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Narcissism and the perception of failure – evidence from the error-related negativity and the error positivity

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Abstract

The literature on narcissism suggests two contradictory ways how highly narcissistic individuals deal with their failures: They might avoid consciously recognising their failures to protect their ego or they might vigilantly turn towards their failures to process cues that are important for maintaining their grandiosity. We tried to dissolve these contradictory positions by studying event-related potential components of error processing and their variations with narcissism. With a speeded go/no-go task, we examined how the error-related negativity (Ne; reflecting an early, automatic processing stage) and the error positivity (Pe; associated with conscious error detection) vary with Admiration and Rivalry, two narcissism dimensions, under ego-threatening conditions. Using multilevel models, we showed that participants with high Rivalry displayed higher Ne amplitudes suggesting a heightened trait of defensive reactivity. We did not find variations of either narcissism dimension with the Pe, which would have pointed to weaker error awareness. Thus, our results only supported the second position: a heightened vigilance to errors in narcissism at early, rather automatic processing stages.

Introduction

Humans strive to see themselves in a positive light (Pincus, Cain, & Wright, 2014). To pursue experiences of Admiration and self-enhancement reflects a basic psychological need inherent in all of us (Grawe, 2004). However, in narcissism, this need gains exceptional importance, rigidly determines mental functioning (affecting motivation, emotion, cognition, behaviour, and perception) and alienates the person from other fundamental psychological needs that are important for well-being and psychological functioning (Grawe, 2004; Sachse, 2013). To date, we do not fully understand how this excessive need to enhance and protect one's grandiosity impacts the perception of failure – whether these failures relate to everyday missteps, like realizing a spelling mistake in a text message, or more dreadful experiences, like crashing one's entrepreneurial endeavour. Do highly narcissistic people steer their attention away from such failures and inhibit further processing as failures endanger their mental representation of grandiosity? Or do they turn towards their failures and exhaustively process them as they provide essential cues for self-enhancement and ego protection? The concepts of cognitive avoidance and vigilance capture these ostensibly diametrical coping dispositions (Hock, Krohne, & Kaiser, 1996). We aimed at investigating whether there is electrophysiological and behavioural evidence for narcissism-related variations in cognitive avoidance of *and* vigilance to self-caused failures.

1.1 Narcissism and information processing

1.1.1 Cognitive Avoidance vs. Vigilance

Several empirical studies suggest that highly narcissistic individuals particularly use cognitive avoidance to cope with failures. For example, highly narcissistic people self-aggrandise by more strongly attributing failures to external causes – and success to their own abilities (Kernis & Sun, 1994; Rhodewalt, Tragakis, & Finnerty, 2006; Stucke, 2003). They assess their current performance and predict their future performance mainly based on their inflated ability estimates and less on their actual past performance (Campbell, Goodie, & Foster, 2004). With this overestimation of their abilities, highly narcissistic people manage to sustain their grandiosity – even though overconfidence and risk-taking can worsen their actual performance (Campbell et al., 2004). They also avoid using the first-person perspective when recalling shameful events and rather revert to the third-person perspective (Marchlewska & Cichocka, 2017). Not least, highly narcissistic entrepreneurs seem to be less capable of learning from and interpreting their business failures (Liu, Li, Hao, Zhang, 2019).

However, instead of cognitively avoiding their failures, highly narcissistic individuals might show vigilance towards them. It was shown that highly narcissistic people reacted to everyday failures with lower state self-esteem levels (than low-narcissistic people; Zeigler-Hill, Myers, &

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Clark, 2010). So, instead of leaving them unaffected, failures might disturb highly narcissistic individuals even more. Grapsas, Brummelman, Back, and Denissen (2020) even incorporated vigilance as a central element in their process model of narcissistic status pursuit. Following this model, errors might represent important cues highly narcissistic individuals vigilantly turn to in order to manoeuvre through ego-threatening situations.

Thus, highly narcissistic individuals might either reduce error processing to avoid conscious awareness of imperfection or enhance error processing to better regulate their behaviour in the pursuit of grandiosity. Which of these seemingly contradicting coping strategies highly narcissistic individuals employ may depend, as we assume, on different *narcissism facets* and the *temporal dynamics* of information processing.

1.1.2 Variations in information processing with different narcissism facets

Based on previous non-error-specific findings, we assumed that vigilance to and avoidance of one's errors could vary distinctively with different narcissism facets. For example, it was demonstrated that the two narcissism facets *grandiosity* and *vulnerability* are related to different attention biases: away from (grandiosity) and towards (vulnerability) negative trait adjectives (Krusemark et al. 2015). These variations in attentional selection could point to differences in processing aversive errors.

Also, the two narcissism facets *Admiration* and *Rivalry* (Back et al., 2013) might vary differently with error processing. For the two facets, different self-esteem stability was observed: whereas Admiration was related to stable self-esteem, Rivalry was associated with self-esteem fragility (Geukes et al., 2017). Assuming that self-esteem stability varies with the processing of ego-threatening errors, one can assume that these facets are also associated with different error processing activity. The Narcissistic Admiration and Rivalry Concept (NARC; Back et al., 2013) regards these facets as two ways how narcissistic individuals can maintain their grandiosity. They can either pursue other people's Admiration by seeking out opportunities to present one's uniqueness, indulging in grandiose fantasies, and behaving charmingly towards others (Admiration). Or they can restlessly protect their grandiosity against ego threats (from other people) by striving for superiority, devaluating other people, and acting aggressively towards them (Rivalry). Through positive feedback loops between these strategies and their outcomes (Admiration: praise, social status, success, etc.; Rivalry: unpopularity, criticism, rejection, etc.) both strategies rigidify over time (Back et al., 2013). In contrast to earlier conceptualisations, the NARC separates agentic (Admiration) and antagonistic (Rivalry) aspects of narcissism. This distinction is in line with more recent models such as the Trifurcated Model (TM; Miller et al., 2016) and the Narcissism Spectrum Model (NSM; Krizan & Herlache, 2018), which also capture agentic traits (with the factors *Agentic Extraversion* [TM] and *Grandiosity* [NSM]) and antagonistic traits (with the factors *Antagonism* [TM] and *Entitlement* [NSM]). We used the NARC as a theoretical framework to explore how the narcissistic need to maintain one's grandiosity varies with error processing. Yet, when one wants to integrate the current data into a broader research context, one could assume similar results for corresponding agentic and antagonistic factors of other narcissism models.

1.1.3 Variations in temporal dynamics

We further assumed that vigilance to and avoidance of errors may vary with the temporal dynamics of information processing. Mental operations unfold and vanish in a range of milliseconds as indicated by electrophysiological markers (Luck, 2014), and identifying these temporal dynamics in neural processing poses a critical aspect in social cognitive and affective neuroscience (Amodio, Bartholow, & Ito, 2014). A study by Horvath and Morf (2009; replicated by Hardaker, Sedikides, & Tsakanikos, 2019), emphasised this point: Analysing response time (RT) data, the authors demonstrated (using a priming task followed by a lexical decision task) that at early stages of information processing, highly narcissistic individuals were hypersensitive to ego-threatening prime words; however, at later stages, they automatically and successfully prevented experiences of worthlessness from surfacing. The Mask Model of narcissism suggests that narcissistic grandiosity serves as a defensive response that masks feelings of worthlessness and inferiority (Akhtar & Thomson, 1982; Kernberg, 1975; Kohut, 1977; Morf & Rhodewalt, 2001; Miller, Lynam, Hyatt, & Campbell, 2017). Thus, conscious avoidance of one's errors (at later error processing stages) might shield one's grandiosity against the emergence of vulnerable states caused by one's vigilance towards errors (at early error processing stages). In light of these considerations, it appears inevitable to apply research methods that respect the temporal dynamics in information processing to better comprehend how highly narcissistic individuals respond to their failures.

