NEURAL CORRELATES OF SELF-ENHANCEMENT IN NARCISSISM:

AN ELECTROENCEPHALOGRAPHY INVESTIGATION

by

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(Under the Direction of W. Keith Campbell and Brett A. Clementz)

ABSTRACT

Studying the neural correlates of the self-serving bias is useful for understanding self-regulatory mechanisms associated with narcissism. Previous research demonstrates that non-self serving attributions are associated with enhanced neural activity in dorsomedial prefrontal cortex (Krusemark et al., 2008), suggesting that it requires greater controlled processing to make unbiased attributions. The present study compared event-related potentials (ERP) responses of 20 narcissists and 20 non-narcissists during a facial recognition task during which they made attributions about their performance and received false feedback on whether they were correct or incorrect. Results demonstrated that both positive and negative feedback elicited self serving attributions. Narcissism moderated the self-serving bias with higher narcissism resulting in more self-enhancing/self-serving attributions after positive feedback. Sensor and source analyses of ERP data on self-serving and non-self serving trials were evaluated for between-group differences. Significant differences were observed on self-serving trials subsequent to positive feedback, with lesser activity emanating from several brain regions, including bilateral occipital cortex, bilateral temporal cortex, left posterior parietal cortex, right dorsomedial prefrontal cortex, and bilateral ventromedial prefrontal cortex in those higher in narcissism. Individuals high in narcissism also exhibited preferential processing of task-related feedback in precuneus and left medial temporal cortex. Implications for self-enhancement and narcissism affecting controlled processing are discussed.

INDEX WORDS: Self-serving Bias, Attributions, Self-enhancement, Narcissism, EEG, Prefrontal cortex, Elizabeth Krusemark, The University of Georgia

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DEDICATION

I dedicate this to my mother Karen. She has been a constant source of encouragement throughout my life and I would like to thank her for supporting me during graduate school.

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I would like to acknowledge and thank my advisors, Dr. Keith Campbell and Dr. Brett Clementz for their guidance and support throughout graduate school. I would also like to thank Dr. Leonard Martin and Dr. Jennifer McDowell for their guidance and advice.

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CHAPTER 1

INTRODUCTION

The characteristic self-promoting and reactive behaviors of narcissists in response to positive and negative outcomes are well documented in social and personality psychology. Narcissists are individuals that hold themselves in high regard, in spite of their faults or shortcomings. These individuals persistently behave in ways to convince others of their grandiose self-perceptions, and distort their own realities to fit with their beliefs of superiority. Based on the dynamic self-regulatory processing model of narcissism outlined by Morf & Rhodewalt (2001), the narcissist is motivated to constantly seek affirmation in order to support this inflated self-concept. One of the strategies mentioned in this model includes biasing interpretations of feedback in order to bolster self-esteem. While research reveals that biased attributions and self-enhancement are prevalent behaviors among most individuals, it is well-known that narcissists use these self-promoting behaviors as a central self-regulatory strategy.

One of the most important self regulatory strategies that narcissists implement is the self serving bias, whereby one attributes causality of success to the self and defends the positivity of the self-concept by externalizing the causality of negative events. By studying how personality shapes self-regulation, one can better understand narcissism as an individual difference. Narcissism provides the ideal system for studying the neural and cognitive mechanisms underlying the self-serving bias.

Even though the literature is rich with investigations examining the influence narcissism has on behavior, very few studies have sought to further explore the cognitive mechanisms underlying these characteristic self-regulatory strategies. Using psychophysiological methods such as electroencephalography (EEG) allow for precise investigations of neural responses related to self-regulation. Previous research has examined the nature of the self-serving bias using EEG (Krusemark, Campbell, & Clementz, 2008), revealing that self-serving attributions recruit less dorsomedial prefrontal cortex activity relative to non-self-serving attributions. These findings suggest that self-serving attributions require less cognitive control over attributional responses, supporting the notion that self-serving attributions are more automatic than unbiased attributions.

The proposed study investigates how narcissism influences neural mechanisms relating to the self-serving bias and to examine the hypothesis concerning self-enhancement as an automatic process using neural correlates of self-serving attributions. Using a social cognitive neuroscience approach to personality and social cognition is a novel method for to support a model of narcissistic self regulation, as the neural correlates of personality are not yet well understood.

