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Decoding the Narcissistic Brain

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ABSTRACT

There is a substantial knowledge gap in the narcissism literature: <1 % of the nearly 12,000 articles on narcissism have addressed its neural basis. To help fill this gap, we asked whether the multifacetedness of narcissism could be decoded from spontaneous neural oscillations. We attempted to do so by applying a machine learning approach (multivariate pattern analysis) to the resting-state EEG data of 162 participants who also completed a comprehensive battery of narcissism scales assessing agentic, admirative, rivalrous, communal, and vulnerable forms. Consistent with the agency-communion model of narcissism, agentic and communal forms of grandiose narcissism were reflected in distinct, non-overlapping patterns of spontaneous neural oscillations. Furthermore, consistent with a narcissistic admiration and rivalry concept model of narcissism, we observed largely non-overlapping patterns of spontaneous neural oscillations for admirative and rivalrous forms of narcissism. Vulnerable narcissism was negatively associated with power across fast and slow wave frequency bands. Taken together, the results suggest that the diverse forms of narcissism can be reliably predicted from spontaneous neural oscillations. The findings contribute to the burgeoning field of personality neuroscience.

1. Introduction

Narcissism's paradoxical appeal has fascinated laypersons and scholars alike. For example, when individuals high in narcissism occupy political or corporate leadership roles (e.g., Presidents or Chief Executive Officers), their decisions may pose risks to the well-being of a country or company. Yet, citizens or stakeholders may still choose to support or re-elect them. Similarly, in everyday contexts, individuals with elevated narcissism can create interpersonal challenges as colleagues, friends, or partners, but relationships with them are often maintained or even valued. A vast literature documents how individuals high in narcissism can both charm and harm countries, institutions, and individuals. This evidence primarily relies on self-reports, behavioral intentions, and, to a lesser extent, observed behaviors, leaving deeper underlying mechanisms relatively underexplored. Neuroscientific approaches, such as examining brain oscillations, may offer additional insights into how narcissistic traits are reflected in neural activity. Here, we investigate whether different facets of narcissism are reflected in specific patterns of oscillatory brain activity.

1.1. Narcissism

1.1.1. Defining narcissism

Contemporary researchers conceptualize narcissism as a normally distributed personality trait. At its core, narcissism comprises two features (Sedikides, 2021). One is egocentric exceptionalism, reflecting a belief in one's own superiority, uniqueness, and entitlement. The other is social selfishness, characterized by a tendency to prioritize oneself over others, often at their expense.

Narcissism, though, is a multifaceted construct. According to the narcissism spectrum model (Krizan and Herlache, 2018), narcissism encompasses a range of facets, typically characterized by entitlement

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and self-importance, and marked by varying degrees of both vulnerable and grandiose forms. These facets are rooted in approach-oriented and avoidance-oriented motivational tendencies, which are shaped and reinforced by social experiences. The model seeks to elucidate the clinical origins and multidimensional nature of narcissism, emphasizing the continuity between normative and maladaptive facets. Similarly, according two-factor structure of narcissism (Miller et al., 2018), the construct comprises grandiose and vulnerable forms. A subsequent three-factor model further delineated the construct into agentic extraversion, antagonism, and narcissistic neuroticism. This framework incorporates elements of the Big Five personality traits, particularly extraversion, agreeableness, and neuroticism, as foundational components.

The most widely studied form of narcissism is grandiose. Individuals high in grandiose narcissism are self-confident, extraverted, and exhibitionistic, which may help them attract supporters, but also contribute to negative outcomes such as displays of dominance, manipulativeness, and risk-proneness. Highly narcissistic individuals self-enhance on agentic dimensions by extolling their own competence, decisiveness, creativity, intelligence, ambition, and vision. Another form of grandiose narcissism is communal narcissism. Individuals high in this form of narcissism self-enhance on communal dimensions, emphasizing their own warmth, prosociality, morality, virtue, and perceived ability to help others. Further, among individuals high in grandiose narcissism, some self-enhance through antagonistic behaviors that diminish others (rivalrous narcissism), whereas others do so through overt self-promotion (admirative narcissism). Vulnerable narcissism, by contrast, is typically associated with traits such as introversion, neuroticism, and defensiveness (Herman et al., 2018; Kirk et al., 2024; Krizan and Herlache, 2018; Miller et al., 2018; Nehrlich et al., 2019; Sedikides, 2021).

1.1.2. Theoretical models

Agency-Communion Model. The agency-communion model (Gebauer and Sedikides, 2018) distinguishes between individuals who pursue self-enhancement primarily in agentic domains (agentic narcissism) and those who pursue it in communal domains (communal narcissism). Gebauer and colleagues (2012) reported results consistent with this model. In Study 1, a measure of agentic narcissism (the Narcissistic Personality Inventory) correlated with agentic (e.g., "I am the most intelligent person") but not communal (e.g., "I am the most helpful person") self-thoughts. Using these communal self-thoughts, the authors created the Communal Narcissism Inventory, which was conceptually distinct from agentic narcissism (Study 2). Although agentic and communal narcissism were associated with the same core self motives (grandiosity, self-esteem, entitlement, and power), these motives were enacted in agentic and communal domains, respectively (Studies 3–4). The conceptual distinctiveness between agentic and communal narcissism has been supported by meta-analytic evidence (Dufner et al., 2019). Insofar as narcissism can be decoded in patterns of spontaneous neural oscillations, then, the agency-communion model suggests that agentic and communal narcissism should be predicted by distinct patterns of spontaneous neural oscillations.

Narcissistic Admiration and Rivalry Concept (NARC) Model. The NARC model of narcissism (Back et al., 2013; Back, 2018) proposes two pathways through which individuals high in narcissistic traits pursue self-enhancement: admiration and rivalry. Admirative narcissism is characterized by self-promotion and efforts at self-enhancement. Individuals high in this form of narcissism often present as ostentatious, charming, and focused on standing out or being unique. In contrast, rivalrous narcissism is associated with self-protective tendencies, including aggressiveness, devaluation of others, and a drive to dominate social interactions. The two forms of narcissism are conceptually distinct as reflected in divergent affective, behavioral, cognitive, and motivational patterns. Insofar as the NARC model anticipates opposing patterns for admirative and rivalrous narcissism, these two forms will be predicted by distinct patterns of spontaneous neural oscillations.

Mask Model. Steeped in psychodynamic tradition (Freud, 1957; Kernberg, 1975; Kohut, 1966), the mask model of narcissism (Kuchynka and Bosson, 2018) conceptualizes narcissistic self-enhancement as a façade protecting a fragile inner core (Kernis, 2003; Westen, 1990). This model posits that individuals with elevated narcissism will initially exhibit hypervigilance to self-threat, followed by self-regulatory responses aimed at masking that hypervigilance. In support of the mask model, individuals with higher levels of narcissism, alongside augmented explicit self-esteem, respond more quickly to subliminal (compared to supraliminal) negative, self-relevant primes (Hardaker et al., 2021; Horvath and Morf, 2009). The relevant studies conceptualize the fragile inner core of narcissism as a psychological state that is activated by self-threat. However, evidence for a stable, trait-like version of this fragile core remains limited (Bosson et al., 2008; Mota et al., 2020). The trait-like fragile inner core proposed by the mask model may be represented in spontaneous neural oscillations. Based on this view, a unique pattern of spontaneous neural oscillations would predict vulnerable narcissism.

