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Theory of mind "beliefs", developmental characteristics and social understanding in children and adolescents with intellectual disabilities

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Abstract

Patterns of development of ToM belief abilities in intellectually disabled (ID) children and typically developing (TD) children matched on their developmental age were investigated. The links between cognition, language, social understanding and ToM belief abilities were examined. EDEI-R [Perron-Borelli M. (1996). *Echelles Différentielles d'Efficiences Intellectuelles. Forme Révisée (EDEI-R)*. Paris: Editions et Applications Psychologiques.] was used to match participants and to assess social understanding. ECOSSE [Lecocq P. (1996). *L'E.CO.S.SE. Une épreuve de compréhension syntaxico-sémantique*. Paris: Presses Universitaires du Septentrion.] assessed the level of syntactic and semantic comprehension of French speaking, to ensure a good comprehension of the questions in false belief tasks. Five tasks assessed the ability in visual perspective taking and in understanding of false belief. A difference in the global ToM ability was found between both groups (difference hypothesis in ID participants). Specific abilities in different ToM tasks showed developmental patterns partially different and partially similar, between ID and TD groups. The interest to assess the understanding of belief by means of several tasks is confirmed. Positive links between cognition, language and ToM abilities were found in both groups, but the impact of cognition and language on abilities in each ToM task is different in both groups. Finally, the specific impact of social understanding and of chronological age on abilities in false belief in ID group is discussed.

Keywords: Intellectual disabilities; Theory of mind; Beliefs; Social understanding; Verbal–non verbal cognition; Language

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Children's folk psychological understanding about persons is examined in the framework of ''Theory of Mind'' (ToM) (de Rosnay & Hughes, 2006). In developmental psychology, the study of ToM – described as ''*the ability to think other people thoughts*'' by Adrien, Rossignol, Barthélémy, Jose and Sauvage (1995) – follows the study of the children's understanding about the physical world, conceptualized by the Piagetian constructivist theory and by the Vygostkian socio-constructivism. ToM concerns ''*the mental world*'': nine mental states were described by Flavell (1999). Amongst them, the mental state ''belief'' is the most frequently studied in the literature about ToM and concerns the ability to acknowledge that people hold beliefs of a simple, factual nature: ''*this acknowledgement evidences a conception of another's mind as holding a certain belief*'' (Dennett, 1978 in Hale & Tager-Flusberg, 2003, p.346). The false belief tasks constitute the original experimental paradigm widely used to assess the understanding of beliefs. False belief tasks assess the ability in an individual to differentiate ones own beliefs and another person's beliefs (Lewis et al., 2006). Authors consider the understanding of false belief as the benchmark of the acquisition of ToM in typically developing (TD) children (Abbeduto, Short-Meyerson, Benson, & Dolish, 2004). Around 4-year-old, a major change in ToM beliefs has been reported in numerous studies (Wellman, Cross, & Watson, 2001). Some comparative studies about TD children and atypical populations verified if this developmental landmark (around 4-year-old) was also observed in deaf children (notably, Deleau, 1997), and in people with autism (Adrien et al., 1995; Baron-Cohen, 1999; Tager-Flusberg, 2001). Other studies about ToM development crossed atypical populations: children with deafness or autism (Peterson, Wellman, & Liu, 2005), autistic people with intellectual disabilities (ID) and TD children matched on their mental age (Baron-Cohen, Leslie, & Frith, 1985; Yirmiya, Pilowsky, Solomonica-Levi, & Shulman, 1999), people with different aetiologies of ID (Abbeduto & Murphy, 2004; Cornish et al., 2005) or people with specific aetiology of ID (Garner, Callias, & Turk, 1999; Lewis et al., 2006). All these ToM research aimed to test the hypothesis of delay versus the hypothesis of difference in the development of ToM belief in atypical populations (Zigler, 1969) in comparison with TD populations. So, in the present study, two first questions were investigated: ''Is the development of ToM belief in ID children and adolescents similar versus different in comparison with TD children matched on their global developmental age (GDA)?'', ''Are strengths or weaknesses in some ToM belief tasks similar versus different in TD and ID groups?'' To explore these questions, it was necessary to use several tasks to observe different abilities developed to understand other's minds (de Rosnay and Hughes, 2006; Hughes, Lecce, & Wilson, 2007; Jervis & Baker, 2004).

Several authors explored in TD children the impact of their individual characteristics on their understanding of beliefs and conceptualized the developmental process of ToM (see Deneault & Morin, 2007 for a brief review of different theoretical models of ToM development). The impact of cognitive characteristics on ToM was studied and refined by the knowledge of ToM in people with ID (Mellier & Courbois, 2005; Tourrette, 2006). Actually, the gap between GDA and chronological age (CA) in ID people allows one to differentiate the specific impacts of cognitive characteristics (verbal and non-verbal cognition) and of life span (CA) on the development of ToM. About the impact of verbal cognition, including multiple skills using receptive or expressive language, the language appeared to be a central factor in ToM belief from the results of many studies in typical and atypical populations (de Rosnay and Hughes, 2006; Tourrette, Recordon, Barbe, & Soares-Boucaud, 2000). Numerous studies found links between performances in standardized measures of language and in ToM tasks (Hale & Tager-Flusberg, 2003; Le Sourn-Bissaoui & Deleau, 2001). Different components of linguistic abilities were considered: syntactic versus semantic abilities, receptive versus expressive language (Astington

& Jenkins, 1999; Comay & Baird, 2004; Hugues et al., 2007; Slade & Ruffman, 2005). Recently, the impact of more precise components of language on ToM belief development was examined. For example, Hale and Tager-Flusberg (2003) explored the links between the mastery of sentence complement structure and the understanding of false belief. About ID populations, Abbeduto et al. (2004) suggested several facets of language ability in link with the skills in false belief: not only gross measures of language (as verbal mental age), nor solely some narrow aspects of language (receptive or expressive) but rather to privilege multiple measures. We also consider the possible impact of the ability to understand and to remind the temporal sequence in a story that is included in several ToM belief tasks. So, in the present study, a third question was investigated: "Are the respective impacts of verbal and non-verbal cognition, linguistic abilities, temporal structuring abilities and chronological age on ToM belief similar versus different in both groups?"