So far, most studies that are informative on the question of how highly narcissistic individuals deal with their failures mainly examined self-report data (Campbell et al., 2004; Kernis & Sun, 1994; Liu et al., 2019; Rhodewalt et al., 2006; Stucke, 2003; Zeigler-Hill et al. (2010);) and RT data (Horvath & Morf, 2009; Krusemark et al. 2015; Hardaker et al., 2019). To our knowledge, no study has investigated neural responses to errors as more direct indicators of how highly narcissistic individuals cope with failures. To fill this gap, we studied error-specific components of the event-related potential (ERP) to deepen our understanding of error processing in narcissism. The ERP technique appears advantageous for this research question for several reasons: It differentiates perceptual processes in a millisecond range (Amodio et al., 2014; Luck, 2014), provides implicit data circumventing the self-enhancing bias in narcissism (Cascio, Konrath, & Falk, 2015; Di Sarno, Di Pierro, & Madeddu, 2018; Raskin, Novacek, & Hogan, 1991;), and respects the contiguity between narcissism-relevant events and narcissism-characteristic responses (Hardaker et al., 2019).

1.1.4 The error negativity

The first ERP component we examined was the error negativity (N_e; Falkenstein, Hohnsbein, Hoormann, & Blanke, 1991; Gehring, Goss, Coles, Meyer, & Donchin, 1993). The N_e appears as a negative deflection in the EEG after an error in a variety of tasks (Gehring, Goss, Coles, Meyer, & Donchin, 2018), peaks from 50 to 100 ms after an error, and mainly emerges from the anterior cingulate cortex (ACC; Dehaene, Posner, & Tucker, 1994; Debener et al., 2005; Luu, Tucker, & Makeig, 2004; Holroyd, Dien, & Coles, 1998; Miltner et al., 2003; Trujillo & Allen, 2007). After correct responses, a similar, slightly weaker component occurs: the correct response negativity (N_c), which resembles the N_e regarding its time course and topography (Vidal, Hasbroucq, Grapperon, & Bonnet, 2000) and possibly reflects the same process as the N_e (Hoffmann & Falkenstein, 2010). The N_e may signal the need for an increase in cognitive control (see the *Conflict Monitoring Theory* [Botvinick, Braver, Barch, Carter, & Cohen, 2001] and the *Reinforcement Learning Theory* [Holroyd and Coles, 2002]). In this view, the ACC signals to other brain regions that performance adjustments are necessary to achieve one's action goals (Holroyd & Yeung, 2012; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004). Also, the N_e seems to be associated with affective-motivational aspects of error processing. Higher N_e amplitudes were demonstrated for higher self-reported negative affect (Hajcak, McDonald, & Simons, 2004; Luu, Collins, & Tucker, 2000), higher scores of worry and general anxiety (Hajcak, McDonald, & Simons, 2003), obsessive-compulsive disorders (OCD; e.g. Endrass et al., 2010; Gehring, Himle, & Nisenson, 2000; Weinberg, Dieterich, & Riesel, 2015), subclinical symptoms of OCD (Grundler, Cavanagh, Figueroa, Frank, & Allen, 2009; Hajcak & Simons, 2002), social anxiety disorders (Endrass, Riesel, Kathmann, & Buhlmann, 2014), and generalized anxiety disorders (Weinberg, Riesel, & Hajcak, 2012; Xiao et al., 2011). Especially, *anxious apprehension* (worry) might account for these findings as high worries stress one's cognitive capacities, and the resulting cognitive deficits may be coped with increased error monitoring (Moser et al., 2013). Other studies, focusing on motivational aspects of error processing showed that the N_e varied with the monetary value of errors (Potts, 2011), with the external evaluation of one's performance (Hajcak, Moser, Yeung, & Simons, 2005), with the error context (competitive vs. cooperative context; García Alanis, Baker, Peper, & Chavanon, 2019), and with aversive sounds contingently following errors (Saunders, Milyavskaya, & Inzlicht, 2015). Furthermore, the N_e varied with individual differences inherently related to a different error processing motivation like a pronounced behavioural inhibition system (Amodio et al., 2008) and perfectionism (Mattes, Mück, Stahl, 2022a; Stahl, Acharki, Kresimon, Völler, & Gibbons, 2015). Weinberg and colleagues (2012) integrated this diverse literature. They emphasised that errors threaten an organism and its goals and assumed that the N_e represents the first evaluation of this threat's significance. The process reflected in the N_e might elicit a variety of cognitive and affective-motivational processes, altogether constituting a defensive response to an endogenous threat (Weinberg et al., 2015). According to this account, the N_e reflects a neurobehavioural trait, a stable tendency to mobilise defensive systems, which the authors termed *trait defensive reactivity* (Weinberg et al., 2012).

1.1.5 The error positivity

The N_e is followed by a positive deflection in the ERP, the error positivity (P_e; Falkenstein, Hohnsbein, & Hoormann, 1994; Falkenstein, Hoormann, Christ, & Hohnsbein, 2000). The P_e shows a more diffuse, centroparietal distribution (Nieuwenhuis, Ridderinkhof, Blom, & Kok, 2001; Vocat, Pourtois, & Vuilleumier, 2008). At least partially, the N_e and the P_e seem to reflect functionally dissociable error monitoring systems (Di Gregorio, Maier, & Steinhauser, 2018; Mattes, Porth, & Stahl, 2022b). While the N_e seems to reflect one's trait defensive reactivity (Weinberg et al., 2012), the P_e is thought to reflect processes that are related to error awareness (Nieuwenhuis et al., 2001). The *Error-Awareness Hypothesis* of the P_e (Overbeek, Nieuwenhuis, & Ridderinkhof, 2005) builds on findings that the P_e (but not the N_e) was higher for consciously perceived than unperceived errors (Nieuwenhuis et al., 2001) and that hypnosis, which weakens error awareness, only reduces the P_e but not the N_e (Kaiser, Barker, Haenschel, Baldeweg, & Gruzelier, 1997). Not least, Murphy, Robertson, Allen, Hester, and O'Connell (2012) reported that the timing of error awareness, indicated by the latency of an error signalling response, correlated with the P_e peak latency, which also points to the linkage between the P_e and error awareness. That the N_e and P_e reflect functionally dissociable error monitoring systems is further substantiated by studies demonstrating a varying dependence on dopaminergic neurotransmission (Overbeek et al., 2005): Only the N_e varies with moderate doses of alcohol (Ridderinkhof et al., 2002), benzodiazepines, and amphetamines (de Bruijn, Hulstijn, Verkes, Ruigt, & Sabbe, 2004). Likewise, mental and neurological disorders and individual differences associated with dopaminergic dysregulation affect the N_e but not – or only to a small extent – the P_e (for review, see Overbeek et al., 2005). Because of their specific functional significance, both components appear to be ideal for investigating the question if highly narcissistic individuals are vigilant towards their self-caused errors and activate a variety of defensive responses (possibly reflected in higher N_e amplitudes) or if they cognitively avoid their errors to safeguard their mentally represented grandiosity (possibly reflected in lower P_e amplitudes).

