**Cognitive and behavioral profiles in children with Autism Spectrum Disorder with and without Attention-Deficit/Hyperactivity Disorder**

Running title: Clinical profiles in ASD with/without ADHD

**ABSTRACT**

**Background:** Understanding the developmental trajectories of children with autism spectrum disorder (ASD) with and without comorbid ADHD is relevant to tailor care plans. This prospective study assessed, for the first time, cognitive, emotional, behavioural, and learning outcomes in adolescence of children with ASD-ADHD and in those with ASD+ADHD in childhood. Possible predictors of severity of ASD core symptoms in adolescence were also evaluated.

**Methods:** Forty-five adolescents without intellectual disability, 26 diagnosed in childhood with ASD- ADHD and 19 with ASD+ADHD, were evaluated at baseline (mean age: 8.6 ± 1.3) and at 5-year follow-up (mean age: 12.9 ± 0.9). Parents and teachers completed questionnaires on executive functions, theory of mind (ToM), emotional/behavioural difficulties (EBD), and learning style at both time points.

**Results**: Overall different developmental trajectories for the two groups were found. In general, deficits in metacognition processes, ToM skills, EBD and learning abilities were more pronounced in the ASD+ group. Over time the ASD+ADHD group, but not the ASD-ADHD, tended to improve in EBD and metacognition but their level of development continued to be lower compared to ASD+ADHD. EBD in childhood were significant predictors of autism core symptoms of adolescents.

**Conclusions:** Our findings highlight the importance of an early identification of comorbid ADHD symptoms in ASD to offer treatment strategies based on specific developmental trajectories.

**Keywords:** autism; ADHD; executive functions; theory of mind; behavioral and emotional problems; longitudinal.

**Key practitioner message**

- No prospective studies have so far assessed the clinical evaluation of children with ASD and ADHD (ASD+ADHD) and children with ASD (ASD-ADHD).

- Different developmental trajectories were found between both clinical groups, with more cognitive and co-occurring mental health difficulties observed in ASD+ADHD.

- Emotional/behavioral difficulties had predictive power over autism core symptoms in adolescence.

- Care plans and treatment strategies may be adapted to strengthen the specific areas impaired in each clinical group.

**Introduction**

The fifth revision of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) formally recognised the co-occurrence of autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD), with the aim to foster a more appropriate and specific therapeutic approach for individuals with both disorders. The co-occurrence of ASD+ADHD ranges between 20 to 70% (Brookman-Frazee, Stadnick, Chlebowski, Baker-Ericzen, & Ganger, 2018; Salazar et al., 2015), depending on the type and characteristics of the samples included, the evaluation procedures, the informants, or the diagnostic criteria. A recent meta-analysis (Rong et al., 2021) including 65 studies, reported pooled current and lifetime prevalence rates of ADHD among individuals with ASD of 38.5 % and 40.2 %, respectively. The impact of ADHD symptoms in individuals with ASD is clinically relevant, as children with ASD and ADHD (ASD+ADHD) generally present with more severe impairments in executive functioning (EF), socioadaptive functioning, and learning-related behaviors (Antshel, Zhang-James, and Faraone, 2013; Leitner., 2014; Yeris., 2020) compared to children with ASD without ADHD (ASD-ADHD).

Additionally, studies comparing the performance in neuropsychological tasks among individuals with ASD+ADHD, ADHD and ASD-ADHD generally report more significant executive impairments in the group with the dual diagnosis. In particular, deficits in inhibition observed in cognitive tasks requiring the withholding of prepotent responses, are commonly associated with ASD+ADHD rather than ASD-ADHD (Sanlunkhe et al., 2021; Tye et al., 2016). More severe impairments in the combined group have also been identified in flexibility (Kado et al., 2020), working memory and vigilance tasks (Goldin, Matson, Tureck, Cervantes and Jang, 2013). For instance, a previous study using questionnaires to measure EF in daily life reported 92% of children in the ASD+ADHD group classified as having impaired EF, compared to 47% of the children with ASD-ADHD and 63% with ADHD (Dajani et al., 2016).