1.1.3. The neuroscience of narcissism

The neuroscience of narcissism is in its infancy. A pioneering systematic review on the topic summarized 35 articles (Jauk and Kanske. 2021). Since then, an additional 18 articles have been published. These 53 articles represent a small fraction (0.45 %) of the 11,854 articles in the narcissism literature (Web of Science, March 22, 2025) and utilize functional magnetic resonance imaging (fMRI), structural MRI, EEG, and peripheral nervous system measures. The largest portion of these 53 articles focus on grandiose narcissism, with only one study addressing communal narcissism. Methodologically, many articles examine peripheral physiological measures (e.g., autonomic nervous system, neuroendocrine) at baseline (Cheng et al., 2013; Noser, 2017; Pfattheicher et al., 2016; Reinhard et al., 2012; Wardecker et al., 2018) or during a laboratory task. Findings from laboratory tasks have been inconsistent, with some associating narcissism with greater autonomic activity (Kelsey et al., 2002; Sommer et al., 2009; Woodman et al., 2011), and others not (Sylvers et al., 2008; Zhang et al., 2015). Neuroendocrine studies have linked narcissism to higher testosterone (Dane et al., 2018; Lobbestael et al., 2014; Mead et al., 2018; Stenstrom et al., 2018; South et al., 2023) and recently researchers have linked narcissism to hormonal balance (Altmann and Roth, 2024). In women, a lower ratio of the length between the second finger and fourth finger (i.e., lower prenatal estrogen/higher prenatal testosterone exposure) was associated with higher grandiose narcissism. In men, a higher ratio of the length between the second finger and fourth finger (i.e., higher prenatal estrogen/lower prenatal testosterone exposure) was associated with vulnerable narcissism. However South and colleagues (2023) did not observe an association between digit ratios and narcissism in women or men. Other neuroendocrine studies have reported inconsistent associations between narcissism and cortisol levels (Dane et al., 2018; Edelstein et al., 2010; Borráz-León et al., 2023). Finally, narcissism has been associated with lower serotonergic activity, but only among patients with a depressive disorder (Mavrogiorgou et al., 2023).

Fewer studies have linked narcissism to neural indices during a laboratory task. In some cases, researchers employed fMRI and produced two key neuroanatomical findings, most of which were highlighted in the aforementioned review (Jauk and Kanske, 2021). First, higher levels of narcissism have been associated with increased activity in the anterior cingulate cortex (ACC) in response to one's own face (Jauk et al., 2017) and to experiences of social exclusion (Cascio et al., 2015). This heightened ACC activity may help to explain the link between narcissistic traits and aggressive responses to exclusion (Chester and DeWall, 2016). Second, higher narcissism scores have been linked to reduced activity in the anterior insula (AI) during tasks involving empathy for others (Fan et al., 2011) and anticipation of interpersonal touch (Scalabrini et al., 2017), as well as reduced activation in brain regions associated with prosocial motives, such as the dorsomedial prefrontal cortex (Stolz et al., 2021). Additionally, structural MRI studies have linked narcissism to increased gray and white matter volume in several prefrontal cortical areas including the medial and ventromedial, anterior/rostral dorsolateral prefrontal, and orbitofrontal cortices as well as the ACC, insula, and bilateral caudate nuclei (Nenadic et al., 2021). Further, narcissism is positively associated with the structure of the posterior cingulate cortex (Schmidt et al., 2023). Beyond individual brain regions, narcissism is associated with alterations in areas linked to the default mode network (Jornkokgoud et al., 2024).

Other researchers have used EEG and found similar results related to empathy (Marcoux et al., 2014), face processing (Mück et al., 2020; Zhang et al., 2016), and feedback processing (Krusemark 2009; Yang et al., 2018a, 2018b). In addition, under conditions of explicit self-threat, higher levels of grandiose narcissism, particularly rivalrous narcissism, have been linked to increased error-related brain activity (Mück et al., 2023). Collectively, this literature has examined how self-reported narcissism relates to behavior on laboratory tasks designed to evoke responses through opportunities to self-enhance or react to social feedback. Stripped of this context, do individuals with higher levels of narcissism exhibit distinct patterns of brain activity compared to those with lower levels?

A small number of studies (summarized by Jauk and Kanske, 2021) have identified context-independent structural brain differences associated with higher narcissism scores (Chester et al., 2016; Jornkokgoud et al., 2023; Jornkokgoud et al., 2024; Mao et al., 2016; Nenadic et al., 2015; Schmidt et al., 2023; Schulze et al., 2013; Yang et al., 2015). Although brain function is partly shaped by structural features (Liégeois et al., 2020), even fewer studies have examined context-independent functional brain differences associated with narcissistic traits. One study observed a stronger negative correlation between structures in the default mode and dorsal attention networks among women (but not men) high in narcissism (Yang et al., 2015). Another study found that greater activity in the postcentral gyrus and AI at rest was associated with higher narcissism (Scalibrini et al., 2017).

Ongoing research is helping to characterize the neural correlates that may differentiate levels or expressions of narcissism. Different narcissism facets are associated with distinct resting-state brain activity: grandiose exhibitionism with reduced dorsomedial prefrontal cortex activation, entitlement and exploitativeness with reduced dorsomedial prefrontal cortex as well as right lateral prefrontal cortex activation, and leadership/authority with increased left anterior temporal cortex activation (Leota et al., 2024). Similarly, higher narcissism scores have been associated with decreased clustering coefficient and local efficiency in the default mode network but increased nodal clustering and efficiency in the right posterior cingulate cortex during resting-state activity (Cao et al., 2022). In addition, narcissism has been predicted from functional connectivity within and between limbic and prefrontal systems (Feng et al., 2018). Collectively, this body of work has begun to link narcissism to spontaneous, context-free patterns of neural activity. However, this work has relied primarily on structural and functional MRI approaches. EEG provides a complementary method for investigating spontaneous neural activity. To date, no study has used EEG to examine whether narcissistic traits can be predicted from resting-state neural oscillations.

1.2. Overview

We fill that void by asking if the multifacetendess of narcissism can be uncovered in spontaneous neural oscillations. We do so by using Multivariate Pattern Analysis of resting state EEG data (Jach et al., 2020) and robust assessments of narcissism. Multivariate pattern analysis provides a data-driven way to predict narcissism from brain signals that represent the collective activity of many EEG electrodes (Grootswagers et al., 2017). This technique is rarely used with EEG data except to predict low-level sensory or cognitive processes (Bode et al., 2012; Cauchoix et al., 2014; Hogendoorn et al., 2015; Turner et al., 2017). Only once has this technique been implemented to successfully decode personality (Jach et al., 2020). Additionally, we include a comprehensive battery of narcissism scales: agentic and communal forms of grandiose narcissism, rivalrous and admirative forms of grandiose agentic narcissism, and vulnerable narcissism.