1.2 Objectives and hypotheses

So far, narcissism-related variations in the N_e and P_e have not been studied; however, the review of the available literature allowed us to derive distinct hypotheses. First, we expected that Rivalry is negatively related to N_e amplitudes (higher Rivalry, more negative N_e) as the defensive nature of this narcissism facet can easily be related to the concept of trait defensive reactivity (Weinberg et al., 2012). Second, we hypothesised that higher admiration was linked to lower P_e amplitudes, possibly resulting from decreased error awareness (Nieuwenhuis et al., 2001). The mentally represented grandiosity of individuals with high admiration (Back et al., 2013) should be inconsistent with conscious error recognition. Such inconsistency would impair mental functioning (Grawe, 2004), wherefore individuals with a strong mental representation of their grandiosity should inhibit conscious error recognition. This hypothesis parallels the finding that individuals with high admiration inhibited processing of their own face presumably to prevent evidence from reaching consciousness that potentially contradicts one's conviction of looking highly attractive (Mück et al., 2020). The assumption of a reduced conscious error recognition is in line with the postulation by Horvath and Morf (2009) that repression – i.e. the automatic, unconscious defence that prevents (ego-)threats from reaching consciousness (Erdelyi, 2006; Wegner & Zanakos, 1994) – constitutes the central self-defensive strategy in the repertoire of highly narcissistic individuals.

To test these hypotheses, participants filled in the Narcissistic Admiration and Rivalry Questionnaire (NARQ; Back et al., 2013) and performed a speeded go/no-go task that involved ego-threatening feedback. The feedback was thought to enhance the N_e for high Rivalry and reduce the P_e for high Admiration: When errors pose an alarming ego threat, amplified by ego-threatening feedback, the hypothesised neural responses should be even more pronounced.

2. Methods

2.1 Participants

A total of 89 participants (64 females, 25 males, no one identified as diverse; mean age = 24.27 years, $SD = 6.00$) right-handed students from the University of Cologne participated and received course credit for participation. None of the participants reported to have suffered from a neurological illness, and every participant had either normal or corrected-to-normal vision. The ethics committee of the German Psychological Association approved the study and participants gave written consent.

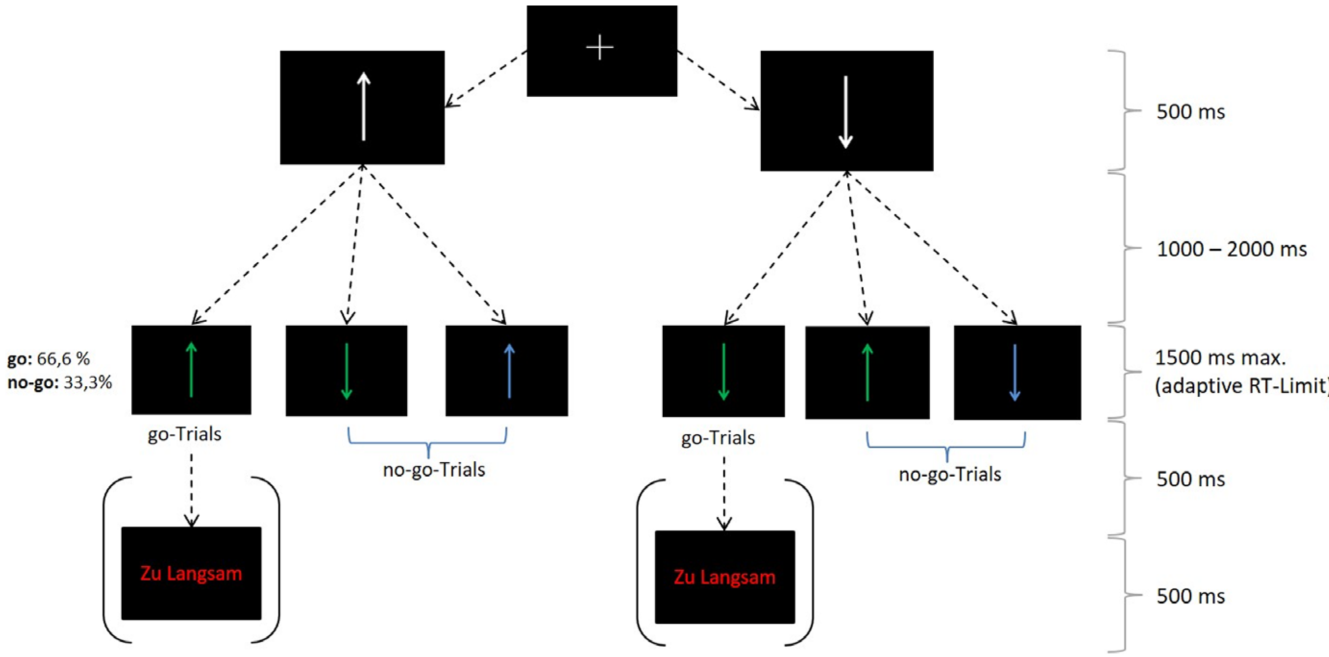

Figure 1. Trial design.
Note. This figure resembles the task illustration presented by Vocat et al. (2008). It shows all possible go and no-go trials.

2.2 Psychometric assessment and cover story

Internal consistency for the Admiration scale reached a Cronbach's α of 0.85 and for the Rivalry scale a Cronbach's α of 0.83. Mean and standard deviation for the Admiration scale were 3.56 ± 0.82 (range: 1.55 to 5.44, centred range: −1.95 to 1.94) and for the Rivalry scale 2.28 ± 0.81 (range: 1.00 to 5.89, centred range: −1.28 to 3.61).

The participants completed the NARQ before the experimental task. This way, the experimental manipulations could not affect the psychometric data. However, the NARQ could affect the experimental data by suggesting that the study was about narcissism. To prevent the participants from guessing the study's actual purpose and therefore disbelieving the faked (ego-threatening) performance feedback, they were told a cover story: After participants arrived at the laboratory, the experimenter asked them if they could participate in another study before the actual experiment, which a colleague would supervise. This study would contain a few questions and only last a few minutes. Participants were told that they would be compensated with the respective course credit. All of the 89 participants agreed to participate and completed the NARQ. At the end of the experiment, participants were debriefed verbally and were given a written document explaining the study's actual background.

2.3 Experimental task

After completing the NARQ, participants performed a speeded go/no-go task, which highly resembled the task designed by Vocat et al. (2008), who also examined the N_e and the P_e. They demonstrated that it provoked many errors, which were necessary for the statistical analyses of both components. The task in the current study was programmed with Uvariotest (Gerhard Mutz). During the task, participants sat in front of a computer screen. A chin rest was used (at a 60 cm distance to the screen) to reduce unwanted movements. The experiment was divided into two sessions. Each session comprised three blocks, separated by a short break, which lasted at least one minute and could be prolonged at will by the participant. Each block contained 96 trials – adding up to a total of 576 experimental trials. Note that the trial number was raised from 84 trials per block for the first nine participants to 96 for the following participants to increase the error frequency.

2.3.1 Trial course

Each trial started with the appearance of a white fixation cross on a black screen (Figure 1). After 500 ms, a white arrow replaced the fixation cross, pointing either up- or downwards, which remained on the screen for a variable duration (1000–2000 ms). Then, the target arrow replaced this white arrow. Participants had to respond to the target arrow when it appeared in green colour *and* pointed in the same direction as the initial white arrow by pressing a key (go trials). In all other cases (when the target arrow pointed in the opposite direction of the initial white arrow and was green *or* when the arrow pointed in the same direction but was blue), the participants should withhold their response (no-go trials). When, in go trials, participants failed to respond within the RT limit, the words “Zu Langsam” (German for “Too Slow”) appeared on the screen and signalled that they had to respond faster in the subsequent go trial.