Dispositional Narcissism

Taking influence from clinical examinations of narcissistic personality disorder, narcissism as an individual difference has been a focus of social and personality research for quite some time. The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, American Psychiatric Association, 1994) describes narcissistic personality disorder (NPD) as a pattern of grandiosity, self-focus, and self-importance, by which narcissists are preoccupied with thoughts and fantasies of success, power, and beauty. These individuals hold their own uniqueness and superiority in high regard, demonstrate exhibitionistic behavior, demand attention and admiration from others, but react severely to threats towards their own self-esteem with rage and defiance. Those with NPD also show a characteristic sense of entitlement, whereby they expect special treatment. Interpersonally, they are exploitive, which serves to undermine their relationships. Dispositional narcissism is considered to be a distinct individual difference and personality process by multiple investigations (Miller & Campbell, 2008; Raskin & Hall, 1979). The following review and research proposal discusses narcissism as an individual difference, rather than a pathological disorder.

Measurement of Narcissism

Raskin and Hall (1979) developed the Narcissistic Personality Inventory (NPI) in order to measure dispositional narcissism, originally based on DSM-III criteria for narcissistic personality disorder. The inventory distinguishes pathological narcissism in those diagnosed with the personality disorder (Prifitera & Ryan, 1984) from nonnarcissistic individuals. Its creators operationalized the construct as containing seven components: autonomy, entitlement, exhibitionism, exploitation, self-sufficiency, superiority and vanity (Raskin & Terry, 1998). NPI scores are positively related to Extraversion, based on Raskin & Hall's validation of the measure with Eysenck Personality Questionnaire (EPQ; 1981). The NPI is also positively related to high self-esteem (Emmons, 1984, 1987; Rhodewalt & Morf, 1995), self-focused attention (Emmons, 1987), need for power (Carroll, 1987), need for uniqueness (Emmons, 1984), and hostility(Bushman & Baumeister, 1998; Raskin, Novacek, & Hogan, 1991). The NPI is negatively related to empathy and perspective taking (Watson, Grisham, Trotter, & Biderman, 1984), agreeableness (Rhodewalt & Morf, 1998, 1995), and the need for intimacy (Carroll, 1987).

Narcissistic Self-Views

Narcissists show a cognitive and affective preoccupation with the self, one's own needs, ambitions, glory, and superiority (Westen, 1990). What makes this grandiose preoccupation ironic is the reactivity narcissists display in response to threats to the self-concept. It is certain that any individual will eventually face failure, and narcissists do not go with exception to this reality. Narcissists manipulate and distort their realities and environments despite actual outcomes of failure in order to maintain a grandiose self-concept. Narcissists' self-views are characteristically unique. Akhtar & Thompson (1982) described the self-concepts of narcissists as haughty, composed of an inflated sense of self-regard and entitlement. Narcissists see themselves as more intelligent and attractive than others (Gabriel, et al, 1984). These high self-opinions reflect an exaggerated self-concept. Not only do narcissists see themselves as superior, but they overestimate their own performance for individual outcomes and group activities (Farwell & Wohlwend-Lloyd, 1998; John & Robins, 1994). This holds true for situations that involve evaluation and when failure threatens the self-concept (Raskin, Novacek, & Hogan, 1991). Rhodewalt & Morf (1995) argued that narcissists claim to be more certain of their positive views than those lower in narcissism. Narcissists are preoccupied and even fantasize about success (Raskin & Novacek, 1991). This is argued to be rooted in narcissistic entitlement, or the sense of deserving or expecting special treatment and outcomes. Entitlement is strongly related to narcissism (Campbell, et al, 2004; Raskin & Terry, 1998; Raskin & Hall, 1979), and is described as the source of the more maladaptive narcissistic behaviors (Emmons, 1987). Empirical findings support the intuitive notion that narcissists think highly of themselves.

Self-Enhancement and Self-Regulation

In order to discuss fundamental behaviors associated with narcissism, it is necessary to define the relevant terms and how they relate to motivation and adaptation of behavior. Self enhancement is described as the manner to which individuals boost the positivity of self-views or to protect the self from negative information (Sedikides & Strube, 1997; Brown & Dutton, 1995; Dunning, 1993). It is also a process by which one distorts reality in service of the self; but is also described as a motivation to uphold positive self-conceptions (Sedikides, 1993). It is useful to consider self-enhancement a fundamental strategy for maintaining positive thoughts about the self, and many behaviors fall under this category to serve the same function. While the term self-enhancement is suggestive of exaggerated self presentation, self-enhancement and positive illusions have been associated with adaptive psychological functioning (Taylor, 1989). Over self-verification and unbiased self-assessment, the self-enhancement motive drives and influences the self-evaluation process, suggesting that individuals are more likely to use information that favors the self-concept rather than confirms or objectively assesses the self-concept (Sedikides, 1993).

