Article

Deficient Emotional Self-Regulation and Sleep Problems in ADHD with and without Pharmacological Treatment

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Abstract

Objective: The purpose of this study is to analyse DESR and its influence on sleep parameters in three different groups of children and adolescents: a group newly diagnosed with ADHD naïve, a group with ADHD under pharmacological treatment and a control group. **Method:** Subjects were a total of 327 children and adolescents. Two groups diagnosed with ADHD: 108 medication-naïve and 80 under pharmacological treatment; and one group with 136 healthy subjects. DESR was defined using anxious/depressed, attention problems and aggressive behaviors (AAA) scales from the Child Behavior Checklist (CBCL), and sleep through the Sleep Disturbance Scale for Children. **Results:** Significant differences were found comparing the three groups ($p = .001$), with a significantly higher profile on DESR in ADHD subjects, especially those who did not undergo treatment, and a positive correlation between DESR and sleep. **Conclusion:** Children and adolescents with ADHD without treatment present higher DESR than healthy controls and consequently higher sleep problems.

Keywords

ADHD, DESR, pharmacological treatment, children, sleep

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a childhood neurodevelopmental disorder with an estimate worldwide prevalence of 7.2% (Thomas et al., 2015) and 6.8% in Spain (Catalá-López et al., 2012). The core symptoms of ADHD consist of inattention, hyperactivity and impulsiveness (American Psychiatric Association [APA], 2013), and they are associated with significant impairment across social, cognitive, academic, behavioral and family functioning (Graziano & Garcia, 2016; Posner et al., 2020).

ADHD has traditionally been considered a cognitive and executive function disorder (Barkley, 1997). However, several studies state that emotional problems are highly prevalent in children and adolescents with ADHD (Anastopoulos et al., 2011; Barkley & Murphy, 2009; Baykal & Nalbantoglu, 2019; Biederman et al., 2012; Bunford et al., 2018; Donfrancesco et al., 2014; Reimherr et al., 2010; Shaw, 2014; Stringaris & Goodman, 2008) and are associated with more severe clinical picture and poorer prognosis (Masi et al., 2015). Emotion problems include constructs such as emotional impulsiveness (EI) and deficient emotional self-regulation (DESR; Barkley, 2015), but the way to measure the latter is not clear. Mick and colleges (Mick et al., 2003) reported that consistent elevation (over >2 Standard Deviations [SD]) in the Child Behavior Checklist (CBCL) attention problems, anxiety/depression and aggressive behavior syndrome scales (CBCL-AAA) could discriminate children with and without pediatric bipolar disorder. More recent findings suggest that an intermediate profile comprising intermediate elevations (>1 and <2 SD) could adequately capture the clinical concept of DESR (CBCL-DESR; Baykal & Nalbantoglu, 2019; Biederman et al., 2012; Donfrancesco et al., 2014; Hudziak et al., 2005; Kutlu, Ardic, & Ercan, 2017; Masi et al., 2015; Spencer et al., 2011).

Deficient emotional self-regulation (DESR) has a central role in the conceptualization of ADHD (Barkley, 2015; Faraone et al., 2019; Graziano & Garcia, 2016). Emotional impulsiveness, difficulties inhibiting inappropriate response, problems refocusing attention and disorganization of coordinated action

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in response to emotional activation (Barkley & Murphy, 2009), resulting in extreme responses that would be considered inappropriate for the developmental age of the person (van Stralen, 2016), are considered characteristics of DESR in the framework of ADHD. Some of these symptoms mentioned above as impulsiveness or inattention can be reduced with pharmacological treatment (Faraone, 2009), but the empiric evidence of the efficacy of pharmacological treatment in the symptoms of emotional dysregulation are controversial.