Finally, abilities in ToM concern the understanding of mental states (notably beliefs and false beliefs) but also concern the prediction and explanation of behaviour on the basis of inferred mental states (Garfield, Peterson, & Perry, 2001; Le Sourn-Bissaoui & Deleau, 2001). Links between social adjustment and ToM abilities were studied in TD and ID populations (Thirion-Marissiaux & Nader-Grosbois, submitted). More precisely, in the current study, the links between the understanding of social conventions and the understanding of beliefs were at the base of the fourth question: "Do similarities versus differences exist in the links between social understanding and ToM beliefs abilities in ID and TD group?"

1. Method

1.1. Participants

Participants were 47 intellectually disabled (ID) children and adolescents (23 males, 24 females) and 43 typically developing (TD) children (21 males, 22 females). The mean CA in ID group ($M = 10.9$ years, S.D. = 2.9) was significantly higher than in the TD group ($M = 4.1$ years, S.D. = .7), $U = 0.0$, $p < 0.001$. The two groups were matched on their GDA (equivalent to MA). The mean GDA did not differ between the ID group ($M = 4.6$ years, S.D. = 0.9) and the TD group ($M = 4.5$ years, S.D. = 0.9), $U = 960.5$, ns. Aetiologies of intellectual disability were diverse: genetic aetiology in 18 participants (13 with down syndrome, 3 with fragile X syndrome, 1 with Turner syndrome, 1 with Williams-Beuren syndrome), non-genetic aetiology in 29 participants (perinatal anoxia, metabolic disease or unknown etiology). Participants were recruited mainly from Belgian French-speaking schools (majority of ID participants were in special schools, one child was in ordinary school). Teachers identified children and adolescents who met the study inclusion criteria: (1) elementary comprehension and production of French; (2) no bilingual children; (3) absence of autistic disorder in ID participants, confirmed by psychologists in Psycho Medico Social Centres. Information letters and a consent form for the child's participation and videotape record were then sent to these children's parents. Three participants were recruited from the Belgian association of parents of children with fragile X syndrome.

1.2. Instruments

Differential Scales of Intellectual Efficiency—revised edition (EDEI-R, Perron-Borelli, 1996). They were used in order to match the participants on their GDA. These scales were

elaborated on for atypical populations, their applicability to ID participants was confirmed (Tourrette, 2006). This allows us to distinguish the verbal developmental age (VDA) and the non-verbal developmental age (NVDA). The VDA was calculated by means of the scores obtained on five scales: vocabulary as pictures denomination; vocabulary as word definition, knowledge, social understanding and conceptualisation. The NVDA was calculated by means of the scores obtained on four scales: classification of couples of pictures, classification of three pictures, categorical analysis and practical adaptation. Furthermore, the *verbal scale of social understanding* provided an indirect measure of social adjustment that corresponds to the understanding and the knowledge of social reality, of rules in social context and in inter-personal relationships. Accordingly, a developmental age in this domain was also established separately.

Test of Syntactical and Semantics Comprehension (ECOSSE, Lecocq, 1996), the French version of the Test for Reception of Grammar (TROG, Bishop, 1983), was the measure of receptive language. Participants were required to select a picture (four pictures presented) that matched the meaning of a word, phrase or sentence read aloud by the experimenter. The score obtained on 92 items is transformed in percentage of success.

ToM belief tasks. Five tasks (see Appendix A for description) estimated the understanding of the mental state ''belief''. The two last tasks were the most frequently presented in the ToM literature.

(1) *Deception skills test* (Oswald & Ollendick, 1989)
(2) *Change of representation task* (Flavell, Everett, Croft, & Flavell, 1981)
(3) *Appearance-reality task* (Flavell, 1986)
(4) *Unexpected-content task* (Perner, Leekam, & Wimmer, 1987)
(5) *Change of location task* (Wimmer & Perner, 1983). Besides the interest for the memorization of the story presented in this false belief task, the play scene (with dolls) corresponds to the symbolic developmental period in which the participants of the current study are located. In order to establish that participants do not just chance upon the correct response at the test question ''where X will look for his chocolate, first?'', they also answer two control questions: the memory control asks ''where X put the chocolate in the beginning?'' and the reality control asks about the current state of reality, that is, ''where the chocolate is at the present time?''.

Five ToM belief tasks were scored from a total of five points (one point for each task).

Temporal structuring test (NBTL, Anglade et al., 1993). This scale assessed the participants' capacity to organise several pictures to develop a script. As temporal structuring ability was involved in false belief tasks (unexpected-content and change of location), it was interesting to verify if this ability was acquired by participants. This test was scored on a total of 13 points.

1.3. Procedure

All participants were tested at school and/or at home. Different tests were administered across several sessions for each participant (during 20–40 min according to the participant's attention). Total administration time varied from participant to participant, but required from 2 to 4 h. EDEI-R, ECOSSE and NBTL were presented before the ToM belief tasks. The administration was led by the examiner in a quiet and familiar room. In order to proceed to the scoring of ToM belief tasks, these sessions were filmed. A synthetic report about the participants' abilities was sent to their parents and teachers.

2. Results

2.1. Preliminary analyses

The normality of participants' results in ToM belief tasks was verified by means of Kolmogorov–Smirnov test and showed that results did not present a normal distribution. So, non-parametric tests were used for all analyses. The variable ''gender'' did not implicate significant difference – neither in the TD nor in the ID group (within group analyses) – in all performances in ToM belief tasks.

Cognitive, social understanding and linguistic characteristics.

The participants' characteristics of development are detailed in Table 1.