We offer three hypotheses. First, based on the agency-communion model (Gebauer et al., 2012), which distinguishes between agentic narcissism (individuals satisfying self-motives of grandiosity, esteem, entitlement, and power in agentic domains) and communal narcissism (individuals satisfying the same self-motives in communal domains), we hypothesize that agentic narcissism and communal narcissism are predicted by divergent patterns of neural oscillations, though our approach regarding specific neural oscillations is exploratory. Second, drawing on the NARC model of narcissism, which distinguishes between the trajectories of admirative versus rivalrous forms of narcissism (Back et al., 2013), we hypothesize that admiration and rivalry are associated with divergent patterns of neural oscillations, adopting an exploratory analysis of these neural patterns. Third, based on the mask model of narcissism (Kuchynka and Bosson, 2018), which posits a fragile core at the heart of narcissism, we hypothesize that hypersensitive narcissism is linked to a unique pattern of neural oscillations, aiming to explore the exact neural substrates.

2. Method

2.1. Participants

Participants were 162 University of Southampton undergraduate psychology students (M_{age} = 19.57, SD_{age} = 2.77; 79 % female; 89 % right-handed) volunteering for course credit. The study was approved by the University of Southampton Faculty Research Ethics Committee (Ethics Number: 68828). This study was not pre-registered.

2.2. Procedure

Participants completed all measures and tasks in a soundproof laboratory room. They underwent resting-state EEG signal recording in the context of a larger study of personality and neural activity. First, participants completed an 8-minute resting-state EEG data collection (4 min with eyes open, 4 min with eyes closed; Huang et al., 2025). They were asked to keep as still as possible. In the eyes-open condition, participants were instructed to look at a fixation cross presented on the screen. Participants first completed the eyes-closed condition, followed by the eyes-open condition. After the resting-state EEG recording, participants completed several tasks (Flanker, Stroop, Monetary Incentive Delay) unrelated to the current study. Lastly, they filled out 10 personality measures, drawn from a larger set of 12. This set of 12 personality measures included the narcissism measures described below as well as others unrelated to the objectives of the current study.[1] We randomized the order and subset of measures that participants completed. Given that each participant completed a random subset of personality measures, the sample size for final multivariate pattern analysis of each measure of narcissism varied between 131 and 135.

2.3. Narcissism measures

2.3.1. Agentic and communal narcissism

We assessed agentic narcissism with the Narcissistic Personality Inventory-13 (Gentile et al., 2013). Participants indicated their level of agreement with 13 statements. Sample statements are: “I will never be

[1] We included the following additional measures: Self-Esteem (Rosenberg, 1965); Extraversion/Neuroticism (John and Srivastava, 1999); Depression, Anxiety, and Stress (Lovibond and Lovibond, 1995); Self-Compassion (Neff, 2003); Self-Control (Tangney et al., 2004); Self-Motives (Gregg et al., 2011); Social Phobia (Connor et al., 2000); Fear of Negative Evaluation (Leary, 1983).

satisfied until I get all that I deserve," "I like having authority over people" (1 = *strongly disagree*, 5 = *strongly agree*; α = 0.81). We assessed grandiose communal narcissism with the 16-item Communal Narcissism Inventory (Gebauer et al., 2012). Sample items are: "I will bring freedom to the people," "I am generally the most understanding person" (1 = *disagree strongly*, 7 = *agree strongly*; α = 0.89).

2.3.2. Narcissistic admiration and rivalry

The NARC model of narcissism decomposes narcissism into admiration and rivalry. We assessed these forms via the Narcissistic Admiration and Rivalry Questionnaire (Back et al., 2013). Nine items reflect rivalrous aspects of narcissism (e.g.," I enjoy it when another person is inferior to me"), whereas nine items reflect admirative aspects of narcissism (e.g., "I deserve to be seen as a great personality"). Participants rated their level of agreement with these items (1 = *not agree at all*, 6 = *agree completely*). Alphas for the total score and each subscale ranged from 0.83 to 0.85.

2.3.3. Vulnerable narcissism

We assessed vulnerable narcissism with the 10-item Hypersensitive Narcissism Scale (Hendin and Cheek, 1997). Participants rated how well each statement characterizes their feelings and behavior. Sample items are: "When I enter a room, I often become self-conscious and feel that the eyes of others are upon me," "I often interpret the remarks of others in a personal way" (1 = *very uncharacteristic*, 5 = *very characteristic*; α = 0.68).

2.4. EEG data collection and preprocessing

We collected resting-state EEG data from 32 scalp sites using Ag/AgCl electrodes embedded in a flexible cap (Brain Products, UK), placed according to the 10–20 system. We used a Brain Vision actiCHamp Plus amplifier (Version: label 004 05/2015, Brain Products, UK) with 500 Hz sampling rate. We used Cz and FPz as the reference and ground respectively (Zhang et al., 2021). We recorded vertical electrooculogram recordings (VEOG) below the right eye. We maintained electrode impedances below 10 kΩ, and amplified signals and sampled at 500 Hz. We processed data using EEGLAB functions implemented in MATLAB (Delorme and Makeig, 2004). We filtered data using a basic FIR filter (0.1–40 Hz, with a 50 Hz notch), and segmented the combined eyes open and eyes closed data into non-overlapping 2000 ms epochs. We replaced bad channels using spherical spline interpolation (Perrin et al., 1989). We corrected blink, eye movement, and other artifacts using Independent Components Analysis (Delorme and Makeig, 2004) and used ICLabel to automatically identify artifactual components (Pion-Tonachini et al., 2019). Segments with a voltage deviation on any channel exceeding ± 100 μV were excluded from further analysis, as was data from the VEOG channel. We extracted the power spectral densities for the artifact free the eyes closed, the eyes open, and the combined data using a Fast Fourier Transform with a 0.5 Hz frequency resolution. We then extracted the average spectral power from within each canonical frequency band (e.g., Delta: 1–4 Hz, Theta: 4–8 Hz, Alpha: 8–12 Hz, Beta: 12–30 Hz, Gamma: 30–40 Hz). For all three conditions (eyes-open, eyes-closed, and combined conditions), we utilized averaged power in frequency bins ranging from 0.1 to 40 Hz for multivariate pattern analysis.

