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Emotion dysregulation and ADHD subclinical manifestations in late adolescents: A study with a focus on inattention

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ABSTRACT. Il presente studio contribuisce alla letteratura volta ad indagare il legame tra la disregolazione emotiva da una parte e le problematiche di iperattività e disattenzione dall'altra, con un focus particolare sul funzionamento esecutivo come ponte tra i due aspetti. I risultati emergenti dall'analisi condotta su di un campione di tardo adolescenti (età media: 18,6 anni; 66% maschi) conferma la forte relazione tra le capacità di identificare, regolare, ed esprimere le emozioni e le componenti più rilevanti del Disturbo da Deficit di Attenzione/Iperattività (DDAI), specialmente in relazione ai deficit attentivi. Implicazioni per l'inquadramento e intervento clinico sono discusse, con particolare riferimento al mantenimento delle difficoltà attentive nel corso dell'età adulta.

SUMMARY. Recent influential approaches to this topic consider executive functions as a bridge between emotional dysregulation and hyperactivity/attention related disorders. Specifically, the ability to self-regulate emotions is viewed as a part of executive functions, which have a particular impact on attentional control. This study explored the relationships between self-reported attention disorders and emotional dysregulation in a sample of 132 non-clinical high school students (age: M = 18.6; SD = .71; 66% males). The research battery comprised four self-report measures which were individually administered to the participants: Brown Attention-Deficit Disorder Scales (Brown ADD Scales), Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A), Difficulties in Emotion Regulation Scale (DERS), Toronto Alexithymia Scale – 20 items (TAS). A series of regression analyses confirmed the stringent relation between the abilities to identify, regulate, and express emotions and the core variables involved in Attention Deficit Hyperactivity Disorder (ADHD), especially in relation to impairments in attentive functioning. Results throw light on the importance of emotion dysregulation in attention and executive control, suggesting the relevance of assessing the individual's abilities to manage affects to better conceptualize the disorder and plan interventions. Implications for research and practice are discussed especially in the context of psychological development and protraction of the condition during adulthood.

Keywords: *Attention deficit hyperactivity disorder, Emotional dysregulation, Adult attention-related issues, Executive functions*

INTRODUCTION

Difficulties in attention are found across different clinical conditions such as, for instance, bipolar disorders (Leibenluft, 2011) but are primarily involved in the Attention Deficit Hyperactivity Disorder (ADHD), a developmental and behaviorally-defined disorder, generally hereditary and characterized by several executive functions deficits (APA, 2013). As documented by research conducted in different countries, ADHD affects about 5-10% of the child population and persists into adulthood in 70% of cases (De la Barra, Vicente, Saldivia & Melipillan, 2013; Millstein, Wilens, Biederman & Spencer, 1997; Scahill & Schwab-Stone, 2000). ADHD is generally intended as a complex disorder, multifaceted and difficult to measure reliably (Hinshaw & Scheffler, 2018). Due to this complexity, some authors argue that actual diagnostic criteria are often not satisfactory, with the most accepted diagnostic systems (e.g., DSM-5) not adequately describing ADHD (Corbisiero, Stieglitz, Retz & Rösler, 2013). A first general reason for this controversial diagnostic status seems to be the overreliance on a categorical (rather than dimensional) diagnostic framework , which has been widely contested in contemporary psychological assessment literature for a variety of clinical entities such as, for instance, personality disorders (Gritti, Plouffe & Blanch, 2019; Widiger & Samuel, 2005). Of equal importance in the challenging ADHD diagnostic definition is the fact that common diagnostic models disregard a potentially key clinical feature, specifically emotion regulation impairment, which seems decisive also in the persistence of ADHD to adult age (Barkley & Fischer, 2010; Corbisiero et al., 2013).

Given contemporary models of ADHD stressing its relevance well beyond childhood (Barkley, Fischer, Smallish & Fletcher, 2002; Brown, 2013), it is of primary importance to investigate the mechanisms at play in key developmental ages such as late adolescence, and the changes that can take place in potential subclinical manifestations of ADHD. Multiple evidence shows, in fact, that the components of impulsivity and hyperactivity tend to recede or drastically change with maturation, for instance taking more subtle and socially acceptable forms, whereas deficits in emotional regulation tend to persist and sustain the concurrent and later impairments observed in adults with ADHD (Barkley, 2014; Ramsay, 2014) a lifespan perspective. The present study focuses on late adolescent period as a fundamental developmental stage where salient changes in psychological functioning, including emotional regulation and attention abilities, can take place, and difficulties in regulating emotions are considered particularly important to predict later social impairment in individuals with persistent ADHD (Bunford, Evans & Langberg, 2018). Importantly, given that hyperactivity symptoms generally tend to diminish over time whereas the inattentive component is particularly problematic for adult individuals with ADHD (APA, 2013), in this study enphasis is given to the (sublinical) manifestation of ADHD with a predominant inattentive presentation (named ADD hereafter). Finally, as will be detailed further in the next sections, in the present work a dimensional standpoint will be used in order to examine the relationships between emotion dysregulation, ADHD symptoms, and attention problems in particular.

