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Relationship between Age and Psychopathological Manifestations in School-Age Children with an Intellectual Disability: The Role of Executive Functioning

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The risk of psychopathology among children with an intellectual disability (ID) is 3 to 4 times higher than their typical peers, with prevalence rates ranging from 35 to 40%. Psychopathological manifestations vary according to sex, age, and IQ of children with an ID. The present study explores the mediating role of executive functions, on the one hand, between age and psychopathological manifestations and, on the other hand, between IQ and psychopathological manifestations in school-age children with an ID. Participants were recruited in a rehabilitation center for people with intellectual disabilities (Quebec, Canada). Parents (106 mothers and 83 fathers) assessed their child (54 girls and 68 boys with an ID from 5 to 21 years old) by filling out the Behavior Rating Inventory of Executive Function (BRIEF) and the Developmental Behaviour Checklist – 2nd Edition – Primary Carer Version (DBC-P). Results showed that parents report a higher level of anxiety and more difficulty with emotional control for girls than boys. Moreover, IQ was not significantly correlated with BRIEF's executive functioning subscales and indexes. Therefore, executive functions could not be considered as a mediating variable between IQ and psychopathological manifestations.

The risk of psychopathology among children with an intellectual disability (ID) is 3 to 4 times higher (Tonge, 2007) than their typical peers, with prevalence rates ranging from 35 to 40% (Dekker & Koot, 2003; Emerson, 2003; Emerson & Hatton, 2007; Tonge, 2007). A better understanding of the variables associated with psychopathological manifestations may allow the development of appropriate intervention and prevention strategies for this clientele.

The assessment of psychopathology in people with an ID is complex because the expression of symptoms may differ from that of the typical population (de Ruiter, Dekker, Verhulst, & Koot, 2007; Tonge, 2007). The lack of standardized instruments, communication and expression difficulties typical among

individuals with an ID, and the fact that ID can mask symptoms of psychopathology are factors that can explain this situation. In addition, there is no consensus on the definition of psychopathology in people with an ID (Dekker, Koot, van der Ende, & Verhulst, 2002; Sturmey, 2007).

Psychopathology is the manifestation of a behavioral, psychological, or biological dysfunction in a person, which results in clinically significant behavioral or psychological symptoms (APA, 2013). They can be subdivided in three categories of disorders: internalized (e.g., depression, anxiety), externalized (attention-deficit, hyperactivity, conduct, and other impulse control disorders), and those related to substance use (Achenbach & Edelbrock, 1978; Krueger, 1999).

Studies show that psychopathological manifestations among children with an ID vary according to their sex, age, and IQ. In this regard, Bradley and Isaacs (2006) mention that the sex differences among typically developing children are likely to be found in children with an ID. Among typically developing children, boys exhibit more externalizing disorders and girls internalized ones. These sex distinctions may be explained by differences in sociocultural education related to child's sex, psychological maturity level, developmental curve, and also some biochemical changes (Winstead & Sanchez, 2005). In children with an ID, many studies showed that externalizing disorders as antisocial behavior, conduct disorders, cognitive problems, are more prevalent among boys (Emerson, 2003; Hastings & Mount, 2001; Steinhausen & Metzke, 2004). Compared with the latter, girls with an ID manifest more internalized disorders as depressive symptoms (Lunsky, 2003). However, other studies found no sex differences (Chadwick, Piroth, Walker, Bernard, & Taylor, 2000; Dekker & Koot, 2003) or more manifestations of internalizing behaviors (e.g., self-absorbed behaviors) by boys (Hastings & Mount, 2001). Links between sex and psychopathological manifestations in children with an ID are still sparsely studied. Consequently, little evidence was provided to explain the disparity in the results.

Research also indicates that externalizing behaviors, including hyperactivity symptoms and conduct disorders, decrease with age, while emotional problems increase (Einfeld, Tonge, & Turner, 1999; Tonge & Einfeld, 2000). However, psychopathological manifestations are less likely to decrease over time in children with a severe to profound ID than in those with a mild ID. This could possibly be due to more severe brain abnormalities (Einfeld et al., 2006). Moreover, children with a severe to profound ID presented

more stereotyped behaviors, self-injury, and social withdrawal (Chadwick et al., 2000; Einfeld et al., 2006; Einfeld & Tonge, 1996; Koskentausta, Iivanainen, & Almqvist, 2007), while children with a mild to moderate ID manifest more antisocial and disruptive behavior as well as depressive and anxiety symptoms (Einfeld et al., 2006; Einfeld & Tonge, 1996; Koskentausta et al., 2007). Finally, results from current research are not consistent on this aspect. While some authors report that children with a severe to profound ID are more at risk of psychopathological manifestations (McCarthy, 2008) others mention that the risk is higher in children with a moderate ID (Koskentausta et al., 2007).