2.3.2 Adaptive response time limit

Before the task, participants were given verbal and written task instructions to respond as quickly and accurately as possible. The RT limit was adjusted individually for every participant (see Vocat et al., 2008) to provoke a large number of errors and keep the task challenging despite learning effects. For Session 1, the RT limit was set to the mean RT of a calibration block (24 trials) preceding the actual experiment. Note that, before this calibration block, the participants performed another 12 practice trials to get to know the task and the apparatus. Similar to Vocat et al. (2008),

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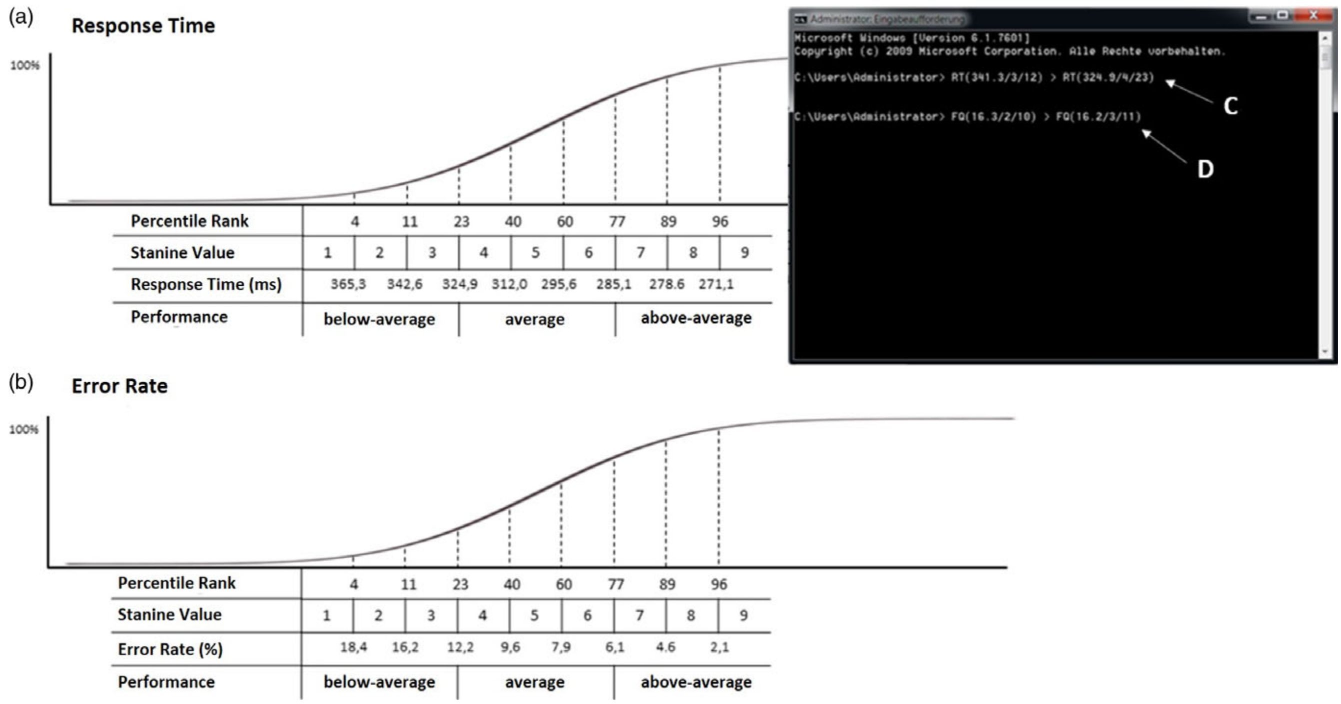

Figure 2. Performance feedback.
Note. All participants were shown (false) norm values of the task for (A) RT and (B) error rate – incorporated into fictional cumulative distributions of both parameters. After explaining the rationale of stanine values, a window popped up on the screen indicating the participants' (faked) performance data. Total values, stanine values, and percentile ranks of the RT (C) and the error rate (D) were presented, and participants were instructed to improve performance by one stanine value in both parameters. Originally, the figure was presented in German.

the RT limit was adjusted in Session 2 to counteract possible learning effects (i.e. 95% of the mean RT in Session 1).

2.3.3 Performance feedback

Following Session 1, an ego-threatening situation was created by presenting participants an unexpected (faked) feedback about their performance, creating a situation of relevance for highly narcissistic individuals (Hardaker et al., 2019). Participants were told that the task is usually used to assess concentration. However, in the current study, this task would be used to measure the influence of motivation on action monitoring ERP components. To measure the impact of motivation on the ERP components, they should improve their performance regarding their RT and error rate in the second session. To this end, the experimenter showed participants (fictional) norm values for the task – comprising (faked) total values, stanine values, and percentile ranks for RT and error rate data. These norm values were incorporated into a figure that indicated (fictional) cumulative distributions (Figure 2A and 2B). After instructing participants that they should improve their performance by one stanine value (to ensure that participants understood the rationale of stanine values, these were explained by referring to Figure 2), a window appeared on the screen displaying their (faked) relatively poor performance. The appearing data indicated that participants' RT data corresponded to a stanine value of 3 (Figure 2C), and their error rate reflected a stanine value of 2 (Figure 2D). Participants were instructed to improve their performance regarding both parameters by one stanine value. Thus, they were told that they performed poorly and were instructed to respond faster *and* more accurately. Of course, the debriefing contained information on this faked feedback.

2.3.4 Apparatus

To record behavioural data, we used a set of eight custom-made force-sensitive keys (see also Stahl et al., 2020). In the current study, we only used one of the eight response keys, namely the key on which the right index finger rested. A force sensor embedded in this key (FCC221-0010-L, DigiKey MSP6948-ND) continuously registered the force applied by the index finger. The key was calibrated prior to the experiment so that the weight of the participant's finger functioned as the baseline for force registration. The analogous response signal was digitised by a VarioLab Ad converter (Becker-Meditec) at a sampling rate of 1024 Hz with a resolution of 16 bits. A brightness-sensitive photo sensor attached to the screen captured the near real-time stimulus onset.

2.4 Data acquisition

2.4.1 Response Time Data

RT was calculated as the time span between stimulus onset and the point in time at which response force exceeded 50 cN (Drizinsky et al., 2016; Stahl et al., 2015).

2.4.2 Electrophysiological recording, pre-processing, and data analysis

The active Ag/AgCl electrodes (Brain Products, Germany) were set up according to the international 10–20 system (FP1, FP2, F7, F3, Fz, F4, F8, FC5, FC1, FC2, FC6, T7, C3, Cz, C4, T8, CP5, CP1, CP2, CP6, P7, P3, Pz, P4, P8, FCz, O1, Oz, O2, AF7, AF3, AF4, AF8, F5, F1, F2, F6, C3', FT7, FC3, FC4, FT8, C4', C5, C1, C2, C6, TP7, CP3, CPz, CP4, TP8, P5, P1, P2, P6, PO7, PO3, POz, PO4, PO8; Jasper, 1958) and online referenced to the left mastoid; the right mastoid served as a passive reference. Vertical and horizontal electrooculograms (EOG) were derived from two electrodes above and below the left eye and two electrodes located beside the outer left and right canthi. The electrophysiological data were recorded with the *BrainAmp Vision Recorder* (Brain Products), while electrode impedances were kept below 10 kΩ. The EEG signal was digitised at a sampling rate of 500 Hz with a BrainAmp DC amplifier (Brain Products) and filtered online using a low-pass filter with a cut-off frequency at 70 Hz and a notch filter at line frequency (50 Hz).