From a categorical to a dimensional perspective in ADHD

A main factor in the difficulty in attaining a consensual definition of ADHD has been the overreliance on a categorical diagnostic definition even though the status of such a discrete entity has been challenged (Koziol & Stevens, 2012; Marcus, Norris & Coccaro, 2012; McLennan, 2016). Consistently with other psychopathological diagnoses, the description of discontinuous phenomena (vs dimensional description) is limited to external symptoms and has no explanatory power. Therefore, when clinicians state that a patient has ADHD (or is affected by another given disorder), but they rely on a controversial diagnostic category, they tend to reify that category itself with its contradictions (Hyman, 2010). In other words, this means that they may turn a psychological set of subjective and objective symptoms into something that might not exist in the real world.

Two main reasons support a paradigm shift in ADHD diagnosis towards a dimensional model: firstly, theoretical frameworks, diagnostic models, and clinical practice provide support that dimensional traits are more reliable for the description of psychopathological entities rather than categories (Clarkin & Livesley, 2016; Coghill & Sonuga-Barke, 2012). Evidence from different fields (e.g., behavioral genetics, neurobiology, clinical psychology, and neuropsychology) has supported the conceptualization of ADHD as an extreme on a continuum (Whitely, 2015). For

instance, some authors suggested that symptoms (such as impulsivity) can be identified, but neuropsychological tests can estimate only their severity. Though similar symptoms differ among people (Aragues, Jurado, Quinto & Rubio, 2011; Koziol & Stevens, 2012), a dimensional hierarchical approach allows examining different types of networks or circuits the symptoms might map on (Kotov et al., 2021) and this would enable to avoid fictitious distinctions between nonclinical and clinical functioning.

Secondly, the shift from a categorical to a dimensional perspective has important implications for ADHD assessment and treatment. Although categorical thinking helps identify the most severe manifestations of attention related issues, clinicians who apply rigid cut-offs might miss relevant information in the case formulation of patients who suffer from milder disorders. Three severity levels (i.e., mild, moderate, and severe) were implemented for ADHD in the DSM-5 but modest changes have been produced in research and in clinical practice (McLennan, 2016). From public health purposes, addressing milder manifestations might have greater potential for population effects.

The role of executive functions in ADHD

Transitioning from a categorical to a dimensional model of ADHD implies to shift focus from distinct criteria defining specific impairments to the underlying processes involved, in particular executive functions (EFs). EFs are central in the clinical understanding of ADHD and attention related disorders. Relying on the distinction between cool and hot EFs (Rubia, 2011), as noted by Zelazo (2020, p. 441): "[although] the most common and consistent correlates of ADHD are measures of cool EF, there is growing appreciation of the role of hot EF difficulties such as high delay aversion, high temporal discounting, and *emotion dysregulation* (Petrovic & Castellanos, 2016)". The construct of EFs is particularly useful to understand and conceptualize ADHD, attention disorders, and their relationship with emotion dysregulation (Adler & Alperin, 2014; Soltanto, 2014). The term EFs refers to self-regulatory processes that organize, direct and manage other cognitive activities, emotional responses and behaviors (Gioia, Isquith & Guy, 2001; Stuss & Alexander, 2000). These operations control and support information processing that contributes to complex and goal-oriented behaviors. Such functions include the ability to plan and anticipate consequences of actions and the ability to direct attention, self-monitoring and self-consciousness to organize, control and change action schemes (Gazzaniga, Ivry & Mangun, 1998; PDM Task Force, 2018).

Specific deficits in these processes might affect the ability to regulate emotions, especially in people who suffer from attention related disorders and ADHD (Chan, Shum, Toulopoulou & Chen, 2008). Although based on different theoretical and methodological backgrounds, two models have included executive functions as a central feature of ADHD (Barkley, 2010; Brown, 2006). In this context, Barkley relied to a greater extent on theoretical models of cognitive functioning (e.g., Damasio, 1994; Fuster, 1997; Goldman-Rakic, 1995), whereas Brown developed his model based on clinical interviews with individuals who were diagnosed with ADHD and their families (Brown, 1996, 2001).

EFs are defined as neuropsychological processes that support human self-regulation, with the potential to change any resulting behaviors, altering the likelihood of their consequences (Barkley, 1997, 2001; Barkley & Murphy, 2006; Kanfer & Karoly, 1972). In this model, ADHD is seen primarily as an impairment of response inhibition. In the model behavioral inhibition refers to three interrelated processes: 1) inhibition of the initial response to an event; 2) interruption of an ongoing response; 3) protection of the delay between the decision to respond to an event and the self-directed responses from disruption by competing responses (interference control or resistance to distraction) (Bronowski, 1977). The response inhibition would be a precondition of self-regulation, and executive functions would refer to a set of self-directed behaviors that promote self-regulation. As such, ADHD and more in general attention disorders are associated with impairments in the prefrontal cortex and its connections to other brain regions, especially the striatum and cerebellum (Castellanos et al., 1994; Iversen & Dunnett, 1990). Along similar lines, Brown (2006) described attention related disorders as impairments of executive functions. The model is based on six cognitive functions clusters (i.e., activation, focus, effort, emotion, memory, and action) which could be impaired in individuals with ADHD. Each cluster includes functions that work through interactive automatic processes, that allow for the execution of everyday activities (Brown, 2001, 2005).