2.5. Multivariate pattern analyses of EEG power spectra

Following the data processing pipeline of Jach and colleagues (2020), we conducted multivariate pattern analyses of EEG power spectra data using support vector regression implemented with the Decision Decoding Toolbox (Bode et al., 2019, 2022). We used Mean Squared Error (MSE) as the model performance metric (Botchkarev, 2019; Hyndman and Koehler, 2006). The mean MSE was 0.60, indicating that the model performance is acceptable. We visualized decoding performance (Figs. 1–3) via ggplot2 (Wickham, 2016) in R version 4.3.1 (R Core Team, 2023). We conducted a series of 15 Support Vector Regressions with a linear kernel in LIBSVM (Chang and Lin, 2011) to predict narcissism scores (agentic, communal, admirative, rivalrous, vulnerable) based on the collective patterns of spectral power across all 31 channels within a frequency bin (e.g., 1 Hz) across three conditions: eyes open, eyes closed, combination of eyes open and closed. We repeated each of these 15 regressions iteratively from 1 to 40 Hz.

To mitigate the risk of high decoding performance by chance, we implemented three procedures based on those introduced by Jach et al. (2020). First, we used 10-fold cross-validation procedures across all analyses to minimize the impact of random variation in decoding performance. Second, we used permuted-label decoding (in addition to support vector regression) to provide a more rigorous test of decoding performance than comparisons against a chance performance (Combrisson and Jerbi, 2015). Third, we directly compared decoding performance across all frequency bands between analyses with original labels and those with permuted labels. To clarify, "labels" in the permuted-label decoding refer to the narcissism scores collected via standardized self-report measures. During permutation testing, these labels were randomly shuffled, breaking any true correspondence between EEG data and narcissism scores. The support vector regression model was retrained on each permuted dataset to generate a distribution of decoding performance expected by chance. By comparing the model's actual performance to this null distribution, we were able to determine whether the EEG-based predictions were statistically meaningful.

2.6. Post-hoc spectral power correlations

To complement the above analyses, we conducted post-hoc Spearman correlations (de Winter et al., 2016) between (1) scores on narcissism measures showing consistent above-chance recoding performance, and (2) neural activity within a specific frequency band (Jach et al., 2020).

3. Results

3.1. Descriptive statistics for narcissism and EEG measures

We present descriptive statistics and correlations among narcissism scales in Table 1. Agentic narcissism was positive associated with admirative, rivalrous, and communal narcissism, but was unrelated to vulnerable narcissism. Communal narcissism was also positively associated with admirative narcissism, but not rivalrous or vulnerable narcissism. Vulnerable narcissism was positively associated with rivalrous narcissism. This pattern of scale intercorrelations is consistent with past research (Back et al., 2013; Gebauer et al., 2012; Gentile et al., 2013; Henttonen et al., 2022; Martin et al., 2019).

3.2. Multivariate pattern analysis of frequency band power estimates

3.2.1. Agentic narcissism and communal narcissism

Agentic Narcissism. Agentic narcissism was not reliably predicted in the combined condition (Fig. 1A). However, the correlation between model-predicted and grandiose narcissism scores was predicted between 14–17 Hz in the eyes-closed condition (Fig. 2A). Agentic narcissism was also predicted between 4–8 Hz in the eyes-open condition (Fig. 3A).

Communal Narcissism. Communal narcissism was associated with activity across frequencies within alpha, beta, and gamma bands. The correlation between model-predicted and communal narcissism scores exceeded chance levels at frequencies between 12–28 Hz, and 35–40 Hz in the combined condition (Fig. 1B). Furthermore, in the eyes-closed condition, the model predicted communal narcissism scores above chance levels, at frequencies between 18–40 Hz (Fig. 2B). In the eyes-open condition, the model predicted communal narcissism scores at above chance levels at frequencies between 8–10 Hz and 12–13 Hz

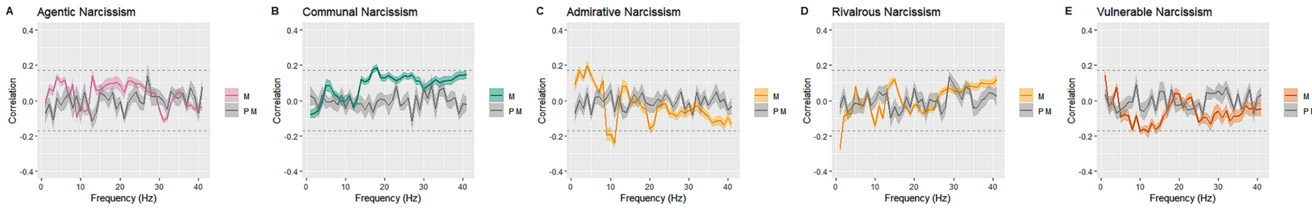

Fig. 1. Mean Decoding Performance for Each Narcissism Scale with Combined Condition.
Note. Coloured lines depict decoding performance while gray lines represent models trained with permuted labels. A dashed horizontal line at $r = 0.17$ is included for comparing decoding performance to this threshold. Error bars reflect the standard error of correlation coefficients. *M* = Mean Correlation Coefficient, PM = Permuted-Labels Analysis Mean Correlation Coefficient.

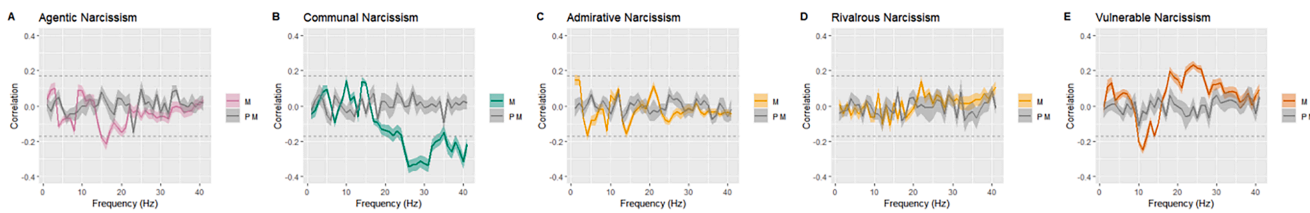

Fig. 2. Mean Decoding Performance for Each Narcissism Scale Under Eyes-Closed Condition.
Note. Coloured lines depict decoding performance while gray lines represent models trained with permuted labels. A dashed horizontal line at $r = 0.17$ is included for comparing decoding performance to this threshold. Error bars reflect the standard error of correlation coefficients. *M* = Mean Correlation Coefficient, PM = Permuted-Labels Analysis Mean Correlation Coefficient.

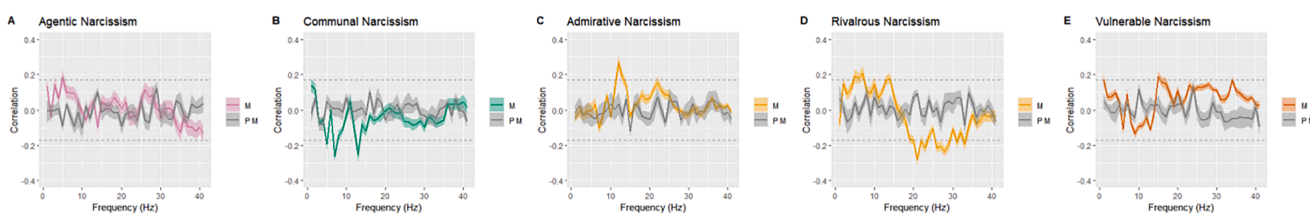

Fig. 3. Mean Decoding Performance for Each Narcissism Scale Under Eyes-Open Condition.
Note. Coloured lines depict decoding performance while gray lines represent models trained with permuted labels. A dashed horizontal line at $r = 0.17$ is included for comparing decoding performance to this threshold. Error bars reflect the standard error of correlation coefficients. *M* = Mean Correlation Coefficient, PM = Permuted-Labels Analysis Mean Correlation Coefficient.