As shown in Table 1, the participants of the two groups presented no significant difference in their VDA, their NVDA, their social understanding developmental age and their temporal structuring ability, in spite of the higher CA in the ID group than in the TD group. So, participants of both groups were perfectly matched, in particular on their VDA and on their vocabulary skills (denomination of pictures and definition of words), frequently used to match TD and ID participants (Baron-Cohen et al., 1985, Jervis & Baker, 2004) or as inclusion criteria in sample (Charman & Campbell, 2002). On the other hand, the ID group obtained lower scores in receptive language (percentage of success in ECOSSE) than the TD group but the level obtained in each group was sufficient to allow participants to understand ToM belief tasks. No significant difference was obtained between VDA and NVDA neither in the TD group (Sign test = −1.1, ns) nor for the ID group (Sign test = −0.3, ns).

2.2. ToM belief tasks

Table 2 presents the participants' mean and median scores in the five ToM belief tasks and in the total of ToM belief.

Analyses between groups showed significant differences in the median of the total of ToM belief and in the medians of two belief tasks: the TD group succeeded significantly better the change of representation and the appearance/reality tasks than the ID group. No significant

Table 1
Cognition, language and temporal structuring abilities in TD and ID groups

Independent variables	TD			ID			Mann–Whitney *U* value
	n	*M* (S.D.)	Mdn	*n*	*M*(S.D.)	Mdn	
Cognition							
VDA (years)	43	4.5(1)	4.4	47	4.5(1.1)	4.3	985
NVDA (years)	43	4.4(.9)	4.3	47	4.5(.9)	4.3	917.5
Social understanding (years)	43	4.7(1.2)	4.5	43	4.7(1.2)	4.5	895
Language							
Vocabulary as picture denomination (years)	40	4.8(.8)	4.8	39	4.7(1)	4.8	749
Vocabulary as word definition (years)	31	4.7(1)	4.7	35	4.9(1.1)	4.7	473
Linguistic comprehension (success %)	40	68(14.1)	67.9	47	61.4(14.4)	58.6	677.5*
Temporal structuring (max. 13)	43	5.2(4.1)	4	43	4.8(3.9)	4	866.5

Note: VDA: verbal developmental age (verbal cognition), NVDA: non verbal developmental age (non-verbal cognition), *M* = mean, S.D. = standard deviation, Mdn = median, *U* values were calculated on medians (non-parametric test), $^{*}p < .05$.

Table 2
Between group analyses: means, medians in ToM belief tasks in TD and ID groups

Dependant variables	TD ($n = 43$)		ID ($n = 47$)		Mann–Whitney U value
	M (S.D.)	Mdn	M(S.D.)	Mdn	
Deception skills test (max.1)	0.8(0.4)	1	0.6(0.5)	1	880
Change of representation task (max. 1)	0.8(0.3)	1	0.6(0.3)	1	737.5*
Appearance-Reality task (max. 1)	0.5(0.4)	0.5	0.3(0.4)	0	687.5**
Unexpected-content task (max. 1)	0.6(4)	0.5	0.6(0.4)	0.5	957.5
Change of location task (max. 1)	0.3(0.5)	0	0.2(0.4)	0	941.5
Total of ToM belief tasks (max. 5)	3(1.3)	3	2.4(1.1)	2.5	761.5*

Note: M = mean, S.D. = standard deviation, Mdn = median, U values were calculated on medians (non-parametric test), $^{*}p < .05$, $^{**}p < .01$.

difference was observed between groups in the deception skills test and in the two false belief tasks (unexpected-content and change of location). We noted that the mean score in the change of location task was low in both groups, suggesting a floor effect for this task in the TD and the ID participants.

Percentage of success in each ToM belief task is presented in Table 3.

Percentage of success was highest in the deception skills test in both groups, whereas the lowest percentages of success were obtained in the change of location task in the TD group and in the appearance/reality and change of location tasks in the ID group. Taking into account the responses to two levels of the change of representation tasks (see Appendix A for details about levels) refines the results in both groups. So, between groups analyses showed a significant difference between both groups (in favour of the TD children) in the level 2 ($U = 782.5, p < 0.05$) but not in the level 1 ($U = 907$, ns).

Closer inspection of performance on the appearance/reality task reveal that amongst participants (63% in the TD group, 85% in the ID group) who, failed in this task, realist errors were more frequently than other types of errors (error in both questions or phenomenist error) in the ID group ($\chi^2_2 = 12.9$, $p < .01$). Conversely, the TD children not more frequently made a specific error ($\chi^2_2 = 0.5$, ns).

Finally, the analysis of the responses to the control questions (memory control and reality control) refined the results in the change of location task in both groups. Between groups analyses showed that – amongst participants who failed in the change of location task (70% in the TD group, 77% in the ID group) – the TD participants more frequently succeeded to the memory

Table 3
ToM belief tasks: percentage of passer participants, GDA of passer participants in TD and ID groups

Dependant variables	TD ($n = 43$)		ID ($n = 47$)	
	Passer n (%)	GDA M (S.D.)	Passer n (%)	GDA M (S.D.)
Deception skills test (max. 1)	33 (77)	4.7(0.8)	30(64)	4.9(0.6)
Change of representation task (max. 1)[a]	27 (63)	4.7(0.9)	18(38)	4.9(1)
Appearance-reality task (max. 1)[a]	16 (37)	4.9(0.8)	7(15)	5.4(0.7)
Unexpected-content task (max. 1)[a]	19 (44)	5.0(0.9)	21(45)	4.6(0.8)
Change of location task (max. 1)	13 (30)	5.2(0.9)	11(23)	5.2(0.7)

Note: GDA = global developmental age (in years), M = mean, S.D. = standard deviation.
[a] Partial success was considered as fail.

control question than the ID participants ($U = 339$, $p < 0.01$). Conversely, there was no significant difference between both groups for the reality control question ($U = 537$, ns).

Links between cognitive, social understanding, linguistic characteristics, temporal structuring ability and ToM belief tasks.

Table 3 presented the GDA of passer participants in each ToM belief task. In both groups, GDA was around 5-year-old. We observed two discrepancies between groups in the passers' GDA (more than 0.2 years): in the appearance/reality task (the TD children succeeded with a lower GDA than the ID children and adolescents' ones), conversely, the ID group succeeded with a lower GDA than the TD group in the unexpected-content task.

