



NEWSLETTER



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BIBLIOGRAFIA ADHD SETTEMBRE 2020

Am J Psychiatry. 2020 Sep;177:844-54.

NEURAL CORRELATES OF THE DUAL-PATHWAY MODEL FOR ADHD IN ADOLESCENTS.

Shen C, Luo Q, Jia T, et al.

OBJECTIVE: The dual-pathway model has been proposed to explain the heterogeneity in symptoms of attention deficit hyperactivity disorder (ADHD) by two independent psychological pathways based on distinct brain circuits. The authors sought to test whether the hypothesized cognitive and motivational pathways have separable neural correlates.

METHODS: In a longitudinal community-based cohort of 1,963 adolescents, the neuroanatomical correlates of ADHD were identified by a voxel-wise association analysis and then validated using an independent clinical sample (99 never-medicated patients with ADHD, 56 medicated patients with ADHD, and 267 healthy control subjects). The cognitive and motivational pathways were assessed by neuropsychological tests of working memory, intrasubject variability, stop-signal reaction time, and delay discounting. The associations were tested between the identified neuroanatomical correlates and both ADHD symptoms 2 years later and the polygenic risk score for ADHD.

RESULTS: Gray matter volumes of both a prefrontal cluster and a posterior occipital cluster were negatively associated with inattention. Compared with healthy control subjects, never-medicated patients, but not medicated patients, had significantly lower gray matter volumes in these two clusters. Working memory and intrasubject variability were associated with the posterior occipital cluster, and delay discounting was independently associated with both clusters. The baseline gray matter volume of the posterior occipital cluster predicted the inattention symptoms in a 2-year follow-up and was associated with the genetic risk for ADHD.

CONCLUSIONS: The dual-pathway model has both shared and separable neuroanatomical correlates, and the shared correlate in the occipital cortex has the potential to serve as an imaging trait marker of ADHD, especially the inattention symptom domain

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Per la ricerca degli articoli pubblicati nella letteratura scientifica nel mese in esame sono state consultate le banche dati Medline, Embase, PsycINFO e PsycArticle utilizzando le seguenti parole chiave (o i loro sinonimi): 'Attention deficit disorder', 'Attention deficit hyperactivity disorder', 'Infant', 'Child', 'Adolescent', 'Human'. Sono qui riportate le referenze considerate rilevanti e pertinenti.

Am J Psychiatry. 2020 Sep;177:792-94.

CHILDHOOD AND ADOLESCENT NEURODEVELOPMENTAL DISORDERS.

Kalin NH.

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Am J Psychiatry. 2020 Sep;177:834-43.

SUBCORTICAL BRAIN VOLUME, REGIONAL CORTICAL THICKNESS, AND CORTICAL SURFACE AREA ACROSS DISORDERS: FINDINGS FROM THE ENIGMA ADHD, ASD, AND OCD WORKING GROUPS.

Boedhoe PSW, Van RD, Hoogman M, et al.

OBJECTIVE: Attention deficit hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and obsessive-compulsive disorder (OCD) are common neurodevelopmental disorders that frequently co-occur. The authors sought to directly compare these disorders using structural brain imaging data from ENIGMA consortium data.

METHODS: Structural T(1)-weighted whole-brain MRI data from healthy control subjects (N=5,827) and from patients with ADHD (N=2,271), ASD (N=1,777), and OCD (N=2,323) from 151 cohorts worldwide were analyzed using standardized processing protocols. The authors examined subcortical volume, cortical thickness, and cortical surface area differences within a mega-analytical framework, pooling measures extracted from each cohort. Analyses were performed separately for children, adolescents, and adults, using linear mixed-effects models adjusting for age, sex, and site (and intracranial volume for subcortical and surface area measures).

RESULTS: No shared differences were found among all three disorders, and shared differences between any two disorders did not survive correction for multiple comparisons. Children with ADHD compared with those with OCD had smaller hippocampal volumes, possibly influenced by IQ. Children and adolescents with ADHD also had smaller intracranial volume than control subjects and those with OCD or ASD. Adults with ASD showed thicker frontal cortices compared with adult control subjects and other clinical groups. No OCD-specific differences were observed across different age groups and surface area differences among all disorders in childhood and adulthood.

CONCLUSIONS: The study findings suggest robust but subtle differences across different age groups among ADHD, ASD, and OCD. ADHD-specific intracranial volume and hippocampal differences in children and adolescents, and ASD-specific cortical thickness differences in the frontal cortex in adults, support previous work emphasizing structural brain differences in these disorders

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Assessment. 2020 Sep;27:1258-71.

THE VALIDITY OF THE SNAP-IV IN CHILDREN DISPLAYING ADHD SYMPTOMS.

Hall CL, Guo B, Valentine AZ, et al.

The Swanson, Nolan, and Pelham Rating Scale (SNAP-IV) is a widely used scale that measures the core symptoms of attention deficit hyperactivity disorder (ADHD). However, there are contradictory findings regarding factor structure. Factor structure and measurement equivalence/invariance analysis on parent and teacher SNAP-IV for children referred for an ADHD assessment (N = 250; 6-17 years), revealed a two-factor structure provided the best fit. SNAP-IV scores were also compared with clinician diagnosis of ADHD and research diagnoses of ADHD and hyperkinetic disorder. Parent ratings of inattention and hyperactivity/impulsivity were good predictors of research but not clinician diagnosis. For teacher ratings, only hyperactivity/impulsivity scores were associated with research and clinician diagnosis. SNAP-IV scores showed high sensitivity but low specificity to clinician diagnosis. The SNAP-IV is a valid outcome measure for use in randomized controlled trials and clinical settings, and is best used as a screening rather than a diagnostic tool for ADHD

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Assessment. 2020 Jul;27:921-40.

THE DIFFICULTIES IN EMOTION REGULATION SCALE–PARENT REPORT: A PSYCHOMETRIC INVESTIGATION EXAMINING ADOLESCENTS WITH AND WITHOUT ADHD.

Bunford N, Dawson AE, Evans SW, et al.

Emotion dysregulation is associated with attention deficit/hyperactivity disorder (ADHD) and confers risk for behavior problems and functional impairment; however, there is little guidance on best practices for measurement in adolescents. We developed a parent-report version of the Difficulties in Emotion Regulation Scale (DERS-P). Evidence of reliability and validity was evaluated in a large community online sample (Study 1: $n = 978$; Mage = 13.52 years; SD = 1.93) and in two samples of adolescents with ADHD (Study 2, Sample 1: $n = 78$; Mage = 12.12 years, SD = 0.91; Sample 2: $n = 206$; Mage = 15.35 years; SD = 0.85). A four-factor solution of the DERS-P was obtained in Study 1 and confirmed in Study 2, with factors demonstrating acceptable internal consistency. The community sample was generally rated as less dysregulated than the ADHD samples. Support was obtained for convergent, concurrent, and incremental validity evidence. These findings provide preliminary evidence for the DERS-P as a psychometrically sound parent-report measure of emotion dysregulation in 11- to 17-year-old adolescents

Brain Imaging Behav. 2020 Aug;14:981-97.

DETECTING MICROSTRUCTURAL WHITE MATTER ABNORMALITIES OF FRONTAL PATHWAYS IN CHILDREN WITH ADHD USING ADVANCED DIFFUSION MODELS.

Wu W, McNulty G, Hamoda HM, et al.

Studies using diffusion tensor imaging (DTI) have documented alterations in the attention and executive system in children and adolescents with attention-deficit/hyperactivity disorder (ADHD). While abnormalities in the frontal lobe have also been reported, the associated white matter fiber bundles have not been investigated comprehensively due to the complexity in tracing them through fiber crossings. Furthermore, most studies have used a non-specific DTI model to understand white matter abnormalities. We present results from a first study that uses a multi-shell diffusion MRI (dMRI) data set coupled with an advanced multi-fiber tractography algorithm to probe microstructural measures related to axonal/cellular density and volume of fronto-striato-thalamic pathways in children with ADHD ($N = 30$) and healthy controls ($N = 28$). Head motion was firstly examined as a priority in order to assure that no group difference existed. We investigated 45 different white matter fiber bundles in the brain. After correcting for multiple comparisons, we found lower axonal/cellular packing density and volume in ADHD children in 8 of the 45 fiber bundles, primarily in the right hemisphere as follows: 1) Superior longitudinal fasciculus-II (SLF-II) (right), 2) Thalamus to precentral gyrus (right), 3) Thalamus to superior-frontal gyrus (right), 4) Caudate to medial orbitofrontal gyrus (right), 5) Caudate to precentral gyrus (right), 6) Thalamus to paracentral gyrus (left), 7) Caudate to caudal middlefrontal gyrus (left), and 8) Cingulum (bilateral). Our results demonstrate reduced axonal/cellular density and volume in certain frontal lobe white matter fiber tracts, which sub-serve the attention function and executive control systems. Further, our work shows specific microstructural abnormalities in the striato-thalamo-cortical connections, which have not been previously reported in children with ADHD

Brain Sciences. 2020;10:1-12.

INVESTIGATING GAIT, MOVEMENT, AND COORDINATION IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS: IS THERE A ROLE FOR MOTOR ABNORMALITIES IN ATYPICAL NEURODEVELOPMENT?

Colizzi M, Ciceri ML, Di Gennaro G, et al.

Motor abnormalities have been suggested to play a role in most neuropsychiatric disorders, as a potential generic neurodevelopmental vulnerability. However, they still represent a neglected area, with a paucity of empirical studies, especially in pediatric populations. This case-control study aimed to comprehensively assess motor functioning in children with atypical neurodevelopment and investigate whether any socio-demographic or clinical characteristics would concur with motor difficulties to distinguish children with neurodevelopmental disorders (NDD) from healthy controls. Socio-demographic (age and gender) and

clinical (intelligence quotient, gait, movement, and coordination) data were collected on 114 children aged 5;10–15 (83 with NDD, 31 healthy controls). Male children were at significantly higher risk for NDD (OR: 13.023, $p < 0.001$). Furthermore, there was a statistically significant interaction between the total intelligence quotient and overall coordination such that increasing levels of total intelligence quotient appeared to protect against the likelihood of being diagnosed with an NDD, but only in the context of a preserved coordination (OR: 0.964, $p = 0.038$). Collectively, results may have important public health implications, as they point towards the development of new approaches to establish an early prognosis in neurodevelopment, including assessing motor difficulties and mitigating their impact on children's quality of life

Clin Neurophysiol. 2020;131:e240.

EL15-1 COGNITIVE FUNCTION IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS FROM CULTURALLY/LINGUISTICALLY DIVERSE BACKGROUNDS.

Kita Y.

Culturally and linguistically diverse (CLD) children are now becoming more popular in the world. Accordingly, hospitals and clinics need to address the practical problems to provide them with medical service even though there are still cultural and language barrier between patient and medical doctor. Especially in pediatrics, these doctors have difficulty in diagnosing neurodevelopmental disorders such as attention deficit/hyperactive disorder (ADHD) due to lack of assessment procedure for cognitive function in CLD children. The present study aimed to reveal cognitive function in CLD children with and without neurodevelopmental disorders. Most of bilingual children showed high performance in executive function like cognitive inhibition and shifting. These high performance might be acquired by frequent language-switch under multilingual environment called as bilingual advantage. On the other hand, double-limited bilinguals had impaired executive function compared with monolingual children. Moreover, bilingual children with ADHD showed lower performance in inhibition task than monolingual children with ADHD, indicating that the multilingual environment become cognitive-overloaded with the patients. These findings suggested that multi-cultural and -lingual background did not always produce high cognitive performance. The cognitive assessments become more necessary for medical diagnosis and treatment to CLD children

Clin Neurophysiol. 2020;131:e253.

S17-3 ASSOCIATION BETWEEN ADHD/ASD AND PAROXYSMAL EEG ABNORMALITY.

Kanemura H, Aihara M.

The high occurrence of epilepsy in children with autism spectrum disorders (ASD) and attention deficit/hyperactivity disorder (ADHD) is a clear indication that ASD/ADHD have a neurobiological basis. Several studies showed that maturation of the frontal lobe is possibly associated with behavioral problems in ASD/ADHD and the onset of seizures. In our previous studies, the presence of frontal EEG paroxysmal abnormalities (PA) might indicate a higher risk of epilepsy in ASD. Moreover, ASD patients with frontal EEG PA showed a significantly higher correlation between EEG/clinical seizures and behavioral improvements. On the other hand, for children with ADHD, frontal EEG PA showed a strong correlation with ADHD-rating scale and global assessment of functioning scores, and that treatment with valproate sodium was effective both in decreasing PA and in improving behavioral problems in at least some ADHD patients with frontal EEG PA. It is being increasingly recognized that transient cognitive/behavioral impairment may accompany interictal spike discharges, especially when these are frequent. These findings suggest that the ASD/ADHD patients with frontal EEG PA have a significantly higher correlation between PA frequency and behavioral problems. The EEG may be of value in assisting in the management of at least some children with ASD/ADHD

Clin Neurophysiol. 2020;131:e256.

S22-1 EXPLORING fNIRS-BASED EVALUATION FOR NEUROPHARMACOLOGICAL EFFECT OF ADHD TREATMENT.

Yukifumi M.

We have explored fNIRS-based biomarker for assessment of pharmacological effectiveness in ADHD children since the objective tool for evaluation has yet to be established. we applied a fNIRS-based clinically oriented evaluation method with young ADHD children, and accumulated evidence of neuro-functional modulation induced by a psychostimulant (MPH) of the right prefrontal cortex, which is critical in inhibitory function (Monden et al., 2012, Clinical Neurophysiology). Subsequently, our detection of the activation pattern in the right prefrontal parietal cortex could serve as an objective neurobiological marker to differentiate the neuropharmacological effects of different ADHD medications, such as ATX and MPH, regarding on inhibition and attentional control (Monden,et al., Neurophotonics, 2014). (Monden et al., 2012, NeuroImage: Clinical) and ATX (Monden et al., 2012 NeuroImage; Clinical, 2014,a,b Neurophotonics). Taken together, fNIRS-based assessment would be a strong candidate tool for the detection of neuropharmacological biomarkers in samples of pediatric ADHD

Clin Neurophysiol. 2020;131:e253-e254.

S17-4 NON-INVASIVE EVALUATION OF BRAIN FUNCTION WITH ADHD: STUDY OF ERPs AND FUNCTIONAL NEAR-INFRARED SPECTROSCOPY (fNIRS).

Kaga Y.

Children with attention deficit hyperactivity disorder (ADHD) often exhibit deficit in executive function. ADHD is behaviourally diagnosed because objective biomarker for ADHD is unclear. For ADHD children, objective biomarker must be simple, definite, and non-invasive evaluations. In recent years, neurophysiological findings with non-invasive brain functional evaluations have been reported for ADHD. We reviewed non-invasive brain functional evaluations for developmental disorders, especially with event-related potentials (ERPs), near-infrared spectroscopy (NIRS), and focus executive dysfunctions in ADHD. In ERP study, evaluation of P300, mismatch negativity (MMN), NoGo potentials, and error related negativity (ERN) has been applied in children with ADHD. Prolonged latency and decreased amplitude of each ERP are reported. Especially, MMN amplitude correlated with ADHD-RS (Yamamuro et al., 2016). Recently, functional NIRS (fNIRS) attracts lots of attention for non-invasive evaluations. For children, fNIRS is applied in a clinical setting because it is easy to fit and measure brain blood flow over time through oxygenated haemoglobin (Oxy-Hb). Oxy-Hb was decreased during executive functional task in ADHD, and increased after treatment with anti-ADHD medications. They reported fNIRS was useful method as a state marker of ADHD with and without medication. Hemodynamic and electrophysiological findings might be useful as biomarker of executive function in ADHD

Clin Neurophysiol. 2020;131:e240-e241.

EL15-2 USEFULNESS OF NEUROFEEDBACK TRAINING FOR CHILDREN WITH ADHD: FOCUSING ON PREDICTION OF EFFECTIVENESS.

Inagaki M.

Neurofeedback (NF) training aims the enhancement of self-regulation over brain activities. While it is largely recognized as an effective treatment for attention deficit hyperactivity disorder (ADHD), the existence of non-responders has also been reported. The present study explored pre-training assessment indices that could predict responders prior to NF training. Twenty-two children with ADHD participated in slow cortical potential (SCP) NF training and completed pre- and post-training assessments. Participants were classified into responders or non-responders based on their progress in the SCP regulation, and pre-training indices that differentiate the two groups were examined by decision tree analysis. The responder rate in NF training was 45.5%. Responders were predicted by pre-training cognitive and neurophysiological measures regarding Stroop tasks, which suggested relatively fair executive function as their characteristics. Given that NF training

is not universally effective for children with ADHD, further studies are necessary to establish application criteria

Computer Methods and Programs in Biomedicine. 2020;197.

DIAGNOSE ADHD DISORDER IN CHILDREN USING CONVOLUTIONAL NEURAL NETWORK BASED ON CONTINUOUS MENTAL TASK EEG.

Moghaddari M, Lighvan MZ, Danishvar S.

Background and objective: Attention-Deficit/Hyperactivity Disorder (ADHD) is a chronic behavioral disorder in children. Children with ADHD face many difficulties in maintaining their concentration and controlling their behaviors. Early diagnosis of this disorder is one of the most important challenges in its control and treatment. No definitive expert method has been found to detect this disorder early. Our goal in this study is to develop an assistive tool for physicians to recognize ADHD children from healthy children using electroencephalography (EEG) based on a continuous mental task.

Methods: We used EEG signals recorded from 31 ADHD children and 30 healthy children. In this study, we developed a deep learning model using a convolutional neural network that have had significant performance in image processing fields. For this purpose, we first preprocessed EEG signals to eliminate noise and artifacts. Then we segmented preprocessed samples into more samples. We extracted the theta, alpha, beta, and gamma frequency bands from each segmented sample and formed a color RGB image with three channels. Eventually, we imported the resulting images into a 13-layer convolutional neural network for feature extraction and classification.

Results: The proposed model was evaluated by 5-fold cross validation for train, evaluation, and test data and achieved an average accuracy of 99.06%, 97.81%, 97.47% for segmented samples. The average accuracy for subject-based test samples was 98.48%. Also, the performance of the model was evaluated using the confusion matrix with precision, recall, and f1-score metrics. The results of these metrics also confirmed the outstanding performance of the model.

Conclusions: The accuracy, precision, recall, and f1-score of our model were better than all previous works for diagnosing ADHD in children. Based on these prominent and reliable results, this technique can be used as an assistive tool for the physicians in the early diagnosis of ADHD in children

Der Nervenarzt. 2020 Jul;91:599-603.

AUFMERKSAMKEITSDEFIZIT-/HYPERAKTIVITÄTSSTÖRUNG IM KINDES- UND JUGENDALTER: AKTUELLER FORSCHUNGSSTAND = ATTENTION DEFICIT HYPERACTIVITY DISORDER IN CHILDHOOD AND ADOLESCENCE CURRENT STATE OF RESEARCH.

Häge A, Hohmann S, Millenet S, et al.

Background: Attention deficit hyperactivity disorder (ADHD), defined by the core symptoms impulsiveness, inattention and motor hyperactivity, is one of the most common neurodevelopmental disorders beginning in early childhood.

Objective: This article reviews the current state of research on the epidemiology, etiology, diagnostics and therapeutic interventions for ADHD in children and adolescents.

Methods: A selective literature search was carried out in PubMed with reference to the German S3 clinical guidelines on ADHD in children, adolescents and adults.

Results and conclusion: The epidemiological prevalence of ADHD in children is estimated to be 5.3%. The etiology is complex and heterogeneous and a high percentage of the phenotypic variance can be explained by genetic influences. The challenge of ADHD diagnostics is to exclude differential diagnoses while simultaneously identifying common coexisting psychiatric conditions. Treatment recommendations depend on the severity of symptoms. In severe ADHD pharmacotherapy should be considered as the first line intervention. Psychostimulants (various methylphenidate and amphetamine preparations) and the non-stimulants atomoxetine and guanfacine are approved in Germany for treatment of ADHD in children and

adolescents. In milder cases as well as in preschool children, psychosocial interventions (including behavioral psychotherapy) are often sufficient

Eur J Epidemiol. 2020 Sep;35:791-93.

ARE WOMEN USING HORMONAL CONTRACEPTIVES THE RISK-TAKERS?

Tiemeier H.

Eur J Epidemiol. 2020;35:795-805.

MATERNAL USE OF HORMONAL CONTRACEPTION AND RISK OF CHILDHOOD ADHD: A NATIONWIDE POPULATION-BASED COHORT STUDY.

Hemmingsen CH, Kjaer SK, Jezek AH, et al.

Although maternal use of hormones has been suspected of increasing the risk for childhood attention-deficit/hyperactivity disorder (ADHD), no study has examined hormonal contraception use in this context. We examined the association between maternal hormonal contraception use before or during pregnancy and ADHD risk in children. This nationwide population-based cohort study included 1,056,846 children born in Denmark between 1998 and 2014. Prescriptions for hormonal contraceptives redeemed by the mother was categorized as: no use, previous use (> 3-months before pregnancy), and recent use (1-3-months before or during pregnancy). Children were followed for ADHD, from birth until 31 December 2015. Cox proportional hazard models were used to estimate hazard ratios (HRs) with 95% confidence intervals (CIs). During 9,819,565 person-years of follow-up (median: 9.2), ADHD was diagnosed or a prescription for ADHD medication redeemed for 23,380 children (2.2%). The adjusted HR for ADHD was higher in children of mothers who had previously (HR 1.23; 95% CI 1.18-1.28) or recently (HR 1.30; 95% CI 1.24-1.37) used hormonal contraception than in those of mothers with no use. The highest estimates were seen for use of non-oral progestin products with HRs of 1.90 (95% CI 1.59-2.26) for previous use, 2.23 (95% CI 1.96-2.54) for recent use, and 3.10 (95% CI 1.62-5.91) for use during pregnancy. Maternal use of hormonal contraception was associated with an increased risk for ADHD in the offspring; more pronounced for non-oral progestin-only than other products

Front Human Neurosci. 2020 Aug;14.

ECONOMICAL ASSESSMENT OF WORKING MEMORY AND RESPONSE INHIBITION IN ADHD USING A COMBINED N-BACK/NOGO PARADIGM: AN ERP STUDY.

Breitling-Ziegler C, Tegelbeckers J, Flechtner HH, et al.

The development of cognitive interventions in attention-deficit/hyperactivity disorder (ADHD) often requires the assessment of multiple cognitive functions. However, experimental settings consisting of various tasks are particularly strenuous for patients and can thus result in poor data quality. For the economical assessment of working memory and response inhibition, this study aims to validate a combined n-back/nogo paradigm by comparing it to single task versions and to demonstrate its applicability for ADHD research. Twenty-five healthy individuals and 34 ADHD patients between 9 and 16 years participated in this event-related potential (ERP) study. Healthy controls underwent single task versions of a 2-back working memory task and a go/nogo response inhibition task as well as the introduced combined 2-back/nogo task. This combined task demonstrated a comparable ERP structure for working memory and response inhibition aspects as single task versions. Behaviorally, higher working memory performance during the combined paradigm indicated lower task difficulty, while high correlations between combined and single task versions still indicated valid working memory measures. For response inhibition performance, different task versions resulted in similar outcomes. The application of the combined n-back/nogo paradigm in ADHD patients revealed the expected working memory and response inhibition deficits, increased omission errors, reaction times, and standard deviation of reaction time, as well as diminished n-back P3 and nogo P3 amplitudes. We

conclude that the combined n-back/nogo task is an effective paradigm for the economical assessment of working memory and response inhibition deficits in ADHD on a behavioral and neurophysiological level

Frontiers in Pediatrics. 2020;8.