Table 1
Means, standard deviations, and correlations among Narcissism Scales.

Narcissism Scale	M	SD	1	2	3	4	5
1. Agentic	2.52	0.64	(0.81)				
2. Communal	3.91	0.87	0.37**	(0.89)			
3. Admirative	3.27	0.82	0.58**	0.60**	(0.83)		
4. Rivalrous	1.72	0.71	0.37**	0.11	0.24**	(0.85)	
5. Vulnerable	2.79	0.58	0.17	−0.03	−0.02	0.35**	(0.68)

Note: $^{*}p < .05$. $^{**}p < .001$. The values in parentheses on the diagonal represent the Cronbach's α of each measure.

(Fig. 3B).

3.2.2. *Admirative and rivalrous narcissism*

Admirative Narcissism. The correlation between model-predicted and actual admirative narcissism was stable between 1–7 Hz, 8–12 Hz, and 18–23 Hz in the combined condition (Fig. 1C). In the eyes-closed condition, the correlation between model-predicted and actual admirative narcissism remained stable between 5 and 8 Hz (Fig. 2C). In the eyes-open conditions, the correlation between model-predicted and actual admirative narcissism remained stable between 12–14 Hz (Fig. 3C).

Rivalrous Narcissism. The correlation between model-predicted and actual rivalrous narcissism scores was not consistently predicted in the combined (Fig. 1D) or eyes-closed conditions (Fig. 2D). In the eyes-open conditions, oscillatory activity was associated with rivalrous narcissism between 2–8 Hz, 12–15 Hz, and 18–35 Hz (Fig. 3D).

3.2.3. *Vulnerable narcissism*

Vulnerable narcissism was associated with resting state oscillations. The correlation between model-predicted and vulnerable narcissism scores was between 5–17 Hz and between 27–33 Hz in the combined condition (Fig. 1E). In the eyes-closed condition, this frequency range was 10–16 Hz and 16–28 Hz (Fig. 2E). Vulnerable narcissism (Fig. 3E) was also predicted by the model between 25–40 Hz in the eyes-open conditions.

3.3. *Post-hoc correlation analyses*

This is the first investigation into the relationship between narcissism and resting-state oscillatory activity, with the models predicting scores on standardized narcissism scales at above chance levels across a range of frequency bands, and during eyes-open and eyes-closed conditions. We proceeded to examine the correlations between narcissism and power at individual channels and frequency bins. We present in Figs. 4–6 Spearman correlation coefficients reporting the strength of the association between spectral power and narcissism across all 31 channels in the eyes-open, eyes-closed, and combined conditions. The plots depict the correlations for each frequency bin (square plots), and the

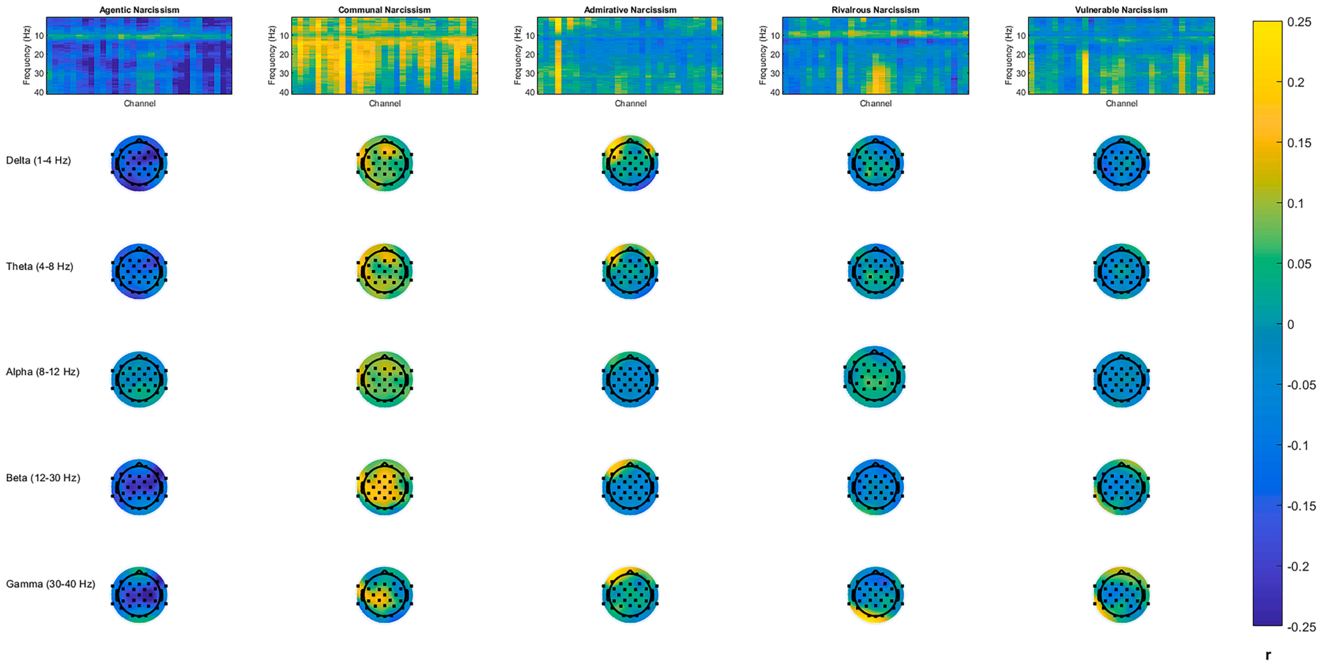

Fig. 4. Correlations Among Spectral Power at Each Electrode and Frequency Bin and Scales in the Combined Condition.
Note. Scalp maps display Spearman correlation coefficients averaged across selected frequency bands. Coefficients above $r = 0.17$ are significant at $p < .05$.