Self-regulation is another term that is often used with reference to monitoring and changing behavior, but can also be used to describe self-control (Baumeister & Heatherton, 1996; Muraven & Baumeister, 2000). Self-regulatory strategies are the particular behaviors that an individual employs to obtain a goal. In this context, self-regulatory strategies are those behaviors that individuals use to be seen in a positive light or to preserve the notion that they are better than others. Along with this notion, individuals judge positive personality traits and adjectives as more characteristic of the self relative to negative attributes (Alicke, 1985; Brown, 1986). Negative aspects of the self are acknowledged, but are often dismissed or minimized as a method of self-enhancement (Green & Sedikides, 2004; Campbell, 1986). Positive attributes are seen as more important, and skills to which one is more proficient seen as rare and unique (Harackiewicz, Sansone, & Manderlink, 1985). In addition to personal self-conceptions, individuals compare themselves to others in a self-enhancing manner; judging positive attributes as more characteristic of themselves than others, but see negative attributes as more diagnostic of others (Alicke, 1986; Brown, 1986). These positive illusions can be validated by examining the descriptions of objective observers in comparison with self-ratings. People made more positive self-ratings than objective raters made on contributions in an interactive task (Lewinsohn, et al., 1980).

Narcissism and Self Enhancement

Narcissists are implicated in the self-enhancement literature often due to a striking tendency to use displays of self-enhancement as a self-regulatory strategy. Empirical results demonstrate the strong tendency for narcissists to show a self-enhancement bias relative to others low in narcissism (John & Robins, 1994). The findings of John & Robins were a significant validation of the narcissism-self-enhancement link. Those low and moderate in narcissism showed a self-diminishment bias or no bias in self-ratings at all (John & Robins, 1994). Narcissists are more likely to overestimate their abilities and performance on tasks (Robins & Beer, 2001; Farwell & Wohlwend-Lloyd, 1998; Gosling, John, Craik, & Robins, 1998; John & Robins, 1994). Overestimation of performance is also inconsistent with actual performance as rated by objective observers in many studies, demonstrating that narcissism brings out a bias in evaluations, not just an optimistic expectation.

Narcissism is also related to self-deceptive enhancement (having favorable self-views) but not social desirability (behaving in accordance so that others approve), so consequently, narcissists are more concerned with the need for admiration than the need for approval (Raskin, Novacek, & Hogan, 1991; Paulhus, 1998). This affects the interpersonal success of the narcissist: self-regulatory strategies have negative effects on relationships but do not necessarily trouble the narcissist. The self-aggrandizing and self-deceptive tendencies of narcissists are noted, but they aren't necessarily maladaptive behaviors, based on the prognosis for psychological well being. Self-enhancement certainly enables one to face challenges that are difficult as well as buffer the self from failure.

Biased Interpretation of Feedback and the Self Serving Bias

One way to maintain a positive view of the self is to distort or bias feedback from the environment. Emmons (1987) discussed the likelihood of narcissists to display attributional egotism (Snyder, Stephan, & Rosenfeld, 1978) more frequently than non-narcissists. Westen (1990) argued that narcissists' emotional reactivity to negative outcomes is mediated by self-serving attributions. Attributional egotism or in other words, self-serving attributions refer to the propensity to attribute positive outcomes to the self, and to externalize causality in reference to negative outcomes.

The self-serving bias is the tendency for individuals to make attributions to personal causes under conditions of success (effort, ability), and to ascribe failure to external circumstances (chance, persons impeding performance, or task difficulty) (Miller & Ross, 1975; Harvey & Weary, 1975; Kelley, 1971; Heider, 1958). Heider labeled these biases in attribution ego-defensive, ego-protective, or ego-biased attributions (1958). Kelley described these biases as compatible with his notion of effective control, stating that individuals need to be able to exercise control over their environment (1971). Snyder and colleagues (1976) discussed attributional egotism in a similar manner, stating that "attributional biases serve to protect and enhance self-esteem" (p. 435). The term egocentricity was born from these theories, (Jones and

Nisbett, 1971, 1987) describing a self-focused individual who assumes that others perceive the world similar to their own view. These views are colored by the individuals' evaluations. Based on this notion, it is not surprising that attributions of causality are focused largely on the self, and only make exception when it contradicts individual positive self-views.