Moreover, available findings suggest that ADHD symptoms contribute to increase deficits in Theory of mind (ToM) and related abilities. Indeed, children with ASD+ADHD showed significantly more difficulties in facial emotion recognition (Oerlemans et al., 2014) and less development of empathy, measured by the performance on “reading the mind in the eyes” test, than ASD-ADHD (Colombi and Ghaziuddin, 2017). Parents’ ratings also revealed a more evident deficit in applying ToM in daily life social contexts in the ASD+ADHD group, in comparison to a typical development (TD) group.

The ASD+ADHD comorbidity is also associated with higher rates of additional mental health (MH) problems. For instance, data from a community sample (Simonoff et al., 2008) showed that when ASD co-occurred with ADHD, the risk of experiencing other psychiatric problems increased by 14% (from 70% in the ASD-ADHD group to 84% in ASD+ADHD). Furthermore, greater severity of ADHD symptomatology significantly related to a higher number of comorbid psychiatric diagnoses, as well as higher levels of symptom severity as assessed by the Child Behavior Checklist (CBCL) (Mansour, Dovi, Lane, Loveland and Pearson, 2017). The total score of the Strengths and Difficulties Questionnaire (SDQ) which includes the emotional, conduct, peer problems and hyperactivity subscales, was also significantly higher in the comorbid group than in the ASD-ADHD (Berenguer et al., 2018).

 In addition to neuropsychological and MH aspects, the co-occurrence of ADHD in individuals with ASD is also relevant for learning functions. Besides the difficulties of ASD such as inflexible style of learning, low classroom engagement and limited comprehension of abstraction, ADHD symptoms increase the negative impact on learning-related behaviours by associating problems in sustained attention, behavioural regulation and metacognition (Rosello et al., 2018). In comparison to ASD-ADHD, the comorbid group exhibited a poorer attitude towards schoolwork, together with more social interaction and behavioural problems at school (Chiang et al., 2018). In a cohort study (Stark et al., 2021), fewer autistic than non-autistic individuals were qualified for upper secondary education (57% and 86%, respectively), but those also diagnosed with ADHD were particularly at risk of non-qualification with an additional 8% increase.

 In conclusion, ASD+ADHD seems to constitute a particular ASD phenotype with a higher risk of executive, ToM, MH and learning problems. However, despite an increasing body of research focusing on the comorbidity ASD+ADHD, to our knowledge all available studies on this topic have used cross-sectional designs. Prospective studies are needed to understand the changes over time in different domains of functioning of children with ASD+ADHD and explore their predictive contribution to ASD symptoms severity and long-term outcomes. In ASD+ADHD, cross-sectional studies reported inattention symptoms as the strongest predictor of social and adaptive functioning (Avni, Zachor and Ben-Itzchal, 2018). However, from a developmental perspective, other possible childhood predictors of severity in adolescents with ASD+ADHD are yet to be explored.

The present study was designed to compare the developmental profile and clinically relevant changes in adolescence of children with ASD+ADHD and ASD-ADHD. We measured changes in behaviour regulation, metacognition, theory of mind, emotional/behavioural problems and learning attitudes. A secondary aim was to assess to which extent these cognitive and behavioural factors predict more severe ASD core symptoms in adolescence. We predicted different clinical trajectories in the two groups. We also hypothesized that cognitive and behavioural factors associated with ADHD predict more severe ASD core symptoms in adolescence.

**Method**

This study was part of an extensive research project designed to investigate the developmental outcomes in adolescence of children with ASD. At baseline and 5-year follow-up, parents completed an interview and questionnaires in a face-to-face session with researchers trained in the administration and rating of the assessment tools. Teachers also provided additional information through questionnaires. All participants were informed of the study aims and written informed consent was obtained. The study was approved by the Ethics Committee of the University of Valencia (HI425284258543).

***Participants***

 Baseline assessment included 52 children with ASD (30 with ASD-ADHD and 22 ASD+ADHD) between 7 and 11 years old, with an intellectual functioning within the normal range (> 80), measured with the Kaufman Brief Intelligence Test (K‐BIT; Kauffman and Kauffman, 2000).