The results of correlation analyses between, in one hand cognition, language, social understanding, temporal structuring ability and in the other hand, ToM belief abilities (five ToM belief tasks and the total of ToM belief), in both groups, are shown in Table 4.

All correlations between cognitive skills and the total of ToM belief were positive and significant (r from 0.50 to 0.65 in the TD group; τ from 0.53 to 0.66 in the ID group). All correlations between language skills and the total of ToM belief were also positive and significant in both groups (r from 0.54 to 0.71 in the TD group; τ from 0.48 to 0.65 in the ID group) excepted for the correlation between vocabulary skills (denomination of pictures) and the total of ToM belief in the ID group. In both groups, temporal structuring ability was positively and

Table 4
Correlations between cognition, language, temporal structuring and ToM belief tasks in TD and ID groups

	Dec. skills	Change of rep.	A/R	Unexp. content	Change of loc.	Total of ToM belief
TD[a] ($n = 43$)						
Cognition						
GDA	0.48**	0.39*	0.43**	0.50**	0.51***	0.65***
VDA	0.50**	0.42**	0.38*	0.50**	0.46**	0.60**
NVDA	0.37*	0.29	0.47**	0.46**	0.53***	0.61**
Social understanding	0.43**	0.45**	0.30*	0.51**	0.43**	0.50**
Language						
Vocabulary as picture denomination	0.50**	0.29	0.38*	0.33*	0.36*	0.54**
Vocabulary as words definition	0.37*	0.33	0.31	0.40*	0.43*	0.55**
Linguistic comprehension	0.49**	0.53***	0.48**	0.48**	0.52**	0.71***
Temporal structuring	0.30*	0.30	0.38*	0.44**	0.38*	0.40*
ID[b] ($n = 47$)						
Cognition						
GDA	0.46**	0.34*	0.34*	0.20	0.45**	0.66***
VDA	0.40**	0.36*	0.33*	0.20	0.30*	0.57***
NVDA	0.41**	0.20	0.23	0.14	0.45**	0.53***
Social understanding	0.44**	0.32*	0.26	0.11	0.40**	0.56***
Language						
Vocabulary as denomination of picture	0.19	0.14	0.10	0.21	0.11	0.27
Vocabulary as definition of words	0.35*	0.27	0.33	0.19	0.26	0.48**
Linguistic comprehension	0.38*	0.40**	0.31*	0.26	0.47**	0.65***
Temporal structuring	0.20	0.13	0.26	0.09	0.31*	0.36*

Note: GDA, global developmental age, VDA, verbal developmental age, NVDA, non-verbal developmental age, *$p < .05$, **$p < .01$, ***$p < .001$.

[a] Bivariate correlation for TD group (r Pearson).

[b] Partial correlations controlling for chronological age for ID group (τ Kendall).

significantly correlated with the total of ToM belief (r = .40 in the TD group; τ = 0.36 in the ID group).

In the TD group, all cognitive skills were positively and significantly correlated with each ToM belief task (r from 0.30 to 0.53), excepted for the correlation between NVDA and performances in change of representation. In the ID group, correlations between cognitive skills and two ToM task (deception skills and change of location) were all positive and significant (τ from 0.30 to 0.46). Three cognitive skills were positively and significantly correlated with performances in change of representation (τ from 0.32 to 0.36), two cognitive skills were positively and significantly correlated with performances in appearance/reality (τ from 0.33 to 0.34) but any correlation between cognitive skills and performances in unexpected-content were significant. In the TD group, temporal structuring ability was positively and significantly correlated with all performances in ToM belief (r from 0.30 to 0.44), excepted for performances in change of representation. In the ID group, this temporal structuring ability was positively and significantly correlated only with performances in change of location (τ = 0.31).

In the TD group, the majority of correlation between linguistic skills and performances in ToM belief were positive and significant (r from 0.33 to 0.53). In the ID group, only positive and significant correlations were obtained between linguistic comprehension and performances in ToM belief (excepted for unexpected-content) (τ from 0.31 to 0.47) and between vocabulary skills (definition of words) and performances in deception skills (τ = 0.35).

Linear regressions analyses by stepwise method were performed in order to verify in which measure the VDA, the NVDA, the linguistic comprehension and the temporal structuring ability could predict the variance of the total of ToM belief abilities in each group. Results are presented in Table 5. In both groups, the linguistic comprehension was the only explicative variable (55% in the TD group and 42% in the ID one) of the variance of the total of ToM belief.

Moreover, logistic regression analyses (backward stepwise, likelihood ratio) were applied in order to examine the relative contribution of five independent variables (VDA, NVDA, linguistic comprehension, temporal structuring ability, effect of interaction between linguistic comprehension and VDA) to ToM performance in each task. Table 6 presents the results of logistic regressions.

First, in the TD group, inclusion of the VDA and, in the TD group, inclusion of interaction between linguistic comprehension and the VDA significantly improves the predictive power of the constant-only model about performances in deception skills. Secondly, only in the TD group, inclusion of linguistic comprehension significantly improved the predictive power of the

Table 5
Summary of multiple regression analyses on predictor abilities of total ToM belief in TD and ID groups

	B	SE/B	BETA	$R^2_{adj.}$	F
TD (n = 43)					
Predictors[a]					
Linguistic comprehension	0.07	0.01	0.75	0.55	48.9***
ID (n = 47)					
Predictors[a]					
Linguistic comprehension	0.05	0.01	0.66	0.42	31.5***

Note: B = regression coefficient, SE/B = standard deviation of B, BETA = standardized regression coefficient, $R^2_{adj.}$ =mul-=multiple regression coefficient (percentage of explained variance), ***$p < 0.001$

[a] Four variables entered = VDA, NVDA, linguistic comprehension and temporal structuring ability

Table 6
Summary of five logistic regression analyses (Backward stepwise - Likelihood ratio - method): five predictors entered in each regression model (VDA, NVDA, linguistic comprehension, temporal structuring ability and effect of interaction between VDA and linguistic comprehension) in TD and ID groups