The origin of psychopathological manifestations seems multifactorial, but as brain abnormalities and diffuse brain damage is commonly observed, the importance of biological factors should be considered (Lussier & Flessas, 2009). Some authors reported that development of the brain and its functions would differ in people with an ID (White, Chant, Edwards, Townsend, & Waghorn, 2005) as well as report that structures of the frontal lobes and of the prefrontal cortex develop atypically (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Japundza-Milislavljjevic & Macesic, 2008; Lussier & Flessas, 2009). Since the prefrontal cortex is considered the seat of executive functions, it suggests some of these functions could not reach full maturity in the context of ID.

Executive functions control and supervise the organization and management of cognitive activities, as well as emotional responses and behaviors (Isquith, Crawford, Espy, & Gioia, 2005). They interact as an integrated supervisory system (Anderson et al., 2001; Huizinga, Dolan, & Van der Molen, 2006; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). More specifically, they allow the

individual to adapt more effectively and easily to new situations when the learned and automatic action routines are insufficient (Goldstein & Naglieri, 2014). These functions include inhibition, cognitive flexibility, working memory, planning, emotional control, initiation, ability to organize material, and self-assessment (Gioia et al., 2000a; Miyake, Friedman, Emerson et al., 2000).

The development of executive functions begins in childhood and continues into early adulthood (Anderson, 2002; Romine & Reynolds, 2005). Several factors contribute to their development. The first factor relates to the growth and maturity achievement of anterior, posterior, and subcortical brain regions (Anderson, 2002; Romine & Reynolds, 2005). The second factor relates to the refinement of connections within the prefrontal cortex and those between the latter and the motor, sensory, and associative brain regions. Finally, myelination of nerve fibers that occurs during childhood and adolescence may contribute to both the development and specification of connections and optimization of executive functions as information transmission would perform more efficiently (Anderson, 2002). For an optimal and appropriate operation of executive functions, it is important that the entire brain is preserved, despite the importance played by the frontal lobes in their operation (Anderson, 1998). The inhibition ability and working memory, which are considered more primary functions, and are among the first to develop, while planning, problem solving, and flexibility develop later (Epsy, Kaufmann, Glisky, & McDiarmid, 2001; Huizinga et al., 2006). Due to an earlier maturation of prefrontal regions in girls, there may be differences in the developmental trajectory of executive functions related to child's sex (Chevalier, 2010). Some authors found that girls performed better on tasks assessing inhibition abilities during the preschool

period (Carlson & Moses, 2001) while others found no difference between the sexes (Hongwanishkul, Happaney, Lee, & Zelazo, 2005). On this issue, Chevalier (2010) mentioned that girls' executive functioning was slightly more efficient than boys', but that the differences were tenuous.

In several neuropsychological and neuropsychiatric disorders that coexist with an ID, such as conduct disorders, attention-deficit disorder with hyperactivity, autism and Tourette's syndrome, executive dysfunctions were observed, notably concerning inhibition ability and working memory (Barkley, 1997; Pennington & Ozonoff, 1996). Thus, children with an ID and with symptoms of these disorders can have deficits in terms of inhibition capacity, attention, working memory or planning (Oosterlaan, Scheres, & Sergeant, 2005; Pennington & Ozonoff, 1996; Roelofs et al., 2015; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

Executive functions in children with ID have not been studied extensively (Willner, Bailey, Parry, & Dymond, 2010). Some studies that focused on specific phenotypes of individuals with an ID identified deficits at different levels. An executive dysfunction is found in people with fragile X syndrome (Van der Molen et al., 2010). Children with velo-cardio-facial syndrome have difficulties in terms of shared attention, cognitive flexibility, and executive control (Bish, Ferrante, McDonald-McGinn, Zackai, & Simon, 2005; Lewandowski, Shashi, Berry, & Kwapil, 2007; Sobin et al., 2004; Woodin et al., 2001), while in adults, these difficulties concern planning and problem solving (Henry et al., 2002). A general executive dysfunction is observed in adolescents and adults with trisomy 21 (Lanfranchi, Jerman, Dal Pont, Alberti, & Vianello, 2010; Rowe, Lavender, & Turk, 2006).