Participants had received a clinical diagnosis in child and adolescent mental health services in the Valencian Community, Spain, following an established research clinical protocol. To confirm the ASD diagnosis, the social communication questionnaire (SCQ; Rutter, Bailey and Lord, 2003) and the revised autism diagnostic interview (ADI-R; Rutter, Le Couteur and Lord, 2003) were administered by a clinical psychologist from the research team. Additionally, an interview with parents was also conducted to evaluate the DSM-5 criteria (APA, 2013) for ADHD. Twenty-two children with ASD also met ADHD diagnostic criteria, considering that a symptom was present with a score of ≥ 2 (2=often; 3=many times). The majority of participants (77.1%) showed a combined presentation (hyperactive/inattentive), and 22.9% had a predominance of inattention. At baseline, 26.7% children with ASD-ADHD (10% risperidone, 13.4% methylphenidate and 3.3% melatonine), and 41.7% children with ASD+ADHD (9.9% risperidone, 27.3% methylphenidate and 4.5% melatonine) were taking psychotropic medication.

Exclusion criteria (neurological or genetic diseases, brain damage, visual/auditory/motor impairment) were evaluated through an extensive clinical history carried out with the families.

Five-year follow‐up assessment included 45 adolescents with ASD (26 ASD-ADHD and 19 ASD+ADHD) between 12 and 15 years old (retention rate of 86.5%). Seven families declined the invitation to attend the evaluations or could not be reached (4 ASD-ADHD and 3 ASD+ADHD). No significant differences in IQ or ASD symptom severity were found among the children who remained in the study and those who did not. About 77% of the adolescents were receiving educational support at follow-up, and around 30% of the participants with ASD-ADHD and 52% of those with ASD+ADHD were taking psychotropics (mainly risperidone and/or methylphenidate).

Both groups of participants were matched on vocabulary, assessed with the subtest from the Wechsler Intelligence Scale for children (WISC-IV) [F(1, 43 ) = 0.69, p = 0.50], IQ [F(1, 43 ) = –0.01, p = 0.99] , age [F(1,43) = 0.39, p = 0.67] and parental education level [F (1,43 ) = 1.18, p = 0.31]. Participants´ demographic information is reported in Table 1.

Insert Table 1 about here

***Tools***

Sociodemographic information was collected for all participants, including age, sex, developmental history, age of diagnosis, medication, support received at school, family structure, and information about any history of MH problems in the family.

*Executive functions.* Teachers filled out the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al, 2000), a questionnaire with good reliability and validity. It consists of 86 items rated on a three-point Likert-type scale (*never*, *sometimes*, *often*) that are grouped in two indexes, behavioural regulation index (BRI) and metacognition index (MI). The BRI includes the subscales of inhibit, shift and emotional control. The MI consists of working memory, initiate, plan/organize, organization of materials, and monitor subscales. In this study, the Cronbach's alpha coefficients for the BRI and MI indexes were α =.83 and α =.85, respectively. Raw scores were used for both indexes.

*Theory of mind.* The ToM Inventory (Hutchins, Prelock and Bonazinga-Bouyea, 2014; Spanish adaptation by Pujals et al., 2016) was completed by parents to evaluate social references and understanding of basic emotions, meta-representations, second-order inferences, and complex social judgements. The ToMI has three subscales (*early*, *basic*, and *advanced*) and a general average score. Each item is rated from 0-20 (“definitely not” to “definitely”), and higher scores indicate good ToM development. The inventory has shown excellent sensitivity (.9) and specificity (.9) (Hutchins et al., 2014), with high internal consistency in a Spanish sample (α= .96) (Pujals et al., 2016).

*Emotional and behavioural problems.* The SDQ (Goodman., 2001) was completed by parents. It has 25 items divided into five subscales and a total difficulty score. It has good statistical and psychometric properties (α=.73) (Goodman, 2001), confirmed also in a Spanish sample (α =.76) (Rodriguez-Hernández et al., 2012). In the present study, internal consistency was between α =.63 for the subscale of peer problems, and α =.81 for the prosocial behavior subscale.

*Learning Behavior Scale* (LBS; McDermott, Green and Francis, 2001). This tool, completed by teachers, offers information on four dimensions of school learning: motivation/competence, attitude toward learning, persistence/attention, and learning strategy/flexibility. High scores indicate good learning behavior. The internal consistency coefficients were found to be high for the total score (.89, .92) and for the subscales (.70 -.87) (McDermott et al., 2001). In our sample, the internal consistency coefficient was high for the total score (α = .93) and all subscales (α = .76–.86).