IMPAIRMENT IN ATTENTION FOCUS DURING THE POSNER COGNITIVE TASK IN CHILDREN WITH ADHD: AN EYE TRACKER STUDY.

Caldani S, Isel F, Septier M, et al.

Attention is a major cognitive function that allows the individuals to focus selectively on a discrete stimulus while ignoring others. Visual information could be driven endogenously, when the goals or desires are voluntary, or exogenously, in response to salient visual events in the environment. Since subjects with attention deficit hyperactivity disorder (ADHD) show heightened distractibility during activities that require significant attentional engagement, we hypothesized that they may be more severely impaired in their ability to perform endogenous tasks than controls. To elicit endogenous and exogenous shifts of attention, we thus used a modified version of Posner's cueing task. We compared oculomotor performance measured by an eye tracker in a group of 31 children with ADHD (mean age = 9.1 -1 1.3 years) and age-, sex-, and IQ-matched typically developing children. Endogenous and exogenous conditions were explored in three distinct visual sub-conditions (valid, invalid, and neutral). We found that children with ADHD showed longer latency during endogenous conditions compared to TD children in invalid sub-conditions. They also performed more errors than controls, during the endogenous task in neutral sub-conditions and during exogenous task in neutral and invalid sub-conditions. Our study suggests that children with ADHD may allocate their attention resource toward the detection of exogenous targets with a deficit in their ability to perform endogenous task. We suggest also that they have a difficulty in the engagement of the inhibitory control system particularly during voluntary saccade performance. This could result from impaired interactions between the ventral and dorsal attention networks as well as in the frontal eye field, although neuroimaging studies are necessary to validate this hypothesis in the ADHD population

Genes Brain Behav. 2020 Jul;19.

GENOME-WIDE ASSOCIATION STUDY OF WORD READING: OVERLAP WITH RISK GENES FOR NEURODEVELOPMENTAL DISORDERS.

Price KM, Wigg KG, Feng Y, et al.

Reading disabilities (RD) are the most common neurocognitive disorder, affecting 5% to 17% of children in North America. These children often have comorbid neurodevelopmental/psychiatric disorders, such as attention deficit/hyperactivity disorder (ADHD). The genetics of RD and their overlap with other disorders is incompletely understood. To contribute to this, we performed a genome-wide association study (GWAS) for word reading. Then, using summary statistics from neurodevelopmental/psychiatric disorders, we computed polygenic risk scores (PRS) and used them to predict reading ability in our samples. This enabled us to test the shared aetiology between RD and other disorders. The GWAS consisted of 5.3 million single nucleotide polymorphisms (SNPs) and two samples; a family-based sample recruited for reading difficulties in Toronto (n = 624) and a population-based sample recruited in Philadelphia [Philadelphia Neurodevelopmental Cohort (PNC)] (n = 4430). The Toronto sample SNP-based analysis identified suggestive SNPs ($P \sim 5 \times 10^{-7}$) in the ARHGAP23 gene, which is implicated in neuronal migration/axon pathfinding. The PNC gene-based analysis identified significant associations ($P < 2.72 \times 10^{-6}$) for LINC00935 and CCNT1, located in the region of the KANSL2/CCNT1/LINC00935/SNORA2B/SNORA34/MIR4701/ADCY6 genes on chromosome 12q, with near significant SNP-based analysis. PRS identified significant overlap between word reading and intelligence ($R^2 = 0.18$, $P = 7.25 \times 10^{-181}$), word reading and educational attainment ($R^2 = 0.07$, $P = 4.91 \times 10^{-48}$) and word reading and ADHD ($R^2 = 0.02$, $P = 8.70 \times 10^{-6}$; threshold for significance = 7.14×10^{-3}). Overlap was also found between RD and autism spectrum disorder (ASD) as top-ranked genes were previously implicated in autism by rare and copy number variant analyses. These findings support shared

risk between word reading, cognitive measures, educational outcomes and neurodevelopmental disorders, including ASD

Infant Behav Dev. 2020;61.

SCREEN TIME IN 36-MONTH-OLDS AT INCREASED LIKELIHOOD FOR ASD AND ADHD.

Hill MM, Gangi D, Miller M, et al.

We examined the relationship between video-based media viewing (screen time), behavioral outcomes, and language development in 120 36-month-old children with a family history of Autism Spectrum Disorder (ASD) or Attention-Deficit/Hyperactivity Disorder (ADHD) or no family history of either condition. Participants were classified into one of three diagnostic groups: ASD (n = 20), ADHD Concerns (children with elevated ADHD symptoms; n = 14), or Comparison (n = 86). Children in the ADHD Concerns group spent more time viewing screen media than Comparison children. Increased screen time was associated with lower receptive and expressive language scores across groups. Future longitudinal studies are needed to determine the direction of effects and causality

Int J Sports Med. 2020 Sep;41:682-87.

SYMPTOM PRESENTATION AFTER CONCUSSION AND PRE-EXISTING ANXIETY AMONG YOUTH ATHLETES.

Kent M, Brilliant A, Erickson K, et al.

Our purpose was to evaluate the effect of self-reported pre-injury anxiety diagnosis on persistent symptom development, vestibular symptom severity, and balance control among youth who sustained a concussion. We performed a retrospective study of patients seen at a specialty pediatric concussion clinic. Patients were 18 years of age or younger, examined within 10 days of concussion, and received care until full recovery. A questionnaire was used to assess pre-existing medical and psychiatric conditions, including anxiety. Our main outcomes were prolonged symptom recovery defined as persistent symptoms for >28 days after concussion) and severity of vestibular symptoms. Patients who reported pre-injury anxiety (n=43; median age=14.9 years; 37% female) were more likely to experience symptoms >28 days post-injury (76 vs. 54%; p=0.04) than those without pre-existing anxiety (n=241; median age=14.9 years; 53% female). After adjusting for sex, history of migraine, depression and ADHD, however, there was no independent association between pre-existing anxiety and prolonged symptom duration (adjusted odds ratio=2.34; 95% CI=0.083-6.63; p=0.11). Pre-existing anxiety was independently associated with self-reported nausea/vomiting severity (β coefficient=0.59, 95% CI=0.07-1.11). A pre-existing anxiety diagnosis does not appear to be associated with persistent symptoms after concussion, although it may be associated with post-injury nausea

International Journal of Radiation Oncology Biology Physics. 2020;108:S127-S128.

ATYPICAL RESTING STATE FUNCTIONAL CONNECTIVITY AND DEFICITS IN COGNITION IN PEDIATRIC BRAIN TUMOR PATIENTS TREATED WITH PROTON BEAM RADIATION.

Anandarajah H, Jiang C, McMichael A, et al.

Purpose/Objective(s): Survivors of pediatric brain tumors experience significant cognitive deficits from their diagnosis and treatment. Currently, robust predictors of cognitive outcome are limited. The current study aims to assess cognitive function and resting state functional connectivity MRI (rsfMRI) in pediatric brain tumor patients that have received proton beam radiation therapy (PBRT).

Materials/Methods: Patients ages 4-18 years old with diagnosis of a brain tumor treated with PBRT underwent rsfMRI scanning during regularly scheduled clinical imaging along with cognitive assessment utilizing the NIH Toolbox Cognition Battery. Scores for the NIH Toolbox were adjusted for highest level of education of both participant and mother, age, sex, and race/ethnicity.

Results: A total of 18 patients were eligible for analysis with a median age at time of PBRT of 10.7 years (range 7.2 - 17.9 years). Radiation volume was whole brain for 5 patients (28%) and conformal for 13 patients

(72%). Follow-up rsfMRI acquisition and cognitive testing occurred at median time of 12 months post-radiation (range 1 - 58 months). Functional connectivity within the dorsal attention network (DAN) was significantly decreased with 67% of study subjects having connectivity strength greater than 2 SD below the mean of age- and sex-matched controls ($p < 0.0001$). Significant impairments were also observed in connectivity strength of the somatomotor ventral ($p < 0.0001$), default mode ($p < 0.0001$), parietal memory ($p < 0.0001$) and salience networks ($p < 0.001$) when compared to controls. Functional connectivity between the DAN and default mode, and parietal memory networks was significantly different compared to matched controls ($p < 0.001$). Neurocognitive testing of study subjects demonstrated significant impairments in total composite, fluid composite and attention/inhibition scores with more than 40% of study subjects scoring greater than 1 SD below the mean of normalized controls for each of these tests ($p < 0.01$). Mean attention/inhibition ($p < 0.001$) and total composite scores ($p < 0.001$) for study subjects were significantly decreased when compared to normalized scores.

Conclusion: Irradiated pediatric patients with brain tumors demonstrated significant deficits in attention and total composite performance. Furthermore, rsfMRI revealed significant differences in functional connectivity in multiple networks in our study population when compared to healthy controls. Further research is needed to assess the potential use of rsfMRI as a predictive marker of cognitive outcome in pediatric brain tumor patients

J Pediatr Psychol. 2020 Oct;45:983-89.

IMPLEMENTING GROUP PARENT TRAINING IN TELEPSYCHOLOGY: LESSONS LEARNED DURING THE COVID-19 PANDEMIC.

Fogler JM, Normand S, O'Dea N, et al.

OBJECTIVE: We recently transitioned from in-person delivery of a brief behavioral parent intervention to telepsychology delivery to meet families' needs during the COVID-19 pandemic. In this topical review, we describe how we used treatment fidelity as a guiding principle to orient adaptations for telepsychology, as well as preliminary findings and early lessons learned in this implementation.

Methods: Using rapid-cycle quality improvement methods, we adapted a brief parent training group (Bootcamp for Attention-Deficit/Hyperactivity Disorder; BC-ADHD) to three groups of caregivers (i.e., 5-7 families) of school-aged children with ADHD ($n = 20$; 85% males). Families were from the following ethnic backgrounds: 75% White non-Hispanic, 15% White Hispanic, and 10% Black. Clinicians completed measures on their implementation experience. Observers completed measures on content/process fidelity and attendance. Caregivers completed measures on demographics, treatment satisfaction, and telepsychology experience.

RESULTS: Telepsychology BC-ADHD can be implemented with comparably high levels of content and process fidelity and treatment satisfaction to in-person groups; and it appears to be feasible and acceptable to caregivers. Caregiver and clinician qualitative feedback revealed themes of appreciating the convenience of telepsychology, while experiencing some challenges in relating to others and sharing over video.

CONCLUSIONS: When treatment fidelity is used as a guiding tool, telepsychology parent training groups can be delivered with high fidelity and appear to be acceptable and feasible to caregivers and clinicians. Future research using larger and more diverse samples, multimethod and multi-informant measurement approaches, and controlled designs is needed to further assess the generalizability and efficacy of telepsychology parent training groups

J Adolesc. 2020 Jul;82:1-10.

RECOGNITION OF EMOTIONAL FACIAL EXPRESSIONS IN ADOLESCENTS WITH ATTENTION DEFICIT/HYPERACTIVITY DISORDER.

Dan O.

Introduction: Attention Deficit/Hyperactivity Disorder (ADHD) is associated with impaired social competencies, due in part to an inability to determine emotional states through facial expressions. Social

interactions are a critical component of adolescence, which raises the question of how do adolescents with ADHD cope with this impairment. Yet, previous reviews do not distinguish between children and adolescents. This review focuses on the ability of adolescents (defined by the World Health Organization as 10–19 years old) with ADHD to recognize emotional facial expressions, when compared to their typically-developing peers.

Methods: Comprehensive database search and analysis yielded 9 relevant studies published between 2008 and 2018.

Results: The studies reviewed here examined recognition of emotional facial expressions in adolescents with ADHD. Behavioral measures (reaction time, reaction time variance and recognition accuracy) show no statistically significant differences between adolescents with ADHD and their typically-developing peers. However, neural responses as recorded using functional Magnetic Resonance Imaging (fMRI) or Event Related Potentials (ERP) find differences in brain activity and the temporal evolution of the reaction between the two groups.

Conclusions: Studies of children and of adults with ADHD find deficiencies in the recognition of emotional facial expressions. However, this review shows that adolescents with ADHD perform comparably to their peers on accuracy and rate, although their neural processing is different. This suggests that the methodologies employed by the ADHD and typically-developing adolescents to assess facial expressions are different. Further study is needed to determine what these may be

J Affective Disord. 2020;277.

HEMODYNAMIC AND BEHAVIORAL PECULIARITIES IN RESPONSE TO EMOTIONAL STIMULI IN CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER: AN fNIRS STUDY.

Mauri M, Grazioli S, Crippa A, et al.

Background: Children with attention deficit hyperactivity disorder (ADHD) exhibit behavioral inhibition deficits, which often lead to emotional dysregulation (ED) affecting individual ability to control emotions and behavioral responses. In ADHD, ED is associated with poor outcomes and comorbidities, with both externalizing and internalizing disorders. This work aims to evaluate sensitivity to emotional stimuli in children with ADHD using functional Near Infrared Spectroscopy (fNIRS).

Methods: During frontal fNIRS recording, 20 children with ADHD and 25 typically developing (TD) peers performed a visual continuous performance task with stimuli of different emotional content (i.e., positive, negative, neutral, and control stimuli without emotional content). This is a cognitive task designed to evaluate the ability to recognize emotional stimuli and to deal with emotional interference.

Results: The ADHD sample showed more variability in response time to stimuli and more false alarms compared to TD group. fNIRS data showed between-group differences in right prefrontal and frontal cortices, with wider hemoglobin concentration changes in the TD group, during positive, negative, and neutral conditions.

Limitations: Owing to the limited possibility of near infrared light to penetrate tissue, fNIRS can only measure cortical activations, while it would be of interest to identify the subcortical areas linked to emotional processing, too.

Conclusions: Findings suggest the presence of emotional processing deficits in children with ADHD, as suggested by poor performances on the e-CPT task, and of peculiar sensitivity to emotional stimuli, linked to atypical hemodynamics of right prefrontal and frontal areas

J Atten Disord. 2020 Aug;24:1437-42.

LETTER REVERSALS, DEFAULT MODE, AND CHILDHOOD ADHD.

Levy F, Young D.

Objective: To investigate the relationship of static reversals, handedness and gender to reaction time variability (RTV) in a sequential sample of 1,109 children referred to a child psychiatry clinic for investigation of possible ADHD.

Method: A DSM-III ADHD diagnosis and ADHD severity ratings (mild, moderate, and severe) by the present investigator was recorded. The age at which the children were still manifesting static reversals as reported by their mother, and right, left, or both-handedness as reported by the mother and observed by the investigator, were noted.

Results: The age that letter reversals were still manifested was significantly associated with RTV for male and female children.

Conclusions: The findings may represent an early manifestation of a failure of suppression of visually symmetrical information and/or a failure of default mode suppression

J Atten Disord. 2020 Aug;24:1403-12.

RECEIVER OPERATING CHARACTERISTIC CURVE ANALYSIS OF SCREENING TOOLS FOR BIPOLAR DISORDER COMORBID WITH ADHD IN SCHOOLCHILDREN.

Cordeiro ML, Farias AC, Whybrow PC, et al.

Objective: We compared Child Behavior Checklist (CBCL)-AAA (Attention Problems, Aggressive Behavior, and Anxious/Depressed) and Parent-Young Mania Rating Scale (P-YMRS) profiles in Brazilian children with ADHD, pediatric-onset bipolar disorder (PBD), and PBD + ADHD.

Method: Following analyses of variance or Kruskal-Wallis tests with multiple-comparison Least Significant Difference (LSD) or Dunn's Tests, thresholds were determined by Mann-Whitney U Tests and receiver operating characteristic (ROC) plots.

Results: Relative to ADHD, PBD and PBD + ADHD groups scored higher on the Anxious/Depressed, Thought Problems, Rule-Breaking, and Aggressive Behavior subscales and Conduct/Delinquency Diagnostic Scale of the CBCL; all three had similar attention problems. The PBD and PBD + ADHD groups scored higher than the ADHD and healthy control (HC) groups on all CBCL problem scales. The AAA-profile ROC had good diagnostic prediction of PBD + ADHD. PBD and PBD-ADHD were associated with (similarly) elevated P-YMRS scores.

Conclusion: The CBCL-PBD and P-YMRS can be used to screen for manic behavior and assist in differential diagnosis

J Atten Disord. 2020 Aug;24:1392-402.

LITERACY AND NUMERACY UNDERACHIEVEMENT IN BOYS AND GIRLS WITH ADHD.

Silva D, Colvin L, Glauert R, et al.

Objective: To determine literacy and numeracy outcomes, among children with and without ADHD by gestational age and gender.

Method: De-identified linked population data from the Western Australian Monitoring of Drug Dependence Systems, Western Australian Literacy and Numeracy Assessment database, and the Midwives Notification System used information on 6,819 children with ADHD compared with 14,451 non-ADHD children.

Results: Twenty-three percent of boys and 28% of girls with ADHD had numeracy scores below the benchmark in School Year 3, compared with 11% of children without ADHD. These differences were also evident in reading, writing, and spelling through primary school. Children with ADHD and reduced gestational age were at a greater risk of not meeting numeracy and reading benchmarks, compared with children born at term.

Conclusion: Children with ADHD are disadvantaged from an early age in key areas of learning, and this risk increased with reduction in gestational age at birth

J Atten Disord. 2020 Aug;24:1443-56.

A NOVEL FEED-FORWARD MODELING SYSTEM LEADS TO SUSTAINED IMPROVEMENTS IN ATTENTION AND ACADEMIC PERFORMANCE.

McDermott AF, Rose M, Norris T, et al.

Objective: This study tested a novel feed-forward modeling (FFM) system as a nonpharmacological intervention for the treatment of ADHD children and the training of cognitive skills that improve academic performance.

Method: This study implemented a randomized, controlled, parallel design comparing this FFM with a nonpharmacological community care intervention. Improvements were measured on parent- and clinician-rated scales of ADHD symptomatology and on academic performance tests completed by the participant. Participants were followed for 3 months after training.

Results: Participants in the FFM training group showed significant improvements in ADHD symptomatology and academic performance, while the control group did not. Improvements from FFM were sustained 3 months later.

Conclusion: The FFM appeared to be an effective intervention for the treatment of ADHD and improving academic performance. This FFM training intervention shows promise as a first-line treatment for ADHD while improving academic performance

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J Exp Psychol Gen. 2020 Sep;149:1615-27.

PARTICIPANT-EXPERIMENTER RAPPORT IN EXPERIMENTAL SETTINGS: A TEST CASE OF EXECUTIVE FUNCTIONS AMONG CHILDREN WITH ADHD.

Gidron M, Sabag M, Yarmolovsky J, et al.

There is a growing interest in the effects of social engagement on cognition, yet, research on the effects of social engagement with the experimenter in empirical contexts has been sparse. During an experiment, the experimenter and participant form a dyad, establishing a certain level of rapport—a sense of a positive and congruent relationship. This rapport is thought to promote performance by providing a comfortable testing environment, thereby reducing resource demand, and enhancing participant engagement and willingness to exert effort to perform. The current study sought to better understand the role of rapport by examining the effects of perceived rapport on effortful control, that is, inhibition and shifting, in an experimental setting among children with and without attention-deficit/hyperactivity disorder (ADHD). Forty-nine children (9 to 12 years old) were divided into two groups based on ADHD classification (i.e., typically developing children, $n = 27$; children with ADHD, $n = 22$). Participants completed the day/night Stroop task and the Wisconsin Card Sorting Task following a short rapport-building conversation with the experimenter. Later, both participant and experimenter filled the CHARM questionnaire reporting the rapport constructed during the experiment. Results show moderating effects of ADHD on the relationship between perceived rapport quality and congruency, and participant's executive functions performance. Specifically, children with ADHD showed higher susceptibility to rapport quality and were impervious to the effects of rapport congruency. Results highlight the importance of rapport with the experimenter in experimental research and suggest incorporating considerations concerning rapport, both in designing the experimental paradigm as well as an independent factor affecting task performance and outcome

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J Neurodevelopmental Disord. 2020 Aug;12.

OBSESSIVE-COMPULSIVE DISORDER AND ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: DISTINCT ASSOCIATIONS WITH DNA METHYLATION AND GENETIC VARIATION.

Goodman SJ, Burton CL, Butcher DT, et al.

Background: A growing body of research has demonstrated associations between specific neurodevelopmental disorders and variation in DNA methylation (DNAm), implicating this molecular mark as a possible contributor to the molecular etiology of these disorders and/or as a novel disease biomarker.

Furthermore, genetic risk variants of neurodevelopmental disorders have been found to be enriched at loci associated with DNAm patterns, referred to as methylation quantitative trait loci (mQTLs).

Methods: We conducted two epigenome-wide association studies in individuals with attention-deficit/hyperactivity disorder (ADHD) or obsessive-compulsive disorder (OCD) (aged 4–18 years) using DNA extracted from saliva. DNAm data generated on the Illumina Human Methylation 450 K array were used to examine the interaction between genetic variation and DNAm patterns associated with these disorders.

Results: Using linear regression followed by principal component analysis, individuals with the most endorsed symptoms of ADHD or OCD were found to have significantly more distinct DNAm patterns from controls, as compared to all cases. This suggested that the phenotypic heterogeneity of these disorders is reflected in altered DNAm at specific sites. Further investigations of the DNAm sites associated with each disorder revealed that despite little overlap of these DNAm sites across the two disorders, both disorders were significantly enriched for mQTLs within our sample.

Conclusions: Our DNAm data provide insights into the regulatory changes associated with genetic variation, highlighting their potential utility both in directing GWAS and in elucidating the pathophysiology of neurodevelopmental disorders. (PsychoInfo Database Record (c) 2020 APA, all rights reserved)

J Pediatr Psychol. 2020 Jul;45:643-53.

CAFFEINE USE AND ASSOCIATIONS WITH SLEEP IN ADOLESCENTS WITH AND WITHOUT ADHD.

Cusick CN, Langberg JM, Breau R, et al.

Objective: The objective of this study was to compare caffeine consumption in the morning, afternoon, and evening in adolescents with and without attention-deficit/hyperactivity disorder (ADHD) and examine associations with sleep functioning.

Methods: Participants were 302 adolescents (ages 12–14) with (N = 140) and without (N = 162) ADHD. Adolescents wore actigraph watches to assess total sleep time and wake after sleep onset and reported on sleep–wake problems and the number of caffeinated beverages consumed per day in the morning, afternoon, and evening. Parents reported on adolescents' difficulties initiating and maintaining sleep. Chi-square tests, odds ratios, and path analyses were conducted.

Results: Analyses controlled for sex, medication status, and pubertal development. Adolescents with ADHD were 2.47 times more likely to consume caffeine in the afternoon and evening than adolescents without ADHD. Path analyses indicated significant associations between afternoon caffeine use and more self-reported sleep problems for adolescents with and without ADHD, and an association between evening caffeine use and self-reported sleep problems only in adolescents with ADHD. Afternoon caffeine use was associated with parent-reported sleep problems in adolescents with ADHD only. Caffeine use was not associated with actigraphy-assessed sleep.