The current drug treatment approaches for ADHD comprise stimulant (methylphenidate, amphetamines) and non-stimulant medications (atomoxetine, clonidine and guanfacine (Clavenna & Bonati, 2017), with stimulants being the first-line treatment of ADHD (National Institute for Health and Care Excellence [NICE], 2018). Some studies reported improvement in emotional lability symptoms with methylphenidate (MPH) (Froehlich et al., 2020; Kutlu, Ardic, & Ercan, 2017; Masi et al., 2016), lisdexamfetamine (LDX) (Childress et al., 2015; Katic et al., 2013) and atomoxetine (ATX) (Schwartz & Correll, 2014). In addition, it is also recommended to those patients with anxiety or depression disorders (Wigal, 2009), even though other investigations argued that the efficacy of psychostimulants in emotional dysregulation symptoms is limited (Al Ghriwati et al., 2017) or they may worsen emotional lability (Pozzi et al., 2019). This controversy regarding pharmacological treatment is also present in sleep. In current literature, we can find studies that support the idea that children with ADHD manifest sleep problems, being under pharmacological treatment or not (Hvolby et al., 2011).

Furthermore, it is also unclear whether sleep problems are part of the pathophysiology of ADHD, occur as a comorbid disorder, are present as a behavioral consequence of ADHD exacerbating other symptoms (Williams & Sciberras, 2016) or what role pharmacological treatment has. Some studies report that children with ADHD present more sleep problems when they manifest emotional dysregulation, such as irritability or temper outbursts (Waxmonsky et al., 2016).

With this background, the main objective of this study was to compare two groups of children with ADHD (one with medication and the other naïve) and a healthy control group in terms of emotional dysregulation assessed with the CBCL-DESR profile in a Spanish sample. We would also like to observe if there is a correlation between DESR and sleep disorders. Based on previous works, our first hypothesis was that a positive CBCL-DESR profile would be significantly more represented in ADHD groups (especially those without treatment) compared with the control group. Our second hypothesis was that those patients with higher scores in the DESR profile would have greater sleep disturbances, thus showing a positive correlation.

Method

Participants

The sample included 327 children from different studies that were carried out in the ADHD Unit at Hospital Sant Joan de Déu, Barcelona (2012–2020). They were divided in three groups: (a) a case group of 108 medication-naïve children recently diagnosed with ADHD (combined, inattentive, hyperactive/impulsive); (b) a case group with 80 children diagnosed with ADHD under pharmacological treatment, and (c) a control group of 136 children without ADHD from Hospital Sant Joan de Déu, Barcelona.

The three groups recruited male and female subjects from 6 to 16 years old (male = 225; female = 101). Participants in both case groups had to meet criteria for diagnosis of ADHD using the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV and DSM-5; American Psychiatric Association [APA], 2013), and should have an ADHD-RS IV parents version score of at least 1.5 standard deviations above the age norm for their diagnostic subtype. In addition, the group recently diagnosed with ADHD had to be medication-naïve. The subjects from the control group were children attending the same schools as the case group participants or from other services of the hospital, did not meet the diagnostic criteria of ADHD according to DSM-IV, and their ADHD-RS IV parents version score was below 1.5 standard deviation from the age norm for the diagnostic subtype. The presence of ADHD and comorbidities was confirmed by applying the semi-structured interview Kiddie-Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime (K-SADS PL; Soutullo, 1999). Exclusion criteria for the three groups included having an IQ less than 70 on the Wechsler Intelligence Scale for Children-IV (WISC-IV; Wechsler, 2007) and WISC-V (Wechsler, 2015), psychosis or generalized developmental disorders. Demographic characteristics are shown in Table 1. Participants had to meet inclusion/exclusion criteria and their parents/guardians had to sign an informed consent form to participate.

Instruments

Assessment included:

1. *Attention Deficit Hyperactivity Disorder Rating Scale IV (ADHD RS IV;* DuPaul et al., 1998) and *Conners Rating Scale-Revised* (Conners et al., 1998) were used to assess ADHD symptoms and its diagnosis according to DSM-IV and DSM-5 (APA; 2013).
2. *The Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime version* (*K-SADS-PL*; Soutullo, 1999) was administered to

Table 1. Comparison of the Sociodemographic and Clinical Variables for the ADHD Naïve, ADHD Treatment and Control Groups.

