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Evaluation of Social Cognitive skills and Theory of Mind in Children with Down's Syndrome

تقييم المهارات الاجتماعية ونظرية العقل عند أطفال متلازمة داون

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Abstract

The aim of this study is to explore the impact of socio-cognitive skills on the theory of mind tasks in children with Down's syndrome according to the chronological age.

The experimental protocol was implemented to evaluate the theory of mind in 60 children aged between 6 and 9 years divided into two groups (control and experimental) and also by age groups. We measured emotions in the first part and cognitive beliefs in the second part. The Vinland Adaptive Behavior Scale (socialization domain) was used to assess the social skills and the Columbia test for measuring the mental age of children with Down's syndrome.

The study showed that the chronological age has an impact on the acquisition of theory of mind and on the social adaptive level of children with Down's syndrome. Mental age has a significant impact on the tasks of the theory of mind according to the age of development of children with Down's syndrome.

ملخص

هدفت الدراسة الحالية إلى تقييم أداء الأطفال المصابين بمتلازمة داون في مهام نظرية العقل تبعاً لمستواهم التكيفي الاجتماعي و العمر الزمني. شارك في هذه الدراسة 60 طفل تراوحت أعمارهم الزمنية ما بين 6 إلى 9 سنوات والتي تم تقسيمهم إلى مجموعتين (المجموعة التجريبية والمجموعة الضابطة). ضمت المجموعة التجريبية 30 طفل مصاب بمتلازمة داون، تم تقسيمهم إلى ثلاثة مجموعات حسب الفئة العمرية الزمنية. و المجموعة الضابطة تضم أيضاً 30 طفل عادي تم تقسيمهم أيضاً إلى ثلاثة مجموعات حسب العمر الزمني. طبقنا على المشاركين تصميم تجريبي لتقييم مهام نظرية العقل (مهام المستوى الأول و الثاني) وكل مهمة تحتوي على مجموعة من الاختبارات تقيس جانب من نظرية العقل إما المقاصد أو الانفعال، وطبقنا أيضاً سلم Vinland Adaptive Behavior Scale (ميدان الاجتماعي) لتقييم المستوى الاجتماعي، و اختبار كولومبيا لحساب النضج العقلي للأطفال المصابين بمتلازمة داون. أسفرت نتائج هذه الدراسة أن العمر الزمني له تأثير على اكتساب نظرية العقل وأنه لا يوجد دلالة إحصائية بين المستوى التكيفي الاجتماعي و نظرية العقل تبعاً للعمر الزمني للأطفال المصابين بمتلازمة داون. بينت الدراسة أن النضج العقلي له تأثير كبير على مهام نظرية العقل وفقاً لعمر الزمني للأطفال المصابين بمتلازمة داون.

الكلمات المفتاحية:

العمر الزمني،
نظرية العقل،
مهارات الاجتماعية،
متلازمة داون.

1. Introduction

The concept of “theory of mind” (TOM) is generally understood as the mental capacity to infer one’s own mental states and those of others, to reason about these states and to understand their articulation with reality (Duval, 2011).

More precisely, this ability makes it possible to decode, interpret and manipulate mental contents such as thoughts, beliefs, desires or even feelings and emotions.

In this regard, it constitutes a capacity for meta cognition since it is used to form representations of a person’s mental state (representation). Through these processes, TOM makes it possible to understand the behavior of others, to explain and predict their actions in a given situation and to adapt our own reactions and behaviors.

This ability is central to human social cognition and plays a key role in social interactions, communication, collaboration, teaching, competition, etc. (Frith and Frith, 2012).

The interest of works on social cognition lies in the fact that they are based on a conceptual framework of the Theory of the mind allowing considering, on one hand, the processing capacities of social information perceptible in a social interaction, and on the other hand the capacities coming from representations and knowledge about the social world.

It is however important to note that social reasoning in real situations remains complex and is based on the integration of a whole series of information processed simultaneously, at the perceptual and representational level (Nathalie Nader-Grosbois, 2011).