In summary, even if authors mentioned a link between abnormal development of executive functions and some neuropsychiatric conditions, and externalizing disorders in childhood (Barkley, 1997; Oosterlaan et al., 2005; Pennington & Ozonoff, 1996), no identified study examined the link between executive function deficits in children with an ID and the psychopathological manifestations. On the other hand, research suggests that psychopathological manifestations in children with an ID vary notably by sex, age, and IQ (e.g., Bradley & Isaacs, 2006; Einfeld et al., 1999, 2006). Consequently, this study aims to verify if: 1) among children with an ID, girls present more internalized and less externalized psychopathological manifestations than boys, and show a more efficient executive functioning, when age and IQ are taken into account; 2) the executive functioning (inhibition, cognitive flexibility, working memory, planning, emotional control, initiation, ability to organize material, and self-assessment) plays a mediating role between age (independent variable) and psychopathological manifestations (dependent variable) in children with an ID, when sex and IQ are taken into account (controlled variables); and 3) the executive functions play a mediator role between IQ (independent variable) and psychopathological manifestations (dependent variable) in children with an ID, when age and sex are taken into account (controlled variables).

Method

Procedure

This research was conducted in the Saguenay-Lac-Saint-Jean region in the northeast part of Quebec Province in Canada. All the families of this region that have a child, from 5 to 21 years old, with a confirmed diagnosis of ID and who is receiving public services from the rehabilitation center for intellectual disabilities received a letter informing

parents of the main objectives of the study. The letter also stated they would be contacted by a professional from the center to invite parents to participate. In a phone call, the professional presented the study objectives, confidentiality and anonymity measures and obtained the consent of families to send their contact information to the principal investigator. A second phone call was made by a research coordinator to gather information about the child with an ID and the family and arrange an appointment for a home visit. During the visit, a research assistant obtained parents' informed consent. Subsequently, they individually completed a self-reported questionnaire, which included a section on child behaviors.

Participants

Among parents who completed the questionnaires, 106 are mothers and 83 fathers (80 couples). The age of fathers ranged from 31 to 62 years ($M = 44.8$, $SD = 7.5$) and from 27 to 60 years for mothers ($M = 41.7$, $SD = 7.5$). Fathers are significantly older than mothers [Welch's t -test (176) = -2.81, $p < .01$]. The last level of education completed is primary/secondary for nearly 60% of parents and 85% consider their family income sufficient to support family needs.

Data collection among parents was based on 122 children (54 girls and 68 boys) from 5 to 21 years old ($M = 13.5$, $SD = 4.9$) with an ID. Concerning ID level, 18% have a mild disability, 42% have a moderate disability, 27% have a severe disability, and 13% have a profound ID. Moreover, 31% have only a slight deficit on adaptive behaviors. Most children live in a nuclear family (71%) and attend a special class (66%) in school. A psychopathological manifestations questionnaire independently completed by mothers and fathers indicated that 75 children (37%) of the sample can be considered as having psychopathological manifestations. Based on observations

made by parents regarding executive functioning, 68 children (34%) of the sample presented difficulties with no sex differences.

Instruments

The Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000b) is designed to assess executive behaviors in children aged 5 to 18 years. It includes 86 items related to behaviors that may be manifested at home or school for which the parent has to assess whether the behavior is either 0 = never a problem, 1 = sometimes a problem or 2 = often a problem. Items are divided into 8 subscales: Inhibit (10 items), Shift (8 items), Emotional Control (10 items), Initiate (8 items), Working Memory (10 items), Plan/Organize (12 items), Organization of Materials (6 items), Monitor (8 items). These subscales are grouped into two indexes. The Behavioral Regulation Index (BRI) includes the first three subscales, whereas the Metacognition Index (MI) the other 5 subscales. An overall score, the Global Executive Composite (GEC), is also available and a T score above 65 is considered clinically significant. The alpha coefficients of the English version vary from .80 to .98. In this study, the alpha coefficients of the French version ranged from .79 to .97 for the overall score, the 2 indexes, and the 8 subscales. Those scores and indexes were used as mediator variables.

The French version of the Developmental Behavior Checklist – 2nd Edition - Primary Carer version (DBC-P; Einfeld & Tonge, 2002) was used to assess psychopathological manifestations in children with an ID aged 4 to 18 years. Parents rated each of the 96 items (15 to 20 min) using a 3-point Likert scale (0 = not true or does not apply, 1 = somewhat or sometimes true, 2 = very or often true). A principal component analysis revealed five factors (Disruptive/Antisocial, Self-

Absorbed, Communication Disturbance, Anxiety, and Social Relating) explaining 43.7% of the variance (Einfeld & Tonge, 2002). A total score above 45 is considered clinically significant. The alpha and test-retest coefficients (2 weeks interval) vary respectively from .66 to .91 and from .51 to .87. In this study, alpha coefficients of the overall score and of the five subscales range from .67 to .95. Those scores were used as dependent variables.

Results

Correlations and hierarchical multiple regressions were used respectively to test the first hypothesis stating sex differences between children on psychopathological manifestations and executive functioning and the two hypotheses on the mediating role of executive functions. The regression analysis can be used to control confounding variables like sex, age or IQ in respect to hypothesis.