Data were divided into segments ranging from 100 ms before, to 600 ms after response onset. A first artefact rejection was applied with a criterion of ±900 μV to eliminate bad epochs, and an occular correction computationally removed blinks (Gratton et al., 1983). A baseline correction, which started 100 ms before response onset, was followed by a second artefact rejection with a criterion of ±100 μV. The EEG data were averaged separately for errors and correct responses (Response Type), and Session 1 and Session 2 (Session Type). We transformed the EEG signals with a current source density (CSD) analysis, which counteracted overlapping, no-process related activity from adjacent electrode sites and made the EEG signals independent from the references (Perrin, Pernier, Bertrand, & Echalli, 1989).

N_e peak amplitudes were measured at electrode site FCz from 0 to 150 ms after response onset and P_e peak amplitudes were assessed at electrode site Cz from 150 to 300 ms after response onset (analogously to Stahl et al., 2015). Two participants committed less than six errors in one session. As the N_e and the P_e can only be accurately quantified with at least six error trials (Pontifex et al., 2010), these participants had to be excluded from the ERP analyses.

2.5 Statistical analyses

Multilevel models (Baayen et al., 2008) were calculated to assess the effects of the within-subject factors (Response Type and Session Type) and the NARQ scales (Admiration and Rivalry) on the dependent variables of interest (N_e and P_e). Maximum likelihood estimation determined the parameters of the calculated multilevel models (Twisk, 2006). Participants were included as a random-effects variable, allowing intercepts in the dependent variables to vary between participants. This improved model fit of the multilevel models analysing effects on RT ($SD = 21.06$ ms [95% CI: 14.89 ms, 29.79 ms], χ^2 $(1) = 10.30$, p = .001), N_e ($SD = 0.018$ μV/cm^2 [95% CI: 0.015 μV/cm^2, 0.020 μV/cm^2], χ^2 $(1) = 245.99$, $p < .0001$), and P_e ($SD = 0.020$ μV/cm^2 [95% CI: 0.017 μV/cm^2, 0.024 μV/cm^2], χ^2 $(1) = 60.94$, $p < .0001$). Crucially, the multilevel models respected the nested structure of the data: Two within-subject factors (Response Type and Session Type) were investigated within each participant.

In a first step, the within-subject factors Response Type (dummy-coded: hits = 0, errors = 1) and Session Type (Session 1 = 0, Session 2 = 1), as well as their interaction were entered into the multilevel models to test general effects on the dependent variables – apart from the effects of both NARQ scales. The factor Response Type enabled the comparison between erroneous (Errors and Too-Slow Errors) and correct responses (Hits and Too-Slow Hits). We did not differentiate between Colour and Orientation Errors because many participants did not commit enough Colour Errors for such a comparison (less than six, see Pontifex et al., 2010); Vocat et al. (2008) also pooled together both error types for the analyses of the N_e and the P_e. The factor Session Type allowed for comparing the dependent variables between Session 1 and Session 2. Additionally, in the multilevel models for the N_e and the P_e, the total number of errors (centred) was entered as a predictor into the model to test for confounding effects of this variable.

In a second step, the continuous predictors Admiration and Rivalry and all possible interaction terms were entered in the multilevel models. The NARQ subscales were centred (Aiken & West, 1991) and the analyses were run with the *R*-package *nlme* (Pinheiro et al., 2010). To disentangle interaction effects that involved any of the narcissism scales, we applied the Johnson-Neyman technique (Johnson & Fay, 1950; Johnson & Neyman, 1936) using the *R*-package *interactions* (Long, 2021). This technique allows to identify values of a continuous moderator for which a continuous or categorical predictor of interest has a significant effect on the dependent variable. The range of these values of the moderator is termed the Johnson-Neyman interval.

3. Results

3.1 Response frequencies

In go trials, 97.38 ± 0.51% hits (mean percentage ± standard error in percentage) and 2.62 ± 0.51% misses occurred across both sessions. Of these hits, 54.27 ± 1.63% were executed within the individual RT limit. Table 1 presents response type frequencies in go trials, separated by sessions.

Error commission rate in no-go trials was 31.67 ± 1.64% across both sessions. On average, participants committed 59.72 errors in both sessions. Of these errors, 80.80 ± 1.36% were orientation errors, and the other 19.20 ± 1.36% were colour errors. In total, 77.09 ± 1.40% of errors occurred within the individual RT limit, and 22.91 ± 1.40% of errors exceeded the RT limit. Table 2 shows frequencies of the specific response types occurring in no-go trials for each session.

3.2 Response times

RTs for the different response types and sessions are presented in Table 3. Note that this table depicts RTs for fast responses (within the RT limit) and "Too-Slow" responses separately.

The multilevel model for RT showed that participants responded significantly faster in Session 2 (mean ± standard error: 266.01 ± 3.40 ms) than in Session 1 (312.14 ± 4.22 ms), $b = -46.50$, $t(599) = -6.22$, $p < .001$. The difference in RTs between hits (291.35 ± 3.45 ms) and all error types (283.68 ± 4.57 ms), $b = -8.05$, $t(599) = -1.06$, $p = .292$, as well as the interaction of session type and response type was not significant, $b = 1.05$, $t(599) = 0.10$, $p = .922$. In the next step, Admiration, Rivalry, and every possible interaction term were entered into the multilevel model. Besides the effect of session type, the model did not reveal any other significant effect.

3.3 Event-related potentials

Grand average CSD-transformed ERP waveforms showed the occurrence of a distinct N_e at electrode site FCz, 0 to 150 ms after response onset (Figure 3A). Topographic maps of mean CSD-transformed ERPs for errors and hits, in Session 1 and Session 2, highlight the characteristic location of the N_e and show a higher negative deflection for Errors than for Hits at electrode site FCz (Figure 3B). Grand average CSD-transformed ERP waveforms also showed the occurrence of a clear P_e at electrode site Cz, between 150 and 300 ms after Errors but not after Hits (Figure 3C).

Table 1. Response type frequencies in go trials

Response Type	Session 1 *M* in %	Session 1 *SE* in %	Session 1 *n* (min, max)	Session 2 *M* in %	Session 2 *SE* in %	Session 2 *n* (min, max)
Hits	98.82	0.43	187.34 (127, 192)	95.94	0.80	181.92 (119, 192)
Fast Hits	60.89	1.66	115.68 (48, 168)	44.88	1.81	85.38 (7, 154)
Too-Slow Hits	37.93	1.58	71.67 (20, 142)	51.07	1.85	96.54 (38, 175)
Misses	1.18	0.43	2.26 (0, 65)	4.06	0.80	7.68 (0, 73)

Note. For the first nine participants, each session contained 36 fewer trials than for the following participants. *M* = mean, *SE* = standard error, *n* = total number of Response Type.

Table 2. Response Type frequencies in no-go trials

Response Type	Session 1 *M* in %	Session 1 *SE* in %	Session 1 *n* (min, max)	Session 2 *M* in %	Session 2 *SE* in %	Session 2 *n* (min, max)
Errors	27.48	1.61	25.89 (5, 79)	35.85	1.83	33.83 (4, 77)
Colour-Errors	5.54	0.88	5.13 (0, 42)	9.61	1.02	9.00 (0, 35)
Orientation Errors	21.94	0.96	20.76 (4, 41)	26.23	1.04	24.84 (0, 44)
Fast Errors	21.27	1.18	20.10 (3, 52)	27.08	1.47	25.64 (1, 65)
Slow Errors	6.21	0.73	5.79 (0, 39)	8.77	0.76	8.19 (0, 35)
Correct Rejections	72.52	1.61	68.91 (5, 91)	64.15	1.83	60.97 (17, 91)

Note. For the first nine participants, each session contained 36 fewer trials than for the following participants. *M* = mean, *SE* = standard error, *n* = total number of Response Type, Fast Errors = errors within the RT limit, Slow Errors = errors exceeding the RT limit.

