.01

The figures illustrated quantitative statistics results in each task of the new ToM all orders between

the three groups, so we can see the differences for three orders of ToM See Figure 2.

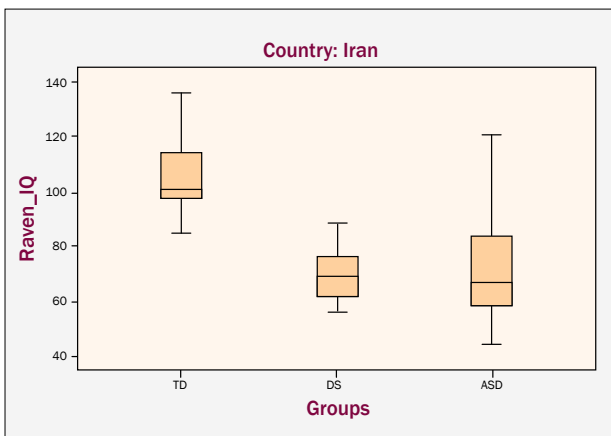
Figure 2. Comparison of the new ToM tasks (NTT_1_ 2 and 3) in the groups



Note: Difference performance in orders of ToM

The data analyses for the IQ correlation with four subscales of ToM variables are presented. Indeed, there were significantly positively correlated in the predicted directions of higher IQ function (see Figure 3).

Figure 3. IQ range scores



Note: Positive relationship between ToM orders and IQ ability

5. DISCUSSION

The objective of this study was to examine how children with ASD, children with DS, and typically developed children are different in Theory of Mind understanding in all orders. Hence, our results for first-order tasks showed that TD group performed better than both these groups. Plus, ASD get better ToM skills scores than DS. In this line high-functioning autism and Asperger's syndrome were competent to pass ToM tasks [6], they could solve first-order tasks later typically group [9, 23, 6]. In the second-order, children with DS did not perform statistically significant different than children with ASD. Importantly, we found that TD children performed better than DS and ASD. In the third-order as well, ASD and DS found nostatistically significant difference. In sum, some individuals with autism can even pass more advanced ToM tasks correctly to understand the mental state of another person [8].

Furthermore, the previous results supported the hypothesis in the possibility of passing the ToM task

by accurate prediction of higher IQ level through false belief attribution in children. Aligned with our results have been numerous reports [6,10, 24, 25, and 26] documented that higher verbal IQ had comparatively better performance on EF and ToM tasks in ASD based on using inner speech to regulate executive control over action, than children with lower verbal IQ. The 7-10 years old AFA could pass the belief question with statistically significant higher in Full and Verbal IQ scores compared with their typical peers [24]. Also, a positive link between cognitive abilities, verbal IQ, and verbal mental age through first-order attribution performance were addressed [6, 10]. In the current study, the pattern was the same in all ToM tasks in all cases except for Smart-RQ and SAR.

This study has some limitations. First, we have to choose tests which had been translated and used in Farsi have certainly reduced the possibility of using other instruments. Second, recording the statistically significant role of ToM developing to mediate by language ability which contributes to false belief understanding, the studies should assess ToM skills through language tests. It adds evidence of ToM performance to bridge a stronger discussion about Iranian individuals due to the lack of literature because most references were far from English language journals.

Further research should be focus on a larger sample thorough measure of ToM task to represent the population's characteristics. Secondly, more specific measuring of overall IQ factors by another test such as WAIS and wide ToM tests to assess accrues result of ToM development. Thirdly, to consider the role of the language ability to pass orders of false-belief tasks, more studies could be account. Finally, the researcher could also be interested in examining ToM processing to possible links with a higher verbal mental age in the children due to this fact that aging would affect on performance the ToM tasks.

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