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Psychobiological personality traits in adults with disorders of arousal: A case–control study

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ABSTRACT

Disorders of arousal (DOA) are parasomnias occurring during Non-REM Sleep (NREM), stemming from incomplete arousal from slow wave sleep and resulting in diverse, complex emotional and motor behaviours. Growing evidence suggests that distinct psychopathological traits play a role in the multifaceted genesis of these occurrences. This multicentre study aims to characterize the personality profiles of adults with and without DOA using the Temperament and Character Inventory-Revised. We included 39 patients diagnosed with DOA (mean age = 30.9 ± 10.2 years, 22 females) and 40 healthy control subjects matched for age and gender (mean age of 32.4 ± 11.6 years, 21 females). Participants completed the Paris Arousal Disorder Severity Scale, the Epworth Sleepiness Scale, the Sleep Condition Indicator, and the Temperament and Character Inventory-Revised. Higher levels of Harm Avoidance, Reward Dependence, and Persistence were predictive of the occurrence of DOA, as were elevated Anticipatory Worry and Attachment, and low Self-directedness. These findings support the hypothesis that certain psychobiological personality traits may be associated with the occurrence of DOA. To deepen our understanding, prospective studies are essential, aiming to delve into the causal relationship between the psychopathological profile and the clinical manifestation of DOA and assess the impact of targeted psychological interventions on DOA symptomatology.

1. Introduction

Disorders of Arousal (DOA) are non-rapid eye movement (NREM) parasomnias characterized by nocturnal episodes of abrupt partial awakening from NREM sleep [1,2]. DOA encompasses a family of disorders such as sleepwalking (SW), night terrors (NT), and confusional arousal (CA) (AASM, 2014; APA, 2013), which can manifest with a wide range of behaviours including screaming in terror, talking, sitting or jumping out of bed, looking around, walking, or even driving [3].

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Abbreviations/acronyms:

Disorder of Arousal (DOA)
Novelty Seeking (NS)
Harm Avoidance (HA)
Reward Dependence (RD)
Persistence (PS)
Self-Directedness (SD)
Cooperativeness (C)
Self-Transcendence (ST)
Temperament and Character Inventory (TCI)
Paris Arousal Disorder Severity Scale (PADSS)
Epworth Sleepiness Scale (ESS)
Sleep Condition Indicator (SCI)
Morningness–eveningness questionnaire (MEQ)

Current diagnostic criteria include: (a) recurrent episodes of incomplete awakening; (b) absent or inappropriate reactivity; (c) limited or absent cognition or dream report; and (d) partial or complete amnesia of the episode (AASM, 2014). Although DOA are more common during childhood [4], they persist into adolescence and adulthood in 25% of cases [5].

Despite the established understanding that DOA stem from slow-wave sleep and not from wakefulness, thereby classifying them as sleep disorders rather than psychiatric conditions, their exact pathophysiology remains elusive. Similarly, the association between DOA and psychopathology has been the subject of a lengthy and ongoing debate, lacking a definitive and conclusive answer [6–14]. According to the so-called "3 P's model", DOA are multifactorial disorders that result from the co-occurrence of various predisposing (intrinsic innate characteristics of affected individuals), priming (acquired conditions/co-morbidities of affected individuals), and precipitating factors (occasional or recurrent triggers; [1,3,15]). In this context, we have previously hypothesized that psychopathological and psychobiological traits could be crucial predisposing factors [3]. In support of this hypothesis, a recent systematic review suggested that there is a clear association between NREM parasomnias and overall psychopathology (especially anxiety), with stress and sleep microstructure as promising mediating factors (see Ref. [12]).

Overall, few studies have specifically investigated the role of personality disorders in DOA. Earlier studies [7,14] reported elevated levels of psychopathology and frequent diagnoses of personality disorders among adults with somnambulism and night terrors. Recently, our research demonstrated that children and adolescents with DOA exhibit distinct psychobiological personality traits when compared to age- and gender-matched subjects without DOA [16]. One such psychobiological trait of interest is temperament, which refers to an individual's biologically based predisposition to learn how to respond emotionally to stimuli and to form behavioural and attachment patterns through associative conditioning [17]. Specific temperaments have been linked to distinct functional activities within the primary monoaminergic system and their related genetic variants [18].