Variables	ADHD naïve ($n = 108$)	ADHD treatment ($n = 84$)	Control ($n = 136$)	p
Age, mean (*SD*)	9.38 (2.46)	10.21 (2.55)	9.91 (2.29)	.04*
Male, (*n*) %	62.96 (68)	72.62 (61)	70.59 (96)	.27
ADHD subtype (*n*), %				
Inattentive	43 (46)	35(29)	–	.509
Hyperactive/Impulsive	6 (6)	5 (4)	–	
Combined	50 (54)	57 (48)	–	
Comorbidities (*n*), %				
Behavioral disorder	13.4 (15)	25.0 (21)	7 (1)	.001*
Phobic disorder	5.4 (6)	7.1 (6)	7 (1)	.037*
Anxiety disorder	16.1 (18)	15.5 (13)	2.2 (3)	.010*
Learning disorder	3.6 (4)	1.2 (1)	1.5 (2)	.219
Eating disorder	0.9 (1)	0 (0)	7 (1)	.372

Note. Data are shown mean (*SD*), unless otherwise indicated. ADHD = Attention deficit hyperactivity disorder.
$p < .05$.

determine comorbidities and confirm the presence of ADHD.

3. *WISC-IV and WISC-V* (Wechsler, 2007) were used to determine IQ.
4. *Child Behavior Checklist* (*CBCL*; Achenbach, 1999), child behavioral and emotional functioning in subjects aged between 6 and 18 years, was used to determine the DESR profile.
5. *Sleep Disturbance Scale for Children (SDSC*; Bruni et al.,1996) was used to evaluate sleep disturbances.
6. Sociodemographic interview (the authors' own elaboration).

DESR Profile

Deficient emotional self-regulation (DESR) was defined using the sum of t-scores of anxious/depression, attention problems and aggressive behaviors (AAA) scales. The CBCL-DESR was defined as positive by a score of >180 (1SD) but <210 (2SD) on the sum of AAA scales (Spencer et al., 2011). Subjects with a score >210 (2SD) were excluded from our sample, being related with bipolar disorder (Biederman et al., 2012; Mullin et al., 2011).

Procedure

This study was approved by the Clinical Research Ethics Committee (CEIC) of Fundació Sant Joan de Déu of Barcelona. All families provided written informed consent. The next procedure was followed: (a) we revised which studies carried out in the ADHD Unit at Sant Joan de Déu, Barcelona, met the same inclusion/exclusion criteria; (b) then we checked how many participants from the database had the same assessment: WISC-IV or WISC-V (Wechsler, 2007), ADHD (DuPaul et al., 1998), Conners Rating Scale-Revised (Conners et al., 1998), CBCL (Achenbach, 1999), K-SADS-PL (Soutullo, 1999), and Sleep Disturbance Scale for Children (SDSC; Bruni et al.,1996); (c) with all the information collected (having discarded subjects who had not answered questionnaires or whose data was not available for possible abandonment of the study), three groups were established: ADHD medication-naïve ($n = 108$), ADHD with pharmacological treatment ($n = 80$), and a control group ($n = 136$).

Data Analysis

Data analysis was conducted using SPSS Version 24.00. Continuous variables were expressed as mean ± Standard deviation (SD), whereas categorical variables were expressed as percentage. Sociodemographic characteristics in the three groups were compared using One-factor ANOVA with post-hoc multiple comparison for numerical variables and Chisquare Test for non-numerical variables. Group comparison was done through One-factor ANOVA with post-hoc multiple comparisons to compare differences in DESR between the three groups (ADHD medication-naïve, ADHD with pharmacological treatment and control group). Non-parametric measures were also used considering CBCL as a categorical variable, through Kruskal-Wallis and Chisquare Test. Finally, to see if there was a significant correlation between DESR and sleep problems, Pearson's correlation was used. Statistical significance was defined as a p value of $<.05$.

Results

Sociodemographic Characteristics

General characteristics of the population studied are summarized in Table 1. The ADHD naïve group consisted of

Table 2. CBCL Profiles.