Table 3. Response times

Response Type	Session 1 *M* (ms)	Session 1 *SE* (ms)	Session 1 *SD* (ms)	Session 2 *M* (ms)	Session 2 *SE* (ms)	Session 2 *SD* (ms)
Fast Responses						
Hits	264.33	2.83	26.67	222.89	4.18	39.47
Colour Errors	225.86	4.54	37.72	188.83	4.40	38.13
Orientation Errors	242.97	2.40	22.66	209.84	3.58	33.81
Slow Responses						
Hits	365.83	4.87	45.97	312.34	3.63	34.20
Colour Errors	371.63	17.52	110.81	287.08	4.40	32.03
Orientation Errors	386.54	8.76	76.83	317.50	6.33	58.33

Note. *M* = mean, *SE* = standard error, *SD* = standard deviation, *Fast Responses* = responses within the RT limit, *Slow Responses* = responses exceeding the RT time limit.

Topographic maps, highlight the characteristic, more diffuse location of the P_e at electrode site Cz for Errors (Figure 3D).

3.3.1 The N_e and narcissism

The multilevel model analysing general effects of Response Type and Session Type indicated a significant main effect of Response Type on the $N_{e/c}$ amplitude, $b = 0.093$, $t(258) = -6.23$, $p < .001$. The N_e was larger (-0.299 ± 0.017 μV/cm²) than the N_c (-0.225 ± 0.014 μV/cm²). Entering the NARQ scales and all possible interaction terms into the model resulted in the data presented in Table 4.

In addition to the main effect of Response Type, the model showed a significant interaction effect of Rivalry and Response Type on the N_e. The Johnson–Neyman technique indicated that N_e differences between Hits and Errors were significant for all Rivalry scores >-1.06. Increasing Rivalry scores were associated with an increasing $N_e - N_c$ amplitude difference (Figure 4).

3.3.2 The P_e and narcissism

The multilevel model analysing general effects on the P_e indicated a significant effect of Response Type: Hits were associated with a lower P_e (0.095 ± 0.014 μV/cm²) than Errors (0.389 ± 0.024 μV/cm²), $b = 0.300$, $t(258) = 12.34$, $p < .001$. The multilevel model, including the NARQ scales and all possible interaction terms, indicated no other significant effects on the P_e. The results of this model are presented in the supplement.

4. Discussion

For the first time, the current study investigated variations of narcissism with error processing on a neural level. With a speeded go/no-go task, we demonstrated that participants with higher Rivalry displayed higher N_e amplitudes after errors. This finding serves as primary evidence that specific responses to failures in narcissism (usually observed at later processing stages, i.e. at the behavioural and self-report level) also occur in early neural processes involved in error processing. In contrast to our predictions, Admiration did not vary with the P_e, and the performance feedback (intended to create an even more ego-threatening situation) did not moderate any effects on the N_e or P_e.

4.1 Rivalry and vigilance towards errors

Our data indicated that participants with high Rivalry showed enhanced processing of performance errors at an early processing

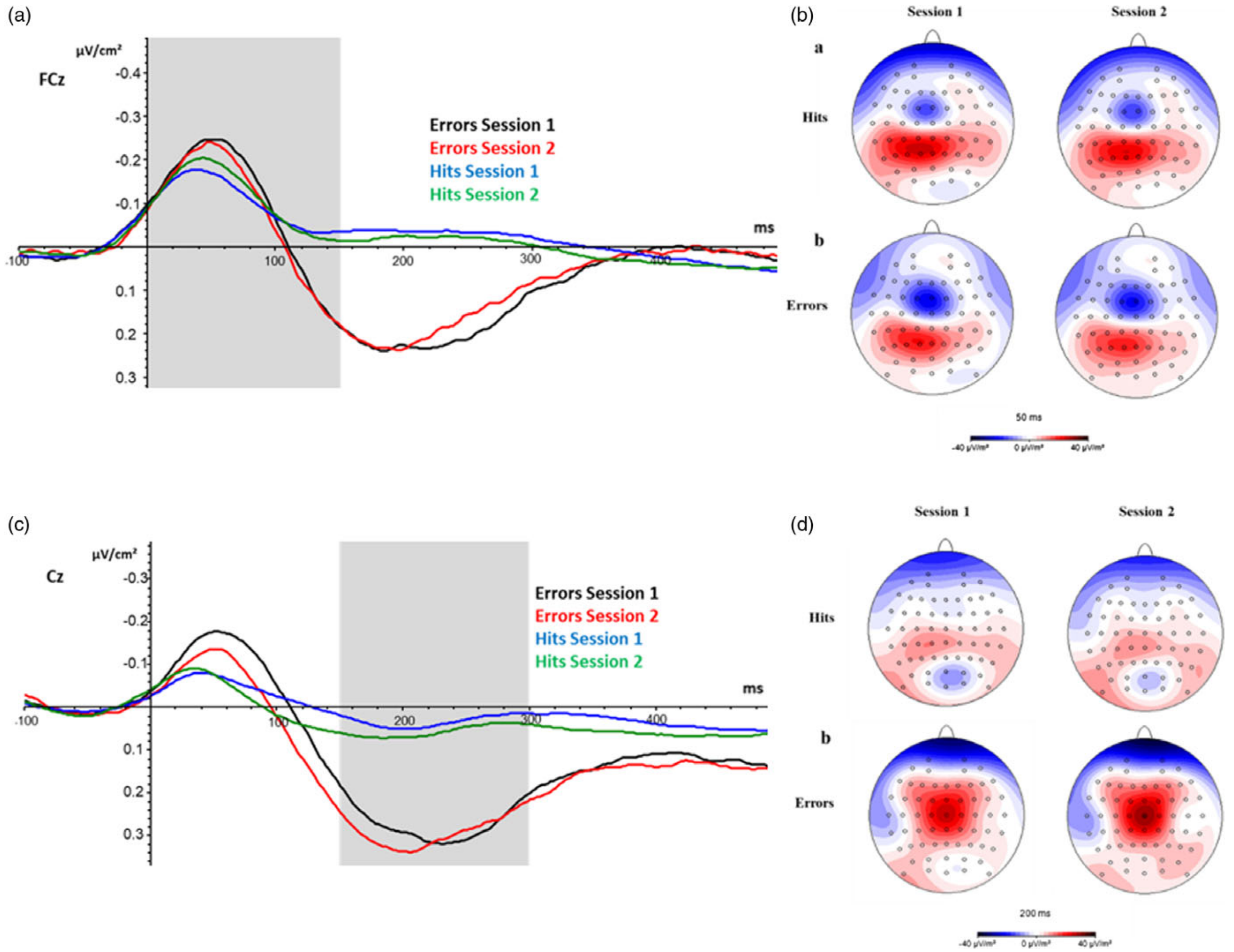

Figure 3. Waveforms and topographic maps for the N_e and P_e components and topographic maps of mean CSD-transformed ERPs, 50 ms and 200 ms after response onset. *Note*. (A) Response locked CSD-ERP waveforms at electrode position FCz (the grey area indicates the time window in which the N_e was inspected). (B) Topographic maps of mean CSD-transformed ERPs, 50 ms after response onset, show the N_e's negative deflection manifesting in blue colour at electrode site FCz. (C) CSD-ERP waveforms at electrode position Cz (the grey area indicates the time window in which the P_e was inspected). (D) Topographic maps of mean CSD-transformed ERPs, 200 ms after response onset, indicate (for error trials) the P_e's positive deflection manifesting in red colour at electrode site Cz.