When we talk about social cognition we are referring to social skills because these are the tools of this capacity that allow us to demonstrate appropriate behavior in a variety of contexts such as at home, at school or at work and in society in general.

According to Baghdadli and Brist-Dubois (2011), social skills are a set of capacities that allow us to perceive and understand the messages communicated by others, to choose a response to these messages and to transmit it by verbal and nonverbal appropriately to a social situation.

Its two cognitive capacities, Theory of mind and social cognition that are essential in the developmental trajectory of typical children, but for children with Down’s syndrome they are relevant with their clinical signs which are very clear: cognitive retardation associated with particular morphological modifications, and usually accompanied by a variable intellectual disability, often mild. The average intelligence quotient for young adults is 50, equivalent to that of a child aged 8–9 years (Malt et al., 2013).

In our survey we observed children with Down’s syndrome for three months and we found that they have no difficulty in social adjustment and also in integration into different social situations such as: group games, establishment of friends, walk in a group, smile or laugh appropriately in response to compliments, and please others.

We have found that they give us the impression of a pleasant and joyful atmosphere. This prompted us to dig into the results of empirical studies on the emotional characteristics of these children in order to guide using our study.

The studies of Landry and Chapieski, (1989) and Sigman, (1999) have shown that babies with T21 were more interested in people than in objects in certain situations while the control children looked more at objects.

In addition, very young children with Down’s syndrome show more muted emotional signals, especially when they express positive emotions with high intensity smiles towards adults.

Cicchetti and Sroufe (1978) report that children with Down’s syndrome are characterized by less intense, shorter emotional expressions and less responsiveness to their environment compared to typical children. For example, they express their emotions of fear less intensely and calm down more difficultly when they experience it; longer distress latency is observable.

Adapted social behavior is based on many factors. It can thus be seen as the result of a complex set of skills, such as cognitive, behavioral, emotional skills, interacting with each other (Frith and Frith, 2001; Adolphs, 2002).

In this perspective, several studies on people with intellectual disabilities have looked at the links between behavioral difficulties and emotional skills. These studies have been able to demonstrate the role of specific skills such as the treatment of faces, and the recognition of emotions or even the understanding of the mental states of others in the establishment of adequate emotional and social behaviors (Loveland, 2006)

Several researchers have found development models, either partially different or partially similar, on the capacities of theory of mind between typical children and children with intellectual deficiency (either intellectual deficiency of genetic origin or non-specific identification) (Koviljka and Loyse, 2011).

Much of the research on the capacity of theory of mind relies on false belief tasks as indicators of whether a child has an understanding of the mental state (Lewis et al., 2006). There have been hundreds of articles on this task that would compare the performance of different groups, of the same mental or chronological age, exploring the success that is correlated with cognitive language and social skills.

All this research on TOM aimed to test the hypothesis of delay compared to the “difference” on the development of belief in TOM in atypical populations compared to populations with intellectual disabilities (called similarly structured hypothesis) (Ziegler, 1969).

For our research, we were not satisfied only with the false beliefs test to identify the TOM, but all the cognitive tests of the latter for a better analysis and a detailed description of the developmental trajectory of children with Down’s syndrome.

In addition, a measurement of the impact of socio-cognitive skills on TOM - which is obvious from the complementary link between these two cognitive capacities - has been made, in order to allow us to discuss the performances of children with Down’s syndrome according to their chronological age.

The problematic of our research is as follows:

- Do T21 children differ in their performance in mind theory tasks according to their chronological age?

- Does the socio-adaptive age of children with Down’s syndrome have an impact on the tests of theory of mind?

2. Research hypotheses

-Do typical children succeed the theory of mind tests according to their developmental age?

- Do children with Down syndrome succeed the theory of mind tests according to their developmental age?

- Do children with Down syndrome succeed the theory of mind tests according to their level of socialization on the Vinland scale?

3. Study protocol

In the present study, we used the experimental program, which corresponds to the stages of the study.

The study was carried out from January 2017 to January 2018.