Conclusion: This is the first study to show that adolescents with ADHD consume more caffeine than peers during later times of the day. Additionally, caffeine use is more consistently associated with poorer subjective sleep functioning in adolescents with ADHD. Pediatricians and mental health professionals should assess for caffeine use in adolescents with ADHD and co-occurring sleep problems

Journal of Pediatric Research. 2020;7:216-22.

IRON AND FERRITIN LEVELS OF CHILDREN AND ADOLESCENTS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER AND ATTENTION DEFICIT HYPERACTIVITY DISORDER-NOT OTHERWISE SPECIFIED.

Ozturk Y, Topal Z, Demir N, et al.

Aim: The study aimed to compare the levels of iron and ferritin in children with Attention Deficit Hyperactivity Disorder (ADHD) and Attention-Deficit Hyperactivity Disorder-Not Otherwise Specified (ADHD-NOS) and to assess the relationship between ADHD symptom severity and anxiety symptom severity with iron and ferritin levels.

Materials and Methods: This study was planned as a cross-sectional, retrospective study. The study was performed by scanning the records of patients who applied to our clinic between January 2012 and January

2013. Accordingly, 205 ADHD and ADHD-NOS case records were evaluated. Patients were diagnosed clinically according to Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR) criteria. ADHD symptom severity was assessed by the Turgay DSM-IV-TR-Based Child and Adolescent Behavior Disorders Screening and Rating scale. Anxiety symptom severity was assessed by The Screen for Anxiety Related Emotional Disorders.

Results: Among the whole sample, 99 (48.3%) patients had ADHD and 106 (51.7%) had ADHD-NOS. In the ADHD group, the average age of the children was 10.88-13.02 years, while that of the children in the ADHD-NOS group was 9.93-12.49 years. Iron and ferritin were measured in 81 of the 205 patients participating in the study. There was no statistically significant difference between the two groups in terms of iron or ferritin levels ($p > 0.05$). Statistically significant negative correlations between ADHD hyperactivity symptom severity and iron levels, and ADHD attention deficit symptom severity and ferritin levels were found. Ferritin levels correlated statistically with the total number of psychiatric diagnoses in the children.

Conclusion: Iron and ferritin levels may be differentially affected in children with ADHD. The results we obtained from our study should be supported by studies with larger samples

J Psychiatr Res. 2020;131:180-86.

PARENTAL AGE AT CHILDBIRTH AND RISK FOR ATTENTION-DEFICIT/HYPERACTIVITY DISORDER IN OFFSPRING.

Kim KM, Choi YJ, Lim MH, et al.

This study investigated the association between parental age at birth and attention-deficit/hyperactivity disorder (ADHD) symptoms in their children. A total of 30,552 children aged 6-12 years participated in the study. ADHD symptoms were rated using the Korean version of the ADHD Rating Scale (K-ARS) by parents. K-ARS scores and odds ratio (OR) for children with high-risk ADHD presented a U-shape curve depending on the age of both parents at birth. The total K-ARS scores and OR for high-risk ADHD were highest in children of fathers and mothers belonging to the youngest age group (aged 20) (K-ARS = 12.33, OR = 2.89 vs K-ARS = 10.98, OR = 2.63) and second highest in children whose father's or mother's age at birth was the oldest (K-ARS = 9.63, OR = 1.65 vs K-ARS = 9.95, OR = 1.95). Our study identified that both spectrums of age-young and old of either parent-were associated with ADHD in children. These are new findings considering that old age of parents as the correlates of offspring ADHD is the inconsistent finding with previous studies and warrant future studies in other cultures that include more detailed information on ADHD symptoms of children and their parents are needed to confirm the present findings

Laterality: Asymmetries of Body, Brain and Cognition. 2020 Sep;25:620-39.

CLINICAL CORRELATES OF LATERALITY AMONG SCHOOL-AGE CHILDREN IN THE UNITED STATES.

Lu N, Rigsby DC, Keim SA, et al.

Researchers have long been interested in whether lateral preference is associated with giftedness, season of birth, and/or ADHD constructs (short attention span, high level of activity, and impulsivity). The objective of this study was to examine these associations in a large, longitudinal sample of U.S. children (National Collaborative Perinatal Project (CPP), 1959–1973). Children born to women in this pregnancy cohort underwent a neonatal exam and an exam at age 7 years to assess lateral preference of the hand and eye, IQ on the Wechsler Intelligence Scale for Children (WISC), and ADHD symptoms. Children with perinatal/neonatal risk factors for neurologic impairment or early signs of neurological abnormality were excluded from our analyses. The final sample included 25,385 children. Associations between laterality and IQ were examined using linear and logistic regression models adjusted for sex, race, and socioeconomic status. Associations between laterality and ADHD symptoms and between season of birth and laterality were estimated using multivariable logistic regression. In this large, longitudinal study of neurologically healthy children, modest associations were observed between hand/eye preference and IQ and hyperactivity only

Mol Psychiatry. 2020 Aug;25:1631-39.

THE IMPORTANCE OF A DEVELOPMENTAL PERSPECTIVE IN PSYCHIATRY: WHAT DO RECENT GENETIC-EPIDEMIOLOGICAL FINDINGS SHOW?

Thapar A, Riglin L.

There is growing appreciation that a developmental perspective is helpful in Psychiatry. However, clinical practice and research, especially in an era of very large sample sizes, often ignore the developmental context. In this perspective piece, we discuss why a developmental view is important in Psychiatry and how recent genetic-epidemiological findings further highlight this. DSM-5 childhood neurodevelopmental disorders such as ADHD, typically onset in early childhood but can persist into adult life; the same ADHD genetic loading appears to contribute across the life course. However, recent longitudinal studies have observed that ADHD symptoms may emerge later during adolescence and adult life in some individuals although the etiology of this late-onset group is unclear. The epidemiology and genetics of depression do not appear to be the same in childhood, adolescence, and adult life. Recent genetic findings further highlight this. Autistic type problems and irritability also appear to show developmental variation in their genetic etiology. These findings raise the question of whether social communication and irritability have the same meaning at different ages. Schizophrenia typically onsets after adolescence. However, it is commonly preceded by childhood antecedents that do not resemble schizophrenia itself but do appear to index schizophrenia genetic liability. We conclude that there is a need for clinicians and scientists to adopt a developmental perspective in clinical practice and research by considering age-at-onset and changes over time as well as different developmental periods when interpreting clinical symptoms

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N Engl J Med. 2020 Sep;383:1050-56.

PHARMACOLOGIC TREATMENT OF ATTENTION DEFICIT-HYPERACTIVITY DISORDER.

Cortese S.

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Neurol Psychiatry Brain Res. 2020 Sep;37:53-59.

THE EFFECT OF BEHAVIORAL PARENT TRAINING OF CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER ON PARENTS' MENTAL HEALTH.

Mehri M, Chehrzad MM, Maleki M, et al.

Background: Parents' mental health can be impacted by sleep problems experienced by children diagnosed with ADHD. This study aimed to investigate the effect of group-based behavioral parent training (BPT) related to sleep problems of children with ADHD on parents' mental health.

Methods: A parallel randomized controlled trial design was used in this study. Participants included 58 parents of school-age children with ADHD who had at least one sleep problem and who were known to medical services in a psychiatric clinic in Rasht city, Iran. Participants were randomly allocated to the intervention or control groups equally. Participants in the intervention group received a 5-week BPT intervention program related to sleep problems of ADHD children including 3 sessions group-based training and 2 telephone follow-up. Data were collected before and two months after the intervention. Data were analyzed using descriptive and inferential statistics via the SPSS software.

Results: The findings revealed two months after the intervention, participants in the intervention group had a significant improvement in the anxiety ($p = 0.01$) and stress ($p = 0.02$) levels compared to the control group.

Conclusion: The results suggest that group-based BPT related to sleep problems of children with ADHD could be an effective strategy in improving parents' mental health

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Nutritional Neuroscience. 2020;23:811-23.

ASSOCIATION BETWEEN THE DIFFERENT DURATION OF BREASTFEEDING AND ATTENTION DEFICIT/HYPERACTIVITY DISORDER IN CHILDREN: A SYSTEMATIC REVIEW AND META-ANALYSIS.

Zeng Y, Tang Y, Tang J, et al.

Objectives: To summarize the current evidence on the association between maternal breastfeeding and the occurrence of attention deficit/hyperactivity disorder (ADHD) in offspring.

Methods: We searched for studies published in English before May 2018 using the PubMed, EMBASE, Cochrane, and Web of Science databases. We included cohort studies, case-control studies, and cross-sectional studies, that focused on the association between maternal breastfeeding and the occurrence of ADHD in offspring. Random effects models were used for combined analyses.

Results: Two cohort studies, 7 case-control studies and 3 cross-sectional studies, with 3,686 cases and 106,907 participants, were included. Children with any maternal breastfeeding had a lower incidence of ADHD than children who were never breastfed (odds ratio [OR]: 0.70; 95% confidence interval [CI]: 0.52-0.93). Further analyses also showed associations between reduced ADHD incidence and duration of breastfeeding. Children breastfed for over 1 month, over 3 months, over 6 months, and over 12 months had a lower incidence of ADHD than children breastfed for less than 1 month (OR: 0.20; 95% CI: 0.11-0.38), less than 3 months (OR: 0.33; 95% CI: 0.23-0.47), less than 6 months (OR: 0.50; 95% CI: 0.41-0.61), and less than 12 months (OR: 0.55; 95% CI: 0.37-0.81), respectively. These results were stable in the 1-month, 3-month, and 6-month breastfeeding groups.

Conclusion: With our meta-analysis, we provide evidence that maternal breastfeeding may reduce the risk of ADHD in children. The causality of this relationship and underlying mechanisms need to be explored in future prospective studies

Pediatrics. 2020 Sep;146.

FAMILY WELL-BEING IN GRANDPARENT- VERSUS PARENT-HEADED HOUSEHOLDS.

Rapoport E, Muthiah N, Keim SA, et al.

BACKGROUND AND OBJECTIVES: Little is known about the 2% of US children being raised by their grandparents. We sought to characterize and compare grandparent- and parent-headed households with respect to adverse childhood experiences (ACEs), child temperament, attention-deficit/hyperactivity disorder (ADHD), and caregiver aggravation and coping.

METHODS: Using a combined data set of children ages 3 to 17 from the 2016, 2017, and 2018 National Survey of Children's Health, we applied survey regression procedures, adjusted for sociodemographic confounders, to compare grandparent- and parent-headed households on composite and single-item outcome measures of ACEs; ADHD; preschool inattention and restlessness; child temperament; and caregiver aggravation, coping, support, and interactions with children.

RESULTS: Among 80-646 households (2407 grandparent-headed, 78-239 parent-headed), children in grandparent-headed households experienced more ACEs ($\hat{I}^2 = 1.22$, 95% confidence interval [CI]: 1.07 to 1.38). Preschool-aged and school-aged children in grandparent-headed households were more likely to have ADHD (adjusted odds ratio = 4.29, 95% CI: 2.22 to 8.28; adjusted odds ratio = 1.72, 95% CI: 1.34 to 2.20). School-aged children in these households had poorer temperament ($\hat{I}^2(\text{adj}) = .25$, 95% CI: -0.63 to 1.14), and their caregivers experienced greater aggravation ($\hat{I}^2(\text{adj}) = .29$, 95% CI: 0.08 to 0.49). However, these differences were not detected after excluding children with ADHD from the sample. No differences were noted between grandparent- and parent-headed households for caregiver coping, emotional support, or interactions with children.

CONCLUSIONS: Despite caring for children with greater developmental problems and poorer temperaments, grandparent caregivers seem to cope with parenting about as well as parents

Prim Care Companion CNS Disord. 2020 Sep;22.

LITTLE AGREEMENT ON TREATING RESIDUAL BIPOLAR DISORDER SYMPTOMS IN A CHILD.

Post RM, Rowe M, Findling R.

BACKGROUND: There is a paucity of studies on treatment of childhood-onset bipolar disorder and its associated comorbidities, which leads to a wide diversity of opinion on choice and sequencing of treatment options.

METHODS: From December 2018 to January 2019, a graphic depiction of medications and weekly ratings of symptoms of mania, depression, anxiety, attention-deficit/hyperactivity disorder (ADHD), and oppositional behavior that parents had rated on their 9-year-old child over a period of several years was sent to experts in child and adult bipolar disorder. These responding medical doctors (MDs, 8 child and 18 adult psychiatrists) rated a comprehensive list of medications that they would choose (and with what priority) to treat the child's now improved mood (mania and depression) but continued mild to moderate symptoms of anxiety, ADHD, and oppositional behavior.

RESULTS: In the whole group, the drugs most highly endorsed were lamotrigine: 69%, lithium: 62%, lurasidone: 62%, quetiapine: 54%, aripiprazole: 46%, and valproate: 42%. Among the antidepressants, 38% endorsed a selective serotonin reuptake inhibitor, 12% a serotonin-norepinephrine reuptake inhibitor, and 27% bupropion. Of the child MDs, 75% suggested increasing the 1-mg dose of risperidone, while few adult MDs suggested this. Conversely, 56% of the adult MDs suggested using valproate, while only 1 child MD did so. There was little consensus on how to manage ADHD symptoms unresponsive to methylphenidate 36 mg/d. How these treatment options were sequenced also varied widely.

CONCLUSIONS: There was wide variation in suggestions on how to treat persistent symptoms of anxiety, ADHD, and oppositional behavior in a child whose mania and depression had been brought under good control. We surmise that this great diversity in recommendations among experts in child and adult bipolar disorder stems at least partially from inadequate literature on treatment and that a new emphasis on funding and conducting studies on efficacy and effectiveness is needed

Prim Care Companion CNS Disord. 2020 Sep;22.

A RANDOMIZED CONTROLLED FEASIBILITY TRIAL OF REMINDER-FOCUSED POSITIVE PSYCHIATRY IN ADOLESCENTS WITH COMORBID ATTENTION-DEFICIT/HYPERACTIVITY DISORDER AND POSTTRAUMATIC STRESS DISORDER.

Ahmadi N, Chaudhry S, Salam T, et al.

OBJECTIVE: To investigate the impact of reminder-focused positive psychiatry (RFPP) on attention-deficit/hyperactive disorder (ADHD) and posttraumatic stress disorder (PTSD) symptoms, vascular-function, inflammation and well-being of adolescents with comorbid ADHD and PTSD.

METHODS: After obtaining informed-consent, 11 adolescents were randomized to RFPP (n = 5) or trauma-focused cognitive-behavioral therapy (TF-CBT) (n = 6). Eight participants (RFPP: n = 4, TF-CBT: n = 4) completed the twice-weekly intervention for a 6-week trial. The RFPP intervention was inclusive of positive psychiatry interventions on (1) traumatic reminders and (2) avoidance and negative cognition. Vascular function measured as temperature rebound, C-reactive protein, homocysteine, ADHD Swanson, Nolan, and Pelham (SNAP) Questionnaire, Clinician-Administered PTSD Scale for DSM-5-Child/Adolescent Version (CAPS-CA), and neuropsychiatric-measures were measured at baseline and 6 weeks. Subjects were followed for 12 months. The study was conducted from September 2016 to June 2018.

RESULTS: A significant improvement in CAPS-CA, SNAP scores, and vascular function of both RFPP and TF-CBT groups was noted at follow-up, but was more-robust in the RFPP group (P < .05). At the sixth week, a significant increase in PERMA, gratitude, resilience, and Posttraumatic Growth Inventory scores and a significant decrease in homocysteine and C-reactive protein levels in the RFPP group, but not the TF-CBT group, were noted (P < .05). At 12-month follow-up, there was no psychiatry hospitalization or suicide ideation reported in either group. A continuation of significant improvement in CAPS-CA and SNAP scores in both groups was noted but was more robust in the RFPP group (P < .05). Similarly, a continuation of significant increase in PERMA, gratitude, resilience and Posttraumatic Growth Inventory scores was noted in the RFPP group but not in the TF-CBT group (P < .05).

CONCLUSIONS: RFPP is associated with improvement in core PTSD and ADHD symptoms, decrease in inflammation, and increase in well-being, vascular function, and posttraumatic growth, as well as a favorable

long-term clinical outcome. This finding highlights the importance of the dual role of RFPP in addressing vulnerability symptoms as well as enhancing well-being in youth with comorbid ADHD and PTSD.

TRIAL REGISTRATION: ClinicalTrials.gov identifier: NCT04336072

Psicología desde el Caribe. 2020 Sep;37.

PROGRAMA DE ENRIQUECIMENTO INSTRUMENTAL (PEI) BÁSICO EM CRIANÇAS COM TDAH E DISLEXIA = FEUERSTEIN INSTRUMENTAL ENRICHMENT (FIE) BASIC IN CHILDREN WITH ADHD AND DYSLEXIA.

Ricci K, Assis CMG, Nogueira MAN, et al.

There is evidence of the effectiveness of Feuerstein's Instrumental Enrichment (FIE), basic version, on intelligence, visuospatial processing, and cognitive flexibility. As such skills may be impaired in neurodevelopmental disorders such as ADHD and dyslexia, their efficacy was investigated in 22 children with such conditions. The experimental group (EG) was compared to pre and post-intervention control in neuropsychological tests, in up to 26 intervention sessions. Interaction between group and moment was analyzed, and performance differences between the two moments were compared. Such a comparison revealed greater gain of the EG in two tasks of cognitive flexibility with large effect size; in eight measures with moderate effect size (including intelligence measures, visuospatial processing and executive functions) and in 13 measures with small effect size. The control group presented greater gain only in appointment. It is concluded that PEI-basic showed effects especially in cognitive flexibility with children with ADHD and dyslexia

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FEASIBILITY OF ECOLOGICAL MOMENTARY ASSESSMENT OF NEGATIVE EMOTION IN GIRLS WITH ADHD: A PILOT STUDY.

Babinski DE, Welkie J.

This study explores the feasibility of using mobile phone ecological momentary assessment to evaluate negative emotion in adolescent girls with attention-deficit/hyperactivity disorder (ADHD). A total of 13 girls with ADHD, ages 12–16 years old (38.5% with comorbid depression), and their mothers completed several daily surveys assessing the intensity and variability of youth negative emotion using mobile phone-based ecological momentary assessment for approximately one week. The rate of response to survey prompts by youth and maternal reports was examined. In addition, associations between girls' and mothers' ratings of negative emotion were calculated. Finally, the severity and fluctuation in negative emotion were compared between girls with and without depression. Girls and their mothers demonstrated a high level of compliance with assessment procedures, and maternal and youth ratings were significantly correlated. In addition, girls with comorbid depression and their mothers endorsed significantly more intense and variable negative emotion compared to girls with ADHD alone. These preliminary findings show that ecological momentary assessment is a feasible and valid method for collecting information on emotion regulation among girls with ADHD and their mothers that can be applied to future work aimed at collecting ecologically valid assessments of functioning in girls with ADHD

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THE STRESS–WNT-SIGNALING AXIS: A HYPOTHESIS FOR ATTENTION-DEFICIT HYPERACTIVITY DISORDER AND THERAPY APPROACHES.

Yde Ohki CM, Grossmann L, Alber E, et al.





Attention-deficit hyperactivity disorder (ADHD) is one of the most common psychiatric neurodevelopmental disorders in children and adolescents. Although ADHD has been studied for nearly a century, the cause and pathophysiology of ADHD is yet largely unknown. However, findings from previous studies have resulted in the formation of a new hypothesis: Apart from the well-known multifactorial etiology of ADHD, recent

evidence suggests that the interaction between genetic and environmental factors and especially Wnt- and mTOR-signaling pathways might have an important role in the pathophysiology of ADHD. The Wnt-signaling pathway is known to orchestrate cellular proliferation, polarity, and differentiation, and the mTOR pathway is involved in several significant processes of neurodevelopment and synaptic plasticity. As a result, dysregulations of these pathways in a time-dependent manner could lead to neurodevelopmental delays, resulting in ADHD phenotype. This review presents further evidence supporting our hypothesis by combining results from studies on ADHD and Wnt- or mTOR-signaling and the influence of genetics, methylphenidate treatment, Omega-3 supplementation, and stress

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Article

Investigating Gait, Movement, and Coordination in Children with Neurodevelopmental Disorders: Is There a Role for Motor Abnormalities in Atypical Neurodevelopment?

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Abstract: Motor abnormalities have been suggested to play a role in most neuropsychiatric disorders, as a potential generic neurodevelopmental vulnerability. However, they still represent a neglected area, with a paucity of empirical studies, especially in pediatric populations. This case-control study aimed to comprehensively assess motor functioning in children with atypical neurodevelopment and investigate whether any socio-demographic or clinical characteristics would concur with motor difficulties to distinguish children with neurodevelopmental disorders (NDD) from healthy controls. Socio-demographic (age and gender) and clinical (intelligence quotient, gait, movement, and coordination) data were collected on 114 children aged 5–15 (83 with NDD, 31 healthy controls). Male children were at significantly higher risk for NDD (OR: 13.023, $p < 0.001$). Furthermore, there was a statistically significant interaction between the total intelligence quotient and overall coordination such that increasing levels of total intelligence quotient appeared to protect against the likelihood of being diagnosed with an NDD, but only in the context of a preserved coordination (OR: 0.964, $p = 0.038$). Collectively, results may have important public health implications, as they point towards the development of new approaches to establish an early prognosis in neurodevelopment, including assessing motor difficulties and mitigating their impact on children's quality of life.

Keywords: Autism Spectrum Disorder; Attention-Deficit/Hyperactivity Disorder; Tourette Disorder; transdiagnostic approach; mental health prevention

1. Introduction

Autism Spectrum Disorder (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), and Tourette Disorder (TD) have been historically classified as distinct disorders, although with the commonality of childhood onset [1]. However, their separation into categorical diagnoses has been questioned [2], due to the evidence of substantial comorbidity [3–5] and overlap in terms of neuropsychological and psychopathological manifestations [4,6–8] as well as neurobiological and genetic underpinnings [9–12]. Clinical research evidence has led to the gathering of such conditions into the single overarching category of neurodevelopmental disorders (NDD), along with other intellectual functioning disorders such as communication and learning disabilities [13], also putting them in the neurodevelopmental continuum with disorders that typically emerge in late adolescence and early adulthood such as affective and non-affective psychoses [1].

Such evidence-based change in nosology urges that the diagnosis and treatment of NDD should involve the assessment and recognition not only of the core features of each single disorder, but also of symptoms and difficulties frequently associated or reported across the conditions [2]. For instance, an impairment in socialization is a core feature of ASD [13] but also frequently reported in ADHD [4,7,14] and TD [15]. Similarly, hyperactivity and impairment in control are core features of ADHD [16], but associated symptoms of ASD [16] and TD [5]. Further, anxiety [14,17], depressive symptoms [14,17,18], obsessive-compulsive behaviors [5,16], and sleep disturbances [14,19–21] are trans-diagnostic features associated with all three neurodevelopmental conditions. Overall, it seems to be a necessary step to reorient the clinical research of NDD in an attempt to unravel the trans-diagnostic nature of their neuropathology.