The general aim of the current study was to investigate whether certain personality traits or profiles could predict DOA occurrence using the Revised version of the Temperament and Character Inventory (TCI-R). The TCI-R identifies four main temperaments: Novelty seeking (NS), Harm avoidance (HA), Reward dependence (RD), and Persistence (PS). Based on one previous pilot study on TCI in parasomnias (DOA and nightmares) in adults [19] and one larger study in children and adolescents [16], we expected higher levels of Novelty Seeking and Harm Avoidance, as well as lower levels of Self-directedness, to predict the likelihood of DOA. Additionally, we hypothesized that certain specific personality profiles, characterized by impulsivity, emotional instability, and hypersensitivity to the loss of social support, would predict DOA occurrence.

2. Materials and methods

2.1. Participants

In the current analysis, 42 patients diagnosed with Disorders of Arousal (DOA) and 42 healthy controls, matched for age and sex, were included. Both groups underwent a detailed clinical interview, and psychopathology was assessed using globally recognized scales, including the Temperament and Character Inventory (TCI-R), covering major behavioural and emotional domains, as well as the Paris Arousal Disorder Severity Scale (PADSS), Epworth Sleepiness Scale (ESS), and Sleep Condition Indicator (SCI).

The inclusion criteria for patients were: (a) a typical history of DOA as per the American Academy of Sleep Medicine's ICSD-3 criteria (AASM, 2014); (b) a minimum of one episode of parasomnia in the past year, determined through clinical interview; and (c) age over 18 years. Exclusion criteria encompassed: (a) parasomnia resulting from a medical disorder or substance use; (b) intellectual disability; (c) epilepsy or other significant neurological comorbidities; and (d) suspected respiratory sleep disorder based on clinical history or revealed by video polysomnography (v-PSG), with an apnea-hypopnea index cut-off of 15.

For control subjects, exclusion criteria included: (a) personal and family history of DOA; (b) intellectual disability; (c) major neurological disorders; (d) known diagnosis of sleep breathing disorder reported by the patient and/or signs/symptoms suggestive of sleep breathing disorder during the clinical interview; and (e) current use of drug treatment.

The data collection spanned a period of 24 months and involved five Sleep Centres, including the Hospital "Santi Paolo e Carlo" (Milan, Italy); the Hospital "Grande Ospedale Metropolitano Niguarda" (Milan, Italy); the Scientific Institute "San Raffaele" (Milan, Italy); the IRCCS Mondino Foundation (Pavia, Italy); and the Regional Civic Hospital of Lugano (Lugano, Switzerland, Italian language).

Patients were either referred to these tertiary hospitals by primary care physicians or other specialized physicians, or they voluntarily participated after learning about the study protocol through advertising and word of mouth. Control subjects were recruited through word of mouth among relatives, colleagues, and friends of the investigators.

Before the study, all participants provided written informed consent. The study procedures underwent a thorough review and received approval from the ethics committees of the participating centres. The coordination of these ethics committees was overseen by the main ethics committee of "Santi Paolo e Carlo" Hospital.

2.2. Clinical interview

All patients underwent a comprehensive clinical interview conducted by a sleep medicine specialist.

The interview covered various aspects, including age, sex, ethnicity, medical and medication history, age of onset, clinical subtype, episode frequency, reported injuries, and recollections related to the narrated events of DOA, along with any precipitating factors.

Clinicians also reviewed videos of witnessed DOA episodes, when available [20,21].

2.3. Questionnaires

All participants in this study completed either an online or paper version of: (a) several validated sleep assessment scales routinely used in our clinical practice, including the Paris Arousal Disorder Severity Scale (PADSS) [22], Epworth Sleepiness Scale (ESS) [23], and Sleep Condition Indicator (SCI) [24,25] for adults; (b) the TCI-R [26] for the evaluation of subjective psychopathological profiles.

2.3.1. Temperament and Character Inventory (TCI)

The Temperament and Character Inventory (TCI) is a personality trait inventory developed by Cloninger and colleagues (1993). It is closely linked to and an extension of the Tridimensional Personality Questionnaire (TPQ), and it has been associated with the dimensions of personality in Zuckerman's alternative five, Eysenck's models, and the five-factor model. The TCI consists of seven dimensions of personality traits, including four temperaments: Novelty seeking (NS), Harm avoidance (HA), Reward dependence (RD), and Persistence (PS), as well as three characters: Self-directedness (SD), Cooperativeness (CO), and Self-transcendence (ST). Each trait comprises various subscales, and these dimensions are derived from a 240-item questionnaire. The TCI is rooted in a psychobiological model aiming to elucidate the underlying causes of individual differences in personality traits [27–29].