*Social Communication Questionnaire* (SCQ. Rutter et al., 2003; Spanish adaptation TEA, 2005). This questionnaire provides information about parents’ perception of autistic symptoms in three domains: reciprocal social interaction, social communication and restricted and repetitive behaviours (RRB). The items refer to specific behaviors that are examples of DSM criteria, trying to improve the understandability for the parent. The items can be scored as absent (=0) or present (=1) with higher scores indicating greater severity. In this study, α was .78, similarly to what originally reported by Rutter et al. (2003) in the UK sample.

***Data analysis***

Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS v 26.0. IBM, 2012). The distribution of the variables as well as their fit to the normal distribution curve, were analyzed by applying the Shapiro-Wilk test. To explore the trajectories in a) executive and ToM processes, b) emotional and behavioral problems (SDQ), and c) learning-related behaviour (LBS) for the two defined groups (ASD-ADHD and ASD+ADHD), a two-way (diagnostic status of the participant: ASD-ADHD and ASD+ADHD)x 2 (time: baseline and 5 years later) mixed ANOVA with repeated measures on the each of the domains in two time periods was performed.

A hierarchical multiple regression analysis was conducted to test whether individual differences in EF, ToM, SDQ and LBS measured in childhood predicted autistic features, as assessed with the SCQ in the adolescence. SCQ follow-up total score was the dependent variable and EF, ToM, SDQ and LBS total scores at baseline were the main predictor variables. The statistical significance was set at p ≤ 0.05 in all analyses.

**Results**

*Developmental profile and changes in adolescence of children with ASD+ADHD and ASD-ADHD:*

*ANOVA on executive functions*

For the behaviour regulation index (BRI), there were significant main effects of time, F (1, 43) = 7.34, p= .009, η2 = .147, and diagnostic status of the participant (group), F (1, 43) = 6.29, p= .01, η2 = .128. There was no significant interaction between time and the diagnostic status of the participant, F (1, 43) = 2.025, p= .162, η2 = .045 (see Table 2).

For the metacognition index (MI), time had a statistically significant impact on the scores (F (1, 43) =10.18, p= .003, η2= .192). The diagnostic status of the participant (group) also had a significant and large effect on the MI: F (1, 43) = 17.72, p< .01, η2 =.292, with the ASD-ADHD group showing better scores at both assessment points. Finally, no significant effect was found for the interaction (time x group) : F (1, 43) = 3.13, p=.08, η2 =.068 (see Table 2).

*ANOVA on theory of mind*

For theory of mind (ToM), time had a significant main effect, F (1, 43) = 6.97, p< .05, η2 =.139, and participants tended to improve. There was a significant effect for diagnostic status of the participant (group), F (1, 43) = 10.36, p< .005, η2 =.194, and ASD-ADHD individuals scored better than the ASD+ADHD group at both assessments. No significant interaction between time and diagnostic status of the participant (time x group) was found (F (1, 43) =.145, p= .705, η2 = .003) (see Table 2).

*ANOVA on emotional and behavioural problems*

Time did not have a significant impact on the scores of internalizing/externalizing problems (F(1, 43)= 2.84, p= .099, 2= .062). On the other hand, the diagnostic status of the participant (group) had a significant effect on internalizing/externalizing problems: F(1,43)= 9.96, p< .005, 2= .188, with better scores in the ASD+ADHD group at T1 and T2. Finally, the interaction (time x group) was statistically significant (F(1, 43)= 4.49, p< .05, 2= .095), with improvements in the ASD+ADHD group, while the scores of the ASD-ADHD participants were very similar over time (see Table 2).

*ANOVA on learning-related behaviours*

Time had a significant impact on the learning scores, and both groups showed better outcomes at T2 (F(1, 43)= 4.19, p< .05, 2= .089). Group had a significant effect on learning and the ASD+ADHD had lower scores: F(1, 43)= 12.84, p< .001, 2= .230. However, the interaction (time x group) was not statistically significant: F(1, 43)= 2.06, p= .159, 2= .046 (see Table 2).

Figure 1 shows the percentage of ASD+ADHD and ASD-ADHD individuals with scores above the clinical threshold on the different variables assessed, showing higher figures in the comorbid group, both at baseline and follow-up.

 Insert Figure 1 about here

Furthermore, the percentage of individuals with four or five variables affected at baseline and follow-up was superior for ASD+ADHD than the ASD-ADHD group (52.6% versus 7.7% at baseline and 21.5% versus 3.8% at follow-up).

 (see Table 3).