Motor abnormalities have been suggested not to be disorder-specific but rather a core phenotype dimension that cuts across neuropsychiatric disorders [22,23]. In fact, they are included among the diagnostic criteria of many conditions, and NDD are no exception, as stereotypic movements are diagnostic of ASD, hyperactivity of ADHD, and tics of TD [13]. Despite research evidence supporting a role of motor abnormalities in the etiology [24,25], nosology [26,27], pathophysiology [28], and management [29,30] of neuropsychiatric disorders, they still represent a neglected area in both clinical practice and research [31,32], with most research evaluating motor functioning mainly focusing on psychosis [33] and a paucity of studies comparing motor abnormalities across different conditions [22].

In light of the lack of empirical studies systematically examining motor function across different neuropsychiatric conditions, especially NDD, the present study attempted to fill this gap by conducting a comprehensive assessment of motor abilities across different domains such as gait, movement, and coordination, in a group of young individuals with NDD as compared to a group of healthy controls. We hypothesized that NDD individuals would present with poorer motor functioning than healthy controls in terms of (i) less proficient spatiotemporal gait organization, indexed by an increased step time as the most investigated [34] and reliable [35] measure of less efficient gait patterning [36]; (ii) less proficient motor skills, indexed by a lower total score at the Movement Assessment Battery for Children, 2nd edition (M-ABC-2) [37]; and (iii) less proficient coordination, indexed by a lower total score at the Developmental Coordination Disorder Questionnaire, as revised in 2007 (DCDQ'07) [38]. Furthermore, we conducted exploratory analyses in order to investigate whether any socio-demographic or clinical characteristics would concur with anomalies in motor functioning to distinguish NDD individuals from healthy controls, especially male gender and dysfunctional neurocognition which are known to play a key role in atypical development [13].

2. Materials and Methods

2.1. Participants

Participants were recruited as part of a larger case-control study, carried out at the Veneto Autism Spectrum Disorder Regional Centre of the Integrated University Hospital of Verona, Italy. Children

aged 5–15 years (the age range for which the movement and coordination instruments have been validated) were screened for a neurodevelopmental disorder (NDD) and included if meeting the diagnostic criteria for Autism Spectrum Disorder (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), or Tourette Disorder (TD), according to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition, (DSM-5) diagnostic criteria. Exclusion criteria were (i) formal NDD comorbidity, i.e., fulfilling DSM-5 diagnostic criteria for two or more different NDD (e.g., fulfilling DSM-5 diagnostic criteria for both ADHD and TD); (ii) formal neuropsychiatric comorbidity, i.e., fulfilling DSM-5 diagnostic criteria for other mental disorders such as schizophrenia spectrum and other psychotic disorders, depressive disorders, anxiety disorders, and obsessive-compulsive and related disorders (e.g., fulfilling DSM-5 diagnostic criteria for both ASD and Obsessive Compulsive Disorder); (iii) any significant medical illness, especially a neurological (e.g., cerebral palsy, epilepsy, or otherwise-classified motor handicap) or orthopedic (e.g., fracture, severe injury) condition; (iv) evidence of a genetic syndrome (e.g., chromosomal abnormalities); (v) severity of the condition such as to preclude the ability to complete the expected assessments.

Healthy control subjects were recruited thanks to the collaboration with a number of primary and secondary schools of the city of Verona as well as the Hospital Pediatric Unit. Those willing to take part in the study were included provided that they were in good overall health and did not satisfy the inclusion criteria for any NDD. As for NDD children, potential control subjects were excluded if they met DSM-5 diagnostic criteria for any other neuropsychiatric disorder or had any significant medical illness or genetic syndrome.

2.2. General Assessment

Sociodemographic data, including age and gender, were collected on all NDD children and control subjects. All subjects underwent an extensive clinical evaluation with experienced physicians, based on analysis of any medical documentation, in-depth physical examination, anamnestic interviews with parents/guardians and children, and assessment of the child's abilities through scales. A cognitive evaluation was performed with the Wechsler Intelligence Scale for Children, 4th edition (WISC-IV).

2.3. Motor Functioning

2.3.1. Spatiotemporal Gait Organization

Children's gait was evaluated using the GAITRite electronic walkway system (GAITRite Platinum; CIR Systems, Franklin, NJ, USA), consisting of a walkway 7.92 m in length and sampling at a frequency of 120 Hz, with integrated pressure sensors, as done in previous studies in similar populations of children with NDD [34]. The reliability of such tool to measure gait parameters in pediatric populations has been proved [39]. As per protocol, participants were asked to perform six walking trials at their normal pace. By taking into account participants' height, weight, and bilateral femoral-tibial length, the following spatiotemporal measures of gait were estimated from the system: (i) velocity (cm/s); (ii) cadence (step/min); (iii) step time (s; time from initial contact of one foot to initial contact of the other foot); (iv) step length (cm; distance from the point of initial contact of one foot to the point of initial contact of the other foot); (v) stance phase (% of the total gait cycle; supporting phase of the gait cycle, from the first to the last contact of two consecutive supports of the same foot); (vi) swing phase (% of the total gait cycle; phase of the gait cycle without support, from the last contact of the first support to the first contact of the following support of the same foot); (vii) single support phase (% of the total gait cycle spent supported by only one foot); (viii) double support phase (% of the total gait cycle spent supported by both feet). For further data analysis, gait parameters were then averaged over the six walking trials and, when appropriate, over the two limbs.

When assessing gait outcome, step time was considered of particular interest, as it is one of the most investigated measures in neurodevelopment [34] and evidence suggests it to be a specific indicator of gait patterning [36], while other measures may be more useful when assessing functional performance

(e.g., velocity) [40] or equilibrium (e.g., support phases) [41]. Moreover, along with cadence, step time has been recently suggested to be the most robust parameter in terms of reproducibility, showing good intraclass correlation coefficient, and yielding a false positive in terms of gait deficits less likely [35]. By contrast, other parameters (e.g., velocity, step length) may change depending on the condition and/or intention of the subjects participating in the gait measurement, significantly increasing the chances of yielding a false-positive result [35].

2.3.2. Movement

Children's motor function was assessed using the Movement Assessment Battery for Children, 2nd edition (M-ABC-2), an individually administered standardized measure of motor function for children aged 3–16 years [37]. The M-ABC-2 is one of the most widely used instruments to identify and describe children's motor difficulties, with established reliability and validity, and it has been already used to assess motor skills in children with NDD [34]. The tool offers three age-related item sets, each consisting of eight tasks measuring: (i) manual dexterity (three tasks); (ii) ball skills (two tasks); and (iii) balance (three tasks). Item scores can be combined to form an overall score as a general marker of motor skills, with a normative mean of 10 and standard deviation of 3. The higher is the score, the greater are the child's motor skills.

2.3.3. Coordination

Children's coordination was assessed using the Developmental Coordination Disorder Questionnaire, as revised in 2007 (DCDQ'07), a parent questionnaire designed as a screening tool for coordination difficulties in children aged 5–15 years [38]. Its reliability and validity have been well established [42], also in Italian populations of children [43]. The tool consists of 15 items, which group into three distinct factors: (i) control during movement; (ii) fine motor and handwriting; and (iii) general coordination. Each item is scored on a five-point Likert scale, leading to a total score ranging from 15 to 75 points. The higher the score, the greater is the child's coordination.

2.4. Data Analysis

All collected variables were summarized by mean, standard deviation, median, interquartile range, minimum and maximum values. Categorical variables were expressed as percentages.

Shapiro–Wilk tests were performed to assess normal distribution of continuous variables. A binomial multiple logistic regression analysis was used to identify the predictors of the case-control status (gender, Intelligence Quotient (IQ), step time, DCDQ'07 total score, and M-ABC-2 total score). The estimating accuracy of the candidate models was measured by C-statistics. Hosmer–Lemeshow test was used to assess the model goodness-of-fit. Sensitivity analysis was run to confirm model estimates after removing highly influential patients identified by residuals examination. Assumption of linearity of independent variables and log-odds was assessed by Box–Tidwell transformation. Continuous variables were centered on their means to reduce possible multicollinearity. The variable full-scale Intelligence Quotient (FSIQ), i.e., the WISC-IV composite score that represents general intellectual ability, was introduced in the model by using a 10-point metrics to obtain more clinically interpretable results. Step time variable was introduced after reciprocal transformation to account for the pronounced skewness. The null hypothesis of no prediction was rejected when odds ratios were significantly different than one. A 5% statistical significance was set. Missing data were handled by listwise deletion. Statistical analysis was carried out by statistical package STATA (version 14).

2.5. Ethics

Protocols and procedures were approved by the research ethics committee at the Integrated University Hospital of Verona (CESC 2242 and CESC 2243). After complete description of the study, informed written consent was obtained from parents or guardians of all cases and control subjects included. By signing the document, they consented to the publication of data originating from the study.

3. Results

3.1. Socio-Demographic and Clinical Characteristics

A total of 114 children participated in the study, 83 children with a neurodevelopmental disorder (NDD) and 31 healthy controls. The median age of cases and controls was 10.07 (IQR: 8.48–11.72; range: 5.58–14.88) and 11.30 (IQR: 9.14–13.28; range: 7.23–15.23) years, respectively. Male children represented 38.71% of the control group and 85.54% of the case group.

As expected, healthy controls showed an intelligence quotient in the average range, movement skill total score substantially overlapping with the normative mean of 10 and standard deviation of 3, and coordination abilities safely above performance warranting the investigation of developmental coordination difficulties. Instead, children with NDD showed an intelligence quotient in the average range, but closer to the lower limit, movement skills which were lower than previously published normative data, and coordination abilities suggestive of potential developmental coordination difficulties. Table 1 reports descriptive statistics of all collected clinical data.

3.2. Predictors of Case-Control Status

Logistic analysis ($n = 100$) highlighted male gender (OR: 13.023, $p < 0.001$) as a statistically significant predictor of having an NDD. Furthermore, the model indicated a statistically significant interaction between total IQ and DCDQ'07 total score (OR: 0.964, $p = 0.038$; Table 2). In particular, the interaction revealed a statistically significant protective role of total IQ but only at higher levels of DCDQ'07 total score (Figure 1).

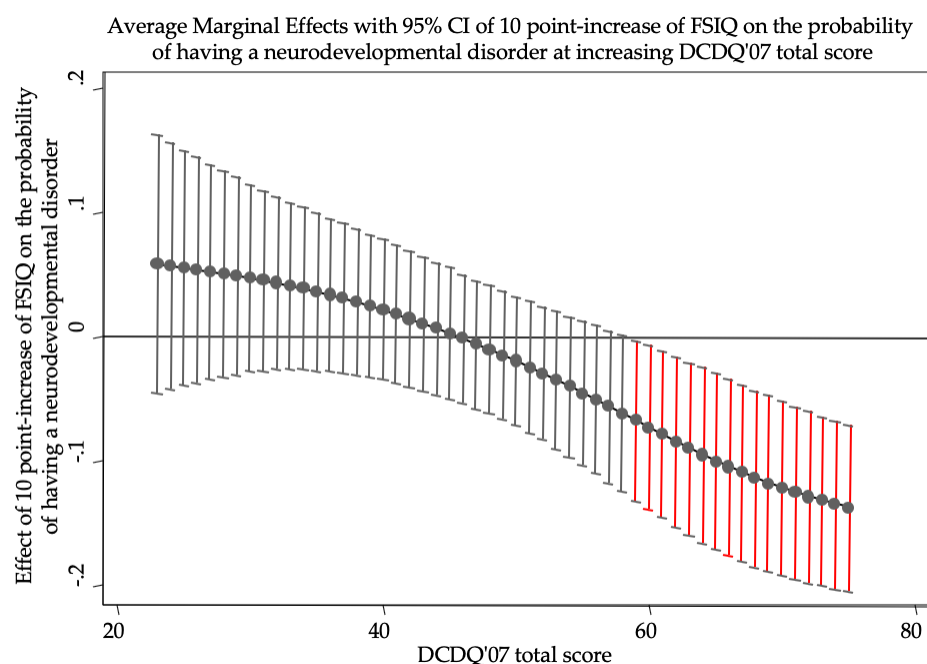


Figure 1. The figure shows the effects of ten-point increase in FSIQ on the probability of having a neurodevelopmental disorder when DCDQ'07 total score is held constant at different values. FSIQ has a statistically significant role (95% CIs do not reach zero probability, red bars) only at high levels of DCDQ'07 total score. At maximum levels of DCDQ'07, a ten-point increase in FSIQ lowers the probability of having a neurodevelopmental disorder of more than 10%. In odds ratio metrics, a ten-point increase in FSIQ constantly lowers the odds of having a neurodevelopmental disorder of 3.6% ($(1-0.964) \times 100$) when DCDQ'07 increases of 1 point. FSIQ, Full Scale Intelligence Quotient; DCDQ'07, Developmental Coordination Disorder Questionnaire, as revised in 2007.

Table 1. Clinical characteristics of the study sample.

	NDD Individuals				Healthy Controls			
	n	M (SD)	Median (IQR)	Range	n	M (SD)	Median (IQR)	Range
WISC IV								
Verbal Comprehension	82	98.93 (15.41)	97 (90–110)	56–142	30	102.87 (14.51)	103 (90–110)	80–140
Perceptual Reasoning	82	103.73 (17.46)	105 (93–115)	54–141	30	110.23 (10.03)	111 (104–115)	91–132
Working Memory	82	89.13 (13.93)	88 (79–100)	52–127	30	99.60 (12.50)	103 (88–109)	79–121
Processing Speed	81	89.54 (18.14)	88 (76–100)	47–129	30	102.27 (17.39)	103 (91–115)	56–132
full-scale Intelligence Quotient	81	95 (17.10)	95 (86–107)	45–141	30	105.83 (12.45)	104 (97–115)	79–132
Spatiotemporal gait organization								
Velocity (cm/s)	79	102.64 (17.61)	102.4 (89.2–114.7)	63.2–143.3	31	108.76 (19.16)	112.1 (89.7–121.5)	74.2–149.4
Cadence (step/min)	79	110.94 (13.69)	110.2 (101.3–119)	78.5–145.9	31	112.35 (10.51)	112.2 (104.5–117.2)	91–138.2
Step time (s) *	79	0.55 (0.07)	0.54 (0.5–0.59)	0.41–0.76	31	0.55 (0.11)	0.53 (0.51–0.58)	0.43–1.09
Step length (cm)	79	55.53 (7.09)	54.53 (50.27–59.52)	43.11–77.67	31	58.13 (8.91)	59.36 (52.1–65.07)	41.25–73.91
Stance phase (%)	79	61(1.51)	61.15 (60–62.05)	57.95–64.15	31	60.45 (1.26)	60.2 (59.3–61.65)	58–63.1
Swing phase (%)	79	38.99 (1.51)	38.85 (38–40.05)	35.85–42.05	31	39.56 (1.28)	39.8 (38.4–40.7)	36.85–42
Single support phase (%) *	79	39.36 (4.89)	38.85 (38–40.1)	26.25–78.3	31	39.55 (1.28)	39.8 (38.4–40.65)	36.75–42.05
Double support phase (%)	79	21.58 (2.99)	21.5 (19.5–23.8)	14.7–27.85	31	20.50 (2.37)	20.2 (18.45–22.8)	15.55–24.25
M-ABC-2								
Manual dexterity *	82	8.39 (4.48)	8 (5–11)	1–19	31	10.23 (3.44)	11 (8–13)	4–16
Ball skills	82	8.38 (3.14)	8 (7–10)	2–19	31	10.13 (3.29)	11 (8–12)	1–16
Balance	82	9.95 (4.88)	9 (6–14)	1–19	31	11.29 (3.23)	11 (10–14)	3–16
Total score	82	8.78 (4.54)	8.5 (5–12)	1–19	31	10.74 (3.71)	11 (8–14)	3–16
DCDQ'07								
Control during movement	77	20.27 (5.39)	19 (16–25)	9–30	29	23.52 (5.51)	24 (21–28)	10–30
Fine motor and handwriting	77	12.82 (4.13)	13 (9–16)	4–20	29	16.55 (3.25)	17 (14–20)	10–20
General coordination	77	14.79 (4.18)	14 (12–17)	5–25	29	18.97 (4.12)	20 (15–22)	11–25
Total score	77	47.88 (11.17)	48 (41–54)	23–74	29	59.03 (12.14)	62 (52–70)	32–75

NDD, Neurodevelopmental Disorders; M, mean; S.D., standard deviation; IQR, interquartile range; * Skewed data as for Shapiro–Wilk test for normal data; WISC-IV, Wechsler intelligence scale for children-fourth edition; M-ABC-2, Movement Assessment Battery for Children, 2nd edition; DCDQ'07; Developmental Coordination Disorder Questionnaire 2007.

Table 2. Predictors of case-control status.

	<i>p</i> -Value	OR	95% CI
Gender	<0.001	13.023	3.693–47.080
Step time	0.661	1.690	0.161–17.705
M-ABC-2 total score	0.361	0.929	0.794–1.087
DCDQ'07 total score	0.054	0.945	0.891–1.001
full-scale Intelligence Quotient	0.368	0.823	0.539–1.257
DCDQ'07 total score * full-scale Intelligence Quotient	0.038	0.964	0.931–0.998

OR, odds ratio; CI, confidence interval; M-ABC-2, Movement Assessment Battery for Children, 2nd edition; DCDQ'07, Developmental Coordination Disorder Questionnaire 2007; *, interaction.

Four patients were shown to be highly influential (standardized residuals lower than -2). When removed from the analysis, model estimations were unchanged. The model selection was based on Akaike Information Criterion. The model showed a satisfying ($p = 0.181$) goodness-of-fit and a 0.862 C-statistic.

4. Discussion

To the best of our knowledge, this is the first case-control study to examine whether a less proficient motor function, as evaluated at the clinical, instrumental, and anamnestic level, could be a trans-diagnostic component of the overarching category of neurodevelopmental disorders (NDD). Results suggest that coordination proficiency and cognitive performance interact on the likelihood of having an NDD. In particular, increasing levels of total intelligence quotient appear to protect against the likelihood of being diagnosed with an NDD, but only in the context of a preserved coordination. In other words, the child's total intelligence quotient is not per se sufficient to protect against an atypical development, without taking into account their coordination abilities.

The finding that the DCDQ'07 was the only instrument able to differentiate NDD children and controls in their motor functioning is not surprising. As a parent questionnaire investigating child's difficulties in day-to-day functioning, it has the double advantage to collect information from the most reliable respondents to report developmental problems of the child and in the context of an extensive observation of the impact of potential coordination difficulties on daily living tasks [38]. Results extend previous literature regarding the usefulness of such self-report questionnaires as integration of motor performance batteries and instruments in order to help the healthcare professional to paint a complete picture of the child motor functioning [44].

The current classification of neuropsychiatric disorders observes the presence of one or more motor-related features in most neurodevelopmental conditions with childhood to early adulthood onset [13]. However, the lack of a scientific consensus about the role of non-normative motor functioning during brain maturation [45] and when to consider it to be pathological [46] as well as the fragmentation of research studies mainly focusing on predefined motor domains [22] has dramatically slowed down our understanding of such phenomena. In the absence of localized lesions or identified abnormalities of the brain, motor difficulties are not considered of pathological relevance in early childhood [47]. However, their persistence in late childhood may reflect a maturational delay affecting the child's sensory integration, motor coordination, and sequencing of complex motor acts [48,49]. While it is sufficiently established that such atypical maturation may continue throughout childhood and adolescence, increasing the risk of poor psychosocial adjustment [50] because of biological (e.g., delayed or problematic brain development affecting language and sphincter control [51,52]) and psychological factors (e.g., rejection, social withdrawal, feelings of failure, low self-esteem [53,54]), we currently struggle in clinical practice to distinguish pathognomonic from non-specific or benign motor manifestations [55]. Furthermore, such motor impairments have often been suggested to specifically lie in the evolutionary trajectory to psychosis, being already present in the early phase of the disorder as well as in relatives of patients and in people at risk to develop psychosis, and to

correlate with the symptom severity [56]. However, other research evidence questioned whether motor impairment would rather represent a generic neurodevelopmental vulnerability, which is not related to a single neurodevelopmental condition [56]. For instance, poorer early motor coordination has been linked with a higher risk of major depressive disorder and generalized anxiety disorder later in life [57]. Noteworthy, childhood neurodevelopmental difficulties on their own have been associated with a higher risk to present in adolescence with mental health difficulties other than psychosis, such as depression and anxiety [58]. Nevertheless, despite evidence is still limited, literature indicates that coordination difficulties may sustain negative biobehavioral trajectories [53,54], highlighting the importance of developing proficient motor skills in order for the child to be and remain in good physical and mental health throughout their life [59].

The neurodevelopmental continuum points in the direction of redefining and rendering more flexible the diagnostic and therapeutic approach to such conditions in order to identify new and trans-diagnostic biomarkers for patient stratification. There is a strong evidence for pleiotropy between ASD, ADHD, and TS, where also cognitive impairments would represent an additional outcome of the same risk for atypical neurodevelopment [60]. The results of the present study extend such findings, suggesting a crucial role for motor impairments, especially inefficient coordination, in the atypical development leading to NDD, even at increasing levels of cognitive performance.

The present findings have at least three important clinical implications. First, rather than being etiologically discrete entities, ASD, ADHD, and TS are better conceptualized as lying on an etiological neurodevelopment continuum [58], where even the manifestation of motor symptoms characteristic of each condition may reflect the severity, timing, and predominant pattern of atypical brain development and resulting biobehavioral expressions. Stereotypic movements, hyperactivity, and tics are currently defined based on a limited comprehension of their nature. Further studies are required to better characterize the phenotype and neurobiology of such phenomena in the wider context of neurodevelopmental motor alterations. Second, most interventions in NDD focus on psychological and behavioral symptoms, learning abilities, and language fluency. Evidence suggests little room for interventions dedicated to improving motor skills, even in those neurodevelopmental conditions where poor motor proficiency is the main issue (e.g., Developmental Coordination Disorder) [61]. Future studies need to longitudinally evaluate the impact of early intervention programs to mitigate motor difficulties in neurodevelopment, also in terms of other psychosocial and neurocognitive parameters of severity and outcome. Third, approaches may be fruitful across diagnostic boundaries in neurodevelopment and future studies will estimate their effectiveness in light of the neurodevelopmental gradient hypothesis that the higher the psychopathological, cognitive, genetic, and sensorimotor severity itself, the greater the neurodevelopmental impairment [60].

The empirical results reported herein should be considered in the light of some strengths and limitations. The main strengths of the study are the adoption of strict inclusion criteria in terms of diagnostic groups, and the detailed assessment of motor abilities. Such aspects of the study design allow excluding that the evidence of motor difficulties in NDD would be attributable to other medical or psychiatric comorbidities or a bias due to a partial assessment. Consistently, we also adopted a cautious approach when selecting parameters indicative of motor dysfunction, especially in terms of gait patterning. The main limitations of the study are that its sample was too limited to fully investigate the predictive value of motor skill impairments in each NDD as well as how motor function would change as a function of age, also reporting a static representation of the phenomenon in neurodevelopment. Future longitudinal studies in larger populations may be able to track the atypical trajectory of neurodevelopment as a function of less proficient motor abilities as well as evaluate the stability of such phenomena from childhood throughout adolescence [47]. Moreover, the case-control imbalance in terms of sample size and gender distribution may have led to a reduced precision of the estimates of the investigated effects, warranting further studies in larger populations in order to investigate the association between coordination and intellectual ability as a function of gender.