3.1. Presentation of the population

The study population was made up of 60 children aged from 6 to 9 years. The subjects were divided into two similar groups of 30 children (Group of children with Down’s syndrome and 30 typical children) with the same chronological Age so that they could be compared.

Children with Down’s syndrome are children with all the traits and pathological characteristics of Down’s disease whose temporal age varies between 6 and 9 years.

Table 1

Summary of the study population.

Subjects	Down's syndrome Children (Experimental group)			Typical topics (Control group)		
	G1	G 2	G 3	G 4	G 4	G 5
Number	10	10	10	10	10	10
Label	G1	G 2	G 3	G 4	G 4	G 5
Age (years)	6 - 7,4	7,5 - 8,4	8,5 - 9,5	6 - 7,4	7,5 - 8,4	8,5 - 9,5

3.2. Place and procedure and study

Children with Down's syndrome have been assessed in their "specialized" class in primary schools where they are registered "Hasnaoui" and "Aysouf" in Tlemcen. They were also tested in the psychologist's office at the headquarters of the association of children with Down syndrome in Tlemcen "ANIT" in the presence of the educator. The test was passed by the experimenter only.

Typical children were assessed in their family homes and also in the "belle air Tlemcen" Kindergarten or nursery school.

The Vinland test (socialization field) was administered before the TOM tasks. The different TOM tests were administered in several sessions of 20 to 40 minutes (depending on the attention skills and motivation of the children). The total passing time varied between 3 to 4 hours (children T21).

3.3. Instruments of study

Two tools were used to achieve the objectives of this research.

3.3.1. The Theory of Mind (TOM) test

The theory of mind is procedurally defined based on success and failure in performing its tasks which are:

The first level includes an emotion task, and it contains four dimensions itself.

The second level contains the destination tasks which are divided into five dimensions.

There are two stages in the acquisition of theory of mind:

The first order theory of mind (acquired around 3-4 years): the ability to attribute to others their own thoughts, beliefs and intentions; second order theory of mind (acquired around age 6-7): knowing that others are also gifted with theory of mind.

In order to determine whether our subjects had acquired first and second order theory of mind, we divided the tests into two parts: TOM emotion and TOM belief, and each part contains stains borrowed from the book by Baron-Cohen. "Teaching autistic children to understand the thoughts of others"

Four TOM emotions tests were offered. They relate to the four basic emotions: joy, sadness, anger and fear; success and their tasks are preliminary.

To assess the theory of belief we used six tests that make up short stories that are told about the subject. They are generally punctuated with various short questions to ensure that the subject has understood the situation and end with a final question aimed at evaluating the acquisition of first or second order theory of mind.

The tasks of the TOM emotions are:

- The task of recognizing photographic emotional facial expressions. (Joy, sadness, anger, fear)
- The task of recognizing schematic emotional facial expressions. (Joy, sadness, anger, fear)
- The task of recognizing emotions depending on the situation. (Joy, sadness)
- The task of recognizing emotions as desired. (Joy, sadness)

Six tests were used to assess the understanding of beliefs.

- Test of aptitude for deception
- Test of distinction between appearance and reality
- Unusual content test
- Creed change of location test
- Proof of future directions
- Pretend play test

3.3.2. Vinland scale

It is the level of socialization of all children in relation to the socialization domain of the vinland scale.

The Vinland Adaptive Behaviour Scales (VABS) also called Vinland scale is a test that measures adaptive skills by examining 4 areas:

- Communication (receptive, expressive and written communication),
- The autonomy of daily life (domestic chores, community behavior),
- Socialization (interactions with others, responsibility and sensitivity towards others)

- Motor skills (fine, global and coordination).

This scale contains 117 questions and is presented in the form of a semi-structured interview with the parents or with the one who takes care mainly of the person concerned. The time taken is evaluated between 30 minutes to 1 hour depending on the person.

At the end of the test and for each area evaluated, the result expresses the average level of competence attained by the person in this area, in age equivalence.

In our study we used the socialization domain to have the socio-adaptive age of our study population.