Emotion dysregulation and ADHD

Over the last decades, empirical evidence has supported the role of self-regulation as an important dimension for psychological assessment of attention related disorders and ADHD (Barkley, 1997, 2011, 2015). In this context, self-regulation is considered as the ability to develop and complete future plans, to interact with other people, to control impulses and ultimately allow people living in the society (Doerr & Baumeister, 2011). A construct which is deeply intertwined with self-regulation is emotional regulation, as posited by models emphasizing the integration of such processes across the lifespan (Diamond & Aspinwall, 2003; Koole, 2010). As described above, difficulties in emotion regulation have been identified as a core feature of attention related disorders and expression of underlying executive functions deficit (Barkley & Murphy, 2006; Barkley & Fischer, 2010).

Emotion regulation plays an important role in everyday activities. When emotions are efficiently regulated, they support cognitive abilities (such as memory and reasoning), behavioral responses, and interpersonal interactions (e.g., Hofmann, 2014; Seibert, Bauer, May & Fincham, 2017). When this process does not take place successfully, a series of maladaptive outcomes are observed, ranging from social difficulties (Eisenberg, Hofer & Vaughan, 2007; Shaver & Mikulincer, 2007; Wranik, Feldman Barrett & Salovey, 2007), to psychopathological disorders (Mullin & Hinshaw, 2007), and physical illness (Sapolsky, 2007).

Gratz and Roemer (2004) reviewed the literature concerning emotion regulation and proposed an integrative conceptualization of the construct as involving: a) the awareness, understanding and acceptance of emotions; b) the ability to control impulsive behaviors and behave in accordance with desired goals when experiencing negative emotions; and c) the capacity to use situationally appropriate regulation strategies flexibly to modulate emotional responses in order to meet individual goals and situational demands. Difficulties in emotion regulation are indicated by the absence or the dysfunction of one or all of such abilities (Giromini, Velotti, De Campora, Bonalume & Zavattini, 2012; Gratz & Roemer, 2004). Within a process model of emotion regulation, Gross (1998, 1999, 2007) suggests a sequence of processes involved in generating emotions in which each process is a possible regulation strategy. Emotion dysregulation can therefore happen on different levels of this process, for example in attentional deployment.

A potential relevant indicator of emotion regulation is alexithymia, intended as a specific form of emotional dysregulation, describing an affective regulation disorder with impairments in the cognitive-experiential domain of the emotional response systems and interpersonal regulation of emotions (Taylor, Bagby & Parker, 1997). Compared to other forms of emotion dysregulation, alexithymia tends to be transversal across the lifespan especially in its contribution to hyperactivity and impulsivity symptoms (Donfrancesco et al., 2013). Importantly, McCloskey and Perkins (2013) included self-awareness and awareness of others, which are closely related to the capacities to acknowledging one's own emotions as well as observing them in other individuals, as "potential indicators of executive functions difficulties" (p. 126).

Such theoretical background regarding emotion regulational processes is consistent with the explicatory models adopted in the present work in regards to attention related disorders, which are in turn associated with few controversies in its description. In particular, traditional definitions of ADHD generally focus on its three clinical components (inattention, impulsivity, and hyperactivity) and behavioral correlates such as the diminished ability to sustain attention or persist on tasks, difficulties to inhibit responses and delay gratification, excessive or inappropriate motor activity, and verbal productivity. However, influential works have underlined how the psychological functioning of individuals with ADHD might be described taking into account the role of maladaptive emotion regulation processes (Barkley, 2015; Brown, 2005). Along similar lines, significant overlaps between psychological functions involved in the Modal Model of Emotions (Barret, Oschner & Gross, 2007) and the most established descriptions of ADHD might be found. For instance, impulsivity might be related to difficulties in situation selection, whereas impairment in effectively deploying attentional resources may be associated with difficulties with emotional reactivity and expression.

Despite a large body of literature suggests the importance of emotion regulation in defining ADHD (e.g., Pelham, 1982; Strauss & Lehitnen, 1947; Woods, 1986), the construct does not currently appear neither among the diagnostic criteria in the DSM-5 (APA, 2013) nor in the ICD-11 (World Health Organization, 2019). Besides historical reasons, methodological issues might explain the exclusion of emotional regulation from the description of diagnostic criteria for ADHD. Firstly, with some notable exceptions,

such as aggressivity (Whalen & Henker, 1985) or frustration tolerance (Mischel, Shoda & Rodriguez, 1989), emotion dysregulation is a construct encompassing both intrinsic and extrinsic processes (Gratz & Roemer, 2004; Thompson, 1994) and is therefore less prone to be studied through performance based methods whereas more observable symptoms such as attentive deficits and behavioral problems tend to be easier to measure and quantify. Secondly, it is possible that research on attention disorders, as well as the assessment measures developed through the years, do not include emotion regulation within the conceptualization of the disorder because they rely on the DSM description of ADHD; this has been limited to impairments in the cognitive (i.e., intattention) or behavioral (i.e., hyperactivity, impulsivity) areas since the DSM-II (APA, 1968; Douglas, 1972). Difficulties in the emotional domain were left out until the fourth edition of the manual, whichintroduced low frustration tolerance, irritability, and humor lability, as associated features. Symptoms of emotional dysregulation per se belonged in fact to the Oppositional Defiant Disorder (ODD) that, standing to the DSM, is closely associated to ADHD (Barkley, 2010).