2.3.2. Paris Arousal disorder severity scale

The PADSS is a rater-administered questionnaire, typically completed by the patients. It is validated for screening DOA and assesses DOA severity and treatment efficacy [22]. The scale comprises 24 items divided into three subscales: PADSS-A: An inventory of the most problematic parasomnia behaviours listed in order of severity. PADSS-B: Evaluates the frequency of episodes, ranging from never to once every night. PADSS-C: Investigates the negative consequences of DOA, such as feeling tired the next day, experiencing shame, or suffering self- or hetero-inflicted injuries. The pathological cut-off is set at 13/14, demonstrating high sensitivity (83.6%) and specificity (87.8%) for DOA [22]. Instructions for the scoring are provided in the Supplementary Material.

2.3.3. Epworth Sleepiness Scale

The ESS is a widely employed tool in the field of sleep medicine, serving as a subjective measure of a patient's sleepiness [23]. This test consists of a list of eight situations in which individuals rate their tendency to become sleepy on a scale ranging from 0 (no chance of dozing) to 3 (high chance of dozing). After completing the test, the values of the responses are summed up, resulting in a total score on a scale of 0 to 24. The scale helps estimate whether an individual is experiencing excessive sleepiness that may warrant medical attention.

2.3.4. Sleep Condition Indicator

The SCI is a clinical screening instrument aligned with the DSM-5 criteria for insomnia. Widely used in clinical practice, the SCI has been subjected to studies establishing reference values across different age and sex populations. The original version demonstrated high internal consistency (Cronbach's alpha 0.86). A principal component analysis suggested a two-factor structure, where items 1 (getting to sleep), 2 (remaining asleep), 3 (nights per week), 4 (sleep quality), and 8 (duration of problem) loaded most strongly on the first factor. Items 5 (personal functioning), 6 (daytime performance), and 7 (troubled or not) loaded on the second factor. Subsequent translations and tests of the SCI in Italy, France, and Hong Kong, utilizing traditional classical test theory (CTT) methodology, further validated its effectiveness [24,25].

2.4. Video-polysomnography

Selected patients (n = 29) underwent one-night video-polysomnography recording (v-PSG) to rule out other potential sleep problems. The v-PSG montages included extended EEG montages (full-scalp EEG with leads positioned according to the International 10-20 System), two electrooculograms (EOG), one chin electromyogram (EMG), EMG of the right and left tibialis anterior muscles, an electrocardiogram (ECG), pulse-oximetry, snoring, and video recording. All v-PSG recordings were visually scored in 30-s epochs following the standard American Academy of Sleep Medicine Criteria by a sleep medicine expert [30]. Subjects with comorbid sleep disorders were excluded from the current analysis if identified during the recording. None of the control subjects underwent v-PSG. Control subjects displaying clinical doubts about any underlying sleep disorder during the clinical screening were also excluded from the analysis.

2.5. Statistical analysis

Questionnaire results were described using median and interquartile range or mean and standard deviation. Qualitative data, such as DOA subtypes, and pharmacological treatments, were described using frequencies and percentages.

Demographic and questionnaire variables were compared between groups (DOA, Control) using t-tests (t), Wilcoxon-tests (W), or chi-squared tests (χ^2).

To assess the internal consistency of the TCI-R facets and scales, the Cronbach's α coefficient was calculated (for full results see Table S1). If the Cronbach's α coefficient of the scales exceeded 0.70, indicating acceptable internal consistency of the items, only the scales (excluding the facets) were retained for further exploratory analyses.

To explore potential differences between the DOA and Control groups on the TCI-R scales, t-tests were performed. In addition, Spearman correlations between TCI-R scales and PADSS scores were examined to investigate the relationships between temperament and character traits and the severity of DOA.

To further investigate whether temperament and character traits predict the probability of having a DOA, logistic regression models were applied using the binary outcome Group (DOA = 1, Control = 0). All predictor variables were standardized prior to analysis to facilitate comparisons across scales and facets and reduce the impact of multicollinearity. Given the large number of potential predictors, including main temperament scales and interactions with character traits, we used a forward stepwise selection approach based on the Akaike Information Criterion (AIC). This method begins with an intercept-only model and iteratively adds the predictor that reduces the model's AIC the most, stopping when no further improvement is possible.

Then, based on previous literature [16,19], three logistic regression models were conducted based on combinations of temperament and character traits leading to specific profiles. The first model investigated impulsivity, with Group (DOA = 1, Control = 0) as dependent variable, and Novelty seeking and Self-directedness as independent variables. The second model examined hypersensitivity to the loss of social support, with Group (DOA = 1, Control = 0) as dependent variable, and HA1, RD3, and Self-directedness as independent variables. The third model explored a profile characterized by emotional instability, impulsivity, and conflict avoidance, which resembles features of DSM-5 Cluster B personality disorders, with Group (DOA = 1, Control = 0) as dependent variable, and Novelty seeking, Harm avoidance and Self-directedness as independent variables.