stage: the higher Rivalry, the higher the difference between the N_e (negativity in error trials) and the N_c (negativity in correct trials). For participants with very low Rivalry, we could not observe any difference between the N_e and the N_c. We assumed that the N_e indicates vigilance to failure in narcissism. Accordingly, the data point to higher vigilance to failures with higher Rivalry. This interpretation is in line with a systematic review of 34 neuroscience studies highlighting that, in response to self-relevant stimuli such as stimuli indicating social exclusion (Cascio et al., 2015), narcissism is linked to increased autonomic, neuroendocrine, and neurophysiological stress reactions (Jauk & Kanske, 2021). These stress reactions manifest, for example, in higher systolic blood pressure (Sommer et al., 2009), cortisol levels (Edelstein et al., 2010), and salience network activation (Cascio et al., 2015; Jauk et al., 2017). However, such stress reactions in narcissism have only been observed for self-relevant stimuli (Jauk & Kanske, 2021). Stimuli that are stressful and self-related but not self-relevant, like loud noises (Kelsey et al., 2001), or other-related stimuli (Fan et al., 2011; Scalabrini et al., 2017) do not elicit such stress reactions or even lead to down-regulation in the corresponding systems (Jauk & Kanske, 2021). Jauk and Kanske (2021) concluded, in line with our assumption, that grandiose narcissism is linked to a heightened vigilance but only in the context of self-relevant and therefore potentially ego-threatening stimuli. The current ERP data, which are time-locked to (self-relevant) errors, are thus in line with several neuroscientific studies already conducted in this line of research.

Beyond interpreting the error-specific activity reflected in the N_e as an indicator of vigilance, Weinberg et al. (2012) considered the N_e as a reflection of one's *trait defensive reactivity*. Accordingly, high Rivalry seems to be associated with this heightened dispositional tendency to immediately initiate several defensive responses after endogenous threats, e.g. after errors. With this higher early error monitoring activity, high Rivalry participants might enhance cognitive control to improve their performance (Holroyd & Yeung, 2012; Mattes et al., 2022b; Ridderinkhof et al., 2004) – and thereby

Table 4. Multilevel model assessing the predictive value of Admiration and Rivalry on the N_e

	b	*SE b*	95% CI	*P*
Intercept	−0.210	0.023	−0.254, −0.167	<0.001***
Number of Errors	0.001	0.001	−0.003, 0.003	0.134
Session Type	−0.025	0.015	−0.054, 0.004	0.103
Response Type	−0.097	0.015	−0.126, −0.673	<0.001***
Admiration	0.044	0.029	−0.012, 0.101	0.133
Rivalry	0.006	0.032	−0.057, 0.068	0.858
Admiration × Rivalry	−0.027	0.026	−0.078, 0.025	0.315
Sessions Type × Response Type	0.038	0.022	−0.003, 0.080	0.076
Session Type × Admiration	−0.022	0.019	−0.059, 0.015	0.250
Session Type × Rivalry	−0.016	0.022	−0.058, 0.025	0.451
Response Type × Admiration	−0.003	0.019	−0.040, 0.034	0.878
Response Type × Rivalry	−0.047	0.022	−0.088, −0.005	0.031*
Response Type × Admiration × Rivalry	0.018	0.018	−0.016, 0.052	0.312
Session Type × Admiration × Rivalry	0.026	0.018	−0.008, 0.060	0.149
Session Type × Response Type × Admiration	0.001	0.027	−0.051, 0.053	0.969
Session Type × Response Type × Rivalry	0.015	0.031	−0.044, 0.074	0.629
Session Type × Response Type × Admiration × Rivalry	−0.007	0.025	−0.055, 0.041	0.772

*$P < .05$,
***$P < .001$.

protect their grandiosity. Also, they might recruit more affective and motivational resources after errors (e.g. Amodio et al., 2008; Pourtois et al., 2010) to energise their self-protection in this potentially ego-threatening situation. A heightened trait defensive reactivity could generally help individuals with high Rivalry to quickly adjust their experience and behaviour to ego threats in a way that protects their grandiosity. Exactly this preoccupation with protecting oneself against ego threats was described for the Rivalry pathway (Back et al., 2013). Yet, it is noteworthy that this self-protection is not only described on a conceptual level but seems to occur at very early information processing stages, within 150 ms after error commission, and can be measured on a neural level.

Interestingly, only for the lowest Rivalry scores (centred scores ≤ -1.06), the N_e was *not* significantly higher for errors than the N_c for correct responses. One could conclude that participants with very low Rivalry scores do not process errors at this early perceptual stage more intensely than correct responses. Possibly, these participants did not activate defensive resources to counteract an error (by recruiting additional cognitive, affective, and motivational resources) because they did not perceive an error as (ego-) threatening. One can speculate that individuals with low Rivalry are not afraid of experiencing vulnerability and imperfection and, thus, do not boost their error processing reflected in the N_e.

Rivalry emerged in the current study as another trait variable that varies with the N_e. which fits easily together with findings on variations between the N_e and other variables related to Rivalry. For example, a pronounced Behavioural Inhibition System (Amodio et al., 2008) and a competitive context (García Alanis et al., 2019) were also demonstrated to be linked to higher N_e amplitudes. The Behavioural Inhibition System was shown to positively correlate with Rivalry, and competing with others seems to be a key aspect of Rivalry (Back et al., 2013).

4.2 Weaker conscious awareness of self-caused errors in narcissism?

The second hypothesis that Admiration is linked to a lower P_e, an ERP component indicating error awareness (Overbeek et al., 2005), could not be confirmed. The literature suggested that highly narcissistic individuals are less aware of their failures and imperfection in everyday life situations (Campbell et al., 2004; Hardaker et al., 2019; Horvath & Morf, 2009; Kernis & Sun, 1994; Liu et al., 2019). We assumed that their reduced awareness of imperfection, indicating repression (Erdelyi, 2006; Horvath & Morf, 2009), might be accompanied by reduced error awareness reflected in smaller P_e amplitudes. Especially, individuals with high Admiration should show smaller P_e amplitudes, as errors are inconsistent with their consciously represented grandiosity and would impair consistent mental functioning (Grawe, 2004). However, our results did not show a lower P_e for higher Admiration. One could conclude that participants with high Admiration are as aware of their self-caused errors as others (Overbeek et al., 2005) but this conclusion appears premature when considering the error evidence accumulation account, which suggests that the P_e merely reflects the amount of accumulated error evidence in a decision process that can *potentially* lead to error awareness (Steinhauser & Yeung, 2010, 2012). When error evidence accumulation reaches a certain threshold, the participant becomes aware of the error and is able to signal error commission (Steinhauser & Yeung, 2010, 2012). In line with this, Boldt and Yeung (2015) reported that the P_e varies with gradual changes in decision confidence (expressed on a 6-point scale