Notwhisstanding this absence in the official nosography, evidence from neuropsychological studies supported the key role of emotion dysregulation in ADHD attention disorders (Shaw, Stringaris, Nigg & Leibenluft, 2014). Empirical studies focused on specific neuroanatomical patterns associated with attention disorder and found evidence for the involvement of the lateral prefrontal cortex (LPFC) and anterior cingulate conrtex (ACC; Bush, Valera & Seidman, 2005) in connection with the medial prefrontal cortex and limbic system. In particular, Ochsner and Gross (2007) found that hyperactive, disattentive and impulsive behavior and emotional inhibition on the one hand, and cognitive and executive control of emotions on the other, are based on the same neural connections. Observational studies on children who were diagnosed with ADHD reported specific differences in many psychological domains, such as expression of negative emotions (Rosenbaum & Baker, 1984), interactions with peers (Johnston & Mash, 2001), and frustration tolerance (Milich & Okazaki, 1991) between clinical and control groups.

Studies on emotion regulation and its interaction with ADHD and attention disorders are important not only in order to expand our knowledge of this clinical condition but also for their implications on treatment and interventions across different ages. For instance, emotional dysregulation of children with ADHD has been found as a risk factor for non-cooperative activities and negative interactions with peers (Whalen & Henker, 1992), such as difficulties in following the rules, tearfulness, and inattention (Mrug, Hoza, Pelham, Gnagy & Greiner, 2007). Similalrly, difficulties in emotion regulation such as emotional impulsiveness are considered major factors in impairment in daily life of hyperactive children as adults (Barkley & Fischer, 2010).

The present study

In the present study we explored the relationships between multiple components of emotional dysregulation, alexithymia (Bagby et al., 1994a, 1994b; Taylor et al., 1997) and their effects on ADHD symptoms in nonclinical late adolescents. Specifically, we expected that emotion regulation skills will be significant predictors of attention abilities after controlling for the role of executive functions.

METHOD

Participants

135 senior students (89 men; corresponding to 66% of the sample) from two different high schools located in the North of Italy were involved in the study. The mean age of the sample was 18.6 years (*SD* = .71; age range: 18.6-19 years; unlike the United States, Italian high schools are five years long, and the usual senior students' age ranges from 18 to 19).

Most of the particpants identified themselves as Italian (*n* = 132, 97.8%), whereas a small fraction had a foreign nationality (*n* = 3, 2.2%). Participants were included in the study only if they were not receiving, nor had received in the past, medical treatment for psychiatric conditions.

Measures

A brief description of each instrument contained in the research battery of this study is provided below, and internal consistency values for each scale used in the analyses is reported in Table 1.

– The *Brown ADD* scales (Brown, 2001; Del Corno, Lang & Schadee, 2007) is a 40-item self-report questionnaire that

Table 1 – Descriptive statistics for target variables

Variable	Min	Max	*Mean*	*SD*	Skewness	Kurtosis	Cronbach's alpha
ADD Total	9.0	93.00	46.5	18.66	.37	−.31	.921
ADD Cluster 1	0	23.00	11.22	4.82	.17	−.50	.728
ADD Cluster 2	0	24.00	12.60	4.98	.23	−.16	.781
ADD Cluster 3	0	24.00	9.76	5.26	.50	−.29	.785
ADD Cluster 4	0	18.00	6.86	4.26	.47	−.62	.743
ADD Cluster 5	0	15.00	6.12	3.21	.34	−.46	.640
BRIEF-A MI	43.00	103.00	68.24	11.22	.51	.41	.890
BRIEF-A BRI	30.00	75.00	50.92	7.93	.36	.08	.829
TAS Total	26.00	79.00	49.80	12.10	.23	−.76	.826
DERS Total	43.00	141.00	85.40	21.40	.36	−.48	.843

Legenda. ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation Scale* total score.

measures a wide set of attention-related symptoms and allows for the assessment of ADHD with specific attention to the predominantly inattentive presentation. The Brown ADD scales require respondents to evaluate how often certain feelings and behaviors occur on a four-point Likert scale. Composite scores represent five core domains related to attention disorders (i.e., clusters): Organizing, prioritizing and activating to work; Focusing, sustaining and shifting attention to tasks; Regulating alertness, sustaining effort and processing speed; Managing frustration and modulating emotions; Utilizing working memory and accessing recall. The test shows excellent internal consistency and test-retest reliability.