Dependant variable[a]	Chi-square test	(d.f.)	*p* value	B	SE	Wald	(d.f.)	*p* value	Exp (B)
"Deception skills" test									
TD ($n = 43$)									
VDA	13.760	(1)	0.00021	2.388	0.966	6.104	(1)	0.013	10.889
ID ($n = 47$)									
Interaction (VDA × linguistic comprehension)	9.297	(1)	0.00230	0.008	0.003	6.823	(1)	0.009	1.008
"Change of representation" task									
TD ($n = 43$)									
Linguistic comprehension	13.541	(1)	0.00023	0.106	0.035	9.3	(1)	0.002	1.111
"Appearance/reality" task									
TD ($n = 43$)									
Temporal structuring	7.324	(1)	0.0068	0.231	0.093	6.206	(1)	0.013	1.260
"Unexpected-content" task									
TD ($n = 43$)									
Interaction (VDA × linguistic comprehension)	11.396	(1)	0.0074	0.010	0.003	8.680	(1)	0.00322	1.010
"Change of location" task									
TD ($n = 43$)									
NVDA	13.268	(1)	0.00027	1.685	0.588	8.205	(1)	0.00417	5.392
ID ($n = 47$)									
Interaction (VDA × linguistic comprehension)	16.282	(2)	0.00029	−0.20	0.10	4.002	(1)	0.0454	0.980
Linguistic comprehension	16.282	(2)	0.00029	0.309	0.117	7.018	(1)	0.0081	1.363

Note: d.f. = degree of freedom, B = regression coefficient, SE = standard deviation, Wald = Wald test, Exp (B) = odds ratio.

[a] All dependant variables are dichotomous: fail (0)/success (1).

constant-only model about performances in change of representation task. Thirdly, only in the TD group, inclusion of temporal structuring ability significantly improves the predictive power of the constant-only model about performances in appearance/reality task. Fourthly, only in the TD group, interaction between linguistic comprehension and the VDA significantly improves the predictive power of the constant-only model about performances in unexpected-content task. So, in the ID group, none variables entered in logistic regressions (to predict performances in change of representation, appearance/reality and unexpected-content) allowed to increase the predictive power of constant-only models. Fifthly, in the TD group, inclusion of NVDA and, in the ID group, interaction between linguistic comprehension and the VDA and linguistic comprehension significantly improve the predictive power of the constant-only model about performances in change of location task.

In addition, comparisons between subgroups divided according to the median (within group analyses) were performed (Tables 7–9). So, each group (TD and ID) were divided according to the medians of GDA, social understanding and CA.

Table 7
Within group analyses: comparison between subgroups (constituted on the median of the GDA) on ToM belief abilities in TD and ID groups

	TD with low GDA range GDA [3–4.3]		TD with high GDA range GDA [4.4–6.4]		Mann–Whitney *U* value	ID with low GDA range GDA [3.3–4.3]		ID with high GDA range GDA [4.4–6.4]		Mann–Whitney *U* value
	M(S.D.)	Mdn	*M*(S.D.)	Mdn		*M*(S.D.)	Mdn	*M*(S.D.)	Mdn	
Deception skills test (max 1)	0.6(0.5)	1	0.9(0.3)	1	169*	0.5(0.5)	0	0.8(0.4)	1	189.5*
Change of representation task (max 1)	0.7(0.3)	0.5	0.9(0.2)	1	147*	0.6(0.3)	0.5	0.7(0.3)	0.8	209
Appearance-reality task (max 1)	0.4(0.4)	0.5	0.7(0.4)	1	146.5*	0.2(0.3)	0	0.4(0.4)	0.3	207
Unexpected-content task (max 1)	.5(0.4)	0.5	0.7(0.4)	1	151*	0.6(0.4)	0.5	0.7(0.4)	0.8	231
Self false belief question (max 0.5)	0.3(0.3)	0.5	0.4(0.2)	0.5	192	0.3(0.4)	0.5	0.5(0.4)	0.5	220
Other false belief question (max 0.5)	0.2(0.2)	0	0.4(0.2)	0.5	150*	0.3(0.3)	0.5	0.4(0.4)	0.5	248
Change of location task (max 1)	0.0(0.2)	0	0.6(0.5)	1	109.5***	0(0.2)	0	0.4(0.5)	0	173**
Total ToM belief (max 5)	2.2(0.9)	2.3	3.8(1.2)	4	74.5***	1.8(0.7)	2	3(1.2)	3.5	107.5***

One range expressed in years. *Note*: *M* = mean, S.D. = standard deviation, Mdn = median, *U* values were calculated on medians (non-parametric test), $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

Table 8
Within group analyses: comparison between subgroups (constituted on the median of the social understanding) on ToM belief abilities in TD and ID groups

	TD with low SU range SU [2.8–4.9].		TD with high SUrange SU [4.6–7.4].		Mann–Whitney *U* value	ID with low SU range SU [2.8–4.5][a]		ID with high SU range SU [5–9]		Mann–Whitney *U* value
	M(S.D.)	Mdn	M(S.D.)	Mdn		*M*(S.D.)	Mdn	*M*(S.D.)	Mdn	
Deception skills test (max 1)	0.61(0.5)	1	1(0.2)	1	151.5**	0.5(0.5)	0	0.9(0.4)	1	165**
Change of representation task (max 1)	0.72(0.3)	0.5	0.9(0.2)	1	154*	0.6(0.4)	0.5	0.7(0.3)	0.5	199.5
Appearance-Reality task (max 1)	0.44(0.4)	0.5	0.63(0.4)	0.8	172.5	0.2(0.3)	0	0.3(0.4)	0	245
Unexpected-content task (max 1)	0.46(0.5)	0.5	0.73(0.3)	1	153.5*	0.6(0.4)	0.5	0.7(0.3)	0.5	235
Self false belief question (max 0.5)	0.24(0.3)	0	0.4(0.2)	0.5	156*	0.3(0.3)	0.5	0.5(0.4)	0.5	198
Other false belief question (max 0.5)	0.22(0.3)	0	0.33(0.2)	0.5	180.5	0.3(0.3)	0.5	0.4(0.4)	0.5	241
Change of location task (max 1)	0.13(0.3)	0	0.5(0.5)	0.5	145**	0.1(0.3)	0	0.4(0.5)	0	177**
Total ToM belief (max 5)	2.3(1.3)	2	3.7(1)	3.5	93**	1.9(0.9)	2	3(1)	3.5	108.5***

Note: *M* = mean, S.D. = standard deviation, Mdn = median, *U* values were calculated on medians (non-parametric test), $*p < .05$, $**p < .01$, $***p < .001$

[a] Range expressed in years.