Variables	ADHD naïve ($n = 108$) Mean ± *SD*	ADHD treatment ($n = 84$) Mean ± *SD*	Control ($n = 136$) Mean ± *SD*	*P*	Post-hoc
Mean	194.19 ± 20.90	190.64 ± 20.58	162.44 ± 13.87	.001	1 > 2,1 > 3*,2 > 3*
CBCL-Anxious/ Depressed	60.67 ± 8.49	62.18 ± 7.13	55.38 ± 6.31	.001	1 = 2,1 > 3*,2 > 3*
CBCL-Attention	70.56 ± 9.53	65.63 ± 8.66	53.32 ± 5.07	.001	1 > 2*,1 > 3*,2 > 3*
CBCL-Aggressive	63.21 ± 9.12	62.60 ± 9.23	53.74 ± 5.93	.001	1 = 2,1 > 3*,2> 3*
DESR	194.19 ± 20.904	190.64 ± 20.58	162.44 ± 13.874	.001	1 = 2,1 > 3*,2 > 3*

Note. DESR = Deficient Emotional Self-Regulation; CBCL = Child Behavior Checklist.
*p = .001**.

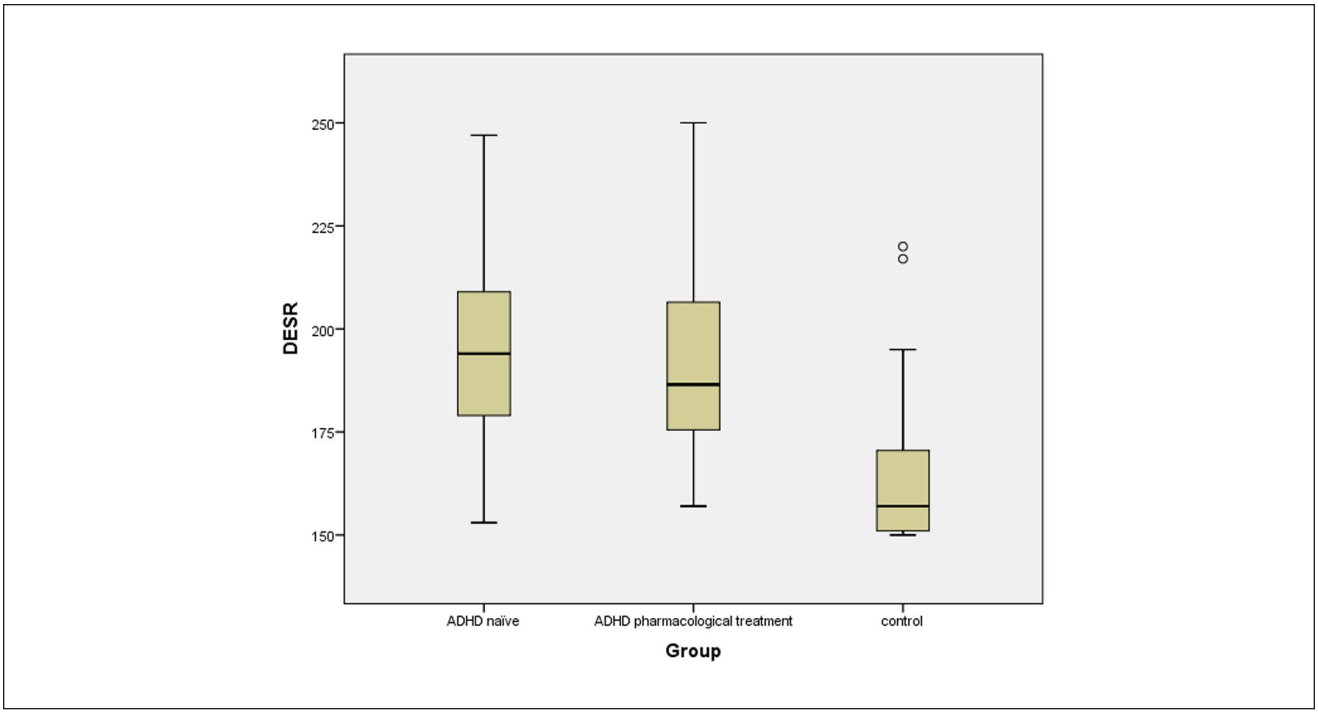

Figure 1. Comparison DESR profiles.
Note. DESR = Deficient Emotional Self-Regulation.

108 participants, with 68 being boys (62.96%), with a mean age of 9.38 (*SD* = 2.46). The ADHD group with treatment consisted of 84 participants, 61 were boys (72.62%), and with a mean age of 10.21 (*SD* = 2.55). Participants from the ADHD treatment group show a higher mean age, with significant differences. The control group had 136 participants, 96 were boys (70.59%), and their mean age was 9.91 (*SD* = 2.29). The percentage of cases from both ADHD groups were diagnosed as combined/inattentive/hyperactive without statistical differences between groups.