 Insert Table 3 about here

*Predictors of ASD core symptoms in adolescence for the ASD+*ADHD *and the ASD-*ADHD *groups.*

A hierarchical multiple regression was calculated with follow-up SCQ total score as the dependent variable and a first block of predictors being baseline total scores of EF, ToMI, SDQ, LBS and Group. In a second block, interactions of all quantitative predictors and Group were entered. This regression allowed us to assess the associations of follow-up SCQ total score with the other measures at baseline as well as with group. The results of the hierarchical model showed that the second block did not add significant prediction into the regression1 (F(5, 33)= .97, p= .108), and therefore that the association between the quantitative predictors and the dependent variable did changed by group. All predictors collectively explained about 20% of the variance. Only the total score of SDQ at baseline was a significant predictor that individually explained the highest percentage of variance of follow-up SCQ scores (β = .364, *p* = .044). Table 4 shows the results of the multiple regression analysis.

Insert Table 4 about here

**Discussion**

This study explored, for the first time, the developmental profile of young people with ASD+ADHD and ASD-ADHD in terms of measures of EF, theory of mind, emotional/behavioural problems, and learning-related behaviors. The impairments in all domains assessed, both at childhood and adolescence, were higher in ASD+ADHD individuals. These results support the greatest severity of the comorbid group (Leitner, 2014; Yerys, 2020) which may be partly explained by deficits in impulsivity regulation and inhibitory control of ADHD.

Two main components of EF, namely the behavioral regulation and metacognition indexes, were analyzed in this study. No significant effect for the interaction were observed in the BRI or the MI indexes. However, in the case of the MI, the effects were close to significance (p=.08; η2 =.068) suggesting that the ASD+ADHD showed some improvement, while the ASD-ADHD did not present with much change over time in metacognition scores (working memory, monitoring, plan/organize). For group and time, significant effects were observed in the BRI and MI indexes, with the ASD+ADHD receiving poorer rates from teachers at childhood and adolescence than the ASD-ADHD. A similar tendency of executive functioning deficits in ASD+ADHD, as assessed by the BRIEF, was found in another cross-sectional study (Dajani et al., 2016), and supported in a recent systematic review including studies that used performance based and indirect measures of EF (Benallie et al., 2021). Moreover, in our study, the percentage of adolescents with affected metacognition and behaviour regulation processes at 5-year follow-up assessment was higher than about 30% in ASD-ADHD and around 50% in the ASD+ADHD group. These findings are relevant for clinical practice, highlighting the need to specifically evaluate executive functioning in ASD. Recent research emphasizes the negative impact of executive deficits on daily live aspects of individuals with ASD such as social cognition, academic functioning, adaptive skills and mental health problems (Pugliese et al., 2020).

In childhood and adolescence, the ASD+ADHD group had a poorer functioning of ToM applied skills compared to the ASD-ADHD group, as suggested by our findings that showed significant differences between groups (ASD-ADHD vs ASD+ADHD) and over time, with no effect for the interaction. This is in line with other cross-sectional studies suggesting ADHD symptoms may contribute to increase deficits in ToM in young people with ASD in performance tasks like “reading the mind in the eyes” (Colombi & Ghaziuddin et al., 2017). The ability to recognize facial emotions may be impaired in individuals with ADHD possibly in relation to the difficulties they experience in sustained attention, inhibitory control and working memory (Van der Meer et al. 2011). However, a considerable number of participants in the ASD-ADHD group also presented deficits in ToM (over 70% individuals in both time points).

 A significant effect for the interaction in emotional/behavioural difficulties was found, indicating over time a decrease of difficulties in the ASD+ADHD group, whereas in the ASD-ADHD these difficulties slightly increased. At childhood, when ASD co-occurred with ADHD, more emotional/behavioural problems were observed, similar to a recent study (Yamawaki et al., 2021). However, in adolescence, both groups showed similar rates of comorbid emotional/behavioral difficulties (68% in ASD+ADHD vs 65% in ASD-ADHD). These results match another study showing a high persistence of associated psychopathology in adolescence for ASD individuals in general (Mandy et al., 2016). It is possible that the use of a clinical interview, rather than questionnaires, to assess MH problems could determine more accurately if the co-occurrence of ASD+ADHD, compared to ASD alone, increases the likelihood of presenting with other psychiatric conditions such as bipolar disorder of depression (Chen et al., 2015).