Preliminary analyses showed that no univariate and multivariate outliers were found and that assumptions of normality, homoscedasticity, collinearity, and linearity were met. Matrix correlations between all variables show that child's sex is significantly related to anxiety [$r(199) = -.17, p < .05$] and to emotional control [$r(199) = -.14, p < .05$]. Thus, according to parents, girls are more anxious ($M = 4.74, SD = 3.27$) and show more emotional control problems ($M = 20.25, SD = 5.77$) than boys ($M = 3.70, SD = 2.76; M = 18.68, SD = 5.29$, respectively). No other significant correlations with child's sex were observed. Consequently, the first hypothesis stating that girls present more internalized and less externalized psychopathological manifestations than boys and show a more efficient executive functioning, when age and IQ are taken into account, is partially confirmed.

To test the second hypothesis on the mediating role between age and psychopathological manifestations, a

partial correlations matrix was computed in order to verify Baron and Kenny's (1986) criteria. According to these authors, three conditions are to be met. First, the independent variable (IV) must be significantly correlated with the mediating variable (MV). Secondly, the MV must be significantly correlated to the dependent variable (DV). Finally, the IV must be significantly correlated to the DV. Moreover, when the MV is considered, the correlation coefficient between the IV and DV decreases or becomes nonsignificant (partial or total mediation). Lastly, to determine if the effect of the MV is significant or not, the Sobel test was applied (MacKinnon & Fairchild, 2009).

The correlations between age and BRIEF's subscales were consequently examined while sex and IQ were controlled (see Table 1). The first criterion was met for 3 executive function components (Working Memory, Organization of Materials, and Monitor) of the Metacognition Index and the latter overall index. Indeed, significant correlations were found between age (IV) and Metacognition Index [$r(199) = -.18, p < .01$], Working Memory [$r(199) = -.22, p < .01$], Organization of Materials [$r(199) = -.31, p < .001$], and Monitor [$r(199) = -.15, p < .01$] subscales. The second criterion of Baron and Kenny (1986) was also met since these four variables (MV) were significantly correlated to all of DBC-P subscales as well as its overall score (DV). Lastly, in relation to the last criterion, age is significantly correlated to two subscales of the DBC-P: Self-Absorbed Behaviors [$r(199) = -.35, p <$

$.001$], and Social Relating [$r(199) = .23, p < .001$].

Subsequently, hierarchical multiple regressions were performed on DBC-P subscales and overall score separately. The control variables (sex and IQ) were entered in the first block of regression analysis. The second block included the age (IV) and the MV alternatively (Metacognition Index, Working Memory, Organization of Materials, Monitor). Sobel tests allow confirmation that Metacognition Index (*Sobel z-value* = -2.54, $p < .05$), Working Memory (*Sobel z-value* = -3.03, $p < .01$), Organization of Materials (*Sobel z-value* = -3.71, $p < .001$), and Monitor (*Sobel z-value* = -2.10, $p < .05$) partially mediate the relationship between age and Self-Absorbed Behaviors subscale (see Table 2). Conversely, the different MVs (Metacognition Index, Working Memory, Organization of Materials, Monitor) increased the effect of age on the Social Relating subscale, suggesting a suppression effect. Sobel tests indicated that all these effects were significant (Metacognition Index: *Sobel z-value* = -2.31, $p < .05$; Working Memory: *Sobel z-value* = -2.81, $p < .01$; Organization of Materials: *Sobel z-value* = -3.15, $p < .01$; and Monitor: *Sobel z-value* = -2.04, $p < .05$). In conclusion, the second hypothesis on the mediator role of executive functions between age and psychopathological manifestations is partially confirmed. In fact, only metacognition indicators play a mediating effect between age and the Self-Absorbed Behaviors subscale, but a suppressor role for Social Relating subscale.

Table 1

Partial correlations between age and BRIEF subscales after controlling for sex and IQ

	1	2	3	4	5	6	7	8	9	10	11
1. Age	--										
2. INHIB	-.08	--									
3. SHIFT	.04	.67 ***	--								
4. EMOCTL	-.04	.69 ***	.64 ***	--							
5. INITIA	-.01	.64 ***	.54 ***	.53 ***	--						
6. WMEM	-.22 **	.61 ***	.56 ***	.45 ***	.72 ***	--					
7. PLAN	-.07	.62 ***	.56 ***	.50 ***	.71 ***	.75 ***	--				
8. ORGMAT	-.31 ***	.51 ***	.42 ***	.48 ***	.51 ***	.59 ***	.59 ***	--			
9. MONIT	-.15 *	.77 ***	.61 ***	.59 ***	.69 ***	.71 ***	.75 ***	.61 ***	--		
10. BRI	-.04	.90 ***	.84 ***	.90 ***	.64 ***	.60 ***	.63 ***	.54 ***	.75 ***	--	
11. MI	-.18 **	.73 ***	.63 ***	.59 ***	.86 ***	.90 ***	.88 ***	.77 ***	.87 ***	.73 ***	--
12. GEC	-.13	.87 ***	.77 ***	.78 ***	.82 ***	.82 ***	.82 ***	.71 ***	.87 ***	.92 ***	.95 ***