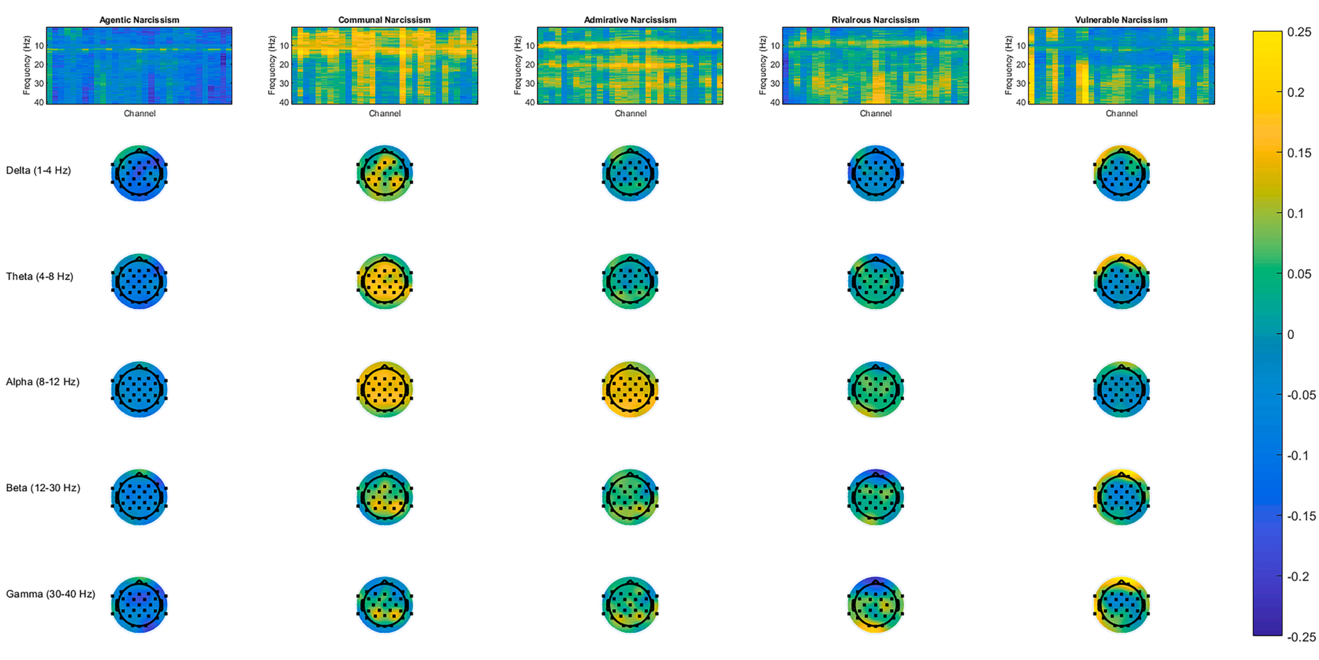

Fig. 5. Correlations Among Spectral Power at Each Electrode and Frequency Bin and Narcissism in the Eyes-Closed Condition.
Note. Scalp maps display Spearman correlation coefficients averaged across selected frequency bands. Coefficients above $r = 0.17$ are significant at $p < .05$.

average correlations across frequency bins where multivariate pattern analysis decoding was feasible (scalp maps).

Agentic narcissism was negatively correlated with oscillatory power in the combined conditions and in the eyes-open condition. For communal narcissism, the relationships were notably consistent across the three conditions. Specifically, power in the delta, theta, alpha, and beta bands were positively correlated with communal narcissism scores in the combined and eyes-closed conditions. Activity in the theta and alpha band at parietal and frontal electrode sites correlated positively with communal narcissism scores in the eyes-open condition. Vulnerable narcissism was negatively correlated with EEG power (delta, theta, and alpha) over the temporal sites in the combined condition. We also observed this negative correlation in the eyes-open condition in the beta and gamma bands. However, we obtained no clear pattern under the eyes-closed condition.

4. Discussion

A miniscule percentage of published articles address the neural basis of narcissism. We asked whether the multifacetedness of narcissism

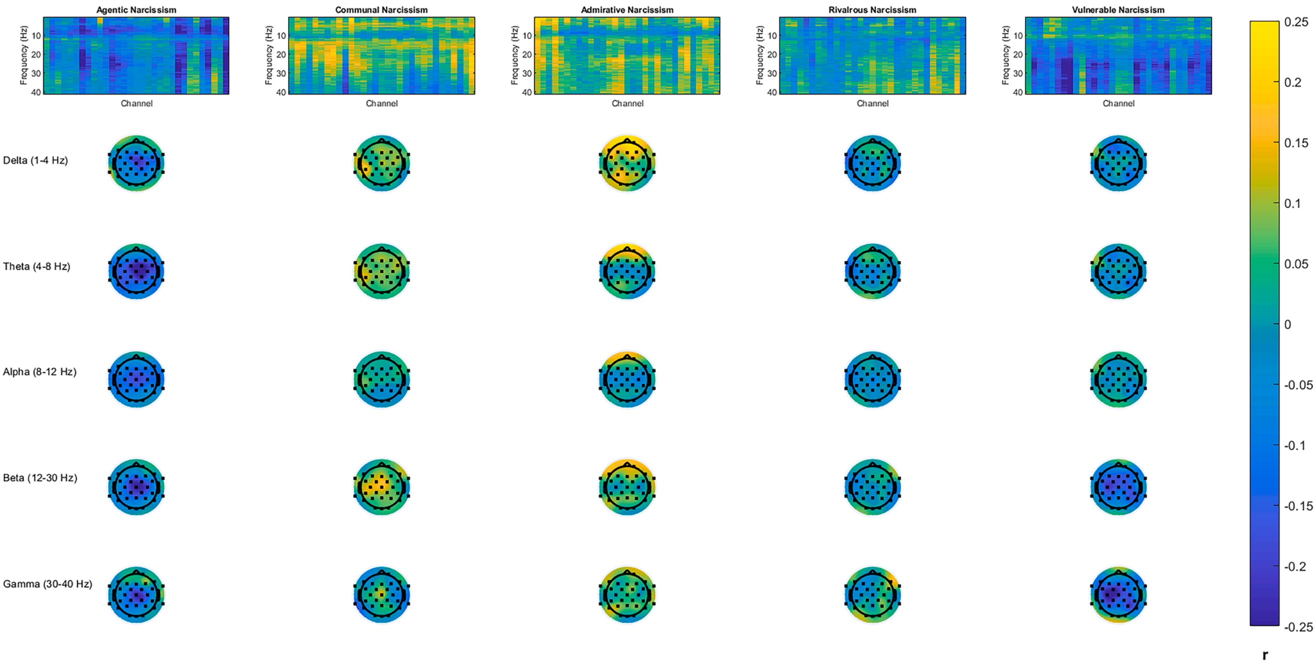

Fig. 6. Correlations Among Spectral Power at Each Electrode and Frequency Bin and Narcissism in the Eyes-Open Condition.
Note. Scalp maps display Spearman correlation coefficients averaged across selected frequency bands. Coefficients above $r = 0.17$ are significant at $p < .05$.

could be decoded from spontaneous neural oscillations. By applying a machine learning approach (multivariate pattern analysis) to resting state EEG data and a robust assessment of narcissism, we demonstrated that individual differences in narcissism can be predicted from spontaneous neural activity and that different forms of narcissism are predicted by distinct patterns of neural activity. Agentic narcissism was negatively correlated with power across fast and slow wave frequency bands. Communal narcissism was positively correlated with power across all frequency bands in the eyes-open, eyes-close, and combined conditions. Admirative and rivalrous forms of narcissism showed divergent patterns of correlations with EEG power. Finally, vulnerable narcissism was negatively correlated with power across fast and slow wave frequency bands.