Table 9
Within group analyses: comparison between subgroups (constituted on the median of the CA) on ToM belief abilities in TD and ID groups

	Younger TD range CA [2.9–4.3]		Older TD range CA [4.4–5.4]		Mann–Whitney U value	Younger ID range CA [6.3–10.3]		Older ID range CA [10.4–19.5]		Mann–Whitney *U* value
	M(S.D.)	Mdn	*M*(S.D.)	Mdn		*M*(S.D.)	Mdn	*M*(S.D.)	Mdn	
Deception skills test (max 1)	0.6(0.5)	1	1(0)	1	136**	0.7(0.5)	1	0.6(0.5)	1	259
Change of representation task (max 1)	0.7(0.3)	0.5	0.9(0.2)	1	127**	0.7(0.3)	0.5	0.6(0.3)	0.5	249.5
Appearance-Reality task (max 1)	0.4(0.4)	0.5	0.8(0.4)	1	105.5**	0.4(0.4)	0	0.2(0.3)	0	225
Unexpected-content task (max 1)	0.4(0.4)	0.5	0.8(0.4)	1	118.5**	0.8(0.3)	1	0.5(0.4)	0.5	178*
Self false belief question (max 0.5)	0.3(0.3)	0.5	0.4(0.2)	0.5	171	0.5(0.4)	0.5	0.3(0.3)	0.5	183.5*
Other false belief question (max 0.5)	0.2(0.2)	0	0.4(0.2)	0.5	115.5**	0.5(0.3)	0.5	0.3(0.3)	0.3	164.5*
Change of location task (max 1)	0(0.2)	0	0.7(0.5)	1	73.5***	0.2(0.4)	0	0.2(0.4)	0	271
Total ToM belief (max 5)	2.2(0.9)	2.3	4.2(0.8)	4.5	25***	2.7(1)	3	2.2(1.1)	2	199.5

One range expressed in years. *Note*: *M* = mean, S.D. = standard deviation, Mdn = median, *U* values were calculated on medians (non-parametric test), $*p < .05$, $**p < .01$, $***p < .001$

First, the median of GDA (4.3-year-old in both groups) divided each group (TD and ID) into two subgroups: the participants with ''low'' or ''high'' GDA.

In the TD group, within groups analysis showed that the participants with high GDA had better abilities in ToM belief in all tasks than participants with low GDA. In the ID group, participants with high GDA presented better skills in ToM belief – specifically in deception skills test and in change of location – than participants with low GDA.

Second, the median of developmental age in the social understanding scale (4.5 years old in TD group, 4.9 years old in the ID group) divided each group (TD and ID) into two subgroups: the participants with ''low'' or ''high'' level in social understanding.

In the TD group, within groups analysis showed that the participants with high social understanding had better abilities in ToM belief in all tasks (excepted for appearance/reality) than participants with low social understanding. In the ID group, participants with high social understanding presented better skills in ToM belief – specifically in deception skills test and in change of location – than participants with low social understanding.

Finally, the median of CA age (4.3-year-old in the TD group, 10.3-year-old in the ID group) divided each group (TD and ID) into two subgroups: the participants with ''low'' or ''high'' CA.

In the TD group, within groups analysis showed that the old participants had better abilities in ToM belief in all tasks than young participants. In the TD, young participants presented better abilities in the unexpected-content task than old participants. Although no significant difference appeared between medians of these two sub-groups for other ToM belief tasks, we noted that older ID participants obtained always lower results (mean) than younger ID participants.

3. Discussion

Considering the first two questions of this study, the development of ToM belief globally presents a different progression in ID in comparison with a TD group. Specific abilities in different ToM belief tasks show developmental patterns, partially different and partially similar, in the ID and TD groups matched on GDA. Our results confirm the interest in assessing the understanding of the mental state ''belief'' by means of several tasks (Bloom & German, 2000). The variety of contents in the different ToM belief tasks raises the possibility that these tasks may test not exactly the same abilities and that some are easier than others (Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998): it allows emphasis on specific strengths or weaknesses in one or in both groups of participants.

This study confirms the ''difference hypothesis'' of the development of global ToM belief and specifically of two abilities of ToM (change of representation and appearance/reality) in the ID group compared to the TD group. First, the ID participants present lower abilities than the TD children in change of representation. This visual perspective taking task mobilizes similar abilities than false belief tasks (Melot, 1999) and communicational task (Resches & Pérez Pereira, 2007): the participant must take another person's perspective in order to formulate two different points of view about one reality (Veneziano & Hudelot, 2006). We postulate that a weakness in the change of representation in the ID participants reflects their harder renouncement of ''egocentric thought'' than in the TD children (Tourrette, 2006). Second, the TD group presented better abilities in appearance/reality than the ID group who responded frequently by realistic error. This weakness in appearance/reality may be explained by the fact that this task requires: a change in visual perspectives taking, abilities to understand the deception about the object and, some executive functions—including working memory, inhibitory control and management of attention that are usually deficient in the ID group (Cornish et al., 2005).

Furthermore, Flavell et al. (1981) postulated a deficit in metacognition abilities explaining difficulties displayed by the TD children before 4 years in visual perspective taking and in distinction between appearance and reality. This deficit in metacognition abilities may be more severely in our ID participants matched on ADG with the TD children (Desoete & Roeyers, 2002).