Most of the early research investigating the self-serving bias requires individuals to complete a task and involves positive and/or negative feedback about task performance. Self-attributions were measured in the early studies, as evidence of the self-serving bias following experiences of success. Miller & Ross (1975) debated whether self-serving attributions would be present after an experience of failure given the data at the time showed a stronger bias towards self-enhancement. Initially, self-serving attributions were measured during interpersonal influence tasks (Arkin, Cooper, & Kolditz, 1980), naturalistic settings involving sports (Mullen & Riordan, 1988), and among clinical populations (Sweeney, Anderson, & Bailey, 1986). Later, the self-serving bias was validated as a phenomenon and research continued to determine how moderating effects contributed to the strength of the result after success and failure outcomes (see Campbell & Sedikides, 1999, for a review).

Some criticisms of the self-serving bias question whether the phenomenon exists, if external attributions are made after failure experiences, or whether the bias is based on expectations about performance rather than grounded by self-enhancement motives (Miller & Ross, 1975; Kelley, 1971). While there is evidence for variation in self-serving attributions across early empirical studies, there is support for multiple moderating effects among more recent investigations. Campbell & Sedikides (1999) conducted a meta-analysis of the empirical literature focused on the self-serving bias. Their model of self-threat classified studies into those involving high or low degrees of threat, and examined whether these variables accentuated or diminished the self-serving bias. Self threat is defined as a failure experience or an experience that questions, threatens, or challenges favorable views about the self (Baumeister, 1996; Hakmiller, 1966). Moderators of self-serving attributions included situational variables such as task type, status of the individual or competitive orientation of the task, and influenced the self-serving bias by eliciting self threat. Tasks that are competitive in nature or that create status iniquities create greater self threat. Individual differences such as self-esteem, self-focused attention, achievement motivation and locus of control moderate threat and affect self-serving attributions. Those with high self esteem, high self-focused attention, high achievement motivation and external locus of control demonstrate the self-serving bias in support of the self-threat model. One who has more monitor, more to defend, and feels less in control will experience more self threat, resulting in a self-serving pattern of behavior. These results speak to the debates in the literature. Self serving attributions do occur after failure experiences or negative feedback, and effect sizes demonstrate that the self-serving bias is a valid phenomenon. Outcome expectancies do affect the self-serving bias, and they were addressed as one of the moderators in the meta-analysis. Those who expect to perform will experience greater self-threat than individuals with lower performance expectations (Campbell & Sedikides, 1999).

Research examining narcissists' responses to interpersonal feedback demonstrates that those high in narcissism are more likely to perceive positive feedback as more accurate than negative feedback (Kernis & Sun, 1994). Narcissists also rate evaluators as more competent following positive feedback on a related task. By distorting perceptions of those who are the bearers of external affirmation or those who help to bolster the narcissists' positive self-conceptions, the individual can make the best of either circumstance. This self-regulatory strategy also affects how narcissists attribute success and failure experiences in interpersonal and intrapersonal domains. Narcissism scores are also related to more self-aggrandizing attributions, whereby individuals attributed positive events to global, stable, and internal causes (Rhodewalt & Morf, 1995). Narcissists demonstrate that they will go to more extremes in order to enhance the self. A study by Campbell and colleagues examined comparative and noncomparative self-enhancement strategies in a series of studies looking at narcissism during dyadic and independent tasks (2000). Individuals high in narcissism display the self-serving bias across domains. In other words, narcissists will self-enhance by stealing the glory from their partner after a success and blame the partner after failure regardless of the closeness of the relationship. Nonnarcissists will self-enhance only when it has no cost for their partner, again confirming the differences in communal orientation between the groups. Narcissists also show a great degree of emotional reactivity to failure; and narcissism predicts aggressive behaviors towards the source of the threat (Stucke & Sporer, 2002; Rhodewalt & Morf, 1998). All of these behaviors are strong evidence that narcissists utilize an arsenal of self promoting strategies, and the self-serving bias continues to be a primary mode of operation.