– The *BRIEF-A* (Gritti et al., 2017; Roth, Isquith & Gioia, 2005) is a 75-item self-report questionnaire that measures executive functions and self-regulation processes. Respondents are required to rate how often certain conditions have been occurred in the previous 30 days on a three-point Likert scale. Nine scales allow for the description of multiple components of executive functioning: Inhibit; Plan/Organize; Shift; Initiate; Task monitor; Self-monitor; Emotional control; Working memory; Organization of materials. The test allows for the calculation of 5 clusters organizing the various components of attention: Cluster 1 (Organizing, prioritizing and activating to work), Cluster 2 (Focusing,

sustaining and shifting attention to tasks), Cluster 3 (Regulating alertness, sustaining effort and processing speed), Cluster 4 (Managing frustration and modulating emotions), and Cluster 5 (Utilizing working memory and accessing recall). The subscales can be combined into three composite scores, i.e., the Behavioral Regulation Index (BRI), consisting of Inhibit, Shift, Emotional control, and Self-monitor scales, and the Metacognition Index (MI), consisting of Initiate, Working memory, Plan/Organize, Task monitor, Organization of materials scales, as well as the Global Executive Composite (GEC), which is the overall score for the evaluation of executive functions. Three validity scales are available, i.e., Negativity, Inconsistency and Infrequency. Higher scores from the correspond to greater executive dysfunctions. The test has from good to excellent internal consistency, and excellent temporal stability over four-week time.

– The *DERS* (Giromini et al., 2012; Gratz & Roemer, 2004) is a 36-item measure of emotional dysregulation; the items are rated on a five-point Likert scale. The instrument provides scores for six components of emotion regulation: non-acceptance of emotion responses and reactions (Nonacceptance); lack of emotional clarity (Clarity); impulse control difficulties (Impulse); lack of emotional awareness (Awareness); limited access to emotional regulation strategies (Strategies); difficulties in undertaking goal-oriented behaviors (Goals). Higher scores indicate impairments in emotion regulation. The test has an excellent internal consistency and a good test-retest stability both in clinical and non-clinical populations (Fox, Axelrod, Paliwal, Sleeper & Sinha, 2007; Gratz, Tull, Baruch, Bornovalova & Lejuez, 2008).
– The TAS-20 (Bagby et al., 1994a, 1994b; Bressi et al., 1996) is a measure of alexithymia which requires respondents to rate how well they are represented by the items on a five-point Likert scale. The items are combined in a total score and three subscales: Difficulties identifying feelings; Difficulties describing feelings; Externally oriented thinking. The test has good internal consistency and test-retest stability both in non-clinical and clinical samples.

In synthesis, the Brown ADD Scales, the BRIEF-A, the DERS, and the TAS-20 were used to measure relevant aspects of ADHD functioning and emotional regulation. The five clusters and the total scale score from the Brown ADD scales were used to measure attention-related difficulties. BRIEF-A Metacognition Index (MI) and Behavioral Regulation Index (BRI) were used as indicators of executive functions, whereas the DERS and TAS-20 scales were utilized to evaluate components of emotional regulation. The construct of alexithymia was included as an indicator of emotional dysregulation according to the evidence that patients who suffer from this condition tend to act impulsively rather than mentalize strong feelings and emotions (La Ferlita, Bonadies, Solano, De Gennaro & Gonini, 2007).

Ethical statements

The board of education of each school where data have been collected approved the participation to the study. Only participants older than 18 years have been recruited and each of them provided written informed consent before entering to the research by filling-up the appropriate document in paper format administered individually by the examiner. The study has been performed in accordance with the ethical standards described in the 1964 Declaration of Helsinki.

Procedures and data analysis

The battery of questionnaires was administered in each class in group, lasted about 35 minutes, and it was supervised by researchers and teachers. Data from three participants were excluded from the analyses because their scores on BRIEF-A were invalid (i.e., high values in Negativity, Infrequency, and Inconsistency scales, and/or more than 14 omitted responses). Therefore, analyses were performed on 132 cases.

After the distributions of the target variables were examined for potential departures from normality and level of internal consistency (i.e., Cronbach's alpha), main analyses started. Firstly, the correlations between executive functions and emotional dysregulation were inspected, considering the BRIEF-A MI and BRI, the DERS and the TAS-20 Total scores, respectively. The relationships among target variables were then studied through a series of multiple regression analyses, to examine the unique contribution of the key components of executive functions, the ability to identify and describe emotions, and emotion regulation on attention-related dysfunctional symptoms. In order to identify the role of emotional dysregulation more precisely in ADHD and behavior regulation after controlling for the influence of the

Metacognition Index, widely thought as the best indicator of the multiple components of executive functions available in the measures used in this study, multiple regression with stepwise method was used. Metacognition Index was entered in the first step and the other predictors were entered simultaneously in the second step. Analyses were performed through the software Statistical Package for Social Science (SPSS).