5. Conclusions

In summary, while awaiting replication, the study results suggest that poor coordination may be a marker of risk for NDD, even in the presence of substantially intact cognitive function, thus providing novel insight into the neurobiology of atypical neurodevelopmental trajectories. Evidence for a role of coordination difficulties in atypical neurodevelopment is also in line with the hypothesis of soft neurological signs in neuropsychiatric disorders [62]. Collectively, this study may have important public health implications, as it points towards the development of new approaches to establish an early prognosis in neurodevelopment, including the assessment of motor difficulties and the mitigation of their impact on quality of life.

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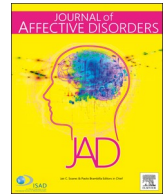
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Research paper

Hemodynamic and behavioral peculiarities in response to emotional stimuli in children with attention deficit hyperactivity disorder: An fNIRS study

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ABSTRACT

Background: Children with attention deficit hyperactivity disorder (ADHD) exhibit behavioral inhibition deficits, which often lead to emotional dysregulation (ED) affecting individual ability to control emotions and behavioral responses. In ADHD, ED is associated with poor outcomes and comorbidities, with both externalizing and internalizing disorders. This work aims to evaluate sensitivity to emotional stimuli in children with ADHD using functional Near Infrared Spectroscopy (fNIRS).

Methods: During frontal fNIRS recording, 20 children with ADHD and 25 typically developing (TD) peers performed a visual continuous performance task with stimuli of different emotional content (i.e., positive, negative, neutral, and control stimuli without emotional content). This is a cognitive task designed to evaluate the ability to recognize emotional stimuli and to deal with emotional interference.

Results: The ADHD sample showed more variability in response time to stimuli and more false alarms compared to TD group. fNIRS data showed between-group differences in right prefrontal and frontal cortices, with wider hemoglobin concentration changes in the TD group, during positive, negative, and neutral conditions.

Limitations: Owing to the limited possibility of near infrared light to penetrate tissue, fNIRS can only measure cortical activations, while it would be of interest to identify the subcortical areas linked to emotional processing, too.

Conclusions: Findings suggest the presence of emotional processing deficits in children with ADHD, as suggested by poor performances on the e-CPT task, and of peculiar sensitivity to emotional stimuli, linked to atypical hemodynamics of right prefrontal and frontal areas.

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by dysregulated cognition and behaviors, resulting in difficulties in paying attention, excessive motor activity and high impulsivity (American Psychiatric Association, 2013). Barkley (1997) stated that the core ADHD deficit is the difficulty in response inhibition. Response (or behavioral) inhibition deficit refers to three interrelated processes: i) a difficulty to inhibit an initial prepotent response (i.e., a response associated to immediate reinforcement); ii) an inability to stop an ongoing response, a skill which usually enables a

delay in decision process; iii) an incapacity to remain focused and to operate interference control. In addition to the behavioral domain, impairment in response inhibition also affects the ability to control emotions, arousal, and self-regulation (Barkley, 1997).

In daily living, emotional self-regulation includes the individual ability to identify and properly interpret environmental emotional stimuli, to recognize individual self-emotions, and to deal with them, generating appropriate social responses (Doumond et al., 2019).

Emotional dysregulation (ED) is a transdiagnostic psychopathological trait which is frequently found in ADHD and associated with poor outcomes and comorbidities with both externalizing (e.g., oppositional

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defiant disorder) and internalizing (e.g., depression, dysthymia) disorders (Shaw et al., 2014; Wang et al., 2018).

ED refers to deficits in physiological arousal regulation and in inhibition of disruptive behavioral response to emotions, an inability to refocus attention after a strong emotional feeling and to have a goal-directed behavior after emotional activation (Biederman et al., 2012). Therefore, ED reflects both failure of cognitive control and high intensity of arousal (Soloff et al., 2015). These deficits cause higher sensitivity to emotional arousal, slower return to baseline activation, and deficits in coping strategies. Especially in children and adolescents, ED is responsible for low tolerance to frustration, impatience, easy anger and excessive emotional excitement (Biederman et al., 2012).

Previous studies on general populations found that ED is present in 38% of children with ADHD, ten times more frequently than in the general population (Stringaris and Goodman, 2009). A longitudinal 4-year follow-up study showed that ADHD is associated with ED in children with a higher number of psychiatric comorbidities, greater social impairment, and persistence of ADHD, if compared with ADHD without ED or healthy controls (Biederman et al., 2012).

Near Infrared Spectroscopy (NIRS) might be a viable approach in the study of the neural bases of emotional processing in samples of children and adolescents with ADHD. NIRS is an optical technique that uses light at specific wavelengths to probe changes in oxygenated and deoxygenated hemoglobin (HbO and HbR, respectively) concentration over time.

Previous functional magnetic resonance imaging (fMRI) studies highlighted a relation between subcortical areas activity and emotional processing (Soloff et al., 2015). For its intrinsic characteristics, NIRS technology does not offer evidences of subcortical activations; still, it presents several advantages in the study of clinical populations. As NIRS is an optical technique that non-invasively monitors the cerebral cortex metabolism with less body fixities than other neuroimaging techniques (Mauri et al., 2018), it gives the opportunity to include patients with behavioral regulation difficulties.

Previous functional NIRS (fNIRS) studies on children with ADHD investigated patients' peculiarities in cortical activations related to impairment in cognition and inattention. These studies successfully used NIRS during different neuropsychological tasks (e.g., Grazioli & Crippa et al., 2019; Mauri et al., 2018). Conversely, a wealth of studies used NIRS to investigate neural correlates of emotional regulation, a field of research frequently overlooked in ADHD.

To our knowledge, only two fNIRS studies previously evaluated the cortical bases of emotional processing with emotional tasks in samples of children with ADHD (Ichikawa et al., 2014; Köchel et al., 2015). Ichikawa et al. (2014) recorded NIRS signals in bilateral occipital cortices in 13 children with ADHD and 13 typically developing (TD) peers (aged 8 to 12 years), while they were passively watching happy and angry facial expressions, in order to evaluate group differences in emotional processing. They found wider HbO concentration changes in the TD vs. ADHD group, in the right hemisphere during the "angry face" condition. In fact, the ADHD group showed increased HbO levels only in response to happy faces, while the TD group showed increased HbO levels in response to both happy and angry faces. In the second study, 14 children with ADHD and 14 TD children were presented emotionally intoned or neutral sentences in order to investigate neural correlates of affective prosody processing. The authors found peculiarities in temporal cortices in the ADHD group compared with the control group. In particular, fNIRS results showed a minor activation of cortical areas linked to emotional identification, despite task execution during angry prosody condition requires higher attention allocation.

Given these premises, the present study aimed to evaluate sensitivity to emotional stimuli in children with ADHD compared with TD children. We measured cortical activation with fNIRS while children were performing a visual emotional continuous performance task (e-CPT) presenting stimuli with different emotional valences, in blocks with specific emotional targets (Soloff et al., 2015).

The task has been previously validated in an fMRI study with adult patients with borderline personality disorder, a condition characterized by ED, especially in response to negative emotions. Former studies showed that this task activates cortical regions linked to cognition and subcortical areas linked to emotional arousal. Intriguingly, this study also found worse performances with negative emotional stimuli, demonstrating the possibility to evaluate neural correlates of emotional dysregulation (Soloff et al., 2015).

Based on the literature, we hypothesized that the worst behavioral performances would be found in the ADHD group, especially with negative emotional stimuli, as a result of the behavioral dysregulation. We also expected to identify hemodynamic cortical peculiarities in the clinical group, which might be a biomarker for behavioral and emotional dysregulation in ADHD patients, as revealed by a possible association between ADHD symptoms and NIRS signals. To our knowledge, the present study is the first fNIRS study aimed to assess emotional interference in cognitive processing in children with ADHD, through the measurement of cortical activations.

2. Methods

The present study is a cross-sectional observational study aimed to evaluate cortical sensitivity to emotional stimuli in children with and without a clinical diagnosis of ADHD. Participants underwent fNIRS while performing a visual performance-CPT in which faces with relevant positive, negative and neutral content were presented. In this study we recruited drug-naïve children with ADHD, admitted to our institute's Child Psychopathology Unit. Our protocol was approved by our institute's ethics committee in accordance with the Declaration of Helsinki (1989). Written informed consent and assent were obtained from all caregivers and participants.

2.1. Participants

Study participation was proposed to 26 drug-naïve children with ADHD, and 27 typically developing (TD) peers aged 6 to 16 years. Two children with ADHD were later excluded based on recruitment criteria.

For all patients, the ADHD diagnosis was made according to DSM-5 criteria (American Psychiatric Association., 2013) by a child neuropsychiatrist with experience in ADHD. A child psychologist (M.Ma.) independently confirmed the diagnosis through direct clinical observation and the administration of the Development and Well-Being Assessment (DAWBA) semi-structured interview to parents (Goodman et al., 2000). Thirty-one percent of patients exhibited ADHD with predominantly inattentive presentation, 11% with predominantly hyperactive/impulsive presentation, and 58% with combined presentation.

The control group was made of typically developing children. The presence of psychiatric disorders, if any, was excluded using the DAWBA parent diagnostic interview.

The exclusion criteria for the whole sample included the presence of intellectual disability, neurological diseases, epilepsy, genetic syndromes and previous treatment with psychoactive drugs. A diagnosis of other psychiatric disorders (e.g. ASD, anxiety, specific learning disorders) was not an exclusion criterion for the ADHD group.

All participants were Caucasian, spoke fluent Italian, and had normal or corrected-to-normal vision. Familial socio economic status (SES) was coded according to Hollingshead scale for parental employment (Hollingshead, 1975).

2.2. Measures

The intelligence quotient was estimated by the Wechsler Intelligence Scale for Children-III or -IV (WISC-III or -IV) (Wechsler, 2006; 2012) for all participants. Only participants with full scale intelligence quotient (FSIQ) scores higher than 80 were included in the study.

2.3. Clinical and behavioral profiles

Clinical and behavioral profiles were assessed through the Child Behaviour Checklist 6–18 (CBCL/6–18) (Achenbach and Rescorla, 2001) and Conners' Parent Rating Scales (CPRS) (Conners, 1997) which were filled out by the participants' parents.

The CBCL/6–18 is a parent report screening form for emotional, behavioral and social problems in children and adolescents aged from 6 to 18. It is an empirically based questionnaire with 8 syndromic scales and 6 DSM-oriented scales (Achenbach and Rescorla, 2001). T-scores of syndromic scales (i.e., Anxious/depressed, Withdrawn/depressed, Somatic complaints, Social problems, Thought problems, Attention problems, Rule-breaking behavior, and Aggressive behavior) were taken into account for analysis.

ED was evaluated by the CBCL-Dysregulation Profile (CBCL-DP) which is the sum of T-scores for the CBCL/6–18 Anxious/depressed, Attention problems, and Aggressive behavior scales (Althoff, 2010; Biederman et al., 2009).

The CPRS are one of the most widely used instruments to assess children with ADHD, measuring both inattention and hyperactivity domain; the "ADHD index" is the CPRS subscale that was considered in the study.

2.4. Stimulation protocol

The participants were seated at a desk, on a height-adjustable chair, approximately 50 cm away (about 34° of visual angle) from the screen such that their eyes focused on the center height of the monitor. During the fNIRS recording, each of them performed a visual emotional continuous performance task (e-CPT) in which stimuli with different emotional valence were presented (Soloff et al., 2015). The stimulation protocol was developed with the Presentation® software (Neurobehavioral Systems Inc.), and stimuli were displayed using a 17" computer screen. The protocol was organized in blocks and consists of a rest condition and task blocks. During the rest condition, participants passively looked at a 1 × 1 cm white cross on a black screen. During task blocks, children viewed 4 types of stimuli: i) positive: faces expressing positive emotions (e.g. joy); ii) negative: faces expressing negative emotions (e.g. anger, fear, sadness); iii) neutral: faces with neutral expressions; iv) distorted: distorted images with scrambled faces (Ekman and Friesen, 1976). For each type of stimuli, 16 different images were selected. All images were 11 cm wide and 16.33 cm high (about 13° of visual angle). The e-CPT requires continuous attention to the task with concurrent inhibition of a preponderant response. Target responses depend on the valence of emotion on which a target letter (i.e. "X") or a distracter (i.e. "A") is depicted. Target images were signaled at the beginning of each block. Children were asked to press a key whenever the target stimulus was combined with the "X" letter (66% of the trials per block). Each block of task conditions comprised 36 trials presented in a pseudo-randomised order. Among these, 24 trials were defined as targets (e.g., faces expressing positive emotions combined with "X" letter). Of the remaining 12 trials, 4 images were target images presented with the distracter (i.e., faces expressing positive emotions combined with "A" letter), 8 were images evenly showing other stimuli (i.e., faces with negative emotions, neutral faces, or distorted images, presented either with "X" or "A" letter).

The whole task sequence was the following (Fig. 1):

Rest - Positive - Distorted - Negative - Neutral - Rest - Neutral - Negative - Distorted - Positive - Rest.

Stimuli were presented for 1000 ms with a jittered interstimulus interval (250–750 ms, 250-ms increments). Press responses with reaction times < 100 ms were excluded to avoid anticipation (response time window: 100 ms - 1000 ms). For each condition, two blocks (54 s each) were used, in addition to 3 rest blocks (30 s each). The whole task lasted 8 min:42 s.

2.5. fNIRS data acquisition, optode localization and data preprocessing

fNIRS data were acquired with a commercial continuous-wave NIRS (DYNOT Compact 9-32, NIRx, Berlin, Germany). An elastic cap of proper size was placed on the participants head, with 6 light sources and 11 light detectors, placed on bilateral prefrontal and frontal areas with the probe center positioned on Fpz and the lowest probe line along the Fp1-Fp2 line (International 10–20 System) (Jasper, 1958). Optode positions, source-detector combinations and corresponding channel numbers are illustrated in Fig. 2. The source-detector distance was 3 cm. Recording wavelengths were set at 760 nm and 830 nm to measure HbO and HbR concentration changes, respectively. NIRS data pre-processing was performed using the Homer2 v2.8 software (Huppert et al., 2009; Piazza et al., 2019). First, the raw data were converted into changes in optical density data. Then, a motion artefact correction technique was applied. The technique consisted in the wavelet-based motion artefact correction approach preceded by a moving average filter performed over 5 s data windows. In the present work, a threshold of 0.1 was used. Data were then filtered with a third order Butterworth 1 Hz low-pass filter, followed by a fifth order Butterworth 0.1 Hz high-pass filter, to further enhance the signal-to-noise-ratio. Finally, the optical density data were converted into concentration changes ($[HbO]$ and $[HbR]$) through the Modified Beer-Lambert Law. For the data conversion, the differential path length factor (DPF) was appropriately calculated accordingly to the age of the tested subjects. Specifically, the DPF was set to 5.7 and 5.1 for the 760 nm and the 830 nm wavelength, respectively.

The preprocessed fNIRS time series were converted by applying the following formula at each data point (p_0) of the 8 task blocks:

$$p1 = (p0 - m_{3s}) / s_{3s}$$

where m_{3s} and s_{3s} are the mean and standard deviation of the fNIRS time series in the 3 s before the first block beginning (Crippa et al., 2017; Grazioli et al., 2019; Ichikawa et al., 2014). Time point concentration data were averaged across different task conditions: i) "Positive", ii) "Negative", iii) "Neutral", iv) "Distorted". fNIRS data from bilateral temporal channels were excluded from further analysis because of a strong signal noise in more than 50% of participants.

HbO and HbR signals were averaged in four regions of interest (ROIs) that were identified as follows: i) left-prefrontal (channels 1–3), ii) right-prefrontal (channels 8–10), iii) left-frontal (channels 4–7), and iv) right-frontal (channels 11–14).

2.6. Statistical analyses

Statistical analyses were conducted using SPSS statistical software package (Version 21.0). Data were visually and statistically inspected to check normality, linearity, independence of observations, and homogeneity of variances.

Preliminary analyses were conducted to assess between-group differences for demographic characteristics. Between-group differences for clinical and cognitive measures were evaluated by Mann-Whitney or Independent-samples t-tests according to variable distributions.

In order to check for possible differences between the ADHD and TD groups in behavioral performances at e-CPT, a 2 × 4 non-parametric version of the repeated measures ANOVA -Wald-type statistic (WTS)-was used, as provided in the nparLD package for R (version 2.15.1, The R Foundation for Statistical Computing; Noguchi et al., 2012), with condition (positive, negative, neutral, and distorted) as within-participant factor and group (ADHD, TD) as a between-participant factor. To explore differences in HbO and HbR signals averaged in each task condition in each ROI, a 2 × 5 × 4 Wald-type statistic (WTS) was calculated, with condition (positive, negative, neutral, distorted, and rest) and ROIs as within-participant factors and group as a between-participant factor. When significant main effects were found, pairwise comparisons were performed using either the Wilcoxon rank sum test between-group comparisons or the Wilcoxon signed rank test for

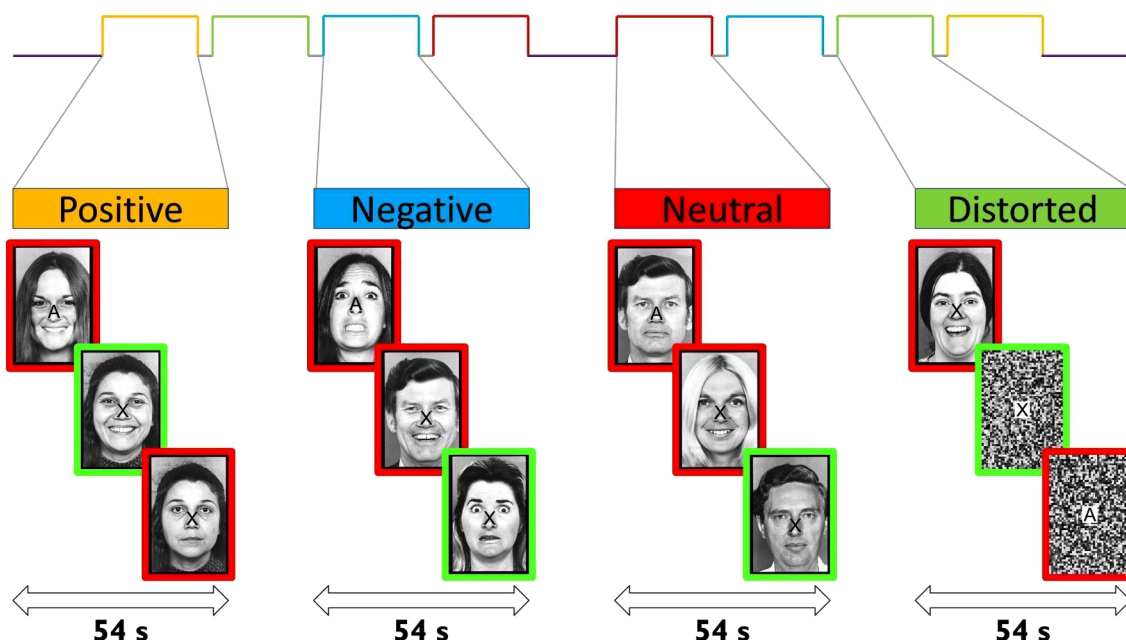


Fig. 1. Task design. Target responses depend on the valence of emotion on which a target letter (i.e. “X”) or a distracter (i.e. “A”) is depicted. In each block of task conditions, children were asked to press a key whenever the target stimulus was combined with the “X” letter. Target images were signaled at the beginning of each block. In Fig. 1, correct responses are signaled by green continuous contour lines.

comparisons within groups. Pairwise comparisons included a Benjamini-Hochberg adjustment for multiple comparisons.

To check for a possible effect of co-diagnosis of autism spectrum disorder (ASD) in our sample of children with ADHD, the above mentioned analyses were carried out on a subsample of children with no ASD comorbidity as well. Indeed, children with ASD could present relevant difficulties in emotion identification via facial expressions (Griffiths et al., 2019).

Spearman correlation analyses were used to evaluate the presence of possible associations between ADHD symptoms and clinical impairment (evaluated with CPRS and CBCL/6–18 subscales), behavioral data from eCPT and hemodynamic characteristics in ROIs which were found to be significantly different between the two groups. The alpha level was set to 0.05 for all data analyses.

3. Results

Four participants in the ADHD group and 2 participants in the TD group were excluded from the study because of non-compliance with behavioral tasks. Twenty children with ADHD and 25 TD peers were evaluated. In the ADHD group, 2 patients were excluded because of technical problems during fNIRS acquisitions. The final sample consisted of 18 children with ADHD diagnosis and 25 typically developing children. In the ADHD group, 5 participants also had a diagnosis of specific learning disorders, 3 participants had an oppositional defiant disorder, 3 participants suffered of anxiety disorder, 2 participants of autistic spectrum disorder and 1 participant of mood disorder.

The two groups were matched for age, gender, FSIQ and familial socioeconomic status (Table 1).

3.1. Clinical and behavioral results

Regarding the clinical profile, children with ADHD showed higher impairments in several domains measured with CBCL/6–18 (with p values ranging from 0.017 to < 0.001), including the CBCL-DP. As expected, children with ADHD had higher clinical scores on the “ADHD index” of CPRS ($p < 0.001$).

The clinical characteristics of the two samples are summarized in Table 1.

Between-group differences were found in e-CPT behavioral performances. A group by condition interaction effect emerged in mean reaction time of hit responses ($WTS(3) = 12.27$, $p = 0.006$), with children with ADHD having faster responses for positive ($p = 0.020$), negative ($p = 0.038$), and neutral stimuli ($p = 0.003$) when compared to TD children. Furthermore, the ADHD group showed more variability in response time to stimuli ($WTS(1) = 4.86$, $p = 0.027$) and more false alarms ($WTS(1) = 5.71$, $p = 0.017$) than did the group with typical development.

The same pattern of results was evident in the subsample of children with no ASD comorbidity.

3.2. fNIRS results

Between-group differences were found for HbO concentration changes. A significant group by condition by ROI emerged ($WTS(12) = 45.78$, $p < 0.001$), with wider changes in TD children than in children with ADHD in right prefrontal ROI during positive, negative, and neutral conditions, and in right frontal ROI in negative condition. No significant differences were found for HbR concentration changes. HbO results are reported in Table 3; HbO and HbR activations in each ROI and condition are depicted in Fig. 3.

As for behavioral task results, fNIRS results were unchanged after excluding participants with comorbid ASD.

Finally, Spearman correlations between HbO activation in right hemisphere, ADHD symptoms and clinical variables and behavioral performances at c-CPT revealed several associations (ranging from Spearman's $\rho = -0.305$ between HbO activation in right-prefrontal ROI during neutral condition and CPRS “ADHD index” to Spearman's $\rho = -0.394$ between HbO activation in right-prefrontal ROI during positive condition and CPRS “ADHD index”) particularly between cortical ROIs found activating significantly differently between the two groups (i.e., right frontal and prefrontal areas) and ADHD symptoms, both measured with the CPRS subscale and the CBCL/6–18 (see Table 4).