The levels are represented according to the standard Vinland score and are represented in table (2).

Table (2)

Adaptive levels according to the standard Vinland score

Adaptive level	Standard Score
Student	131 above 160
moderately high	116 to 130
moderately	85 to 115
moderately weak	70 to 84
low	below 20 to 69

4. Results and discussion

4.1. Result of the theory of mind test

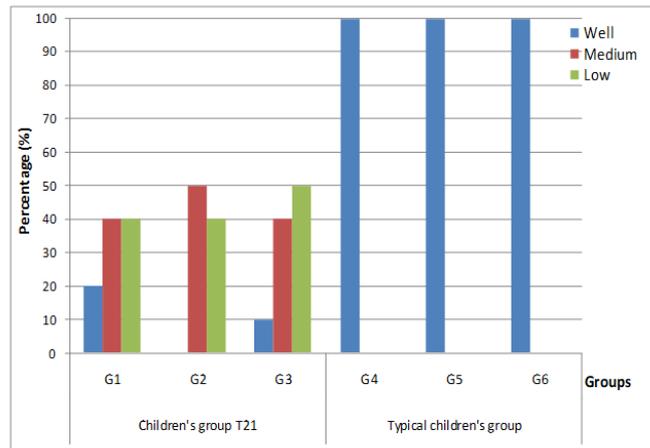
The results of the TOM test are illustrated in Figure (1).

The results show:

- A workforce of 60 children from the study population.
- The two study groups (T21 and typical)
- The levels obtained by the children concerning the performance of the tasks of the theory of the global emotion and belief. We found that the groups of typical children all have a good theory of mind and that they acquired it at the age of 6 years. The group of T21 have disturbances in their TOM level according to their chronological age.

Figure 1

Test of the theory of the mind of study groups (T21 and typical)



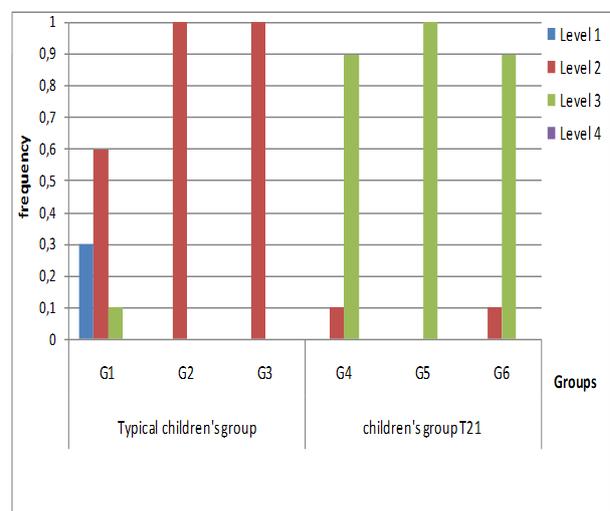
4.2.Result of Vinland test (social skill)

Figure (2) shows the results of the frequency of children’s adaptive behavior (socialization) level.

We observe that the level of typical children varies between the acceptable, moderately acceptable, high levels but that for the T21 group we observe a change in level according to age, which is consistent with our research hypothesis.

Figure 2

Result of the Vinland scale of the study groups (T21 and typical)



4.3. Correlations between theory of mind tests and social skills

The results of Pearson’s correlation tests (Table 3) showed us a strong positive correlation between social age and mental age in group n° 1 (6 - 7.4 years) ($p < 0.005$) also a positive correlation between mental age and Tom tests ($p < 0.05$)

There is a positive correlation ($p < 0.01$) between mental age and social age in population n°3 (8.5 - 9.5). The other populations did not show significant correlations.

Table (3)

Partial correlations between theory of mind tests and social skills

Groups		TOM	Social age	Mental age
T1	Social age	0,58		
	Mental age	0,68*	0,82***	
	Chronological age	0,52	0,32	0,40
T2	Social age	0,41		
	Mental age	0,20	0,47	
	Chronological age	-0,09	-0,04	-0,33
T3	Social age	0,43		
	Mental age	0,43	0,79 **	
	Chronological age	-0,41	0,14	-0,23

*** $p < 0,005$; ** $p < 0,01$; * $p < 0,05$.

4.4. Comparison of developmental age on the performance of theory of mind

The results of the ANOVA intra-group analysis of the TOM test of typical children and those with Down’s syndrome are represented in tables 4.