RESULTS

The ten target variables met the assumptions of normality (see Table 1) and, with one exception (i.e., ADD Cluster 5), all scales reached good or excellent levels of internal reliability. Results of the correlations between executive functions and emotional dysregulation, considering the BRIEF-A MI and BRIEF-A BRI, the DERS and the TAS-20 Total scores, showed positive statistically significant correlations ranging from moderate to high and statistically significant ($p \leq .01$, two tailed) (see Table 2; although being a particularly stringent procedure in the context of an exploratory study, we also calculated Bonferroni correction to the correlations tested following reviewer's suggestion. No significant pattern emerged, but it is noteworthy that 8 out of 14 correlations remained significant after applying the correction. Namely, these were the correlations between all ADD clusters and TAS total score and those between ADD clusters 2, 3, 4 and DERS total).

Multiple regression analyses were conducted after checking that multicollinearity indexes for regression models were appropriate, excluding the presence of problematic correlations between the predictors. Results from multiple regression analyses with stepwise method, with Metacognition Index entered in the first step and the other predictors entered simultaneously in the second step are showed in Table 3.

Table 2 – Correlations of ADHD and executive functions with emotion dysregulation

	TAS Total	DERS Total
BRIEF-A BRI	.44**	.62**
BRIEF-A MI	.43**	.44**
ADD Cluster 1	.52**	.52**
ADD Cluster 2	.41**	.48**
ADD Cluster 3	.38**	.40**
ADD Cluster 4	.59**	.67**
ADD Cluster 5	.38**	.46**

Legenda. BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation* Scale total score.
** $p \leq .01$

Table 3 – Linear regressions predicting Brown ADD clusters and total score from BRIEF-A MI (Step 1), and multiple regressions predicting Brown ADD clusters and total score adding BRIEF-A BRI, DERS Total, TAS-20 Total to the model (Step 2)

	Brown ADD scales											
	Cluster 1		*Cluster 2*		*Cluster 3*		*Cluster 4*		*Cluster 5*		*ADD Total*	
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1	.53***		.45***		.53***		.13***		.32***		.56***	
BRIEF-A MI		.73***		.67***		.72***		.36***		.56***		.75***
Step 2	.08***		.05*		.01		.44***		.06*		.12***	
BRIEF-A MI		.57***		.56***		.67***		−.01		.44***		.56***
BRIEF-A BRI		.13		.02		.07		.36***		−.03		.14*
DERS Total		.09		.21*		.04		.29**		.26*		.20**
TAS-20 Total		.15*		.02		.04		.25**		.04		.12
Total R^2	.61***		.49***		.54***		.57***		.37***		.68***	

Legenda. BRIEF-A MI = BRIEF-A Metacognition Index; BRIEF-A BRI = BRIEF-A Behavioral Regulation Index; ADD = *Brown Attention-Deficit Disorder Scale*; ADD Cluster 1 = Organizing, prioritizing and activating to work; ADD Cluster 2 = Focusing, sustaining and shifting attention to tasks; ADD Cluster 3 = Regulating alertness, sustaining effort and processing speed; ADD Cluster 4 = Managing frustration and modulating emotions; ADD Cluster 5 = Utilizing working memory and accessing recall; TAS Total = *Toronto Alexithymia Scale* total score; DERS Total = *Difficulties in Emotion Regulation Scale* total score.
* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

Importantly, results indicate that, with the exception of ADD Cluster 3 (Regulating alertness, sustaining effort and processing speed) in which Metacognition Index was the only significant predictor of the ADD variance, the addition of emotional dysregulation index and behavioral regulation to the equation, after controlling for Metacognition Index, systematically increased the portion of predicted variance in ADHD.

A more thorough analysis of the combined model shows specific patterns of associations between the measures of emotional dysregulation and behavioral regulation and the ADHD clusters. In the case of ADD Cluster 1 (Organizing, prioritizing and activating to work), the best predictor when controlling for Metacognition resulted to be the level of alexithymia reported by the participant (r = .15, $p \leq .05$). Dysregulation as measured by the DERS was in turn the best predictor after Metacognition Index for ADD Cluster 2 (Focusing, sustaining and shifting attention to tasks; r = .21, $p \leq .05$) and ADD Cluster 5 (Utilizing working memory and accessing recall; r = .26, $p \leq .05$). As noted above, ADD Cluster 4 (Managing frustration and modulating emotions) was the area in which the influence of emotion and behavioral dysregulation was stronger, with alexithymia, emotional and behavioral dysregulation, measured by the DERS, TAS-

20 and BRIEF-A respectively, being the sole predictors of executive functioning impairment (r = .29 and .25, $p \leq .001$).

Finally, the scores of the five ADD clusters considered as a whole (ADD Total) were predicted by a combination of factors in which, after controlling for the effect of Metacognition Index, emotion dysregulation as measured by the DERS (r = .20, $p \leq .01$) preceded behavioral regulation measured by the BRIEF in terms of predictive power (r = .14, $p \leq .05$).