K-SADS confirmed the diagnosis of all patients in both ADHD groups and comorbid disorders in the three groups as behavioral disorders, phobic disorders, anxious disorders, learning disorders and eating disorders, showing statistically significant differences between the three groups in behavioral disorders ($p = .001$),anxiety disorders ($p = .010$) and phobic disorders (p = .037)

DESR Results between the Three Groups

Significant differences were found comparing both ADHD groups (naïve: 194.19 ± 20.90; and with pharmacological treatment: 190.64 ± 20.58) with the control group (162.44 ± 13.87), with a significantly higher CBCL-DESR profile in ADHD subjects ($p = .001$). Higher scores in ADHD without treatment were also observed, although differences were not significant. See in Table 2 and Figure 1.

Results from CBCL-scales show higher scores in the three scales: Anxious/Depressed, Attention Problems and Aggressive Behaviors in subjects with ADHD compared to

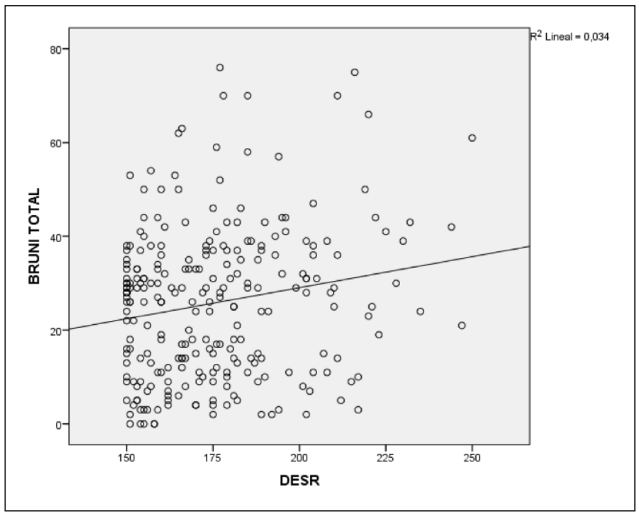

Figure 2. Correlation between DESR profile and sleep disturbances.
Note. DESR = Deficient Emotional Self-Regulation.

the control group ($p = .001$). There were also significant differences in the Attention Problems scale comparing both ADHD groups, with ADHD subjects under treatment (65.63 ± 8.66) having better scores in this scale than subjects without treatment (70.56 ± 9.53) and, therefore, fewer attention problems.

Correlation between DESR and Sleep

Lastly, a correlation was made between DESR profile and sleep, to see if sleep problems increased when there was more emotional dysregulation. The correlation was positive and significant ($p = .02$), indicating that the greater the dysregulation, the higher the scores on sleep disturbances (see Figure 2).

Discussion

This study was conducted with the aim of assessing the importance of DESR in ADHD population in a Spanish sample. The current report revealed significantly greater DESR in individuals diagnosed with ADHD, whether they were under treatment or not, compared to the healthy control group. These results seem to be consistent with other studies (Baykal & Nalbantoglu, 2019; Donfrancesco et al., 2014; Spencer et al., 2011), which found that a high portion of children and adolescents with ADHD met the criteria for the CBCL-DESR profile compared with a control group. Moreover, children with ADHD without pharmacological treatment had also higher scores on DESR profile than those undergoing pharmacological treatment. However, current studies are confusing about this, as little psychopharmacological research has been conducted to address this aspect of ADHD and, since DESR symptoms are often variably responsive to pharmacological treatment depending on the individual child (Srivastava & Coffey, 2014), some studies have found that pharmacological treatment of ADHD has been proven to increase irritability.

Current literature has emphasized the presence of emotional related problems in ADHD (Anastopoulos et al., 2011; Barkley & Murphy, 2009; Baykal & Nalbantoglu, 2019; Biederman et al., 2012; Bunford et al., 2018; Donfrancesco et al., 2014; Reimherr et al., 2010; Shaw, 2014; Stringaris & Goodman, 2009). Moreover, some investigations argued that emotional symptoms, as emotional impulsiveness and DESR, should be considered a core feature of ADHD and included in diagnostic criteria (Barkley, 2010; Faraone et al., 2019). This study, as Reimherr et al.'s (2010), supports evidence that DESR has to be considered a basic component of ADHD, rather than a comorbid condition.