In other respects, our results confirm the ''delay hypothesis'' of development in three abilities in ToM belief in the ID children and adolescents, in comparison with the TD children: deception skills, unexpected-content and change of location. During the deception skills test, the participant has to deceive his/her partner (the experimenter). Whereas in order to pass false belief tasks, the participant has to understand that he/she has been deceived (in appearance/reality and unexpected-content tasks), that another person could be deceived (in unexpected-content task) or has been deceived (in change of location task). The assessment of the early ability to use deceptive strategy – about the age of 2 1/2 years in the TD children (Yirmiya et al., 1998) – and the procedure used in this task (the participant has to imitate the ''deception'' strategy displayed by the experimenter), constitute two arguments to explain specific strengths observed in both groups. Second, similar abilities in unexpected-content task were observed in both groups. In their meta-analyses, Yirmiya et al. (1998) also reported no significant difference between the ID and the TD groups, in their review of studies that have used the unexpected-content task. Third, the similar abilities observed in change of location in both groups contrast with results reported by other authors (Abbeduto & Murphy, 2004; Abbeduto et al., 2004; Yirmiya et al., 1998) who emphasize that the ID individuals were not performing so well as the TD children.

Differences and similarities in ToM belief abilities in both groups may be refined by answers to the third question of this study. In general, our results show positive links between global ToM belief abilities and cognitive skills in both groups (de Rosnay and Hughes, 2006). About the TD preschoolers, some authors postulate a major qualitative change in the development of ToM belief around 4–5-year-old (Gauthier & Bradmetz, 2005), corresponding to a cognitive reorganization (Resches & Pérez Pereira, 2007) and other authors consider a gradual change – from 3 to 6-year-old (for a review of the literature about this debate, see Mitchell, 1996). Most often, the success in false belief tasks – around 4–5-year-old – is considered as a ''litmus-test'' (Wellman, 1988; Baron-Cohen, 2000) to access to a ''representational ToM'' (Melot, 1999). Abilities in false belief reflect the recognition that the mind does not simply copy the world, but rather the mind represents and interprets the world (Tager-Flusberg, 2001). In our study, the success in the two false belief tasks – around 5-year-old – in both groups confirms this developmental landmark in ToM development. But the impact of cognitive skills on abilities in each false belief task is different in both groups. So, all the cognitive skills are positively linked with unexpected-content performance in the TD group, but not in the ID group. It is possible that some abilities in executive function were not sufficiently mobilized in the ID group (Carlson, Moses, & Breton, 2002; Wellman & Liu, 2004), but it was not evaluated in the current study. About the change of location task, the ID and the TD participants with high GDA presented better abilities than the ID and the TD participants with low GDA. Some links are observed in both groups between cognitive skills and performances in this task. Furthermore, the non-verbal cognition is the only predictor of performances in change of location, no predictor appearing in the ID group. This result confirms the positive link between the TD participants' abilities in change of location task and their non-verbal cognition found by Abbeduto et al. (2004) in the TD group but not in the ID group. In our study, the floor effect observed in change of location task may be explained by

the fact that some abilities necessary to pass this false belief task. Notably abilities in solving the cognitive conflict presented in this task (Deneault & Morin, 2007; Kikuno, Mitchell, & Ziegler, 2007) are not again mobilized by the ID and the TD participants with a GDA around 4 1/2. It seems that most our participants are not yet in the ''*developmental window*'' allowing them to pass this task (Hale & Tager-Flusberg, 2003). Furthermore, the use of control questions allows to emphasize a weakness in working memory in ID group (Charman & Campbell, 1997).

In comparative studies, the matching of the TD and the ID participants on GDA allows the researcher to analyze the impact of life span (CA) on the understanding of false beliefs in the ID group. So, the earlier success in the unexpected-content task in the ID group than in the TD group may be explained by the frequent training for classification and putting in order in special intervention (usually, Smarties are put in a Smarties box). These abilities in classification would be more stimulated in special elementary schools than in secondary schools that privilege social learning and the development of autonomy in ID adolescents (Thirion-Marissiaux & Nader-Grosbois, submitted). This original hypothesis could explain that young ID participants displayed better abilities in unexpected-content task than older ID participants. Jervis and Baker (2004) also found a negative impact of life span on the ID adults' understanding of false belief. Finally, all cognitive skills and temporal structuring ability are linked with the TD children's performances in appearance/reality task; this structural cognitive pattern – notably the impact of temporal structuring ability – could explain the better distinction between appearance and reality in the TD group than in the ID group.

Concerning the positive links between language and ToM, the strongest link is observed between global ToM belief abilities and receptive language. It must be reminded that the TD group displays better abilities in receptive language than the ID group; this may perhaps explain the differences observed between groups in global ToM belief abilities. The linguistic comprehension is also a predictor of global ToM belief abilities and of performances in several ToM belief tasks in the TD and the ID participants. The receptive language is linked with all ToM tasks in both groups, except with the ID participants' performances in unexpected-content task. Abbeduto et al. (2004) also found positive links between the measure of TROG (English version of ECOSSE) and the ID participants' abilities to change of location task. This task requires that children understand words included in longer utterances rather than isolated words (Slade & Ruffman, 2005). The absence of a link between receptive language and performances in unexpected-content or change of location tasks in the TD children obtained by Tourrette et al. (2000) may be explained by the Khomsi's test (Khomsi, 1987). The importance of receptive language is also pointed when linguistic comprehension constitutes an inclusion criterion in a sample (Charman & Campbell, 2002; Jervis & Baker, 2004) or when control questions are not succeeded by participants (Garner et al., 1999). The links between expressive language and each ToM task are very different in the TD and the ID groups. Expressive language is positively linked with global ToM belief abilities in both groups, except for abilities in denomination of pictures in the ID group. The TD children' abilities in denomination of pictures (semantic aspect) and in definition of words (syntactic aspect) are positively linked with their performances in three ToM belief tasks. A specific link was also emphasized by Tourrette et al. (2000) between expressive language and abilities in change of location in the TD children. In the other hand, only the semantic aspect of expressive language is positively linked with the ability to distinguish appearance and reality. It is plausible that responses in this task mobilize more semantic abilities than syntactic ones. We do not forget the particular heterochrony in language development in the ID persons (Abbeduto & Murphy,

2004). The analyses of individual profiles of ToM may emphasize specific strengths or weaknesses in the different components of language (Thirion-Marissiaux & Nader-Grosbois, 2006). So, it would be interesting to include the assessment of pragmatic abilities in language in comparative ToM research (Abbeduto et al., 2004). Actually, Deleau, Guehenneuc, Le Sourn, & Ricard (1999) found that conversational experiences and mastery of discourse are predictors of ToM belief abilities. Conversations with peers – particularly with older siblings (Jenkins & Astington, 1996) and with adults constitute an ideal context where children learn the understanding of other's beliefs.