In terms of learning-related abilities, a significant effect was found for time and group, but not for the interaction. The deficits as measured with the LBS, were higher in the ASD+ADHD group than in ASD-ADHD. The difference between groups decreased over time, though adolescents with ASD+ADHD continued to show poorer learning behaviors. In any case, participants with ASD+ADHD and ASD-ADHD experienced considerable learning-related problems at childhood (84% vs 61%, respectively) and at follow-up (74% vs 54%). Such figures are of similar magnitude to those in a study showing that over a half of high functioning children with ASD experienced problems in learning attitudes and behaviours (Estes et al., 2011). The impairments in attention and inhibition may contribute to the challenges at school, such as motivation/competence, attitude towards learning, persistence/attention, and learning strategy/flexibility. These impairments in LBS may in part explain the high risk of non-qualification for secondary education of adolescents diagnosed with ASD+ADHD (Stark et al., 2021).

A relationship between the level of ASD symptoms and more mental health comorbidity in children has been reported (Rosenberg et al., 2011). More specifically, our study explored potential predictors of ASD symptoms in adolescence. Emotional and behavioral difficulties was the only variable with predictive power, and higher scores in the SDQ predicted more severe symptoms, emphasizing the importance of prompt detection and support of these needs. The results are in line with those of another study where emotional/behavioural problems predicted longitudinal trajectories of symptoms in autism from childhood to adulthood (Simonoff et al., 2019).

The findings of the present study have clinical implications for the assessment and management of children with ASD. Timely assessment of possible co-occurring ADHD symptoms coupled with more intensive educational, psychological, and psychiatric interventions are key to effectively manage the higher load of MH problems and other deficits in children with ASD+ADHD. This subgroup could benefit from a variety of pharmacological and non-pharmacological interventions for ADHD that would differ from those for ASD-ADHD. Adolescents with ASD+ADHD (58%) seem to require pharmacological treatment in more cases than ASD-ADHD (34%) or ADHD without ASD (49%) (Murray, 2010), and the efficacy of ADHD medications for the treatment of young people with ASD+ADHD has been supported in a recent meta-analysis (Rodrigues et al., 2020) even though individuals with ASD+ADHD showed less tolerance to ADHD medications and benefit less from them compared to people with just ADHD (Cortese et al., 2012). Furthermore, self-regulation and one-to-one delivery are relevant components of interventions for learning outcomes of students with ADHD, and alongside behaviour modification and classroom adaptations should be considered in children with ASD+ to target specific areas of impairment (Harrison et al, 2019; Moore et al., 2018).

The study results should be considered in the light of its limitations. The evaluation was based on parents´ and teachers´ questionnaires and the interpretation is limited by measurement issues. The assessment using direct vs. indirect measures provides a different set of information. Therefore, as highlighted by a recent meta-analysis, several different sources of information could be beneficial for the assessment of participants with ASD (Tonizzi et al., 2021). Moreover, the limited sample size may not have sufficient statistical power to detect meaningful effects. The predominance of males is another factor that may limit the generalization of the results to female population with ASD+ADHD, even though it reflects the sex ratio commonly seen in CAMHS and it is similar to the ratio of the majority of studies including clinical samples of both neurodevelopmental disorders. The role of different interventions on the outcomes of this study could not be considered as information to this regard was not collected systematically enough to facilitate the analysis.

In conclusion, the present findings point to a more severe presentation in adolescents with co-occurring ASD+ADHD, compared to ASD, in terms of metacognition, theory of mind, learning behaviours and emotional/behavioural problems. Future research could use multiple types of measures (e.g., observation, standardized interviews, or neuropsychological tasks) and larger samples to increase the strength of evidence on the cognitive, socio-emotional and learning profile of the co-occurrence of ASD and ADHD, and it should also control for medication of the different groups.