4.1. Theoretical implications

An outstanding question in the narcissism literature concerns the neural processes underlying narcissism (Sedikides, 2021). This literature has concentrated mainly on self-reports, but the neural underpinnings of narcissists' thoughts, feelings, and behavior are largely unknown. This study complements prior work by revealing the neural correlates of self-reports. In doing so, the study provides evidence of neural correlates consistent with several prominent theoretical models of narcissism. We elaborate on these below.

4.1.1. Implications for the agency-communion model of narcissism

The agency-communion model of narcissism distinguishes between individuals who fulfil self-motives such as grandiosity, esteem, entitlement, and power primarily in agentic domains (agentic narcissism) versus those who fulfil these motives in communal domains (communal narcissism). In the combined condition, agentic narcissism could not be reliably predicted, but communal narcissism could, and was associated with EEG power between 12 and 28 Hz, and between 35 and 40 Hz. Agency and communion were distinguished in the eyes-closed condition. Agentic narcissism was negatively associated with EEG power between 14 and 17 Hz and communal narcissism was negatively associated with EEG Power between 18 and 40 Hz. Agentic and communal narcissism were also distinguished in the eyes-open condition. Agentic narcissism was positively associated with EEG power between 4–8 Hz, whereas communal narcissism was negatively associated with EEG power between 8 and 10 Hz and 12 and 13 Hz.

Thus, in line with the agency-communion model, agentic and communal forms of grandiose narcissism manifest in distinct and non-overlapping patterns of spontaneous neural oscillations. These findings offer neuroscientific insights into the agency-communion model (Gebauer and Sedikides, 2018), identifying distinct neural correlates that co-occur with divergent self-motives, though their functional significance remains to be determined. Agentic narcissism is linked to lower EEG power (14–17 Hz) in eyes-closed conditions and higher power (4–8 Hz) in eyes-open conditions. These oscillatory patterns may reflect individual differences in brain activity that are associated with agentic self-enhancement tendencies, such as the pursuit of validation through competence and achievement. By contrast, communal narcissism is associated with reduced EEG power across broader frequency bands (18–40 Hz eyes-closed; 8–10 Hz, 12–13 Hz eyes-open) and this pattern may track self-enhancement in communal narcissism, who derive self-esteem from perceived morality and social connectedness. Furthermore, these divergent oscillatory patterns should be considered in task-based paradigms that assess the electrophysiological investigations of the motivational processes that drive self-enhancement in agentic and communal narcissism.

4.1.2. Implications for the NARC model of narcissism

According to the NARC model of narcissism (Back et al., 2013; Back, 2018), grandiose narcissism can be decomposed into two distinct paths, rivalry and admiration. Individuals high in rivalrous narcissism pursue self-enhancement by devaluing others, whereas those high in admirative narcissism engage in overt self-promotion (Back et al., 2013). Admirative narcissism was positively correlated with EEG power between 1 and 7 Hz and negatively correlated with EEG power between 8 and 12 Hz, and 18 and 23 Hz in the combined condition. In the eyes-closed condition, admirative narcissism was negatively correlated with EEG power between 5 and 8 Hz. In the eyes-open condition, admirative narcissism was positively correlated with EEG power between 12 and 14 Hz. There was no reliable correlation between rivalrous narcissism and EEG power in the combined or eyes-closed conditions. In the eyes-open condition, rivalrous narcissism was positively correlated with EEG power between 2 and 8 Hz, 12 and 15 Hz, and negatively correlated with EEG Power between 18 and 35 Hz.

In summary, admirative and rivalrous narcissism share a positive correlation with EEG power between 12 and 14 Hz in the eyes-open condition. Yet they are also distinguishable – admirative narcissism by its correlations with EEG power in the combined and eyes-closed conditions and rivalrous narcissism with its negative correlation with EEG power between 18 and 35 Hz. The unity and diversity in these correlations with EEG power provide preliminary neurophysiological correlates that may support NARC models distinguishing admiration from rivalry. Follow-up research should continue to examine the patterns of neural oscillations that distinguish admiration from rivalry and their implications for narcissistic status pursuit (Grapsas et al., 2020; Zeigler-Hill et al., 2019).

Building on the NARC model, researchers have proposed a self-regulatory framework of narcissistic status pursuit (Grapsas et al., 2020). This framework describes four stages: situation selection, vigilance, appraisal, and response execution. It suggests that individuals higher in admiration or rivalry engage distinct self-regulatory strategies across these stages. The current findings highlight distinct neural correlates of admiration and rivalry that could be explored further in task-based research on social evaluation and decision-making. EEG offers a useful tool for capturing rapid neural responses to status-related cues and for identifying candidate neural markers of self-regulatory tendencies.

This study provides preliminary evidence linking spontaneous brain activity to individual differences in narcissism and illustrates a methodological approach for investigating how narcissism may relate to different aspects of self-regulation. These findings lay the groundwork for future studies that aim to explore the psychological and functional relevance of these neural correlates in the context of status-driven behavior.

4.1.3. Implications for the mask model of narcissism

According to the mask model of narcissism (Kuchynka and Bosson, 2018), narcissistic self-enhancement is a façade protecting a fragile inner core (Kernis, 2003; Westen, 1990). Support for a stable trait-like fragile inner core to narcissism has been limited (Bosson et al., 2008; Mota et al., 2020). In the combined condition, vulnerable narcissism was distinguishable from all other forms of narcissism in 27–33 Hz activity. In the eyes-closed condition, vulnerable narcissism was distinguishable in 10–16 Hz activity. Finally, in the eyes-closed condition vulnerable narcissism was distinguishable in 35–40 Hz activity. Thus, we show preliminary evidence that spontaneous neural oscillations are correlated with vulnerable narcissism in ways that may align with the fragile inner core proposed by the mask model. If these patterns of spontaneous neural oscillations do represent the fragile inner core of narcissism, then they should be modulated by negative and self-relevant primes (Hardaker et al., 2021; Horvath and Morf, 2009). Follow-up studies will do well to test this possibility. Our findings provide neuroscientific evidence supporting the two-factor structure of narcissism model (Miller et al., 2021), thereby bolstering the distinction between grandiose and vulnerable narcissism as foundational forms. Consequently, our findings may stir research into more refined aspects of the proposed structure, including agentic extraversion, antagonism, and narcissistic neuroticism, thereby contributing to a more comprehensive mapping of the neural correlates associated with narcissism. Additionally, grandiosity and vulnerability are considered phenotypic markers of pathological narcissism in clinical contexts (Pincus and Lukowitsky, 2010). Hence, our research may offer neuroscientific support for the classification of distinct narcissistic forms in clinical diagnosis and offer a scientific basis for the development of targeted interventions and therapeutic strategies for narcissism-related conditions.