As measures of effect size Cohen's d (d) was used for the t-tests, Cramer's V (V) for chi-square tests, and Wilcoxon's r (r) for the Wilcoxon tests. All p-values were adjusted for multiple comparisons using Holm's method, and the corrected p-value was reported.

All statistical analyses were conducted using RStudio [31], with statistical significance set at $p < .05$.

3. Results

3.1. Demographic and clinical features

Eighty-four participants took part in the study (DOA = 42, Control = 42). Of these, two participants in the Control group were excluded due to a PADSS score >6, two participants in the DOA group were excluded due to a PADSS score ≤1, and one participant in the DOA group was excluded due to epileptiform abnormalities detected in the EEG trace. Thus, the final sample consisted of 39 participants in the DOA group (M_{age} = 30.9, SD = 10.2, range = 19–74, 22 females) and 40 participants in the Control group (M_{age} = 32.4, SD = 11.6, range = 19–72, 21

females).

Among the DOA patients, eight had a diagnosis of CA (19.6%), 12 had SW (29%), three had ST (7.3%), 10 had both CA and SW (24.4%), three had both SW and ST (7.3%), one had both CA and ST (2.4%), one had CA, SW, and ST (2.4%), and one had SW and sexsomnia (2.4%).

Sixteen patients (41.0%) were undergoing pharmacological treatment at the time of assessment; these treatments were not specifically prescribed for DOA, but reflected ongoing therapies previously prescribed for DOA and/or other comorbid conditions. Among them, one was taking a benzodiazepine (6.2%), one was taking both a benzodiazepine and an alpha2-delta ligand (6.2%), one was on estroprogestinic hormone therapy (6.2%), three were receiving treatment for hypothyroidism (18.8%), one was taking antihypertensive medication (6.2%), one was on alpha2-delta ligand therapy (6.2%), one was taking both alpha2-delta ligand therapy and Hydroxytryptophan (6.2%), two were taking Hydroxytryptophan alone (12.5%), four were taking Melatonin (25.0%), and one was taking both Melatonin and Hydroxytryptophan (6.2%).

Table 1 shows differences between groups for the PADSS and SCI scores, with higher PADSS scores in the DOA group, indicating greater DOA severity, and lower SCI scores in the DOA group, indicating more severe insomnia symptoms. Notably, the two groups did not differ in ESS and MEQ scores, indicating no differences in sleepiness symptoms or chronotype between them. The majority of participants in both groups had an intermediate chronotype.

3.2. TCI-R analysis

The comparison between the DOA and Control groups on the TCI-R scales revealed no differences (all p's > 0.076), as shown in Table 2 (for a graphical representation, see Fig. 1).

To explore potential relationships between temperament and character traits and the severity of the disorder of arousal, correlation analyses were performed between the PADSS total score and TCI-R scales. These analyses did not reveal any significant correlation (all p's $>$ 0.155).

The logistic regression model including the TCI-R scales as predictors indicated that higher scores in Harm Avoidance (OR = 3.02, 95% CI [1.59, 6.36], SE = 0.35, z = 3.15, p = .001), Reward Dependence (OR = 2.05, 95% CI [1.15, 3.97], SE = 0.31, z = 2.30, p = .021), and Persistence (OR = 1.99, 95% CI [1.05, 4.14], SE = 0.34, z = 2.00, p = .045) were associated with an increased likelihood of being in the DOA group (see Fig. 2). Conversely, the stepwise selection did not identify any character traits as a predictor of DOA occurrence.

The logistic regression model examining impulsivity traits, with NS and SD as predictors, did not show any effects of these traits or their interaction in predicting DOA (all p's > 0.140). Similarly, the model examining the profile characterized by emotional instability, impulsivity, and conflict avoidance did not reveal an interaction between NS, HA, and SD in predicting DOA (all p's > 0.108). The logistic regression model assessing hypersensitivity to the loss of social support revealed a role in RD3 in predicting DOA (OR = 1.84, 95% CI [1.03, 3.51], SE = 0.31, z = 1.96, p = .049), with DOA group showing higher attachment. In addition, the model indicated a significant interaction between HA1, RD3, and SD (OR = 0.45, 95% CI [0.20, 0.87], SE = 0.37, z = −2.17, p = .029), suggesting that the Self-directedness trait moderates the relationship between HA1 and RD3 traits, as shown in Fig. 3. In particular, the results indicate that when SD is high, increasing levels of RD3 and HA1 are associated with a lower probability of DOA. Inversely, when SD is low, and RD3 and HA1 are high, the probability of DOA increases, suggesting a moderating effect of self-directedness on the influence of Anticipatory Worry and Attachment.