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**Table 1.** Sociodemographic data

|  |  |  |
| --- | --- | --- |
|  | T1 | T2 |
|  | ASD- (N=30) | ASD+ (N=22) | ASD- (N=26) | ASD+ (N=19) |
|  | M (SD) | M (SD) | M (SD) | M (SD) |
| Age | 8.86 (1.43) | 8.19 (1.25) | 12.50 (.94) | 12.68 (1.05) |
| Males (%) | 93.3% | 86.7% | 88.5% | 94.7% |
| IQ | 100.37 (12.4) | 102.27 (13.62) | 101.54 (13.28) | 101.47 (12.72) |
| Total SCQ score | 24.30 (5.96) | 19.80 (6.25) | 13.38 (3.85) | 15.32 (6.65) |
| Hyper/Inatt. SDQ | 5.13 (2.66) | 7.86 (1.88) | 4.46 (2.55) | 6.53 (2.38) |
| With medication (%) |  26.7% |  41.7% | 30.8% | 52.6% |
| With educational support (%) | 93.3% | 96.7% | 73.1% | 84.2% |

Note: ASD-: ASD-only diagnosis; ASD+: co-occurrence of ASD+ADHD; Hyper/Inatt. SDQ: hyperactivity/inattention subscale of the strengths and difficulties questionnaire; IQ: intelligence quotient; SCQ: social communication questionnaire

**Table 2.** Executive functions (BRI, MI), ToMI, SDQ and LBS for ASD- and ASD+ groups

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | dfn | dfd | F | *p* | 2 | $$ASD\overbar{X}\_{1}$$(SD) | $$ASD+\overbar{X}\_{1}$$(SD) | $$\overbar{ASDX}\_{2}$$(SD) | $$ASD+\overbar{X}\_{2}$$(SD) |
| BRI | 1 | 43 | 7.38 | .009 | .147 | 51.46(13.02) | 62.84 (12.11) | 48.62 (12.89) | 53.74 (14.39) |
| MI | 1 | 43 | 17.72 | <.001 | .292 | 80.73 (13.52) | 100.36 (12.58) | 75.77 (16.94) | 83.05 (19.07) |
| ToMI | 1 | 43 | 10.36 | <.005 | .194 | 8.88 (3.23) | 7.03 (2.52) | 10.55 (2.46) | 8.28(3.06) |
| SDQ | 1 | 43 | 9.96 | <.005 | .188 | 17.04 (5.98) | 23.37 (5.05) | 17.46 (5.03) | 19.68 (5.91) |
| LBS | 1 | 43 | 12.84 | <.001 | .230 | 33.41(7.44) | 23.84(9.32) | 34.50(8.01) | 30.00(10.63) |

Note: ASD-: ASD-only diagnosis; ASD+: co-occurrence of ASD+ADHD; BRI: behaviour regulation index; dfd: degrees of freedom error denominator; dfn: degrees of freedom error numerator; MI: metacognitive index; ToMI: theory of mind inventory; SDQ: strengths and difficulties questionnaire; LBS: learning behaviour scale; SD: standard deviation; $\overbar{X}\_{1}:mean T1; \overbar{X}\_{2}: mean T2$

**Table 3.** Percentage of participants in the ASD- and ASD+ groups that exceeded the clinical cut-off points on the different domains assessed.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of domains affected |  | 1 | 2 | 3 | 4 | 5 |
| T1 | ASD- | 20% | 40% | 20% | 6.7% | 6.7% |
| ASD+ADHD | 6.7% | 20% | 10% | 26.7% | 36.7% |
| T2 | ASD- | 19.2% | 26.9% | 23.1% | 26.9% | 3.8% |
| ASD+ADHD | 10.5% | 15.8% | 15.8% | 36.8% | 21.1% |

**Table 4.** Hierarchical regression analysis for predicting follow-up SCQ scores

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Baseline factors** | **B** | **EE** | **Beta** | **t** | **p** | **R** | **R2** |
| EF (MI) | -0.06 | 0.07 | -.19 | -0.81 | .425 | .447 | .200 |
| EF (BRI) | 0.10 | 0.07 | .276 | 1.39 | .171 |  |  |
| ToMI total  | .0.33 | 0.28 | -.194 | -1.15 | .253 |  |  |
| SDQ total Pro | .299 | .143 | .364 | -2.7 | **.044\*** |  |  |
| LBS total | -0.01 | 0.13 | -.027 | -0.11 | .910 |  |  |
| Group | -0.37 | 1.05 | -.072 | -0.35 | .723 |  |  |

\**p* < .05. Note: EF=Executive function. GEC= General executive composite; ToMI = Theory of mind; SDQ total Pro= Strengths and difficulties questionnaire total problems; LBS total= Learning behavior scale total

**Figure 1**. Difficulties in each variable for the ASD- and the ASD+ groups at baseline and follow-up