DISCUSSION

The present study aimed at evaluating the role of emotional dysregulation in late adolescents, with the main hypothesis being that capacities to regulate emotions and affects, along with the more general metacognitive abilities, would be a significant predictor of subclinical symptoms of attention-related disorders. We sought to examine in a late adolescents' nonclinical sample if difficulties in managing emotions and affects would have contributed to a higher presence of difficulties similar to those generally reported by individuals with ADD (e.g., struggles being attentive or utilizing working memory efficiently).

Firstly, our results confirmed the expected finding in the light of the reviewed literature: problems in metacognition proved to be the best predictors of lower scores in the scales from Brown's ADD questionnaire evaluating the presence of attention deficits. This confirms the close association between executive functioning, in this case specifically measured in its components of planning and organization rather than in its more behavioral dimension, and attention disorders. Such connection could be explained by the neuroanatomical proximity between the prefrontal cortex and associated areas which are considered the bases of executive functions and the cerebral regions normally observed as dysfunctional in ADHD (Murphy, Barkley & Bush, 2001; Roth & Saykin, 2004; Woods, Lovejoy & Ball, 2002).

Beyond this anticipated finding, significant relations were found between emotion regulation and deficits normally associated to ADHD and ADD. The central hypothesis arguing in favor of the importance of emotional dysregulation in the definition of ADHD and ADD was substantially confirmed. In fact, with the exception of ADD Cluster 3 (Regulating alertness, sustaining effort and processing speed), whose variance was predicted solely by the Metacognition Index, adding emotion and behavioral dysregulation into the equation, after controlling for the Metacognition Index, systematically increased the portion of predicted variance of the ADD overall score as well as the single clusters for which specific patterns emerged. Therefore, the expected link between the adult's capacities to regulate and express emotions, measured by the DERS and TAS-20 scales, and the presence of cognitive difficulties that are frequently shown by individuals with ADD as the predominant difficulty was confirmed.

In terms of the relationship between dimensions of emotion regulation and the different clusters of ADD, results showed several significant relationships. The role of emotion regulation in defining the various ADHD (predominantly inattentive subtype) components might be interpreted in relation to the models that consider the abilities to self-regulate and managing affects as a key component of the executive functions' domain (Barkley, 2015; Brown, 2005).

A central point to consider in understanding the present results is that controlling for the effect of Metacognition Index allowed to more closely study the relations between emotion regulation and attention problems without the influence of the primary factor involved in the psychological and cognitive impairment reported by individuals with problems in the areas generally affected by ADHD. The impact of metacognition difficulties on the different clusters was exclusive in the domains of regulation of alert, ability to sustain effort and processing speed (ADD Cluster 3) but not in the remaining ADD clusters. As discussed, the important impact of Metacognition difficulties in ADD clusters was fairly expected considering that Metacognition Index reflects abilities such as initiating activities, sustaining working memory, organizing strategies, and generating problem solving ideas (Roth et al., 2005). However, beyond this finding, difficulties in emotion regulation and capacities to identify and recognize one's own affective states resulted to be significantly connected to the presence of impairment in the cognitive functions relevant to negative outcomes, such as ADD symptoms, independently from the level of metacognitive functioning.

Both Barkley (2015) and Brown (2005) pointed out how impairment in executive functions would be particularly relevant in the clinical functioning of adult individuals with attention problems and ADHD, also to a greater extent than what is observed for younger individuals. Considering emotional regulation intimately connected to executive functions, the influence of emotion dysregulation and

alexithymia in the domains of activating and organizing to work, as well as using working memory and sustaining attention during tasks (ADD Cluster 1, 2 and 5) that have been observed in the present sample might be interpreted as instances of the interference of emotional stimulations on the higher colder cognitive functioning of the individual. Moreover, fluctuations in such cognitive abilities might have important repercussions on the level of efficacy and motivation with which people will face everyday tasks and possibly could ultimately affect their work achievement and success.

Finally, even though less central to the overall aim of the present study, the analysis focused on the ADD cluster relative to the abilities to manage frustration and modulate emotions (Cluster 4) revealed how these processes are mainly connected to the individual's capacity of maintaining an appropriate control over their behavior and emotional responses. In other words, difficulties in inhibiting impulsive thoughts and actions, shifting from one problem-solving set to the other, modulating affective responses and monitoring one's own behavior, were associated to greater emotional interferences in thought processes and execution of tasks. Although interesting, this association might be mainly due to some overlap between the measures used for studying behavioral regulation, emotion regulation and emotional interferences as part of the ADD scores and should be therefore confirmed in other settings.

The close connection between emotion dysregulation and the defining components of ADHD goes in the direction of the conceptualizations identifying emotion dysregulation as a central dimension of attention-related impairments. Consequently, emotional dysregulation patterns might associate with and have cumulative effects in those of hyperactivity and impulsivity. Along these lines, the role of emotion and affect regulation might represent a useful tool in the treatment of individuals with attention problems and a crucial point of intervention to improve their psychological well-being. In this regard, the results of the present study suggest that from a primary prevention standpoint for ADHD, and especially ADD, incorporating specific interventions aimed at fostering greater emotional awareness and regulation might be valuable. As such, individuals experiencing attention deficits, but also difficulties in organizing for everyday tasks, managing frustration and emotions as well as using their working memory efficiently, might benefit from helping them limiting the interference of emotion dysregulation on their cognitive functioning.