Table 1
Median (IQR) or mean ± SD and group comparisons of demographic variables and questionnaire results.

	DOA (n = 39)	Control (n = 40)	Test	p	Effect size
Age	30.9 ± 10.2	32.4 ± 11.6	t = −0.62	0.999	d = −0.14
Gender (F/M)	22/17	21/19	χ^2 = 0.01	0.999	V = 0.01
PADSS	12.0 (6.2)	0 (0)	W = 1	<0.001	r = 0.89
ESS	7.3 ± 4.5	5.4 ± 3.7	t = 2.10	0.157	d = 0.47
SCI	16.5 (6.0)	25.0 (5.5)	W = 1255	<0.001	r = 0.64
MEQ	49.5 (14.5)	52.0 (13.0)	W = 427	0.999	r = 0.06

Notes. DOA: Disorders of Arousal; PADSS: Paris Arousal Disorder Severity Scale; ESS: Epworth Sleepiness Scale; SCI: Sleep Condition Indicator; MEQ: Morningness–eveningness questionnaire.

Table 2
Median (IQR) or mean ± SD and group comparisons of TCI-R scales.

TCI-R scales	DOA (n = 39)	Control (n = 40)	Test	p	Effect size
NS	100.0 (20.0)	99.5 (20.2)	W = 660	0.757	r = 0.13
HA	100.2 ± 17.3	94.3 ± 16.1	t = 1.57	0.606	d = 0.35
RD	108.1 ± 15.0	99.1 ± 15.7	t = 2.61	0.076	d = 0.59
PS	121.4 ± 19.7	115.7 ± 18.5	t = 1.32	0.757	d = 0.30
SD	132.1 ± 16.4	138.5 ± 16.3	t = −1.74	0.509	d = −0.39
CO	140.0 (18.5)	142.5 (15.0)	W = 890	0.757	r = 0.12
ST	66.8 ± 15.0	63.4 ± 13.5	t = 1.05	0.757	d = 0.24

Notes. DOA: Disorders of Arousal; NS: Novelty Seeking; HA: Harm Avoidance; RD: Reward Dependence; PS: Persistence; SD: Self-directedness; CO: Cooperativeness; ST: Self-transcendence.

4. Discussion

The present multicentric case-control study, conducted on a considerable sample of adults diagnosed with DOA and a control group matched for age and gender, aimed to investigate whether specific personality traits might characterize individuals with DOA. To this end, we administered the TCI-R questionnaire, which evaluates both temperament and character dimensions of personality.

Unlike previous research, we did not observe differences in personality traits between the two groups. Notably, two earlier studies, one involving a small sample of adults with a diagnosis of DOA [19], and the other involving children and adolescents with DOA [16], reported higher novelty seeking and lower self-directedness in DOA individuals, suggesting a personality profile marked by impulsivity and heightened reward sensitivity. However, we found that three out of the four temperament traits predicted the probability of DOA occurrence. Specifically, higher levels of harm avoidance, reward dependence, and persistence were associated with a higher probability of DOA occurrence, suggesting a personality profile characterized by behavioural inhibition in response to potential punishment, increased sensitivity to social rewards, and perseverance despite frustration [27]. Interestingly, none of the character traits emerged as predictors of DOA occurrence. However, although the persistence trait is often conceptualized as an adaptive dimension of temperament, previous work suggests that, in specific personality configurations, elevated Persistence may be associated with a more rigid or perseverative coping style rather than flexibility. In particular, high Persistence combined with elevated Harm Avoidance and low Self-Directedness has been linked to increased vulnerability to anxiety disorders [32]. Within this theoretical framework, the association between Persistence and DOA observed in our study may reflect a compensatory or overcontrolled response in individuals characterized by heightened arousal instability, rather than a purely adaptive trait.