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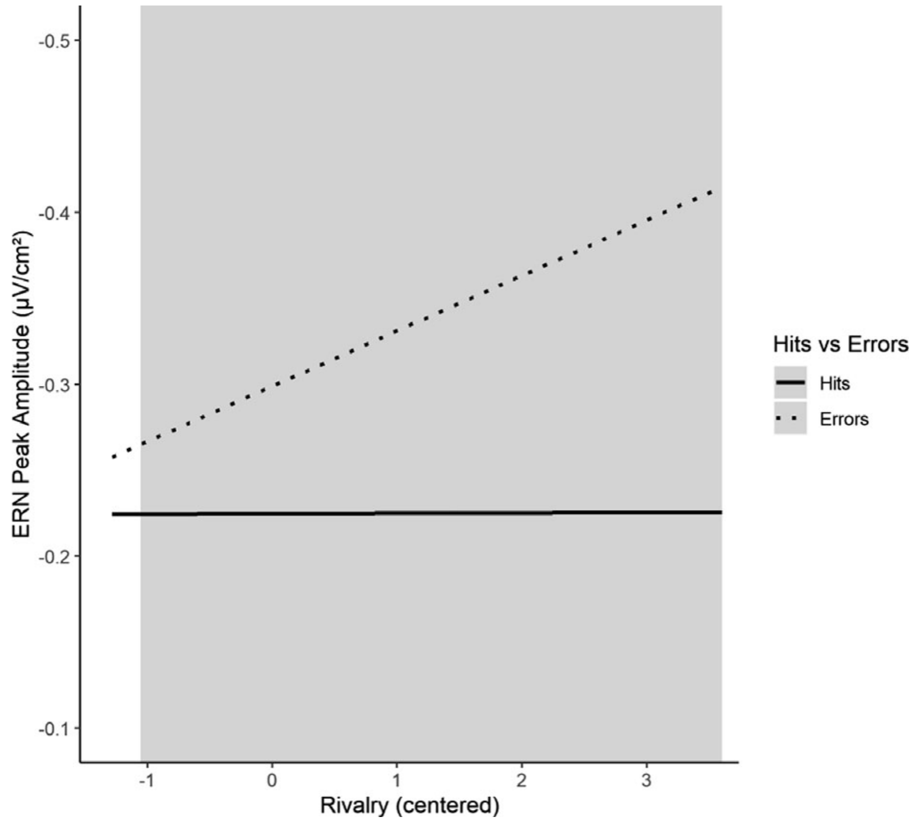

Figure 4. Interaction effect of Rivalry with Response Type on the N_e amplitude.
Note. The grey area indicates the regions of significance for this interaction effect. The interaction effect is illustrated (only) for the range of the observed centred Rivalry scores (min = −1.28, max = 3.61).

ranging from "certainly wrong" to "certainly correct") being highest for "certainly wrong" and reducing gradually for the other subjective ratings (Boldt & Yeung, 2015). According to this literature, the P_e reflects error evidence accumulation and not error awareness itself (Steinhauser & Yeung, 2010, 2012). In light of this literature, our data indicate that individuals with high Admiration accumulate as much error evidence as individuals with low Admiration (reflected in similar P_e amplitudes). Yet, they might have a higher internal decision criterion at which an error is consciously detected. Casually worded, individuals with high Admiration scores possibly need to be confronted with more and clearer error evidence until they admit to themselves and others that they have committed an error. However, our data cannot substantiate this assumption, and – based on our findings – more specific studies can be designed.

4.3 Future studies and limitations

To examine if the decision criterion at which an error can be consciously reported (Steinhauser and Yeung, 2010, 2012) varies with Admiration, future studies could use an error signalling paradigm in which participants index their response confidence (Rabbitt, 1968, 2002; for ERPs, see Boldt & Yeung, 2015). One can hypothesise that Admiration moderates the effect of error signalling behaviour on the P_e. That is, individuals with high Admiration might show higher P_e amplitudes for signalled errors.

Moreover, it would be interesting to link error detection itself to incentives – not the performance in a primary task. A paradigm in which participants would be rewarded for a high error detection accuracy possibly circumvents the self-enhancing bias in narcissism (Raskin et al., 1991). In such a task, errors would still be ego-threatening, but highly narcissistic individuals would nevertheless be eager to accurately detect their errors when this would be framed as a sign of their grandiosity. Thereby, one might better understand the variations of narcissism, error signalling, and the P_e with less confounding effects by the self-enhancing bias in narcissism (Raskin et al., 1991).

Also, it would be interesting to study variations of narcissism with another error processing ERP component: the feedback-related negativity (FRN; Hauser et al., 2014; Miltner et al., 1997; Nieuwenhuis et al., 2004). Miltner et al. (1997) demonstrated that not only an incorrect response elicits a negative deflection in form of the N_e but also trial-by-trial *feedback* indicating a false response. This FRN peaks within 200 to 300 ms after stimulus onset at mid-central electrode sites and is computed as the wave difference between feedback indicating a false and correct response (Hauser et al., 2014; Nieuwenhuis et al., 2004). Neural responses to feedback could vary with narcissism, not least because narcissism-specific responses to feedback have already been demonstrated on an explicit level: Kernis and Sun (1994) reported that highly narcissistic individuals attributed more (less) competence to the diagnostician and a higher (lower) diagnosticity to the evaluation technique when receiving positive (negative) feedback on a given speech compared to individuals with low narcissism. Such varying explicit responses to feedback could also manifest on a neural level, in FRN variations. It has to be noted that variations of narcissism with the FRN have already been examined in a monetary gambling task with low- and high-risk decisions (Yang et al., 2018a) and in an ultimatum game in which participants were given fair and unfair offers (Yang et al., 2018b). Neither of these studies demonstrated variations between narcissism and the FRN but neither investigated the FRN in response to self-caused action errors.

We were interested in the question of whether Admiration and Rivalry, two central strategies to maintain narcissistic grandiosity,

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are linked to error-specific brain activity: We hypothesised that Admiration is related to cognitive avoidance and Rivalry to hypervigilance to self-caused failures, which should affect error processing ERP components. To clarify, Admiration and Rivalry only capture aspects of narcissism related to grandiosity and self-entitlement; the NARC does not aim to assess vulnerable aspects of narcissism (Krizan & Herlache, 2018). Thus, future studies could also investigate variations of error processing ERP components with vulnerable narcissism. One can also assume higher N_e amplitudes for vulnerability given that higher N_e amplitudes were found for related constructs like higher self-reported negative affect (Hajcak et al., 2004; Luu et al., 2000), higher worries, and higher general anxiety (Hajcak et al., 2003).

The paradigm was constructed to establish ego-threatening conditions. For this reason, an ego-threatening feedback was implemented – after the first half of the experiment – to show participants that they had performed poorly in Session 1 and to urge them to perform better in Session 2. The results showed that this (faked) ego-threatening feedback neither affected the N_e nor the P_e and neither covaried with Admiration nor with Rivalry. This lack of effect could be explained by the potentially high stress level that was associated with the speeded go/no-go task itself (Vocat et al., 2008). The time pressure and the high error rate in the task could have created considerable ego-threatening conditions already in Session 1 – resulting in only a minor, statistically insignificant incremental ego-threatening effect of the faked feedback. It was difficult to verify whether participants believed in the feedback. Directly asking a question about the validity of the presented feedback would have led to answers certainly confounded by the participants' narcissism scores as highly narcissistic individuals attribute bad performances more strongly to external causes (Kernis & Sun, 1994). Hence, participants were only indirectly asked about their experiences with the experimental task settings and none of them questioned the validity of the feedback on one's own accord.

5. Conclusion

At the beginning of the current study, we outlined that the literature on narcissism has suggested two contradictory ways how highly narcissistic individuals deal with their failures: either by consciously avoiding them or by vigilantly turning towards them. We suggested that this contradiction might be solved by respecting different narcissism dimensions, i.e. Admiration and Rivalry, and by taking the temporal dynamics of perceptual processing into account. The current results only supported the vigilance hypothesis: The results showed that Rivalry was linked to an intense early error processing (reflected in higher N_e amplitudes), which we interpreted as hypervigilance to self-caused failures.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/pen.2022.7.

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Conflict of Interest. The authors declare nothing to disclose.

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