Note. INHIB=Inhibit. SHIFT=Shift. EMOCTL=Emotional Control. INITIA=Initiate. WMEM=Working Memory. PLAN=Plan/Organize. ORGMAT=Organization of Materials. MONIT=Monitor. BRI=Behavioral Regulation Index. MI=Metacognition Index. GEC=Global Executive Composite of Behavior Rating Inventory of Executive Function (BRIEF).

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2

Results of mediation analysis using hierarchical multiple regression

Mediating Variable (MV)	Dependent Variables (DV)	Initial β coefficient for age	β coefficient for age after introduction of the MV	Percentage of explained variance (r^2)
Metacognition Index	Self-Absorbed Behaviors	-.35***	-.25***	45.5
	Social Relating	.23***	.32***	29.7
Working Memory	Self-Absorbed Behaviors	-.35***	-.24***	39.5
	Social Relating	.23***	.34***	26.1
Organization of Materials	Self-Absorbed Behaviors	-.35***	-.22***	31.9
	Social Relating	.23***	.34***	15.3
Monitor	Self-Absorbed Behaviors	-.35***	-.26***	45.8
	Social Relating	.23***	.29***	21.2

Note. The percentage of explained variance includes age and the MV.

*** $p < .001$.

The same procedure was carried out to verify the third hypothesis that stated executive functions perform a mediating role between child's IQ and psychopathological manifestations, taking into account sex and age. A partial correlations matrix (see Table 3) showed there was no significant relationship between children's IQ and any of BRIEF's subscales. Thus, the first criterion of Baron and Kenny (1986) necessary for mediation is not met. Consequently, no further analyses were conducted and the third hypothesis was unconfirmed.

Discussion

The first hypothesis stated that girls with an ID present more internalized and less externalized psychopathological manifestations than boys and show a more efficient executive functioning than boys. Results partially confirm this hypothesis. Indeed, sex is significantly linked to anxiety as assessed by the DBC-P. Girls showed higher scores than boys. This result converges with those reported by other authors (Bradley & Isaacs, 2006; Einfeld, et al., 2006; Winstead & Sanchez, 2005).

Bradley and Isaacs (2006) indicated, among other things, that sex differences observed in the general population in relation to psychopathology may also be found among people with an ID. Thus, in children with typical development, biological, cognitive, and emotional development of girls is faster than boys. This is due to the fact that puberty occurs earlier. The same mechanisms operate for the majority of children with an ID, but puberty may occur at a later chronological age than in typically developing children (Morano, 2001). In addition to these phenomena, boys and girls with an ID are more exposed to negative social experiences such as peer rejection, stigma or intimidation (Reiss & Benson, 1984). The combination of negative social experiences may affect children's perception about themselves (Emerson & Hatton, 2007). As in general population, anxiety appears more prevalent for girls with an ID.

In this sample, anxiety is the only significant sex difference concerning psychopathological manifestations. In other studies, many authors found no sex differences on psychopathological

Table 3

Partial correlations between IQ and BRIEF subscales after controlling for sex and age

	1	2	3	4	5	6	7	8	9	10	11
1. IQ	--										
2. INHIB	-.07	--									
3. SHIFT	-.01	.67 ***	--								
4. EMOCTL	-.04	.69 ***	.64 ***	--							
5. INITIA	-.14	.64 ***	.54 ***	.53 ***	--						
6. WMEM	-.09	.61 ***	.56 ***	.45 ***	.72 ***	--					
7. PLAN	-.11	.62 ***	.56 ***	.50 ***	.71 ***	.75 ***	--				
8. ORGMAT	-.31	.51 ***	.42 ***	.48 ***	.51 ***	.59 ***	.59 ***	--			
9. MONIT	-.05	.77 ***	.61 ***	.59 ***	.69 ***	.71 ***	.75 ***	.61 ***	--		
10. BRI	-.05	.90 ***	.84 ***	.90 ***	.64 ***	.60 ***	.63 ***	.54 ***	.75 ***	--	
11. MI	-.14	.73 ***	.63 ***	.59 ***	.86 ***	.90 ***	.88 ***	.77 ***	.87 ***	.73 ***	--
12. GEC	-.10	.87 ***	.77 ***	.78 ***	.82 ***	.82 ***	.82 ***	.71 ***	.87 ***	.92 ***	.95 ***

Note. INHIB=Inhibit. SHIFT=Shift. EMOCTL=Emotional Control. INITIA=Initiate. WMEM=Working Memory. PLAN=Plan/Organize.