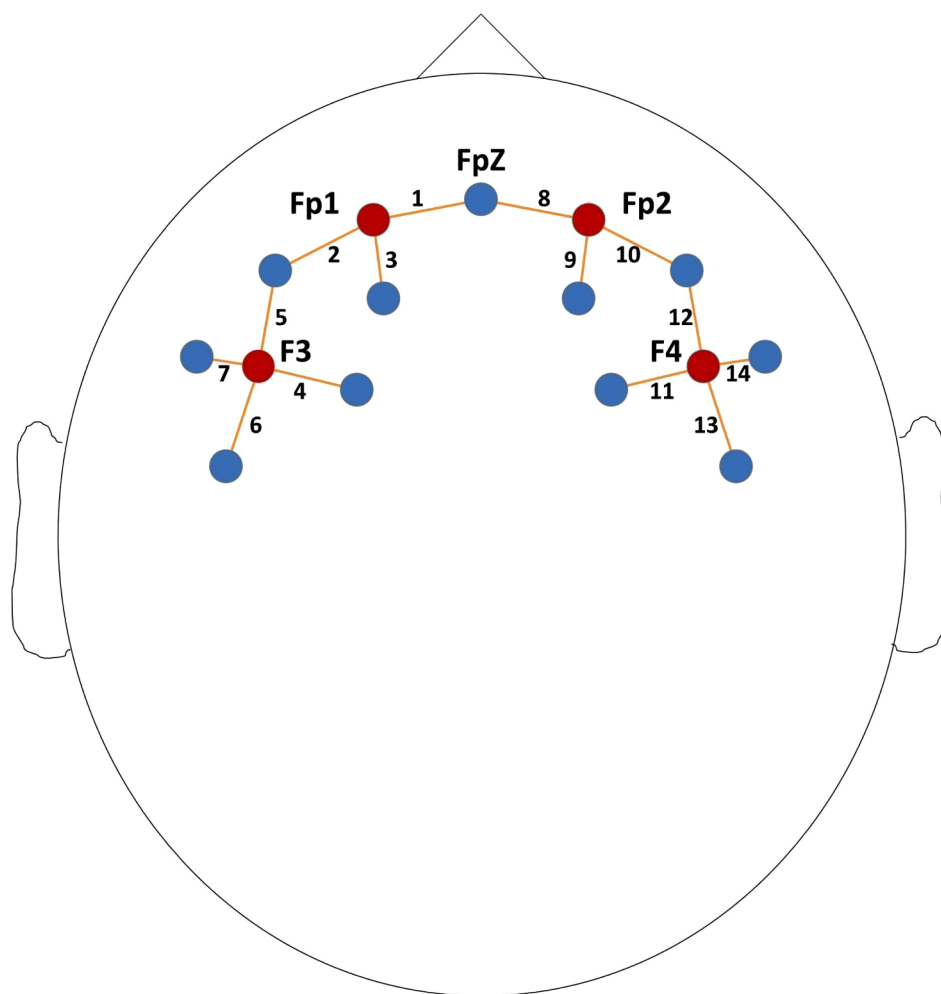


Fig. 2. NIRS optode localization: probe center was positioned on Fpz and the lowest probe line along the Fp1-Fp2 line. Red circles: sources; blue circles: detectors; regions of interest: left-prefrontal = source 1 (Fp1) and channels 1–3, right-prefrontal = source 3 (Fp2) and channels 8–10, left-frontal = source 2 (F3) and channels 4–7, and right-frontal = source 4 (F4) and channels 11–14.

Table 1

Participants' demographic, cognitive and clinical characteristics.

	ADHD (N = 18)	TD (N = 25)		p
Female:Males	2:16	4:21	0.21 ^a	1.000
Age (mean ± SD)	11 ± 3.2	10.3 ± 2.9	0.73 ^b	0.462
SES (mean ± SD)	53.5 ± 19.7	47.2 ± 12.3	1.18 ^b	0.245
FSIQ (mean ± SD)	98.7 ± 14.2	106.4 ± 17.8	1.50 ^b	0.141
CBCL/6–18 Syndromic Scales (mean ± SD)				
Anxious/depressed	64.33 ± 8.07	56.57 ± 6.39	3.44 ^a	0.001
Withdrawn/depressed	60.67 ± 9.97	57.26 ± 7.69	1.26 ^a	0.216
Somatic complaints	56.56 ± 6.19	53.57 ± 5.34	1.66 ^a	0.150
Social problems	63.67 ± 8.53	54.70 ± 4.34	4.07 ^a	< 0.001
Thought problems	62.00 ± 9.79	55.22 ± 6.51	2.54 ^a	0.017
Attention problems	71.78 ± 8.14	53.74 ± 4.31	8.52 ^a	< 0.001
Rule-breaking behavior	63.67 ± 9.08	53.87 ± 5.62	4.02 ^a	< 0.001
Aggressive behavior	69.06 ± 11.21	55.65 ± 7.42	4.38 ^a	< 0.001
CBCL-DP	205.17 ± 23.48	165.96 ± 15.47	6.43 ^a	< 0.001
CPRS				
ADHD index	80.06 ± 10.46	46.17 ± 5.88	13.34 ^a	< 0.001

Table 1: ADHD = attention deficit hyperactivity disorder patients group; TD = Typically developing peers group; SD = standard deviation; SES = Socioeconomic status; CBCL = Child behavior Checklist; SD = standard deviation; DP = Dysregulation Profile; CPRS = Conners' parent rating scales.

^a = Fisher exact test.

^b = Independent Sample t-test.

Table 2
Samples' e-CPT behavioral performances.

e-CPT (mean ± SD)	ADHD	TD
Positive stimuli		
Mean of hits RT (ms)	647.74 ± 88.68	716.03 ± 81.79
SD of hits RT (ms)	189.65 ± 38.18	180.65 ± 43.72
Number of commission errors	9.22 ± 4.40	6.32 ± 4.32
Number of omission errors	7.94 ± 6.87	4.52 ± 3.60
Negative stimuli		
Mean of hits RT (ms)	680.82 ± 142.00	729.78 ± 95.03
SD of hits RT (ms)	224.05 ± 89.50	181.36 ± 51.59
Number of commission errors	9.83 ± 4.11	8.48 ± 4.17
Number of omission errors	7.78 ± 11.03	5.28 ± 5.24
Neutral stimuli		
Mean of hits RT (ms)	639.25 ± 66.15	723.41 ± 84.54
SD of hits RT (ms)	193.31 ± 48.92	173.88 ± 45.84
Number of commission errors	7.61 ± 4.05	5.48 ± 3.74
Number of omission errors	4.33 ± 5.17	4.12 ± 4.67
Distorted stimuli		
Mean of hits RT (ms)	565.12 ± 80.28	590.16 ± 84.01
SD of hits RT (ms)	185.89 ± 53.05	145.06 ± 44.34
Number of commission errors	5.33 ± 3.24	2.96 ± 4.46
Number of omission errors	3.78 ± 5.20	1.24 ± 2.03

Table 2: ADHD = attention deficit hyperactivity disorder patients group; TD = Typically developing peers group; e-CPT = emotional continuous performance task; SD = standard deviation; RT = Reaction Time.**Table 3**
HbO concentration changes in each ROI, in each task condition (a.u.).

	ADHD	TD	<i>p</i> ¹
Left-prefrontal (channels 1–3) (mean ± SD)			
Positive stimuli	0.55 ± 3.51	2.35 ± 5.18	0.382
Negative stimuli	0.11 ± 2.53	1.92 ± 5.31	0.299
Neutral Stimuli	0.4 ± 3.09	2.06 ± 5.54	0.421
Distorted Stimuli	0.14 ± 2.74	1.24 ± 4.19	0.559
Right-prefrontal (channels 8–10) (mean ± SD)			
Positive stimuli	1.97 ± 4.51	4.32 ± 6.32	0.041
Negative stimuli	0.77 ± 2.28	3.37 ± 5.31	0.021
Neutral Stimuli	1.82 ± 4.41	3.5 ± 5.71	0.038
Distorted Stimuli	1.5 ± 4.53	3.42 ± 4.91	0.065
Left-frontal (channels 4–7) (mean ± SD)			
Positive stimuli	1.19 ± 2.99	1.22 ± 3.11	0.883
Negative stimuli	0.83 ± 2.38	0.84 ± 3.29	0.883
Neutral Stimuli	1.28 ± 2.74	1.07 ± 3.77	0.883
Distorted Stimuli	1.08 ± 2.61	0.67 ± 2.84	0.990
Right-frontal (channels 11–14) (mean ± SD)			
Positive stimuli	0.5 ± 4.78	5.23 ± 4.57	0.054
Negative stimuli	0.22 ± 4.26	4.67 ± 4.14	0.030
Neutral Stimuli	0.7 ± 3.84	4.29 ± 4.19	0.052
Distorted Stimuli	0.37 ± 4.07	4.05 ± 3.67	0.091

Table 3: HbO = Oxygenated hemoglobin; ROI = region of interest; a.u. = arbitrary unit; ADHD = attention deficit hyperactivity disorder patients group; TD = Typically developing peers group.¹ = Benjamini-Hochberg adjusted for multiple comparisons.

4. Discussion

The main aim of the present study was to evaluate whether children with ADHD showed a peculiar sensitivity to emotional stimuli compared with TD peers by fNIRS measures of cortical activation during a visual e-CPT. Emotional regulation and processing abilities were evaluated both clinically and neurophysiologically in 18 children with ADHD and 25 typically developing peers.

As expected, the ADHD group showed higher impairments on several domains measured by the CBCL/6–18 and the CPRS. Children with ADHD did not only obtain higher clinical scores on scales strictly related to the core symptoms of the disorder (e.g., ADHD index) but also

on clinical measures of internalizing issues. In fact, children with ADHD showed higher scores on the CBCL/6–18 “Anxious/depressed” and “Social problems” scales. Particular attention should be given to significantly higher “CBCL-DP” scores, in line with previous research (Peyre et al., 2015). Clinical CBCL-DP scores during childhood are indeed known as a transdiagnostic risk factor of worst prognosis for both internalizing and externalizing disorders in adolescence and adulthood (Althoff et al., 2010).

Regarding the e-CPT, this was the first time that e-CPT was used to evaluate individuals in developmental age, with and without neurodevelopmental disorders. Children in the ADHD group showed the worst behavioral performances, with a higher number of commission and omission errors and a greater reaction time variability for correct responses throughout the task. Those trends in between-group difference reach statistical significance for mean reaction time during “positive”, “negative” and “neutral” conditions with children with ADHD being faster than TD peers, as well as for reaction time variability and number of commission errors with children with ADHD showing significantly higher values. The e-CPT is a task that specifically requires subjects to pay attention to stimuli with affective content, allowing to measure possible different effects of emotional context on cognitive processing (Soloff et al., 2015). Hence, it explores the ability to recognize an emotional stimulus as well as the ability to deal with emotional interference –especially with negative valence. Therefore, with the e-CPT, it is possible to consider behavioral responses from both a neuropsychological point of view and an emotional point of view.

Regarding the former of the two perspectives, our results are in line with the literature on neuropsychological deficits in ADHD. Poor behavioral performances on continuous performance tasks are one of the most frequent neurocognitive deficits observed in patients with ADHD owing to their inability to inhibit responses (e.g. Pievsky and McGrath., 2018). Moreover, it is worth to underline that reaction time variability, measured in terms of standard deviation of reaction times, is one of the neuropsychological measures which better differentiate individuals with ADHD from control subjects (Di Martino et al., 2008; Pievsky and McGrath., 2018). From an emotional processing perspective, we found significant differences — regardless of the type of emotion block — in reaction time variability and a greater number of commission errors. As stated before, we expected worse performances on facial expression recognition in the ADHD group, particularly with negative blocks. Unexpectedly, our findings suggest that both positive and negative facial expressions may affect cognitive control in ADHD children during task performance. Therefore, there seems to be a greater burden of this interference effect in children with ADHD, likely linked to the general behavioral inhibition deficits. With respect to the whole sample, it seems nonetheless that negative emotional context causes a non-significant trend of greater difficulties in behavioral performances.

ED might result in deficits in identifying and properly interpreting environmental emotional stimuli (Doumond et al., 2019). Difficulties in recognition of emotional cues and in particular, facial emotional expressions have been previously identified in children with ADHD (Dickstein and Castellanos, 2011; Ichikawa et al., 2014). For humans, face expressions are the most important emotional stimulus. They are the most powerful means to communicate emotional state to others and, as a consequence, their recognition is essential to create relationships in any social context. A deficit in this area could therefore account for the difficulties in socializations frequently experienced by children with ADHD.

The neural network linked to emotional face recognition includes prefrontal areas, predominantly involved in top-down cortical regulation of attention, temporal areas linked to processing of facial expressions, and subcortical circuits that evaluate emotional valence and arousal of the stimulus (Dickstein and Castellanos, 2011; Ichikawa et al., 2014; Soloff et al., 2015). With optical techniques, such as NIRS, it is possible to measure hemodynamic changes only in cortical areas. We therefore focused on frontal and prefrontal bilateral cortices

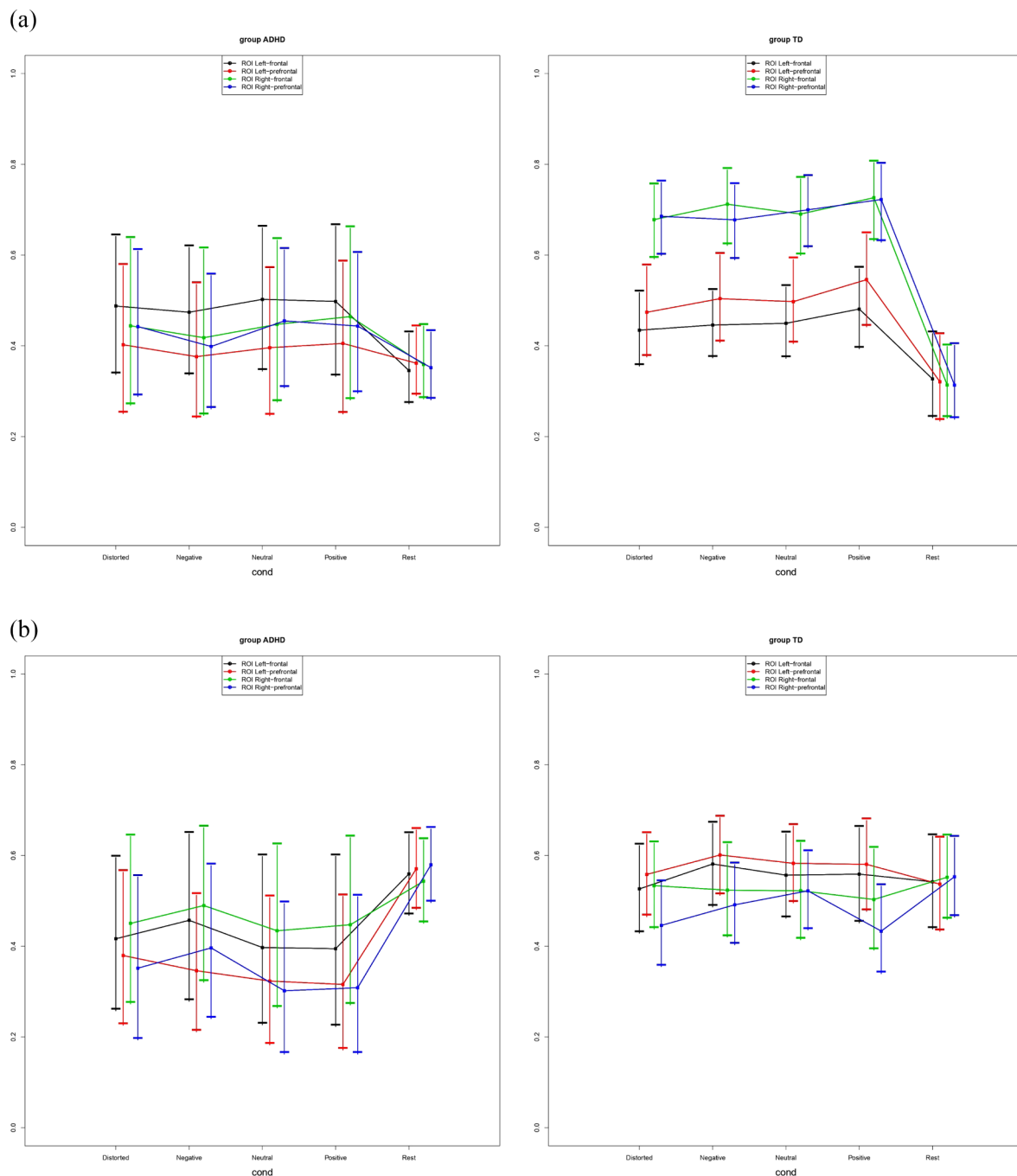


Fig. 3. a. HbO activations in each ROI and condition. ADHD = Attention Deficit/Hyperactivity Disorder; TD = Typically Developing; Cond = Condition. Error bars represent 95% confidence intervals.

b. HbR activations in each ROI and condition. ADHD = Attention Deficit/Hyperactivity Disorder; TD = Typically Developing; Cond = Condition. Error bars represent 95% confidence intervals.

in order to evaluate possible peculiarities in areas linked to the attentive component of emotional processing.

We found different responses in HbO between ADHD and TD groups in right prefrontal cortex during “positive”, “negative” and “neutral” task conditions and right frontal area during negative task condition, with wider concentration changes in the control group.

Previous studies comparing TD children and children with ADHD consistently found a lower activation of clinical groups during different neuropsychological tasks (Grazioli et al., 2019; Grazioli et al., 2019; Mauri et al., 2018; Ichikawa et al., 2014; Soloff et al., 2015). Moreover, in line with previous study, through NIRS we found peculiarities in cortical activation of individuals with ADHD to be localized in the right

hemisphere (Mauri et al., 2018; Ichikawa et al., 2014; Köchel et al., 2015).

The right lateralization effect found in our study could be explained through an analysis of the e-CPT characteristics. This task determines subjects’ responses based on the affective context (i.e., negative, positive or neutral faces) and an additional attentional demand (presence of an “X” rather than an “A”). Hence, subjects are required to perform an attention-driven cognitive task that is directly related to emotional processing. Neurophysiology studies suggest that the right dorsolateral area activity is crucial in all emotions processing, specifically in top-down attentional control functions (Wyczesany et al., 2018). Hence, right lateralization in terms of greater activation found in control

Table 4
Spearman correlation coefficients between HbO mean concentration changes and clinical symptoms and behavioral performances.

	Right-prefrontal ROI Positive	Negative	Neutral	Right-frontal ROI Negative
CBCL/6–18				
Anxious/depressed	−0.13	−0.106	−0.136	−0.07
Withdrawn/depressed	0.055	0.112	0.047	0.139
Somatic complaints	−0.11	−0.052	−0.123	0.01
Social problems	−0.232	−0.179	−0.297	−0.149
Thought problems	−0.16	−0.152	−0.171	0.068
Attention problems	−0.344*	−0.271	−0.369*	−0.328*
Rule-breaking behavior	−0.277	−0.237	−0.342*	−0.236
Aggressive behavior	−0.209	−0.14	−0.229	−0.042
CBCL-DP	−0.271	−0.216	−0.29	−0.179
CPRS				
ADHD index	−0.394*	−0.289	−0.305*	−0.344*
e-CPT Positive condition				
Mean of hits RT	0.29	0.12	0.13	0.12
SD of hits RT	−0.13	0.07	−0.11	−0.10
Number of commission errors	−0.32*	−0.11	−0.29	−0.22
Number of omission errors	−0.05	−0.09	−0.19	−0.01
e-CPT Negative condition				
Mean of hits RT	0.27	0.01	0.09	−0.04
SD of hits RT	0.03	0.19	−0.11	−0.24
Number of commission errors	−0.16	−0.01	−0.11	0.02
Number of omission errors	0.00	−0.22	−0.16	−0.02
e-CPT Neutral condition				
Mean of hits RT	0.10	−0.05	0.16	0.03
SD of hits RT	−0.10	0.11	−0.14	−0.23
Number of commission errors	−0.18	0.11	−0.07	−0.21
Number of omission errors	0.09	−0.12	−0.17	−0.02
e-CPT Distorted condition				
Mean of hits RT	−0.05	0.13	−0.11	−0.05
SD of hits RT	−0.21	−0.05	−0.26	−0.30*
Number of commission errors	−0.17	0.01	−0.07	−0.12
Number of omission errors	−0.04	−0.05	−0.22	−0.04

Table 4: ROI = region of interest; CBCL/6–18 = Child Behavior Checklist; CBCL-DP = Child behavior checklist dysregulation profile; CPRS = Conners' parents rating scale; e-CPT = emotional continuous performance task; RT = Reaction Time; SD = standard deviation. * $p < 0.05$.

subjects could be possibly reconducted to the e-CPT task intrinsic characteristics.

Our study was the first that investigate interference of emotions with cognition in a sample of children and adolescents with a diagnosis of ADHD by fNIRS in frontal lobes.

Previous fNIRS studies (Ichikawa et al., 2014; Köchel et al., 2015) conducted in children with ADHD and TD peers used tasks focused on passive emotional processing. The first study (Ichikawa et al., 2014) found between-group HbO responses to positive (i.e., joy expressions), yet not to negative (i.e., anger expressions), faces in temporal areas. The other study (Köchel et al., 2015) performed fNIRS acquisitions in temporal areas to measure neural correlates of auditory emotional processing and found minor activation in children with ADHD during angry prosody.

Considering previous similar studies conducted through other methodologies, Williams et al. (2008) found atypical neurophysiological responses related to a facial expressions identification task in children with ADHD. Similarly to the present study, their work identified a clinical profile characterized by impairment in the emotional domain and significant brain activity reduction in children with ADHD compared to TD peers. Williams and colleagues work, however, used event-related potentials (ERPs) on occipitotemporal brain systems. This study results suggested a reduction in occipitotemporal cortex activation in response to emotional faces across both right and left hemispheres. The results found in early neural pathways could possibly suggest an atypical emotional processing in ADHD related not only to higher cognitive control domain associated with frontal and prefrontal areas activity — as suggested by our study results — but also to early sensory stages that input to subcortical regions as the amygdala (Williams et al., 2008).

However, given methodological differences, it is not possible to directly compare our results with those of previous studies. In fact, our participants were asked to perform active recognition of emotional stimuli and, at the same time, exert cognitive inhibition. Furthermore, we measured cortical activation in frontal and prefrontal cortices in order to evaluate neural correlates of cognitive control of emotional processing.

HbO concentration changes in the regions found activating differently between TD children and those with ADHD, were significantly negatively correlated with indexes of attention problems and rule-breaking behavior (CBCL/6–18) as well as with ADHD index (CPRS) and with behavioral performances at e-CPT. These findings suggest a relationship between atypical neural activation and clinical and behavioral peculiarities as well. Specifically, lower HbO activation was found being related to higher scores in clinical scales and worse performances in the behavioral task, thus confirming a possible relationship between peculiar brain metabolism in children with ADHD and the clinical and behavioral characteristics.

To summarize, considering a generally greater activation in the control group, we found altered NIRS performances in children with ADHD in all task conditions presenting a human face with or without emotional valence, also finding between-group differences in NIRS signal in blocks with “neutral” emotional value, but not emotional recognition alterations. It seems therefore that blocks comprising faces were easier to perform for TD children.

In our ADHD sample, we found atypical hemodynamic activation in the right prefrontal and frontal cortices while performing e-CPT. Thus, it is possible to hypothesize that these peculiarities are linked to cognitive control and the emotional processing of positive, negative and neutral valence stimuli.