The Automaticity of Self Enhancement

Given that self-enhancement seems to be rooted in a motivation to protect the self and bolster self-esteem, it should be an easily accessible tool that which an individual may utilize. Social and personality researchers have investigated the nature of self-regulation, with the goal to better understand how self-regulation is improved and hindered. Self-regulation is the ability to alter one's behavior or responses, and is often described as a limited resource (Vohs, Baumeister, & Ciarocco, 2005; Muraven, Tice, & Baumeister, 1998). One of the most important forms of self-regulation is the ability to present the self to others effectively. In other words, self-presentation is a skill that humans possess and develop over time. Gaining efficacy in this domain is fruitful for some, and others struggle at self-presentation. Thus, self-presentation is either an effortless process that is somewhat automatized or it can be difficult under certain circumstances. Portraying oneself in an inconsistent manner has negative effects on self-regulatory resources (Vohs, Baumeister, & Ciarocco, 2005). Moreover, depleting self-regulatory resources makes self-presentation more difficult. This is also consistent support for the notion that self-presentation is an automatic, effortless process that is made easier when it is consistent with portraying the self in a positive light. It is made more effortful and requires more control when it is inconsistent with typical self-portrayals or it is hindered by self-regulatory depletion. Approaching this idea from a cognitive perspective, it is known that controlled processes are effortful and can demand attentional resources (Schneider & Shiffrin, 1977). Controlled processes are also limited in capacity, and automatic processes are those behaviors that happen readily without demands on attention. These processes do not tax the limits of the system, and are based on learned information. If self-enhancement is a biased form of self-presentation, it is likely to be a highly automatized, learned process for those high in narcissism. If self-enhancement is natural for individuals, then restraining this process would require more effort and control. Additional literature examining self-enhancing behaviors supports the notion that positive self-evaluation is easier for people to endorse, and that denying negative self-evaluations is equally as effortless (Paulhus & Levitt, 1987). Individuals not only make self-enhancing and self-protective responses to descriptive traits, but they do so more quickly during such tasks. Given that the endorsement of positive traits was associated with faster response times in this study, it is fair to say that there is support for the notion of automatic self-enhancement. This theory is the foundation for the proposed study, and further discussions of neural correlates supporting cognitive processing follow in the next section of the literature review.

Neural Underpinnings of Related Constructs

Personality One of the few personality traits that have been examined in the area of neuroscience is extraversion. Extraversion is positively related to narcissism (Paulhus, 2001; Paulhus & John, 1998), and is pertinent to research in personality neuroscience. Based on Eysenck's arousal theory of personality (1967), extraverts show less arousal than introverts during most experiences. Fink (2004) examined neural activity among introverts and extraverts, finding that extraverts demonstrate less cortical activity (and less event-related desynchronization) in left hemisphere relative to introverts. Arousal and emotional responses have been measured with regard to extraversion. Canli and colleagues conducted another investigation among extraverts to examine anterior cingulate (ACC) reactivity to valenced words in an emotional Stroop task (2004). Extraverts had increased ACC activity when viewing positive words, a conclusion attributed to the overall positive state that is associated with extraversion. Eisenberger, Lieberman, & Satpute (2005) also examined personality effects on cognitive control processes using individuals high in neuroticism and extraversion. During an oddball task, extraverts exhibited increased lateral and medial prefrontal cortex (PFC) activation relative to neuroticism. Extraversion was also positively related to rostral ACC activation, left lateral PFC, and lateral posterior parietal (LPPC) activity. Neuroticism was associated with greater dorsal ACC activity. This is evidence that extraversion as a personality trait has unique influence on neural mechanisms of perceptual processing and processing requiring cognitive control.

Self-Processes and Medial Prefrontal Cortex A recent group of neuroimaging studies are dedicated to the investigating activity related to self-processes. Self processing or self-reflection has been consistently associated with activity in medial prefrontal cortex (mPFC) (Moran, et al., 2006; Ochsner, et al., 2005; Mitchell, et al, 2005; Ochsner, et al., 2004; Vogeley, et al., 2001).

Judgments about whether attributes are self-descriptive, taking a first-person perspective, reflecting on one's current emotional state, and mentalizing about similar others all recruit mPFC. Recruitment and reflection upon the self is necessary for making internally generated inferences, and is germane to the proposed study. A review by Beer (2007) examined the results of Moran, et al., and questioned whether the mPFC activation associated with self-descriptive ratings reflected accurate or inflated self-views. Investigations of orbitofrontal cortex (OFC) show evidence that lesions in OFC result in unrealistically positive self-views (Beer, et al., 2006), demonstrating these findings pose an unresolved issue with respect to self-evaluation in prefrontal cortex. While it is clear that self-relevant information and self-reflection recruit similar regions of activity, there is still some debate about what cognitive processes are supported by subregions of the prefrontal cortex.