ORGMAT=Organization of Materials. MONIT=Monitor. BRI=Behavioral Regulation Index. MI=Metacognition Index. GEC=Global Executive Composite of Behavior Rating Inventory of Executive Function (BRIEF).

*** $p < .001$.

manifestations among children with an ID (Chadwick et al., 2000; Dekker & Koot, 2003). The complex interactions between age, level of ID, and sex may be explained by the heterogeneity of psychopathological manifestations among children with an ID and differences observed with those typically developing (Einfeld et al., 2006; Witwer & Lecavalier, 2008). Thus, it is difficult to identify the contribution of each factor and the interaction may better reflect the whole. Moreover, Mash and Dozois (2003) found that, in children with typical development, sex differences among preschoolers and elementary school children are tenuous or sometimes nonexistent, but increase with age. Considering the fact that socio-emotional development and brain maturation occur later in children with an ID, it is possible that sex differences may also occur later and accentuate with age. Nevertheless, the relationships between sex and psychopathological manifestations in children with an ID were not studied extensively and so far results diverge. Now that dual diagnosis in ID is recognized, Hodapp and Dykens (2005, 2009) recommend that studies address this topic.

The first hypothesis also postulated executive functions of girls with an ID are more efficient than that of boys, but the only emerging sex difference concerns emotional control. However, it appears that girls experience more difficulties than boys in modulating their emotional responses by showing, for example, emotional lability or overreacting to innocuous events (Gioia et al., 2000b). Some authors suggested that executive functioning of girls with typical development was slightly more efficient than boys (Chevalier, 2010), particularly in terms of inhibition capacities (Carlson & Moses, 2001), due to an earlier maturing of prefrontal brain regions in girls. The fact that brain development of children with an

ID occurs later and with anomalies, in comparison to typically developing children, may explain the few sex differences found between boys and girls (Lussier & Flessas, 2009). In addition, some studies reported no sex differences in executive functioning among children with typical development (Hongwanishkul et al., 2005). On the other hand, the higher level of girls' anxiety observed by parents may contribute to emotional control difficulties. Finally, it is socially expected that girls should be quieter and more reserved than boys (Carter, Silverman, & Jaccard, 2011). Consequently, as behavioral problems exhibited by girls with an ID are more prevalent than in the general population, they can underlie emotional control difficulties.

The second hypothesis stated that executive functions play a mediating role between age and psychopathological manifestations in children with an ID. Results showed that metacognition had a mediating role between age and self-absorbed behaviors and a suppression effect in the relationship between age and social related problems.

Even if authors report children with an ID manifested less self-absorbed behaviors as they get older, few hypotheses were formulated to explain this relationship (Cormack, Brown, & Hastings, 2000; Einfeld & Tonge, 2002; Einfeld et al., 2006). Einfeld et al. (2006) and Witwer and Lecavalier (2008) indicated sex and ID level were related to psychopathological manifestations, but that other variables may also intervene in this relationship. Metacognition could therefore be one of these variables. De Ruiter et al. (2007) suggested age could have a positive or a negative relationship depending on the type of psychopathological manifestations. According to these authors, developmental stages of children with an ID may differ or

occur later than those of typically developing children due to a deficit or a delay concerning communication skills development. Emotions are thus more likely to be expressed through impulsiveness, social withdrawal or behavioral problems such as self-absorbed behaviors. Consequently, the older the child gets, the more likely he should develop communication and social skills, which would reduce behavioral disorders as in young children with typical development. This developmental stage might occur later in children with an ID (de Ruyter et al., 2007). In this sense, Lussier and Flessas (2009) argued that frontal lobes of children with an ID may develop more belatedly and would not reach maturity due to frequent brain abnormalities. The decline of self-absorbed behaviors with age may also be related to acquisition of language skills which are linked to executive functions development (Denckla, 1996; Dodd & Crosbie, 2011). Indeed, authors demonstrated that verbalization of relevant information while solving tasks involving executive functioning promotes children's performance (Fernyhough & Fradley, 2005; Kirkham, Cruess, & Diamond, 2003; Müller, Zelazo, Hood, Leone, & Rohrer, 2004). Children with better language skills also have more efficient executive functioning (Espy, Bull, Martin, & Stroup, 2006). Therefore, just as in children with typical development, language development seems to contribute to an increase in metacognitive capacities in children with an ID. Acquisition of metacognition, which relates to the ability of the child to initiate, plan, organize, and maintain an effective strategy for problem solving in working memory, enables him to self-regulate and reflects his ability to adjust in a current task and also to consider environmental feedback (Gioia et al., 2000b). It allows the child to increase self-awareness and sensitivity to the surrounding world, and also to decrease self-

absorbed behaviors. Development of executive functions, notably metacognition, is linked to adaptive functioning and socio-emotional skills development (Dodd & Crosbie, 2001). Moreover, Einfeld et al. (2006) found children with severe to profound ID have the highest scores concerning self-absorbed behaviors and the latter are negatively correlated with age. Consequently, children with mild to moderate ID exhibit less self-absorbed behaviors, greater language skills and metacognition capacities. Considering a later maturation of the frontal lobes, metacognition capacities are also likely to develop later in children with severe or profound ID.