The relations between emotion regulation and attention-related impairments might also contribute to explain developmental mechanisms observed in the trajectory from childhood to adulthood in individuals with ADHD and attention related difficulties (Bunford et al., 2018). Evolving from childhood to adolescence and then adulthood, hyperactivity tends to decrease, whereas cognitive difficulties, and inattention, in particular remain more stable, although with different intensity and frequency according to the mutated developmental tasks and requests of the environment (Weiss & Hechtman, 1993). The consequences in adulthood might result in work-related and interpersonal problems, which in turn lead to repeated job changes, conflicts, and dissatisfaction. Consequently, self-regulation and more specifically the ability to tolerate feelings of frustration for failures might play as a risk factor for the adaptation to one's environment and quality of life (Adler & Silverstein, 2018; Barkley, Murphy & Fischer, 2008).

On a more speculative side, evidence of the involvement of emotion regulation abilities in ADHD, although observed in this case in an adult sample, might also contribute to throw light on the different etiopathogenetic and maintaining factors of the disorder. Considering the relational nature of the phenomenon of emotion dysregulation, it is possible to envision the role played by individual differences in emotion regulation during early childhood in the development of the relationship with the caregiver and, in turn, in the child's future personality. If constitutional individual differences in temperament and relatedness can contribute to shape specific responses of the caregiver (Thomas, Chess & Korn, 1982), early impairment in emotion regulation and their impact on the child-caregiver interaction might contribute to the environmental factors that bear on the concrete and daily managing of ADHD (Henker & Whalen, 1999; Seymour, Chronis-Tuscano, Iwamoto, Kurdziel & MacPherson, 2014). In a circular pattern of reciprocal influence, child-caregiver interactions might themselves affect, along with the innate abilities of self-regulation and sensory process, the child's relational development (Greenspan, 1997).

The findings of the present study contribute to throw light on the interactions between the construct of emotion regulation and executive functions, supporting views that identify emotional dysregulation as tightly connected to other problems which are generally reported by individuals with ADHD such as inattention and impulsivity.

CONCLUSIONS

In conclusion, the findings of the present work represent a contribution that goes in the direction of enriching our understanding of the psychological functioning of individuals with attention-related disorders as well as of those with problems in the executive functions domain when they face the challenges of adult life. In line with this, extending our knowledge about how difficulties in the understanding and management of emotions interact with impairments in the domain of executive functioning might be crucial for better understanding and treating individuals who show clinical problems related to ADHD during the life-span (Barkley & Fischer, 2010).

Furthermore, given that most of the empirical research on the inattentive subtype of ADHD is drawn from research on ADHD (Adams, Milich & Fillmore, 2010), tailoring our analysis to attention deficit specifically contribute to the literature on this less studies but equally relevant clinical presentation.

Considering that difficulties in experiencing and dealing with emotions are not included in the descriptive criteria for ADHD in the major diagnostic systems, this investigation contributes to a more clinically accurate understanding of the disorder. A more thorough definition and understanding of the different psychological dysfunctions implied in a disorder might also be useful in planning and tailoring therapeutic interventions for the target clinical populations.

Limitations and directions for future research

Along with the promising findings, the present study also retains a few limitations that might serve as a stimulus for future research. Most notable is the exclusive focus on self-report assessment of the variables object of analysis. Although less demanding and invasive for participants, relying only on self-reports might have somewhat limited the inferences and findings that might derive from the collected material. Considering the benefits of multimethod assessment (Meyer et al., 2001), future studies aimed at connecting the various aspects of ADHD and emotion dysregulation on young adults encompassing also other sources of data (e.g., performance measures and informant-reports) could be particularly useful to deepen the understanding of the relationships between these constructs. Moreover, relying on multiple sources of assessment might also circumvent potential psychometric shortcomings of a single method. In this study, for instance, although most of the scales used reached good to excellent levels of internal consistency, one scale (i.e., ADD Cluster 5) resulted to be in the acceptable range. Although this does not challenge the validity of the study findings, but it might have reduced the strength of the observed relationships.

Secondly, the present work is based on a correlational logic, and this therefore prevents us from drawing solid causal paths. Studying such constructs in experimental settings or with an emphasis on longitudinal trajectories would potentially allow to improve the generalizability of our findings. A promising avenue for future research would be to investigate the influence of the participants' age, for example replicating the analyses of this study across different age groups, on the relationships between the different variables. This would also help to understand if the significant relationships identified between emotional dysregulation and aspects of hyperactivity and inattention is specific to the late adolescence period or can be generalized to older individuals.

Finally, the fact of focusing on a non-clinical setting might have the benefit of expanding the description of the relationships between emotion regulation and variables connected to executive functioning to below the cut-off samples and allows for generalization to the general population. However, replicating the present study on clinical settings would be important to corroborate the results obtained and potentially provide further information.

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