4.2. Limitations

As the current research is an exploratory investigation, several points should be considered for future studies. First, brain activity involves interactions across multiple frequency bands and regions, rather than functioning in isolation (Canolty and Knight, 2010). Analyzing these elements separately may overlook critical interdependencies, thereby limiting understanding of brain function. Therefore, given that our data are not linked to specific cognitive processes, future research should incorporate task-related paradigms and place greater emphasis on interactions between different frequencies and brain regions to achieve a more comprehensive understanding of the cognitive processes—such as reward, learning, and decision-making—associated with different forms of narcissism.

Second, we used a linear kernel for MVPA to simplify the model and reduce the risk of overfitting, particularly given the small sample size (Misaki et al., 2010). However, this choice may have constrained the model's ability to capture nuanced neural patterns and does not fully mitigate the issue of a limited sample size. Future studies could benefit from employing non-linear kernels with larger sample sizes, as these approaches are better suited for capturing the complex patterns necessary to accurately predict multifaceted constructs such as narcissism. Third, the reliability of the Hypersensitive Narcissism Scale was 0.68, which falls slightly below the commonly accepted threshold of 0.70 (Taber, 2018), though a reliability coefficient of 0.68 is considered acceptable in certain contexts (Van Griethuijsen et al., 2015). The lower reliability may be due to differences in gender composition. In our study, the sample comprised women and men. In the original study (Hendin and Cheek, 1997), the three samples consisted of either women or men. Given that gender differences in narcissism have been frequently noted in the literature (Grijalva et al., 2015; Weidmann et al., 2023), this sampling discrepancy may have influenced the scale's reliability. Moreover, even in the original study, one reliability coefficient did not meet the 0.70 threshold ($\alpha = 0.62$, Sample 3). Additionally, vulnerable narcissism is difficult to distinguish from psychopathology and neuroticism, as it is largely account for by neuroticism, low agreeableness, and psychopathology (Miller et al., 2018). This highlights the potential utility of MVPA as a promising methodological approach for differentiating narcissism from related constructs, such as neuroticism and psychopathological symptoms (e.g., depression, anxiety). Furthermore, MVPA may offer useful applications in the clinical classification of personality disorders.

4.3. Future directions

We are reluctant to attribute a specific psychological interpretation to these findings for three reasons. First, we see this research as an initial step in identifying the patterns of neural activity associated with the polyhedric complexity of narcissism. Future work aimed at confirmatory analyses can link specific patterns of activity to other psychological processes. Second, due to the multiply determined nature of spontaneous neural activity, attributing individual variations in one (or more) portions of the power spectral to a specific unmeasured psychological state is risky, because it relies on reverse inference. For example, although variation in power within the canonical beta band (13–30 Hz) is often linked to motor control (Meyniel and Pessiglione, 2014; Sugata et al., 2020) and vigilance (Perez-Edgar et al., 2013; Schutter et al., 2001), it would be inappropriate to conclude that, because we were able to decode narcissism based on activity within this band, narcissism has a basis in motor control and vigilance. Such a conclusion would be strengthened if well-controlled experiments showed that motor control or vigilance manipulations enhanced the decoding of narcissism within the canonical beta band. Well-controlled experiments are needed to uncover the psychological processes underlying the diverse relationships observed between spontaneous neural oscillations and narcissism. Third, we avoided attributing the patterns observed to specific canonical bands. Rather, we considered the power spectra due to known individual differences in the dominant frequencies within canonical bands, and recent findings indicate that slow frequency power (e.g., 1–7 Hz) is likely a mixture of a true oscillatory signal and an underlying aperiodic signal (Cesnaite et al., 2023; Donoghue et al., 2020a, 2020b, 2022; Finley et al., 2022, 2024; McKeown et al., 2024). Follow-up work could examine the relative contributions of true oscillatory signals and the aperiodic signal to the decoding of narcissism in spontaneous neural oscillations.

We discovered that narcissism can be decoded in spontaneous neural oscillations. But what utility do these oscillatory patterns have for predicting narcissists' behavior in the laboratory and in daily life? Our findings may lay the foundation for investigations linking multivariate patterns of neural oscillations to the intrapersonal (e.g., feelings of superiority, internalizing positive feedback, derogating the source of negative feedback) and interpersonal (e.g., looking down on others, seeking acclaim from others) strategies that narcissists' use to regulate their self-esteem (Morf and Rhodewalt, 2001; Sedikides et al., 2004). The associations between these oscillatory patterns and self-esteem regulation may help clarify the adversarial nature of narcissists' interpersonal relationships as colleagues, friends, partners, and leaders.

Future work should continue to use multivariate pattern analysis to decode personality traits in spontaneous neural oscillations. The current investigation is only the second to successfully do so. The first investigation decoded Big Five traits (Jach et al., 2020) and observed that agreeableness could be decoded from EEG power ranging from 8 to 19 Hz and neuroticism from 3 to 6 Hz. Personality traits reflect relatively stable patterns of the ways people think, feel, and behave. On the dark side of human personality, narcissism along with psychopathy, Machiavellianism, and sadism form the Dark Tetrad (Paulhus & Williams, 2002; Buckels et al., 2013). A more recently theorized light triad (Kaufman et al., 2019) is composed of Kantianism (treating people as ends unto themselves), Humanism (valuing the dignity and worth of each individual), and Faith in Humanity (believing in the fundamental goodness of humans) which is conceptually distinguishable from the Dark Tetrad (Lukić and Živanović, 2021). Our findings may represent a starting point for research mapping the full constellation of dark and light personality traits onto the brain with multivariate patterns analysis. Such an endeavor may help researchers, organizations, and governments predict the anti-social consequences of malevolent traits and the pro-social consequences of benevolent ones (Moor and Anderson, 2019; Sijtsema et al., 2019; Ucar et al., 2023).

5. Conclusion

We demonstrated that individual differences in narcissism can be predicted from spontaneous neural activity and that different forms of narcissism are predicted by distinct patterns of neural activity. The findings may stimulate renewed interest in identifying neural correlates of narcissism and provide a foundation for future studies on the neural basis of personality traits. This development would benefit the burgeoning field of personality neuroscience, which seeks to formulate strong neuroscientific theories for the biological basis of variation in personality.

CRediT authorship contribution statement

Zhiwei Zhou: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation, Conceptualization. **Chengli Huang:** Writing – review & editing, Project administration, Investigation, Data curation. **Esther M. Robins:** Writing – review & editing, Project administration, Investigation, Data curation. **Douglas J. Angus:** Writing – review & editing, Methodology, Conceptualization. **Constantine Sedikides:** Writing – review & editing, Supervision. **Nicholas J. Kelley:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

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.

Data and code availability statement

Data, materials, and code are available on the Open Science Framework: https://osf.io/ah4f9.

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