Contrary to what was expected, results highlighted the suppression role of metacognition in the relationship between age and social related problems. The suppression effect of a variable (metacognition) means that its introduction into the relationship between the independent variable (age) and the dependent variable (social related problems) increases the proportion of variance explained by the independent variable (MacKinnon et al., 2009). The older the child gets, the more likely s/he is to demonstrate skills in terms of metacognition and also become at risk for relationship problems. Einfeld et al. (2006) found relationship problems increase, while other types of psychopathological manifestations tend to decrease with time. They hypothesize that an increase of anxiety symptoms and of relationship disorders in girls might reflect that the social skills of the child are more solicited with age, for example when leaving a protected environment, such as school. Several authors also identified that as children with an ID get older they face more psychosocial stressors than typically developing children

(de Ruiter et al., 2007; Emerson & Hatton, 2007; Wallander, Dekker, & Koot, 2006). These stressors can produce negative consequences on personality development of the child, his/her emotional adjustment, and attachment capacities, which can lead to inappropriate social behavior and eventually to relationship problems (Tonge, 2007). Child's metacognitive development allows him to become more aware of the world around him, of his/her condition, of his/her differences, and the look of others over him, but his skills in terms of problems solving remain nevertheless limited. In this sense, Lussier and Flessas (2009) report that in children with a mild ID, development usually stops at the concrete operational stage. Thus, these children are likely to be less skilled to solve new or unusual problems because they lack metacognitive strategies and have difficulties using them spontaneously. De Ruiter et al. (2007) found the adolescence period confronts the child with an ID with his personal limitations and s/he becomes more at risk to develop internalized disorders that can cause or be expressed by relationship problems. Evans (1998) added these children would have an unrealistic self-concept, which would expose them to multiple failures in their interpersonal relations. This would make children more vulnerable to depression, which can be expressed by social withdrawal and relationship problems. Although results show a reduction of executive problems with age, the executive functioning of these children is not as efficient as that of typically developing children. Thus, an altered or incomplete development of executive functions, and more specifically of metacognition, does not allow the child to acquire sufficient socio-emotional capabilities to adequately adapt to his environment. To this end, Danielsson, Henry, Messer, and Rönnerberg (2012) found the global executive functioning of children

with a mild ID is significantly less efficient than that of children of the same chronological age. Finally, this result may be related to that discussed above, namely that the development of metacognition with age is linked to less self-absorbed behaviors. Consequently, the child, who is more open to others and less centered on him/herself, has more opportunities to interact socially, but this also creates more opportunities to have relationship problems.

As in typically developing children, metacognition development is related to age among children with an ID, but contrary to what was expected, it is not the case for behavioral regulation. Behavioral control is the child's ability to show cognitive flexibility and to modulate emotions and behavior through appropriate inhibitory control. It allows metacognitive processes to develop into an active and effective problem solving system and more generally, to support effective self-regulation. Moreover, Gioia et al. (2000b) indicated behavioral regulation would occur prior to metacognition development. This raises the question whether behavioral regulation skills stop developing earlier in children with an ID than among those typically developing. In the latter, the inhibitory capacity, part of behavioral regulation, starts to develop during preschool years and improvements can be noted up to the age of 21 (Best, Miller, & Jones, 2009; Huizinga et al., 2006; Romine & Reynolds, 2005). Inhibitory capacity is also recognized as playing a fundamental role in other executive functions development (Best et al., 2009). A deficit of inhibitory processes in infancy could then have a negative influence on the development of other executive functions without necessarily nullifying their development because, in the current sample, changes are observed on metacognition.