We found that the developmental age of children significantly influences their performance on the tasks

of the theory of the mind ($P < 0.05$).

Table (4)

Averages, Standard deviations and significance thresholds of the test of the theory of the mind of groups of children.

Source of variations	Sum of squares	dll	Mean of squares	F	p	CF*
Factor	1017	5	203,4	29,47	2,67 E-14	2,39
Error	372	54	6,9			
Total	1389	59				

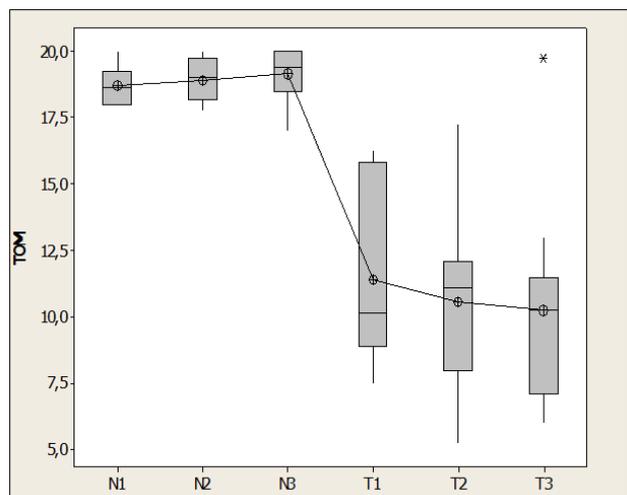
* CF :Critical value for F

3 allow us to compare by pair two well-differentiated groups: children T2 and T3 differ from those of children T1 in the performance of the TOM according to age groups.

With typical children we do not notice any difference in the performance of the TOM according to chronological age.

Figure 3

Mustache box of the TOM test distributed according to the control and test groups



4.5. Comparison of developmental age at socio-adaptive level

The ANOVA intra-group analysis represented in table 5 allowed us to verify the existence of a statistically significant difference between the socio-adaptive age and the chronological age of the groups with a greater value $F = 58.34$ than the value of the critical $F_{2, 39}$ ($p < 0.005$).

And the interpretation of this meaning is that the socio-adaptive level changes according to the chronological age of the children, and to see this difference we have used a POST HOT TEST to identify the difference.

Table 5

Averages, Standard deviations and significance thresholds according to the ANOVA test of the Vinland test

Source of variations	Sum of squares	dll	Mean of squares	F	p	CF*
Factor	14797	5	2959,5	58,34	1,5E-20	2,39
Error	2739,	54	50,73			
Total	17536	59				

* CF :Critical value for F

Figure 4 illustrates the mustache box of the Vinland test distributed according to the control and test groups.

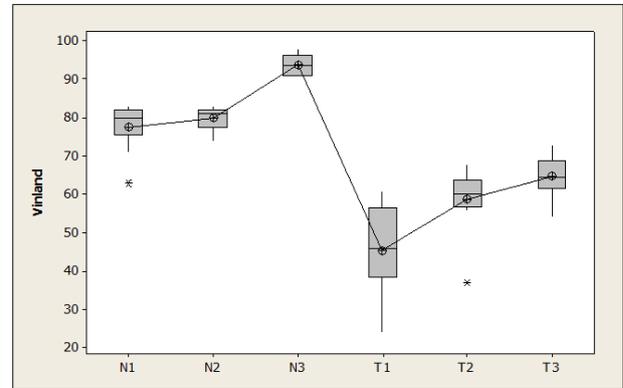
The Tukey test shows two well-differentiated groups: children T2 and T3 that differ from those of children T1 in the socio-adaptive age tests of the Vinland test for the experimental group and for the control group N1 and N2 different from N3.