Taken together, our results suggest that when cortical activation in areas linked to cognitive control is evaluated, children with ADHD do not show neural abnormalities specifically linked to difficulties in emotional processing of negative stimuli but these abnormalities are more likely related to a general deficit in dealing with complex tasks demanding behavioral inhibition. This point of view is also sustained by the fact that, when we considered cortical areas presenting statistically significant between-group differences in hemodynamic activations, we found that these areas (i.e., right prefrontal and right frontal cortices) are associated with symptoms of inattention, impulsivity and restlessness, measured both by CPRS and CBCL/6–18, but not with internalizing or emotional lability traits.

5. Limitations

For data interpretation, it is important to consider some limitations that our study presents. First, the limited size of our sample. It might be crucial to replicate our findings in an independent sample with a higher number of participants. Second, the use of a task previously implemented for fMRI acquisition in an fNIRS environment, in consideration of the limited compliance of our clinical patients. It is worth to note that, owing to the limited possibility of near infrared light to penetrate tissue, fNIRS can only measure Hb concentration changes in upper cortical areas.

Our study also presents some strengths. To our knowledge, it is the first study to investigate emotional processing in children and adolescents with ADHD using an “active” task which requires participants to deal with emotion recognition. Moreover, our study is the first in this field conducted on a completely drug-naïve sample, a condition necessary to exclude possible drug-related neurobiological effects.

Conclusion

In conclusion, our findings suggest the presence of deficits in emotional processing, as suggested by poor performances to e-CPT task, in children with ADHD as well as a peculiar sensitivity to emotional stimuli linked to atypical hemodynamics of right prefrontal and frontal cortical areas. Moreover, these peculiarities, which were seen both with positive and negative emotional stimuli, seem to be linked to behavioral inhibition deficits. While performing an emotional task that requires cognitive control, children with ADHD did not show abnormalities specifically linked with negative stimulus processing – contrary to what was previously reported in the literature (Ichikawa et al., 2014; Kochel et al., 2015) – but did show abnormalities related to a general deficit in behavioral inhibition.

Contributors

M.N. conceptualized the study design and methodology; S.B., E.G., E.R. and M.Ma. conducted the investigation; A.B., S.G., U.P. and M.Ma. performed neuroimaging and statistical analysis; E.M., V.D. and P.B. supervised the neuroimaging data interpretation; M.Ma. wrote the original draft of the manuscript; A.C., S.G., M.N., and M.Ma. contributed to the discussion of the results; all the authors agreed on the final version of the manuscript; M.N. and M.Ma. were responsible for findings acquisition.

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Declaration of Competing interest

None

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La dislessia: disabilità o differente iperabilità?

La dislessia è una combinazione di difficoltà e abilità che influenza il processo di apprendimento in uno o più ambiti: lettura, ortografia, scrittura e calcolo. Questo disturbo, fondato su una base neurobiologica, viene classificato all'interno dei DSA (disturbi specifici dell'apprendimento).

A lungo la definizione di dislessia si è basata sul modello medico, in cui la dislessia serviva ad attribuire un'etichetta o un marchio per rappresentare un disturbo, cioè un'identità deficitaria.

L'autrice di questo libro vuole invece proporre una nuova concezione di dislessia, fondata sul modello sociale. La dislessia può essere compresa a fondo e valutata solo per quello che è: una neurodiversità; con questo termine si intende una diversità del cervello umano e del funzionamento neurocognitivo, in cui le abilità cambiano a seconda delle attività svolte.

La dislessia ci consente di comprendere come i limiti o i disturbi siano spesso il prodotto della società odierna, nel momento in cui questa ci impone la lettura come unico (o quasi) strumento di apprendimento. I "deficit" dell'essere dislessici sono spiegati come artefatti di aspettative sociali ed educative inappropriate: sarebbe utile trovare soluzioni sociali ed educative per bypassare le barriere. Forse se si riuscissero a sospendere le connotazioni limitanti riguardo alle disabilità di apprendimento, le persone neurodivergenti potrebbero riconoscere la verità liberatrice: ogni

mente umana contiene il potenziale per un'iperabilità (vantaggio accresciuto ottenuto dalla conversione di una condizione percepita come un impedimento, quale la dislessia) che aspetta solo di essere scoperta.

Partendo da questi assunti e dai nuovi criteri di classificazione della dislessia, l'autrice sposta il focus sulla scuola e i meccanismi di apprendimento dei dislessici.

Non esiste un metodo di insegnamento della letto-scrittura "unico per tutti": studenti diversi rispondono a differenti attività, ma il modo migliore per raggiungere tutti gli studenti è attraverso l'apprendimento multisensoriale. L'apprendimento multisensoriale è una delle strategie di coinvolgimento più efficaci per l'apprendimento: il cervello umano si è evoluto per imparare a crescere in un ambiente multisensoriale. Le attività multisensoriali possono insegnare agli studenti ad associare in modo più veloce lettere o parole a suoni.

Pur avendo una base genetica, i disturbi dell'apprendimento sono condizionati dall'ambiente: più l'ambiente scolastico è sfavorevole, più c'è la possibilità che si presentino le difficoltà. Nonostante la società si stia muovendo in una direzione tale per cui vi è la possibilità di personalizzare e adattare le cose alle nostre esigenze individuali, il sistema educativo attuale rimane bloccato in un approccio di massa, uguale per tutti, e ciò è pericoloso soprattutto per i dislessici.

C'è bisogno di maggior autonomia nel sistema scolastico, sia per gli insegnanti che per gli studenti.

Dovremmo smettere di concentrarci sull'apprendimento come obiettivo educativo, ma dovremmo porre invece il focus sulla realizzazione, cioè sull'aiutare gli studenti ad essere le persone migliori e più capaci che possono essere.

Un adolescente, la cui dislessia non sia mai stata riconosciuta e affrontata, ha un'alta possibilità di manifestare psicopatologie secondarie come depressione, sindrome ansiosa, disistima, inibizione emotiva con conseguente abuso di droghe o alcol o comportamenti delinquenziali. Per questo è essenziale la



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*La dislessia
Dalla scuola al lavoro
nel terzo millennio*
Il Pensiero Scientifico
Editore, Roma
240 pp., 18,00 euro

necessità di un riconoscimento quanto più precoce del bambino dislessico o, nel caso di un adulto, l'importanza di una diagnosi e, eventualmente, di un percorso di sostegno psicologico. Un percorso scolastico difficile e frustrante può costituire un trauma vero e proprio per l'individuo: nel periodo evolutivo, il maggiore, se non l'unico, fattore di stima sociale del sé, è rappresentato dalla riuscita nei percorsi scolastici. Il sé non è un *datum*, esso si costruisce nel tempo in base ai rimandi che ci provengono dall'esterno e, se questi sono tali da rimandarci continui fallimenti, l'immagine che ci si costituirà di se stessi sarà sicuramente fallimentare. Il rischio è che questi soggetti, colti da una persistente sfiducia, colpiti da "impotenza appresa" possono decidere che non valga più la pena studiare ed impegnarsi, arrivando così nei casi più estremi anche all'abbandono scolastico.

L'autrice ci accompagna poi a capire quali sono le potenzialità dei dislessici e come il mondo del lavoro potrebbe trarre vantaggio da queste. I dislessici mostrano una dominanza cerebrale non regolare: le diversità trovate nella struttura del loro cervello e funzionamento, secondo alcuni autori, sono le cause e non le conseguenze delle difficoltà di lettura. Il profilo cognitivo dei nativi digitali simile a quello dei dislessici: i nativi digitali, che meglio utilizzano l'emisfero destro del cervello sono più creativi, più veloci nei movimenti, perché il loro sistema nervoso è diverso: la loro intelligenza è multipla, capace di gestire contemporaneamente un certo numero di attività diverse.

I vantaggi offerti dai media digitali potrebbero diventare parte di una riconcettualizzazione della dislessia, in modo da fornire nuovi veicoli per l'espressione e la comunicazione

Gli studiosi suggeriscono che la maggiore creatività associata alla dislessia si fonda parzialmente su una base neurofisiologica, eventualmente mediante un più alto profilo olistico di elaborazione delle capacità spaziali. I soggetti dislessici hanno un modo divergente di pensare, che permette un'originalità nell'elaborare le informazioni, un'espressione

non convenzionale di sentimenti e opinioni, e che può anche supportare la risoluzione dei problemi della vita quotidiana. Queste caratteristiche risultano vantaggiose in lavori che richiedono il pensiero tridimensionale come l'astrofisica, la biologia molecolare, la genetica, l'ingegneria e la grafica computerizzata.

I punti di forza dei dislessici si allineano alle capacità e alle abilità fondamentali del lavoro del futuro, ma questi punti di forza andranno cercati, riconosciuti, compresi e armonizzati, in modo da creare valore all'interno di un'azienda.

Semplici misure di inclusione e aggiustamenti sul posto di lavoro possono aiutare a rimuovere le barriere per i dislessici; queste comprendono sia la formazione di consapevolezza per colleghi e dirigenti, sia la formazione per gli stessi dipendenti dislessici.

Il libro si conclude con le storie di personaggi dislessici che, nonostante le difficoltà incontrate, sono riusciti ad intraprendere carriere e percorsi di successo.

L'augurio che Rossella Greci sostiene al termine delle sue riflessioni è quello che le menti dislessiche possano avere sempre più spazio e maggiori possibilità di realizzare le loro potenzialità, in una società che continuerà il suo cammino verso l'evoluzione e la neurodiversità sarà proprio la lente con cui si dovrà guardare oltre.

Il libro ha una grafica strutturata in modo tale da favorire la lettura dei soggetti dislessici, è scorrevole e offre interessanti spunti di riflessione sia per questi soggetti, che per i loro genitori. La visione positiva della dislessia, fortemente sostenuta da Rossella Greci, si spera possa portare alla realizzazione scolastica e personale di tutti gli individui "neurodiversi".

Quella che l'autrice propone è una visione quasi "ottimistica" di una situazione che purtroppo al giorno d'oggi risulta ancora un grande problema per molti. Nonostante sia scientificamente dimostrato che i soggetti dislessici possono avere delle "iperabilità", queste non sempre trovano un contesto ambientale adatto che consenta loro di manifestarsi. Troppe volte vi sono difficoltà nella tempistica e nella valutazione della dislessia:

come sottolineato da Rossella Greci sono rari i casi in cui la diagnosi viene fatta precocemente e questo comporta anni di frustrazione, sofferenza, vergogna, umiliazione da parte dei compagni, oltre che dolori fisici come forma di somatizzazione (mal di pancia, difficoltà di respiro, ecc.). Anche la valutazione diagnostica non è ancora una prassi che viene effettuata abitualmente e con facilità: deve essere eseguita da specialisti esperti mediante test. Non tutti i genitori hanno la possibilità (tempo e risorse) per seguire un percorso appropriato. Inoltre in alcune situazioni il problema è rappresentato dalla mancata segnalazione precoce da parte dei docenti. Le difficoltà di un dislessico non sono semplici, possono evolvere e modificarsi con il passare degli anni e in ogni fase l'atteggiamento degli insegnanti, dei compagni di classe e della famiglia hanno un notevole peso nel determinare evoluzioni positive o negative del vissuto psicologico di questi ragazzi. Bisognerebbe trovare un giusto equilibrio: da un

lato si dovrebbe evitare di semplificare il problema attribuendolo a pigrizia, svogliatezza e mancanza di impegno a scuola. Dall'altro lato è necessario che, una volta posta la diagnosi e forniti ai soggetti dislessici gli strumenti e le forme di supporto appropriati, questi siano stimolati ad applicarsi ad apprendere. È vero che i soggetti dislessici hanno delle potenzialità che possono consentire loro di emergere in alcune aree della convivenza. Tuttavia sono molti gli ostacoli che questi devono superare prima di arrivare al traguardo. Per questo motivo, sebbene molti dei punti sottolineati dall'autrice siano condivisibili, a tutt'oggi parlare di dislessia come abilità è ancora utopico e distante dai vissuti dei soggetti dislessici e dei loro familiari.

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Le lettere sono sempre gradite, e vengono sempre pubblicate. Si prega solo una ragionevole concisione, cercando di non superare le 3000 battute. Qualche taglio editoriale e qualche intervento di editing che non alteri il senso della lettera saranno, a volte, inevitabili.

IL GRAFFIO Il pediatra, il NPI e... Leopardi



Vi raccomando di leggere e, al caso, di rileggere le operette morali di Leopardi. In particolare il dialogo di un Islandese con la Natura: causa di tutti i mali che lo affliggono e al contempo cinicamente disinteressata alla sofferenza, come anche alla felicità, di ogni sua creatura. A torto o ragione, la lettura di questo imperdibile pezzo della letteratura italiana mi ha riportato a pensare al dialogo che ho orecchiato di recente tra un pediatra e un neuropsichiatra amici di tutti voi. Diceva il pediatra, come di consueto un po' esagitato e un po' presuntuoso nel volersi mostrare preparato sull'argomento: «Vi siete accorti anche voi NPI o no dell'epidemia di casi psichiatrici tra bambini e adolescenti che nei fatti tocca a noi pediatri affrontare in prima battuta nei nostri ambulatori e nei nostri Pronto Soccorso (PS)? Almeno il 10% dei bambini che vediamo in ambulatorio sono affetti da un disturbo mentale (esplicito o mascherato da altro tipo di sintomo) e le acuzie NPI sono diventate il primo motivo di accesso degli adolescenti al PS dopo i traumi. Per molti di noi pediatri tutto questo è causa di tormento e frustrazione, nella consapevolezza della nostra inadeguatezza e al contempo dell'urgenza di cambiare i modi, gli scopi e il ritmo del nostro lavoro. Abbiamo bisogno del vostro aiuto ma non avvertiamo che la consapevolezza di questa urgenza sia condivisa con voi». A quel punto il neuropsichiatra ha fatto una smorfia (sembrava soffrire anche lui e questo mi ha subito lasciato ben sperare...). «Noi NPI siamo ben consapevoli (ne siamo travolti...) dell'esplosione del problema della salute mentale in età evolutiva. Si tratta di una sollecitazione imperdibile a mettere insieme saperi ed esperienze per trovare soluzioni condivise. A fronte di questa consapevolezza, perché le cose vadano a sistema nel modo più vantaggioso, sembra peraltro opportuno, per il pediatra come per il NPI, il richiamo a esercitare la pazienza: proprio nel senso leopardiano della parola, di attivo apprendimento di un modo paziente di affrontare la realtà («... la pazienza è la più eroica delle virtù, proprio perché non ha nulla di eroico». G. Leopardi, Zibaldone)». «Qualcosa da dire - ha ripreso il pediatra - avremmo anche sull'autismo che noi pediatri abbiamo ora imparato a intercettare tempestivamente come voi stessi ci avete raccomandato e insegnato a fare. Ma che, una volta diagnosticato, resta spesso "sospeso nell'aria" alla ricerca di una cura e finisce ancora, purtroppo nella larga maggioranza dei casi, preda delle reti assistenziali private. Mi sembra urgente e irrinunciabile che tutte le Regioni operino sinergicamente per raggiungere livelli condivisi di diagnostica e di presa incarico terapeutica perché vengano applicati e garantiti economicamente in ogni modo i livelli minimi di assistenza (LEA). Ma altrettanto urgente risulta, per tutti noi, anche una riflessione sui modi di comunicare e di agire la diagnosi (su cosa cioè viene lasciato per sempre in*

quella famiglia con l'atto di diagnosi) e sulla responsabilizzazione terapeutica che oggi imponiamo alla famiglia stessa (su cosa cioè viene lasciato per sempre a quella famiglia trasferendole così chiaramente l'atto di cura)». «E che dire dell'ADHD? - incalza ancora il pediatra, sempre un po' antipatico - Nonostante i Centri di riferimento regionale autorizzati alla diagnosi e cura lavorino molto bene, l'ADHD rimane in Italia un problema largamente sottostimato, sia per quel che riguarda il numero di casi diagnosticati e trattati sia per quel che riguarda la dovuta consapevolezza (medica e sociale) della sofferenza del bambino e della gravità delle ripercussioni a lungo termine che questa condizione comporta se non adeguatamente trattata. Cosa state facendo voi NPI in questo senso, al di là del lavoro che svolgete nelle vostre strutture?» «L'ADH - ribatte il NPI - rappresenta la vera sfida di tutta la NPI moderna. Sfida che impone di tener conto degli elementi genetici e biologici della malattia e al contempo del contesto ambientale che ne modula l'espressione (oggi improntato dall'iperattività piuttosto che dalla pazienza...). Sfida che impone quindi di agire ogni terapia consapevole che nel tempo le determinanti biologiche e ambientali si modificano, sapendo utilizzare (o al caso sospendendo) i farmaci, come ogni altra forma di terapia, al momento giusto nel corso dello sviluppo. Affrontando, certo, in ogni occasione ci venga data, quel conformismo-perbenismo medico e quell'ignoranza sociale che ancora moraleggiano sulla terapia farmacologica così come su altre forme di psicoterapia di documentata efficacia, umiliando così la sofferenza delle vittime». «Si dice che siamo ora davanti a una grande occasione - ha ripreso il pediatra per concludere - quella di riformare il Sistema Sanitario e con questo le cure e l'assistenza all'età evolutiva. Ci pensiamo insieme? Sì, certo. Ma prima c'è bisogno tra di noi di un patto di assunzione di responsabilità. C'è bisogno, senza condizioni, di un atto di vera e propria paternità. Di un patto che si carichi dell'onere di identificare e perseguire un bene comune in età evolutiva, sfuggendo alla tentazione del paternalismo: di cui troppo spesso si abusa e che, intriso spesso di un interessamento tanto ostentato quanto strumentale, si adopra a elencare i problemi ma mai a farsene carico». Alla fine, a me che origliavo, è sembrato che il NPI avesse la stessa voglia di far bene (e di farlo insieme) che motiva tanti di noi. E che anche lui, forse, abbia bisogno di sentire da noi la stessa reale disponibilità personale, lo stesso sapersi mettere nei panni degli altri, la stessa tempestività nel cambiare ritmo, che noi continuamente gli chiediamo. Mi piace sperare, a questo punto, che anche lui desideri proseguire e approfondire questo dialogo. E sono sicuro che, assieme a tanti altri neuropsichiatri, lo farà. Con pazienza, certo...

Alessandro Ventura

*Giornate Pediatriche Perugine 2020 (dialogo tra A. Albizzati e A. Ventura)

Cosa deve sapere ogni pediatra sulla comunicazione aumentativa alternativa (CAA)

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È un approccio dai vari volti, ma con lo scopo univoco di offrire alle persone con bisogni comunicativi complessi la possibilità di utilizzare canali che si affiancano alla comunicazione orale. La comunicazione aumentativa alternativa (CAA) offre numerose potenzialità, ma è ancora poco diffusa nel nostro Paese. "Comunicare è un diritto di tutti, favorirne la possibilità è un dovere sociale".

CHE COS'È LA CAA?

Si tratta di un'area della pratica clinica che cerca di compensare la disabilità temporanea o permanente di soggetti con bisogni comunicativi complessi. È una **Comunicazione interattiva** e viene usata da entrambi i *partner* comunicativi: quello verbale e quello con deficit di linguaggio o non verbale: quando viene utilizzata dal *partner* comunicativo verbale è a supporto della comprensione del linguaggio parlato (recettiva); spesso si avvale di gesti o segni e immagini e utilizza un doppio *input* comunicativo sia visivo che uditivo.

È **Aumentativa** perché ha lo scopo principale di **potenziare, ampliare ed espandere** (in inglese *augmentative*)¹ la comunicazione e il linguaggio supportando tutte le potenzialità comunicative della persona a partire dalle vocalizzazioni e dal linguaggio verbale esistente.

È **Alternativa** perché utilizza modalità alternative alla comunicazione tradizionale: si avvale di gesti, segni, ausili per la comunicazione e tecnologia avanzata e rientra nella tecnologia assistiva.

CHE COSA NON È...

Non è una tecnica riabilitativa perché non può essere patrimonio solo

WHAT PAEDIATRICIANS NEED TO KNOW ON AUGMENTATIVE ALTERNATIVE COMMUNICATION (AAC)

(Medico e Bambino 2020;39:513-517)

Key words

Augmentative Alternative Communication (AAC), Double communicative input, Complex disabilities, Assistive technology,

Summary

Augmentative Alternative Communication (AAC) is an area of clinical practice that tries to compensate for the temporary or permanent disability of individuals with complex communication needs. It uses gestures or signs and images and utilises a double communicative input, both visual and auditory. It is Augmentative because its main purpose is to enhance and expand ("augmentative" 1983 ISAAC) communication and language, supporting all the communicative potential of the person. It is Alternative because it uses an alternative method to traditional communication: it utilises gestures, signs, aids for communication and advanced technology, falling within Assistive Technology (AT). AAC users are mainly those with complex (cognitive and communicative) disabilities. Moreover, it is also used in all those temporary situations in which communication is hindered by traumatic factors (intensive care, first aid) or linked to the issue of integration / inclusion. For example, foreign people can benefit from the use of AAC in order to reduce discomfort in social relations and language learning. The Authors highlight the potential of AAC both on the basis of scientific and clinical evidence and describe the evolution of two clinical cases followed at the Child and Adolescent Neuropsychiatry Unit in Como (Italy).

del terapeuta, ma deve essere adottata e condivisa da tutti i contesti di vita del suo fruitore, in ogni momento e luogo della sua vita: risponde così alle continue esigenze di cambiamento ed è quindi un **sistema flessibile**, su misura per ogni persona.

Il modello di intervento risulta essere esclusivamente e imprescindibilmente **partecipativo** e prevede l'attivazione di tutto il contesto di vita del soggetto interessato cioè la famiglia, la scuola, i Servizi sociali, le strutture

sanitarie, i Centri ludico-sportivi-ricreativi, la struttura religiosa e la biblioteca che frequenta. Tale attivazione è subordinata a un percorso formativo presso Centri dedicati.

CHI SONO GLI UTENTI?

Principalmente quei soggetti in età evolutiva e in età adulta, portatori di una disabilità complessa (cognitiva e di comunicazione) capaci di utilizzare

strategie per esprimere bisogni comunicativi legati a scelte, emozioni e stati d'animo.

Inoltre tutte quelle situazioni temporanee in cui la comunicazione è ostacolata per impedimenti legati a fattori traumatici (Terapia Intensiva, Pronto Soccorso) oppure legate alla problematica di integrazione/inclusione: le persone straniere possono beneficiare dell'utilizzo della CAA al fine di ridurre il disagio nella comunicazione interpersonale, nelle relazioni sociali e nell'apprendimento della lingua.

QUANDO UTILIZZARE LA CAA?

È importante considerare che l'unico prerequisito fondamentale per la presa in carico con la CAA è l'attivazione del contesto in termini di collaborazione continuativa nel tempo e partecipazione al percorso formativo sia del soggetto che della collettività, mentre età, livello cognitivo o gravità di compromissione non sono fattori così rilevanti.

PERCHÉ UTILIZZARE LA CAA?

La CAA migliora il linguaggio verbale implementando le abilità di comunicazione e interazione². Soggetti con disturbo dello spettro autistico migliorano il loro uso del linguaggio parlato comprensibile se esposti a simboli grafici, visivi e parole durante l'interazione con il *partner* comunicativo, in situazioni quotidiane³.