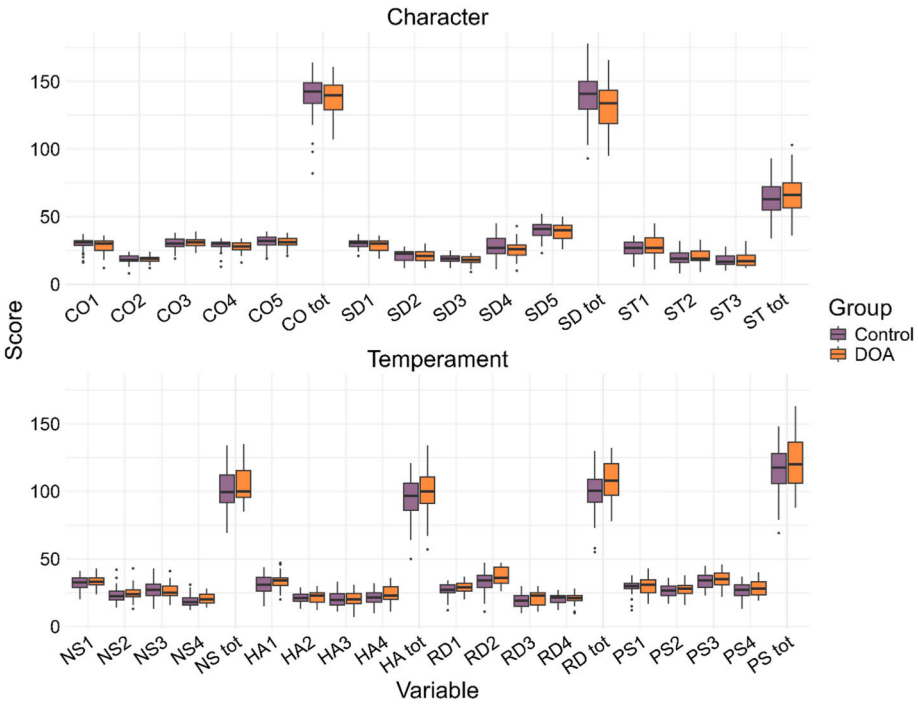

Fig. 1. Boxplot representation of TCI-R facet scores, divided into temperament and character dimensions, for the two groups (Disorders of Arousal, Control). The horizontal line indicates the median; the box limits represent the first and third quartiles. Black dots indicate outliers, defined as values exceeding 1.5 times the interquartile range (IQR) from the first and third quartiles.

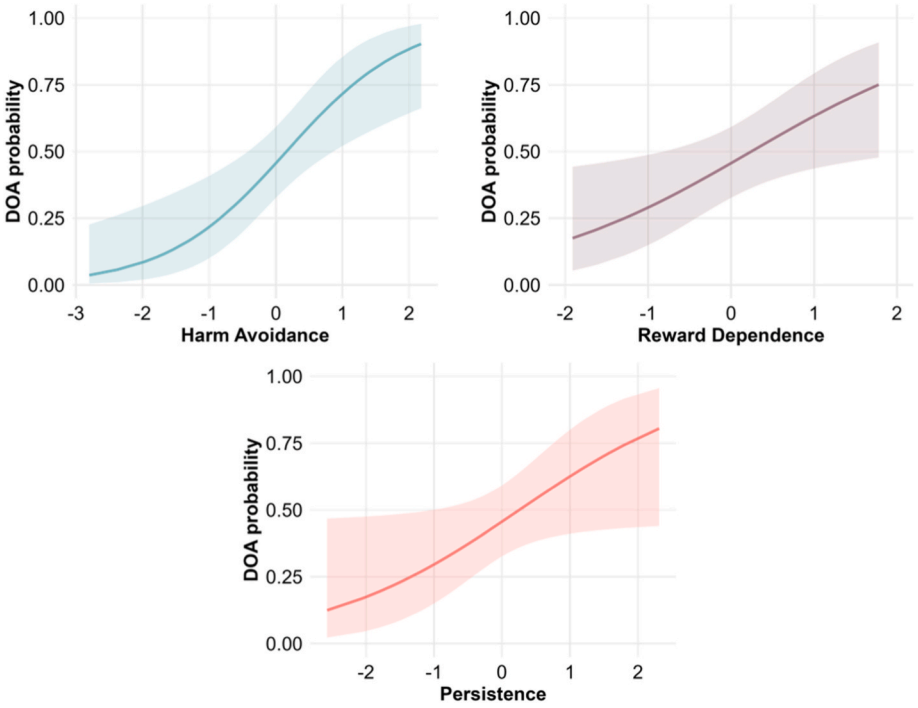

Fig. 2. Temperament traits and probability of DOA. The line represents the predicted probability of being in the Disorders of Arousal (DOA) group. The shaded area indicates the 95% confidence interval.

It is worth saying that TCI-R dimensions are most meaningful when interpreted in combination, as personality profiles, rather than in isolation [27]. Thus, we conducted further analyses to explore interactions between personality traits.