In reference to the last question, even if similar performances in social understanding were observed in both groups, our results show that a high ability in social understanding helps the development of ToM belief abilities more in the TD group than in the ID group. Melot (1999) postulated that the ability to distinguish appearance and reality was necessary for social adjustment, allowing to understand that appearances of the word are sometimes misleading. In our study, the positive link between appearance/reality abilities and social understanding was only observed in the TD group. According to Garfield et al. (2001), ToM development and acquisition of knowledge about social life and about persons go together. It is plausible that high ability in social understanding and good knowledge of social rules and conventions are helpful in social interactions. As we mentioned about mental state ''emotions'' (Thirion-Marissiaux & Nader-Grosbois, 2008) intellectual disabilities may affect life span and more particularly social interactions (analyzed in Thirion-Marissiaux & Nader-Grosbois, submitted) and conversational practises (Deleau, 1997).

To conclude, we postulate that relationships between language, ToM belief and abilities in social interactions are necessarily multiple, bidirectional (as also suggested by Hughes & Leekam, 2004) and partially different in the TD and the ID groups.

Wellman and Liu (2004) considered that the development of ToM belief includes the understanding of multiple concepts acquired in an extended series of developmental accomplishments. The use of several tasks allowed us to analyse differences and similarities in ToM belief abilities between both groups.

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Appendix A

(1) *Deception skills test* (Oswald & Ollendick, 1989). First, the participant took pleasure in looking for a hidden object in the experimenter's hands and secondly participant hid the object him/herself in his/her hands. The experimenter noted if the participant had hidden the object by holding his/her hands in his/her back, if he/she showed both fists closed and if the object was really hidden. The game was repeated three times. The test was successful (1 point) if the three criteria were fulfilled for at least 2 out of 3 trials.

(2) *Change of representation task* (Flavell et al., 1981) was based on two concrete supports. At task 1, a cat drawn on a cardboard side and a dog drawn on the other side were presented to the participant. At task 2, a turtle drawn on a sheet placed between the experimenter and the participant. For each level, two questions were asked to the participant ''*what do you see?*''

and "*what do I* [the experimenter set opposite the participant] *see*?" The participant obtained 0.5 point if he/she answered correctly to two questions of one task and 1 point for the correct answers in two tasks.

(3) *Appearance-reality task* (Flavell, 1986). Three substitute objects – (a) a flashlight in the shape of a mobile phone, (b) an eraser in the shape of a peanut in its shell and (c) a telescope looking like a glue stick – were presented to reduce the risk of misreading the object (real or visible) and to appreciate the stability of the participants' performances. Two questions were asked to the participant about each substitute object: "*If you look at this object and you don't touch it, what does it look like?*" and "*What is it, in reality?*" The answers could be given by verbalization or by pointing at a picture amongst two (for (a): a picture of a flashlight and a picture of a mobile phone). Some young TD or ID participants with low VDA mimed their answers (with a conventional gesture – for e.g., gesture of calling – as reference to the functional aspect of the object). The participant obtained 0.5 point if he/she answered correctly to two questions about 1 substitute object and 1 point for the two correct answers about 2 or 3 substitute objects. Analyse of the answers emphasize different types of errors: the phenomenist error ("*it looks like a mobile phone and it's a mobile phone*" the realist error ("*it looks like a flashlight and it's a flashlight*") and the error to both questions ("*it looks like a flashlight and it's a mobile phone*").

(4) *Unexpected-content task* (Perner et al., 1987). This task assessed the participant's ability to predict the false belief given the situation. Participant was shown a Smarties box and the experimenter asked: "*what is it inside the box?*" (The expected response is: Smarties, sweets, chocolates). The participant then opened the box and found that there were pencils inside the Smarties box. The pencils were returned to the box and the participant was then asked: "*what did you think was in the box before the box was opened*?" (Question about self false belief) and "*what will your mother/teacher think was in the box, your mother/teacher had not seen inside the box*?" (Question about other's false belief). The participant obtained 0.5 point if he/she answered correctly to 1 question and 1 point for the correct answers to both.

(5) *Change of location task* (Wimmer & Perner, 1983). The task assessed the participant's ability to predict the doll's behaviour given the false belief of the doll: the story concerns a doll who believes that a desirable object (chocolate) is in one location when, as the participant knows, it is actually ranged in another location. The experimenter placed a doll's house on the table and presented the story of "Max and the transfer of chocolate" to the participant with the help of three dolls. These represented members of the participant's family (correspondence between the hair colour of dolls and hair colour of members of the participant's family): his/her mother (mother doll), his/her older brother, sister or his/her older first cousin (child doll) and the participant him/herself (participant doll). The participant doll did not participate in the story but was hold by the participant and the final questions were asked to the participant doll (methodological adaptation from Wimmer & Perner, 1983). The story presented mother doll and child doll at home. The child doll ranged chocolate in the green cupboard in the living room. While child doll was outside the home, mother doll took chocolate, cooked a chocolate cake and ranged chocolate in white cupboard in the kitchen. After, child doll returned to inside the home, he/she was hungry and would like to eat some chocolate. The final ToM belief question was: "*where will X [child doll] look first for the chocolate*?" Two control questions were asked: "*where was the chocolate at first*?" (Control memory question) and "*where is the chocolate now*?" (Control reality question). The participant obtained 1 point if he/she answered correctly to the ToM question. The answers to control-questions are used for qualitative analyses.

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