La CAA con tavole di comunicazione mediante immagini ha aumentato la frequenza e la lunghezza delle espressioni verbali durante la lettura di storie⁴ e ha implementato sia l'attenzione congiunta che le capacità grafico-rappresentative, come emerso da ricerche in ambito clinico.

QUALI I PRESUPPOSTI TEORICI DELLA CAA?

I capisaldi teorici alla base del modello di intervento con la CAA sono due: i **neuroni specchio** e l'**ICF** (classificazione internazionale del funziona-

mento, delle disabilità e della salute, redatta dall'Organizzazione Mondiale della Sanità).

I primi sono un sistema automatico che entra in risonanza con le azioni effettuate da un altro, attivando lo stesso *partner* motorio necessario a compiere le azioni osservate, senza agire però concretamente.

La **teoria dei neuroni specchio** mette in evidenza come lo snodo chiave che differenzia l'uomo dai primati sul piano comunicativo non è stato tanto il linguaggio, quanto la funzione comunicativa e sociale attraverso gesti naturali e specifici quali indicare e mimare^{5,6}. Dal momento che la capacità umana di comunicare si è sviluppata prima dai gesti e poi dal linguaggio è un sistema attivo fin dalla nascita: infatti i neonati nascono con una serie di competenze innate che favoriscono lo sviluppo della comunicazione, ma tali competenze necessitano dell'interazione con l'altro per svilupparsi e implementarsi^{7,8}. Ecco che ogni atto comunicativo presuppone almeno due *partner* che attraverso la ripetizione regolare di sequenze creano un terreno comune noto e condiviso che permette la comunicazione intenzionale in una turnazione di gesti e parole. Questa capacità dell'uomo di collaborare con altri uomini verso fini congiunti e di agire con una intenzionalità comunicativa condivisa è unica e specifica della comunicazione umana^{9,10} e rende dunque fondamentale l'intervento di CAA nei soggetti con bisogni comunicativi complessi.

L'**ICF**, redatta dall'Organizzazione Mondiale della Sanità, ha portato a un grande cambiamento dello sguardo sulla disabilità, che non viene più classificata in base alla conseguenza della malattia, bensì *in base alle componenti della salute che sono intese come fattori fondamentali di salute e benessere*¹¹. Se guardiamo dunque alla disabilità come al risultato dell'interazione fra fattori individuali e fattori contestuali/ambientali¹², anche la comunicazione risulta tra questi e nel caso di un disturbo complesso o situazioni contingenti/ambientali problematiche può essere causa di un

ampliamento della disabilità così come in presenza di strategie e facilitatori può risultare un fattore assolutamente rilevante per una riduzione della stessa. L'intervento di CAA ha lo scopo di creare strumenti utili a promuovere e sviluppare la comunicazione spontanea con conseguente riduzione della disabilità (ICF), incrementando la partecipazione attiva e l'intenzionalità comunicativa nei diversi ambienti.

QUALI GLI STRUMENTI?

Gli strumenti e le tecniche utilizzate nella CAA sono diversi e molteplici in base alla patologia, all'età ai bisogni personali e alle caratteristiche cliniche. Una prima distinzione si basa sul tipo di sistema utilizzato: corporeo, cioè segni manuali, gesti e vocalizzazioni, **CAA non assistita**, oppure extracorporeo, cioè disegni, fotografie, simboli tridimensionali o lineari, **CAA assistita**. Quando il sistema assistito si avvale del supporto di dispositivi tecnologici o ausili informatici, in base al livello di tecnologia si distinguono sistemi di CAA a bassa tecnologia oppure ad alta tecnologia¹³. Il linguaggio dei segni è un esempio di CAA non assistita, i PECS (sistema di comunicazione per scambio di simboli), le tavole comunicative, gli *Inbook* (libri con il testo scritto in simboli) sono esempi di CAA assistita.


CAA E STRUTTURE SANITARIE: L'ESPERIENZA DI COMO


L'ambulatorio di Neuropsichiatria infantile si occupa di diagnosi, cura, riabilitazione e presa in carico dei minori che soffrono di malattie neurologiche, psichiatriche, disturbi neuropsicologici e disabilità di vario grado. L'intervento è allargato alla famiglia e all'ambiente di vita e viene effettuato da una *équipe* multidisciplinare.


Tra i vari interventi, quello della CAA sui minori con difficoltà di comunicazione linguistica occupa un posto di rilievo e viene proposto sia in ambito ambulatoriale che in via sperimentale.

ESEMPI DI STRUMENTI IN CAA

Didattica in CAA: testo di storia semplificato in simboli

conoscere


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civiltà


























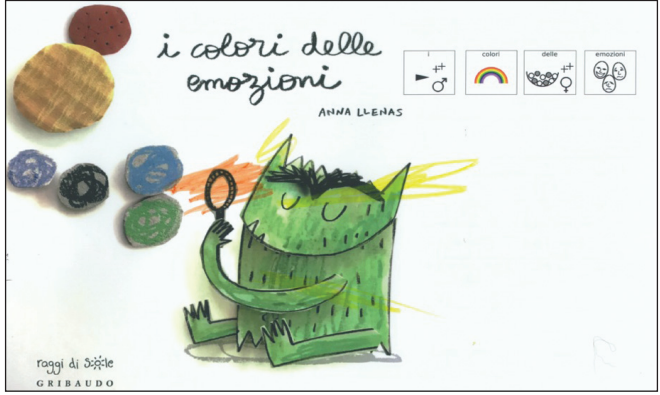

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gioco 	gioco 	pongo 	libro 	disegno 	foglio 
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basta 	non 	mi piace 	divertente 	noioso 	ancora 


Tabella a tema per la scelta


Inbook





Libri modificati su misura


Ma


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Per saperne di più: www.sovrazionalecaa.org - www.csinbook.altervista.org - www.isaacitaly.it

tale presso il reparto di Pediatria dell'ospedale Sant'Anna di Como, dove l'équipe dedicata alla CAA fornisce una consulenza al reparto di Genetica pediatrica, diretta dal dottor Angelo Selicorni, finalizzata ad attivare percorsi di CAA, fornendo materiali informativi e supervisioni ai Centri riabilitativi di riferimento.

L'obiettivo di incontrare genitori e bambini affetti da sindromi genetiche, perlopiù rare, è di individuare gli strumenti più efficaci per sviluppare l'intenzionalità comunicativa e la capacità di attenzione condivisa all'ascolto così da sostenere la comunicazione (comprensione e linguaggio), creando situazioni/ambienti facilitanti e motivanti. Uno di questi strumenti è il libro illustrato in simboli, personalizzato, cioè fatto sull'esperienza e il vissuto del bambino, oppure il libro in simboli costruito "su misura" per il bambino, quindi modificato dal testo originale¹¹. Per offrire miglior accoglienza ai pazienti e alle loro famiglie sono stati "etichettati" con simboli di CAA gli ambienti sia del reparto di Pediatria che del Pronto Soccorso pediatrico e all'interno della libreria presente in reparto, è stata allestita una piccola sezione di libri in simboli CAA.

I libri in simboli sono un valido strumento anche quando traducono fedelmente il testo originale (*Inbook*) e vengono usati nella nostra Unità Operativa di Neuropsichiatria Infantile e dell'Adolescenza (UONPIA) nei laboratori con piccoli utenti con bisogni comunicativi complessi, tra cui anche stranieri esposti a bi-trilinguismo, così da condividere un modello di lettura ad alta voce anche con i genitori che spesso necessitano di percorsi che supportino il legame affettivo con i figli e la capacità empatica. I laboratori vengono anche svolti nelle scuole sia dell'infanzia che primaria e secondaria di primo grado così da generalizzare la proposta di lettura ad alta voce di libri in simboli, favorendo l'integrazione e l'inclusione del soggetto con bisogni comunicativi complessi nella sua classe e nell'ambiente scolastico.

La CAA e gli strumenti di CAA, utilizzati nel progetto di intervento ambulatoriale sia durante i laboratori

Figura 1

di lettura sia nei trattamenti neuro-psicomotori individuali e di gruppo, hanno permesso a molti dei nostri utenti e alle loro famiglie di migliorare le relazioni sociali, aumentando le possibilità di integrazione, inclusione nei diversi contesti di vita, potenziando il coinvolgimento dei *partner* comunicativi sia genitori che insegnanti e coetanei. Di seguito due casi clinici che illustrano le modalità di intervento con la CAA.

Caso 1: sindrome da alterazione globale dello sviluppo psicologico non specificata

Il bambino nasce nel 2005. All'età di tre anni viene fatta una valutazione neuro-psicomotoria che evidenzia un difetto di regolazione del comporta-

mento, con instabilità psicomotoria, associato a un quadro di disfasia. Presenta un potenziale cognitivo, ma essendo **esposto a tre lingue** (filippino, inglese, italiano) la comprensione è deficitaria così come l'espressione linguistica è gravemente compromessa. In seguito alla valutazione inizia il trattamento psicomotorio presso la UONPIA di Como con frequenza bisettimanale. All'età di sei anni l'*équipe* multidisciplinare decide di inserire il bambino all'interno del Progetto regionale "Supporto delle gravi disabilità della comunicazione in età evolutiva" che, con la formazione e supervisione dell'*équipe* del Centro sovrazonale di Comunicazione Aumentativa, diretta dalla dottoressa Costantino, si occupa di formare in CAA le UONPIA della

Lombardia e i contesti di vita dei loro utenti. Dopo una valutazione sulle capacità comunicative emerge che il bambino ha un **disturbo di comprensione significativo** e fatica a comprendere le parole se isolate dal contesto: si comporta come una persona straniera alle prese con una lingua sconosciuta; il suo livello cognitivo è migliore del suo livello linguistico.

Le proposte di intervento messe in atto durante l'approccio neuro-psicomotorio integrato alla CAA hanno comportato un utilizzo massiccio di **libri su misura**, l'utilizzo degli strumenti di CAA in simboli WLS (*Widgit Literacy Symbols*) e l'utilizzo in un primo momento di un ausilio a uscita in voce (32 caselle) e successivamente di un *tablet* dotato di un *software* per griglie con simboli in CAA (*Figura 1*). Con la crescita del bambino si è considerata la necessità di lavorare sulle capacità/autonomie sociali ed è stato proposto un percorso condiviso con un altro utente con bisogni comunicativi complessi, utilizzando la CAA come linguaggio comune a entrambi gli utenti. Durante la presa in carico con la CAA sono stati anche proposti laboratori di lettura ad alta voce con libri in simboli *Inbook* sia presso il Servizio di Neuropsichiatria sia presso la scuola primaria e secondaria di primo grado che tutt'oggi frequenta con una buona riuscita sia dal punto di vista degli apprendimenti (la CAA lo supporta nella comprensione dei testi e nelle verifiche personalizzate) sia dell'integrazione e inclusione all'interno della classe.

La *Tabella I* evidenzia i cambiamenti significativi avvenuti.

CASO 1: CAMBIAMENTI SIGNIFICATIVI AVVENUTI CON LA CAA

Prima dell'intervento in CAA	Dopo l'intervento in CAA
Bambino silente, agisce i bisogni e usa poco la comunicazione non verbale	Ecolalia differita contestuale e imitazione gestuale del simbolo associato alla parola (basta/ancora) Olofrase contestuale al bisogno
Comprensione della lingua inglese	Miglioramento della comprensione della lingua italiana e produzione di parole fino alla produzione di semplici frasi legate al contesto
Scrittura guidata e imitativa al PC	Scrittura spontanea di singole parole al PC con iniziale significato contestuale. Lettura di simboli, ma anche di parole ad alta familiarità senza simbolo associato
Isolamento con i pari	Iniziali rapporti con i coetanei e maggior coinvolgimento nel piccolo gruppo classe fino alla partecipazione a momenti extrascolastici come compleanni e pizze di gruppo

Tabella I

CASO 2: CAMBIAMENTI SIGNIFICATIVI AVVENUTI CON LA CAA

Prima dell'intervento in CAA	Dopo l'intervento in CAA
Bambino con assenza di produzione verbale in lingua italiana/poche parole in turco. Vocalizzi afinalistici	Ripetizione di parole bisillabiche e trisillabiche con supporto del simbolo, aumento delle parole nella lingua madre, riduzione importante dei vocalizzi afinalistici
Scarsa comprensione del messaggio verbale sia in lingua turca che in italiano	Miglioramento della comprensione della lingua italiana e produzione spontanea di parole legate alla presentazione del simbolo
Atteggiamento ipo-reattivo di fronte alle proposte	Partecipazione alle attività strutturate e semi-strutturate

Tabella II

Caso 2: disturbo generalizzato dello sviluppo non ancora specificato (ICD 10, F 84.9)

Il bambino, originario della Turchia, nasce a maggio 2016 a Como, con parto eutocico dopo una gravidanza fisiologica. Riscontro di ipoglicemia in prima giornata di vita trattata con infusione con soluzione glucosata. Il bambino ha raggiunto la deambulazione autonoma ai 13 mesi. All'età di tre anni la valutazione neuro-psicomotoria ha evidenziato un comporta-

MESSAGGI CHIAVE

- ❑ Comunicare è un diritto di tutti, favorire la possibilità di comunicare è un dovere sociale.
- ❑ La CAA rappresenta più di una pratica clinica dal momento che costituisce una vera e propria lingua per chi è portatore di bisogni comunicativi complessi.
- ❑ È di supporto alla relazione, allo scambio comunicativo fra pari, sostiene le autonomie sociali e gli apprendimenti in ogni contesto di vita.

mento ipoattivo, assenza di gioco strutturato, comportamenti e azioni non finalizzati e stereotipati, grave ritardo nello sviluppo del linguaggio. In ambiente domestico è esposto prevalentemente alla lingua di origine, il turco. I genitori hanno riferito che il bambino dice solo poche parole nella sua lingua ("mamma", "finito", "ancora") e che tende a giocare da solo, senza ricercare l'interazione con gli altri; le autonomie personali presentano un marcato ritardo. Inizia così un trattamento individuale psicomotorio con cadenza bisettimanale integrato all'uso della CAA dal momento che la comprensione, l'espressione linguistica e l'intenzionalità comunicativa sono gravemente compromesse e limitate a vocalizzi spesso afinalistici.

Le proposte di intervento messe in atto durante l'intervento neuro-psicomotorio hanno integrato l'uso della CAA per sostenere la comprensione del messaggio verbale e lo scambio comunicativo. Sono state proposte at-

tività ludiche, partendo da un livello senso-motorio, supportate dai simboli di CAA (*Figura 1*) che la terapeuta della neuro- e psico-motricità dell'età evolutiva ha usato in entrata per supportare la comprensione dell'azione e stimolare l'attenzione condivisa. Il rapido cambiamento che si è evidenziato dopo circa due mesi di intervento ha permesso la proposta di lettura di semplici libri in simboli CAA e l'ampliamento del *setting* con proposte di attività ludiche strutturate e semi-strutturate.

La *Tabella II* evidenzia i cambiamenti significativi.

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ABA: l'analisi comportamentale applicata

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L'analisi comportamentale applicata (ABA) e l'autismo sono un binomio da almeno trent'anni. L'ABA è rivolta ai comportamenti socialmente significativi (abilità scolastiche, sociali, comunicative, adattive) e questo la rende adatta a essere impiegata per il recupero delle disabilità intellettive ed evolutive in genere e non, come comunemente si pensa, solo nell'autismo. La descrizione dei due casi clinici è il punto di partenza per fare capire al pediatra su cosa si basano i principi e come dev'essere applicata. Una caratteristica fondamentale dell'ABA è quella di essere evidence-based.

CASO 1

Giacomo è un bimbo di 3 anni e 6 mesi, che recentemente ha ricevuto diagnosi di disturbo dello spettro autistico, livello di gravità 2, con compromissione del linguaggio associata, in assenza di compromissione cognitiva (criteri DSM-5). Le insegnanti riferiscono, oltre alle difficoltà nella comunicazione verbale, alcune importanti rigidità nel comportamento del bambino, difficoltà di fronte a piccole variazioni della routine scolastica e bassa soglia alle frustrazioni e ai dinieghi, soprattutto durante i giochi. La mancanza di flessibilità rappresenta un'importante criticità anche in ambito familiare, in quanto i genitori hanno difficoltà nel contenere l'irritabilità di Giacomo nei semplici cambi di routine quotidiana (uscite da casa per andare a scuola, uscite da scuola, tragitti alternativi in macchina). Si procede quindi a impostare un programma di intervento sulla base dell'analisi comportamentale applicata. Si effettua un assessment delle preferenze del bimbo e delle abilità funzionali e si costruisce un curriculum comportamentale attraverso l'osservazione in situazione non strutturata e durante la somministrazione della testistica principale. Si indagano quindi le preoccupazioni dei genitori e le loro priorità, che al momento, includono la necessità di lavorare sulle aree del linguaggio e della flessibilità.

Considerate le difficoltà fonetico-fonologiche e morfosintattiche oltreché la tendenza di Giacomo a portare la conversazione verso argomenti di proprio interesse, la presenza di interessi ripeti-

ABA: APPLIED BEHAVIOUR ANALYSIS

(Medico e Bambino 2020;39:527-528)

Key words

Applied Behaviour Analysis, ABA, Therapeutic approach

Summary

The paper reports the most characterising aspects and clinical applications of the applied behaviour analysis (ABA) through the description of and the comment on two cases. The aim is to share this important therapeutic approach with infantile neuropsychiatrists and psychologists for a correct indication and its prompt application.

tivi (animali e numeri) e, considerate le emergenti abilità di attenzione ed emozione condivisa, si struttura un piano di intervento su tre aree principali: comunicazione, abilità sociali e attività di gioco. In particolare, nell'ambito della comunicazione, il bambino viene stimolato ad aumentare l'utilizzo della gestualità deittica e la varietà della gestualità convenzionale e aumentare il numero degli scambi comunicativi con progressivo incremento del numero delle richieste. Nell'ambito delle interazioni sociali si favorisce l'interazione fisica con un coetaneo stimolandolo a condividere un gioco che gli piace per almeno 5 minuti. Nell'ambito del gioco si mira a un ampliamento degli interessi e a potenziare il gioco simbolico/immaginario avvalendosi del video-modeling. Dopo un anno di trattamento appare possibile evidenziare un significativo miglioramento in tutte e tre le aree con un funzionamento globale, scolastico e familiare, significativamente migliore rispetto all'inizio del progetto riabilitativo. Sulla base delle nuove com-

petenze acquisite si rimodula il piano di intervento, al fine di continuare a potenziare le competenze adattive del bambino, prestando sempre la giusta attenzione alle sue preferenze e alle necessità dei genitori, ricordando che più precoce è l'intervento maggiore è l'efficacia del trattamento.

CASO 2

Mario è un ragazzino di 12 anni, affetto da disturbo dello spettro autistico di grado moderato associato a disabilità intellettiva moderata, che, da alcune settimane, appare marcatamente irritabile e oppositivo, tanto da non riuscire più a svolgere le proprie attività quotidiane (scuola, riabilitazione, sport). Appare inoltre marcatamente aggressivo nei confronti della figura materna verso la quale mostra anche comportamenti ipersessualizzati. Nonostante la terapia farmacologica in corso (aripirazolo 15 mg) appaia discretamente efficace nel controllare l'irritabi-

lità, persistono improvvisi e imprevedibili episodi di violenti acting out, tali da richiedere il ricovero ospedaliero nel reparto di Neuropsichiatria infantile della propria città, dove, in associazione a una rivalutazione della terapia farmacologica in corso viene garantito un intervento di analisi comportamentale applicata.

Sulla base dell'osservazione continuativa in reparto vengono evidenziati alcuni importanti antecedenti. L'aggressività del ragazzo appare generalmente conseguente al rifiuto da parte della figura genitoriale di assecondare alcune richieste (in particolare approcci a carattere sessuale o rassicurazioni ripetitive quali cantare ininterrottamente la stessa cantilena), prevalentemente la sera, dopo cena. Tale condizione sembra essere attivata dalla tendenza del ragazzo a ritardare e trattenere l'evacuazione, come da auto-stimolazione sensoriale, che esita quindi in una pulsione sessuale che Mario non ha ancora imparato a gestire, con conseguente rabbia e frustrazione che sfocia in aggressività.

In collaborazione con il personale infermieristico, viene condotta una valutazione delle preferenze per individuare le attività più gradite al ragazzo al fine di ripristinare un clima collaborativo e appropriate routine personali che scandiscano le varie fasi della giornata. Viene inoltre introdotto l'uso di supporti visivi che sostengano il ragazzo nella comprensione di ciò che caratterizza la sua giornata. Inoltre, in accordo con la famiglia, viene individuata una figura specializzata nell'ambito della psicoeducazione per un ragazzo in età puberale con disabilità intellettiva che parallelamente al lavoro con il ragazzo possa fornire alla famiglia dei consigli educativi sulla gestione della sfera sessuale. Al termine del ricovero gli episodi di aggressività appaiono ri-

dotti per intensità e frequenza, si suggerisce ai terapisti e ai genitori di proseguire il lavoro impostato in reparto anche all'interno del contesto familiare e di procedere con un graduale reinserimento del giovane nelle sue attività quotidiane.

ANALISI COMPORTAMENTALE APPLICATA (ABA, APPLIED BEHAVIOUR ANALYSIS)

Sebbene il termine ABA e autismo vengano considerati un binomio da almeno tre decenni, l'analisi comportamentale applicata non nasce proprio con l'autismo, ma come metodologia per il recupero delle disabilità intellettive in genere. Con il termine analisi comportamentale applicata si definisce la scienza applicata, che deriva dalla scienza di base conosciuta come analisi del comportamento di Skinner. Rappresenta sostanzialmente l'area di ricerca finalizzata a elaborare i dati che derivano dall'analisi del comportamento per descrivere le interazioni tra determinati comportamenti e condizioni esterne, spiegare come avvengono e, su queste basi, prevederne le caratteristiche e la probabilità di comparsa nel futuro, e influenzarne (modificarne) la forma e la funzione¹. Tale tipologia di intervento appare particolarmente efficace nell'aiutare soggetti con disturbi dello spettro autistico o con disabilità intellettiva, ad acquisire nuove specifiche competenze. In particolare trova un'ottima applicazione nella gestione di comportamenti problema altamente invalidanti quali irriducibilità, aggressività auto- o eterodiretta e severa oppositività.

Attraverso l'analisi comportamentale applicata vengono identificate le cause e le risposte che determinano il

rinforzo e che quindi mantengono un dato comportamento e attraverso l'analisi degli antecedenti e delle conseguenze si identificano le strategie maggiormente proficue atte a "spezzare" il circolo vizioso di un comportamento maladattivo. L'ABA, nella sua forma classica è un intervento effettuato da psicologi e terapisti della riabilitazione che basano il proprio lavoro su un ampio raggio di condizionamenti operanti. Le terapie, generalmente effettuate al domicilio e all'interno dei contesti di vita dei piccoli pazienti, possono essere piuttosto lunghe (anni) e prevedere un impegno anche sino a 40 ore settimanali, ma garantire al contempo ottimi risultati sostenendo i piccoli pazienti in diversi modi: aumentando comportamenti e abilità adattivi, mantenendoli nel tempo; facilitando l'apprendimento di nuove abilità e conoscenze; estendendo e generalizzando comportamenti e abilità da una situazione all'altra; riducendo le condizioni in cui si verificano comportamenti problema e la loro intensità e frequenza².

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