Contrary to Turner and colleagues [16], we did not identify traits associated with impulsivity, approach-avoidance conflicts, or emotional instability; features commonly related to cluster B personality disorders. However, consistent with Perogamvros and colleagues [19], we identified that high anticipatory worry (HA1) and attachment (RD3), combined with low self-directedness (SD), increased DOA probability. High self-directedness, by contrast, buffered this risk. According to Cloninger and colleagues (1993), self-directedness reflects an individual's ability to

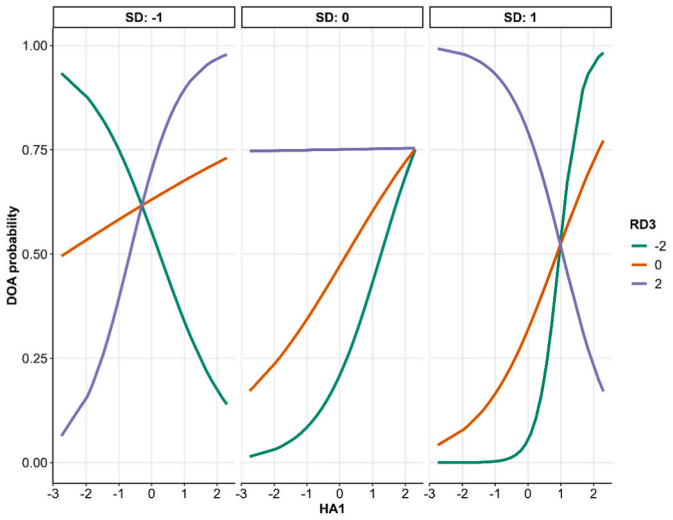

Fig. 3. Predicted probability of belonging to the DOA group as a function of Anticipatory Worry (HA1), Attachment (RD3), and Self-directedness (SD). The lines represent the predicted probability of being in the DOA group. The three panels show the probability of DOA when Self-directedness is fixed at −1, 0, and 1 standard deviations from the mean score, respectively, and the line colours represent the RD3 deviations from the mean score. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

adapt and regulate the behaviour in line with personal goals, and lower levels are considered a vulnerability factor for personality disorders. This profile, marked by anticipatory worry and high attachment, may reflect hypersensitivity to social loss, potentially denoting anxious attachment. This interpretation aligns with previous findings, reporting a higher prevalence of DOA in children with separation anxiety [33], as well as in adolescents with insecure attachment styles [34]. Moreover, we found no associations between DOA severity, assessed with PADSS, and personality traits, in contrast with Castelnovo and colleagues [3], who reported a positive relationship between DOA severity and general psychopathology, measured with the Child Behavior Checklist (CBCL), in children and adolescents.

It is important to clarify from the outset that the personality profiles discussed here reflect traits, not diagnosable disorders, that may, in some cases, predispose individuals to the development of more severe psychological disorders, as previously discussed by Turner and colleagues [16]. Supporting this, a study conducted on the psychometric characteristics of the Italian version of the TCI-R [35] confirmed that certain personality traits (e.g., high harm avoidance, low self-directedness) are linked to increased psychopathological risk, with self-directedness negatively associated with impulsivity and aggressiveness, and positively with secure attachment.

Within the framework of the 3P model (described in Ref. [15]), temperament traits, characterized by early emergence, lifelong stability, and genetic influence, may predispose individuals to DOA onset or persistence into adulthood. Supporting this, studies on adult DOA patients suggest that the persistence of the disorder into adulthood, since its usual decline with age, may be related to psychological more than to genetic factors [7,14], with adults experiencing ongoing DOA reporting greater psychopathology, lower familial aggregation, later onset, and more frequent events compared to those whose symptoms have remitted [8]. Genetic contributions to both personality [17] and DOA [15] are well-documented. Differently from character traits, which develop throughout adulthood [27], temperament traits have marked genetic and neurobiological bases that may explain why no character trait directly predicted the probability of DOA occurrence, while instead playing a mediating role.

Supporting the hypothesis of temperament traits as predisposing factors of DOA, some studies underlined the neurobiological bases in common between DOA and personality traits that characterize this population. A study conducted by Ramm and colleagues [36] found higher levels of anxious rumination in patients with DOA, corresponding to HA1 and RD3 in the TCI-R, and revealed a positive correlation between this personality trait and posterior cingulate cortex (PCC) volume. PCC seems to be involved in the default mode network, contributing to arousal and awareness, and it was found to show an increase in cerebral blood flow during a sleepwalking episode [37]. In addition, DOA and temperament traits seem to share some neurobiological mechanisms. For example, medications enhancing GABA activity and modulating serotonergic and noradrenergic activity have been found to trigger sleepwalking and, more generally, NREM parasomnias [38,39]. At the same time, according to Cloninger [40], high levels of HA are characterized by high serotonergic activity, and high levels of RD are characterized by low basal noradrenergic activity.