The last hypothesis stating that executive functions play a mediator role between IQ and psychopathological manifestations in children with an ID is unconfirmed because IQ is not significantly correlated with the various executive functions studied in this research. According to previous authors, the links between IQ and executive functions differ. Thus, some studies with non-clinical populations showed links between performances in so called intelligence tasks and tasks assessing executive functions (Carpenter, Just, & Schell, 1990; Miyake, Friedman, Rettinger, Shah, & Hegarty, 2000; Salthouse, Fristoe, McGuthry, & Hambrick, 1998). More specifically, Luciano et al. (2001) raise the possibility that executive functions and intelligence share a common variance that could be explained by frontal lobe development level. In a sample of adults with an ID of various etiologies, Willner et al. (2010) observed very weak links between IQ and performance on tasks assessing executive functions. However, other authors indicate that it is not all executive functions that have links with intelligence (Friedman et al., 2006). Therefore, Hooper et al. (2008) as Kirk, Mazzocco, and Kover (2005) found that IQ is related to low performance on executive function tasks, particularly concerning inhibition, flexibility, planning, and working memory in children with fragile X syndrome or Turner syndrome. Results of the current study are not in the same direction as those found in previous research (Carpenter et al., 1990; Miyake, Friedman, Rettinger et al., 2000; Salthouse et al., 1998). Those latter focused on homogeneous samples of children for whom the etiology of ID was known (Hooper et al., 2008; Kirk et al., 2005). In the current study, the sample included children with different or unknown origins of ID. This sample heterogeneity may have contributed to the

fact that IQ is not linked to the various executive functions assessed by the BRIEF.

The BRIEF is a questionnaire that allows an ecological assessment of executive functioning based on behaviors observed at home or school. However, different authors observed that BRIEF scores are not or are only slightly correlated to those obtained with tests assessing executive functions, such as inhibition, and working memory (Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; McAuley, Chen, Goos, Schachar, & Crosbie, 2010; Vriezen & Pigott, 2002). According to McAuley et al. (2010), this questionnaire better assesses attention deficits and hyperactivity than executive functioning. The BRIEF's Working Memory subscale is particularly sensitive to these problems and the combination of Working Memory, Inhibit, Shift, and Plan/Organize subscales are good predictors of AD/HD (McAuley et al., 2010). Thus, future studies could include tests to assess executive functioning and compare results with measurements reported by members of the entourage. The factorial structure of the BRIEF is also questioned by various authors. According to some, a factorial structure with three factors: one related to behavioral regulation, another to metacognition and a third to emotional regulation could account for more explained variance (Egeland & Fallmyr, 2010; Peters, Algina, Smith, & Daunic, 2012). In addition, the Monitor subscale should be divided in two in order to account for differences between tasks and behavior management. On the other hand, Keogh and Bernheimer (1998) reported clinicians and researchers insist on behavior problems assessment using various informants to obtain a more accurate portrait of the behavior in different environments. In this study, children's assessment was generally done by their two parents. Even if it was done separately, this

constitutes a limitation since their evaluations are not completely independent as they are from the same family. Moreover, parental assessment of child behavioral problems could be affected by their level of psychological distress. As the latter is more prevalent among parents of children with an ID than in general population (Baker et al., 2003), they may report more child behavioral problems (Renk et al., 2007).

Representativeness of the study's sample may affect external validity. It is composed of parents receiving services from a center for children with an ID. In Quebec it is known that families having a child with a mild ID are less likely to use services available. This may contribute to the lack of variability concerning IQ and the small correlations found between IQ scores and various executive functions or psychopathological manifestations assessed, respectively, by the BRIEF and DBC-P. Consequently, it would be interesting to conduct this study with a sample including more children with a mild ID. As significant links were found in studies on typical populations, it would be useful to understand why correlations were not found in ID.

Conclusion

Until now, few studies investigated executive functions of children with an ID due to characteristics of the population that limit neuropsychological tests choice, but the current study showed that an assessment of executive functioning of these children through informants provides interesting results for clinical purposes. Among reviewed papers, no studies examined the relationship between executive functions and psychopathological manifestations. Furthermore, parental observations showed that girls have a higher level of anxiety and

greater difficulties in terms of emotional control than boys. Future studies should investigate if emotional control difficulties identified by parents are a consequence of girls' higher anxiety level.

The current study also revealed that development of executive functions, mainly metacognition, could explain a decrease of self-absorbed behaviors when the child gets older and an increase of relational difficulties, as the child becomes more aware of his capabilities, limitations, and his environment. Interventions that enable the development of metacognition functioning among children with an ID should be considered as well as their preparation to deal with this awareness. Consequently, metacognition constitutes an element that practitioners in schools and services centers could include in their interventions. Knowing that some children with an ID have metacognition abilities that may develop, it becomes possible to implement interventions that contribute to acquire strategies to palliate or compensate for their executive deficits. Interventions are also needed to prevent increasing relationship problems with age. Development of students' metacognitive skills, including those related to problem solving, could help to improve their social integration. In conclusion, this study showed that metacognitive capacities of children with an ID appear to develop sufficiently to allow them an openness to the world and awareness of their condition and differences, but the level achieved does not seem to allow proper adaptation. Even if improvements in executive functioning are noted as children with an ID get older, metacognition does not develop at the same rate and to the same level than in typically developing children.

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