Therefore, considering emotional dysregulation as part of ADHD, we should also take it into account when performing treatment, applying an intervention that includes emotional variables combined with pharmacological and psychoeducational treatment (Sánchez et al., 2019). Although it remains unclear whether pharmacological treatment would be less effective for ADHD or exacerbate anxiety in these patients (Wigal, 2009), our study found that subjects with ADHD under pharmacological treatment had lower scores in DESR, and therefore had a better emotional regulation compared to ADHD without treatment. These results are similar to other studies that found that children with higher levels of irritability or anxiety symptoms at baseline showed a decrease in those components after taking pharmacological treatment (Froehlich et al., 2007). Other studies have observed that patients that experienced an improvement in ADHD core symptoms (attention, disorganization and hyperactivity/impulsiveness) after taking pharmacological treatment also experienced improvement in other symptoms, such as emotional dysregulation (Reimherr et al., 2010). Nevertheless, the efficacy of pharmacological treatment to treat emotional dysregulation is weak compared with the efficacy of this treatment when managing ADHD core symptoms (Faraone et al., 2019).

It is important to find out if children with ADHD manifest comorbidities such as anxiety, behavior disorders or depression, not only because they are associated with a poorer prognosis (Masi et al., 2015) but also have been associated with sleep disturbances (Huang et al., 2011; Schwartz et al., 2004; Stein et al., 2012).

Little information is available on the interplay between sleep and emotional regulation (Gruber, 2014). Moreau et al. (2014) suggested that sleep problems in children with ADHD could be related to comorbid symptomatology. In our study, a straight relation was found between sleep disturbances and emotional dysregulation, indicating that children

with ADHD with emotional dysregulation had more sleep disturbances or that sleep disturbances may be the cause of emotional dysregulation. These associations between sleep and emotional dysregulation are likely to be bidirectional, with sleep problems or insufficient sleep exacerbating emotional and behavioral difficulties, and emotional dysregulation compromising sleep patterns (Gregory & Sadeh, 2012).

The results from this study must be tempered by various limitations. First, the lack of consensus on how to measure emotional dysregulation in the current literature leads us to interpret these results with caution. Second, DESR and sleep disturbances were obtained through rating scales or questionnaires, answered by parents who may over- or under-report deficits. This limitation emphasizes the need for a multi-informant method (self-report, teacher's and parent's reports) and calls for future research to include these sources (Bunford et al., 2018).

Despite these limitations, we have confirmed literature findings that ADHD is associated with higher rates of DESR, and that there is a bidirectional relation between DESR and sleep disturbances, without identifying which is the primary cause.

Our study had several strengths. It was carried through a large sample size; ADHD naïve group were newly diagnosed with ADHD; the Kiddie Schedule for Affective Disorders and Schizophrenia for school-age children was used to assess ADHD diagnosis and comorbidities; and well validated measures of ADHD and comorbidities were used. For future studies, it would be interesting to study the relationship between DESR and sleep disturbances in depth, to find out its primary cause. In addition, studying sleep disturbances not only through questionnaires or sleep diaries but also through objective measures such as actigraphy or polysomnography would allow us to obtain more objective markers.

Conclusion

Our findings suggest that children and adolescents with ADHD present higher levels of DESR than healthy controls. Furthermore, those subjects with ADHD without pharmacological treatment experience more DESR than those with pharmacological treatment. DESR could be the cause of sleep disturbances found in subjects with ADHD or sleep disturbances are a key antecedent of self-regulation problems, existing a positive correlation between both.

Finally, this study highlights the importance of identifying DESR in ADHD population, even considering it a core feature of ADHD.

Declaration of Conflicting Interests

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Ethical Approval

The three studies were approved by the Clinical Research Ethics Committee (CEIC) of Fundació Sant Joan de Déu and were conducted following the ethical principles of the Declaration of Helsinki.

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