The present results should be interpreted considering some limitations. First, although the sample size was larger than in previous studies, it was still insufficient to allow differentiation between specific DOA subtypes, preventing us from investigating whether they differ in terms of personality profiles. A further limitation is that video polysomnography (VPSG) was available only for a subset of participants. Although VPSG allows the exclusion of relevant comorbid conditions, such as epilepsy or sleep-disordered breathing, it was performed only in selected cases based on a reasonable clinical suspicion, in accordance with routine clinical practice and due to limited availability. These factors should be taken into account when interpreting the present findings. Another limitation concerns the assessment of personality, which relied exclusively on a lengthy self-report questionnaire, potentially increasing participant burden and introducing bias due to fatigue. Additionally, no systematic data were collected on potential priming factors that might promote DOA episodes, such as stress or anxiety, making it impossible to account for their influence. Although clinical history indicated that none of the participants had received a formal Axis I psychiatric diagnosis and none were taking psychotropic medications for major psychiatric disorders, we did not include standardized measures of stress or anxiety (e.g., STAI, DASS), nor did we perform structured psychiatric interviews. Consequently, while major psychopathology can be reasonably excluded, we cannot fully rule out the contribution of subclinical psychological factors that may influence both personality traits and vulnerability to disorders of arousal. Future research should integrate ecological methods such as Ecological Momentary Assessment (EMA), as previously employed by Yoshiuchi and colleagues [41], to assess these factors (e.g., stress, anxiety, medication use) in daily contexts and consider prospective designs to better disentangle the relationship between personality traits and vulnerability to disorders of arousal. In particular, the use of standardized dimensional measures of stress and anxiety, together with systematic assessment of sleep features, psychiatric comorbidities, and medication use, will be essential to clarify the contribution of these factors.

Moreover, our case-control design prevents us from assessing a causal relationship between temperament traits and DOA occurrence. Therefore, the associations identified in this study should not be interpreted as evidence of predisposition. A further step forward in the investigation of personality profiles in DOA patients would be the implementation of prospective studies. This would allow for causal inferences regarding the relationship between personality traits and DOA onset or persistence into adulthood. Such findings could have important clinical implications for the treatment of DOA, particularly by emphasizing the role of psychological and behavioural factors. Notably, cognitive behavioural therapy has already been proposed as a treatment approach for DOA (for a review, see Ref. [42]), focusing on strategies for managing stress and anxiety. If personality traits are confirmed as predisposing factors for DOA onset or its persistence into adulthood, targeted psychotherapeutic interventions might be applied in children with DOA, potentially preventing chronicity. An additional limitation

concerns the statistical power. An a priori power analysis was not conducted, as the sample size was constrained by the availability of diagnosed DOA patients recruited across multiple sleep centres. As a result, the study may have been underpowered to detect small effect sizes, and null findings should be interpreted with caution.

To conclude, certain temperament traits, such as reward dependence, harm avoidance, and persistence, appear to predict DOA occurrence in adults, while character traits, like self-directedness, may modulate this risk. Future research should adopt prospective designs and more ecologically valid methods to assess personality.

CRediT authorship contribution statement

Angie Baldassarri: Writing – original draft, Visualization, Software, Formal analysis, Data curation. **Elena Zambrelli:** Writing – original draft, Investigation, Data curation. **Katherine Turner:** Writing – review & editing, Data curation. **Andrea Galbiati:** Writing – review & editing, Data curation. **Nicola Cellini:** Writing – review & editing. **Giulio Perrotta:** Writing – review & editing. **Romano Bianchi:** Writing – review & editing. **Marco De Pieri:** Writing – review & editing. **Luigi Ferini Strambi:** Writing – review & editing. **Michele Terzaghi:** Writing – review & editing. **Raffaele Manni:** Writing – review & editing. **Paola Proserpio:** Writing – review & editing, Data curation. **Lino Nobili:** Writing – review & editing. **Mauro Manconi:** Writing – review & editing. **Maria Paola Canevini:** Writing – review & editing. **Anna Castelnovo:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Data curation.

Ethics approval

All participants provided informed consent. The study protocol was approved by the local Ethics Committee of "Santi Paolo e Carlo" Hospital.

Data and code availability statement

All datasets and code underlying the results are publicly available in the Open Science Framework repository at https://osf.io/rsm27.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2026.108858.

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