We conclude that socio-adaptive level serves change according to chronological age but not in a linear way (The higher the age, the more social skills) because we find that the group of children with Down’s syndrome aged 6- 7 years old have a higher socio-adaptive level

than those of 8 to 9 years old.

Figure 4

Mustache box of the Vinland test distributed according to the control and test groups



Through this study, we are contributing in three important ways to research in the areas of theory of mind development in children with Down’s syndrome.

First of all, this is, to our knowledge, the first study examining the consistency between the socio-adaptive level of performance of theory of mind according to the chronological age of children with Down syndrome from 6 to 9 years old who is a crucial phase in the development and acquisition of cognitive processes. Also this is a specific study to children with Down syndrome, not as a control group with intellectual disabilities, because several authors report comparative studies concerning children with intellectual disabilities, deal with the development of TOM, emotion, argue that children with intellectual disabilities have less capacity for recognizing emotional expression than typical children matched in developmental or chronological age (Nader, 2015).

It is very difficult to assess the intellectual capacities of a person with Down’s syndrome, because most psychometric tests require motor or visual coordination capacities, of muscular tone, of communication, which make that the intellectual capacities of people with Down’s syndrome, often performing poorly in these areas, are frequently undervalued.

In our research, we voluntarily selected our instruments to be in direct contact with the subjects and to be able to control them and give a precise estimation of the

interpretation of the tests.

Our population was also selected according to the appropriate age group to have an optimal result according to our research hypotheses.

Contrary to our expectations, our study revealed that chronological age does not play a role in the performance of the theory of mind of subjects with Down's syndrome aged from 6 to 9 years, matched according to their chronological age. This is the opposite for typical children by age group.

Also, the socio-adaptive level is not a factor related to the chronological age of our subjects with Down's syndrome and also for typical children.

Our study confirmed the comparative studies which deal with the development of theory of mind, that argue that children with intellectual disabilities exhibit less capacity for recognition of emotional expression than typical children matched in chronological age (Nader, 2015)

Our study also aimed to explore the developmental trajectory of children with Down's syndrome and we can say that children with Down's syndrome have other factors than their developmental age which favors the acquisition of cognitive capacity.

Charman and Cambell (1998) found coordination between the capacities which contribute to support the comprehension of the mental states of the child. As children pass relatively briefly through these stages of development, it is less easy to note the fluctuations in the structural relationships between capacities in the rate of development of theory of mind.

We underline the interest of our research which relates to the acquisition of TOM in the Down's syndrome which relates to the observation of mental organisms in the developmental trajectory of these children, and to propose if possible a specific chronological line for them.

Thirion-Marissiaux and Nader (2011) found no developmental heterochrony between the different scenarios relating to the four emotions for each of the two groups, whereas this heterochrony was observed in our study in children with Down's syndrome (experimental). The results of the TOM emotion tests

were not a success, a failure on the emotion of anger and grief may have translated this lack of success into a confusion of understanding of these two emotions, the children with Down's syndrome interpreted the situations of grief by anger, and this is due to their emotional experience.

On the other hand, in the tests of the photographed faces they made the difference between the two emotions. Our result was supported by the study by Quintal, (2001), who also observed this heterochrony (Nader and Thirion, 2001).

Intellectual impairment affects TOM tests but not in all respects because the socio-adaptive age of children with Down's syndrome has been correlated with the chronological age of children, social skills are representations of mental states, so we can locate these last in a multimodal line representative of social mental states.

5. Conclusion

This research made it possible to underline variability in the development of theory of mind by bringing socio-adaptive age and also to underline the impact of its factors on the developmental trajectory of children with Down's syndrome according to age group.

Finally, it would be wise in future research to compare other developmental patterns to which neurocognitive research could be applied that can confirm the exact age of acquisition of this capacity in children with trisomy.

Teachers are advised to stimulate children with Down's syndrome by co-solving problems of different perspectives between pupils according to mental state for the acquisition of TOM

Conflict of Interest

The authors declare that they have no conflict of interest.

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