Neural Underpinnings of Self Enhancement Self enhancement has been the focus of very few neuroscientific investigations. Watson and colleagues examined the self-positivity bias using ERP (2007). A study by Watson et al. (2007) found that reaction times were faster to self-endorsed positive words and non-self negative words, replicating similar findings by Paulhus & Levitt (1987). They also found a larger N400 response to self-negative and non-self positive words. The N400 (Kutas & Hillyard, 1980) has been an index of semantic discrepancy in language studies, and is argued to be an index of the mismatch between self-relevant words and a positive self-concept in the Watson study. Another investigation used transcranial magnetic stimulation (TMS) to test whether self-enhancement recruited activity in the medial prefrontal cortex (Kwan, et al., 2007). Prior to stimulation, participants showed self-enhancement in self and other ratings of trait adjectives. After TMS was applied to medial PFC, participants demonstrated less self-enhancing judgments.

Causal and Attributional Processes Causal judgments and attributional processes have been examined in cognitive neuroscience independently from self-enhancement biases. By examining the differences between causal and simple associative judgments, Satpute et al., (2005) found that while there were many similar regions active for both types of judgments, casual judgments activated distinct regions in dorsolateral PFC and precuneus. The authors hypothesized that this region would be associated with causal judgments based on previous findings that show DLPFC activation with deductive and inductive reasoning (Goel, et al., 1997; Christoff, et al, 2001), role binding (Waltz, et al., 2002), and working memory task completion (Smith & Jonides, 1999). Fugelsang and Dunbar (2005) conducted another imaging study of causal reasoning to examine biases associated with causal judgments. Their investigation sought to determine how individuals perceived the plausibility of a theory based on the consistency of data available. Evaluating data consistent with a plausible theory recruited parahippocampal gyrus, whereas evaluating data inconsistent with a theory activated anterior cingulate, left DLPFC, and precuneus. There is consistent recruitment of DLPFC across both of these studies, implicating this region in causal reasoning. While these studies are important to better understand the neural underpinnings of causal judgments, these investigation do not examine self-enhancement and attributions in concert.

Exploring Neural Substrates of the Self-Serving Bias Two studies have investigated the self-serving bias using fMRI and dense array EEG. Blackwood and colleagues (2003) studied the differences between self-responsibility and self-serving attributions using fMRI. Self-responsibility was operationalized as internal or personal attributions for both positive and negative events. Self-responsibility was associated with activations in bilateral premotor cortex and cerebellum. Self-serving attributions activated dorsal striatum, a region associated with motivated behavior. Non-self-serving attributions activated left orbitofrontal cortex, which has been identified to support the suppression of reward (Elliot, et al, 2000). The authors posited that the orbitofrontal activation associated with non-self serving attributions was useful for more deliberative strategies. While these results are intriguing, the authors used hypothetical events to measure the self-serving bias. Participants were presented with statements during the scan such as: “A friend thinks you are dishonest”, or “A friend sent you a postcard”, and were asked to imagine the event and make a decision to attribute the statement to the self, another person, or an external cause such as the circumstances, or chance. All of the statements were interpersonal in nature, and involved making a forced choice attribution between the 3 causes. What this study does not reconcile is whether these statements are based on a social desirability motive, that is, the tendency for individuals to respond in order to be viewed favorably by others. Social desirability is related to self-esteem maintenance, but is not the primary motivation behind self-serving attributions (Raskin, Novacek, & Hogan, 1991). Individuals made internal attributions for positive interpersonal events and external attributions for negative events, but these events had no relation to intrapersonal aspects of self. Typically, studies examining the self-serving bias require individuals to make attributions for their own performance on an achievement-related task. These paradigms minimize social-desirability effects by allowing participants to make private attributions for their performance, and enable them to judge only personally or circumstantially relevant outcomes. A more recent investigation by our laboratory used a more traditional approach to capture the self-serving bias (Krusemark, Campbell, & Clementz, 2008). In this study, a repeated measures facial recognition task measured participant performance across trials using dense-array EEG. Individuals received instructions describing the task as a predictor of psychological well-being to influence motivation for achievement. Participants completed the task and were told at each trial whether they made a correct or incorrect response to the faces, regardless of actual performance. This bogus feedback was randomly administered in order to manipulate the frequency of failure and success experiences equally. Participants made more self-serving attributions during the task overall, but this effect was stronger after failure experiences (negative feedback). Event related potentials were measured continuously during the task, and were analyzed relative to face stimuli, feedback presentation, and attribution statement presentation. ERPs to the attribution statements were collapsed across attributions, only enabling us to examine self-serving versus non-self-serving attributions. Responses to the attribution statements revealed that preceding a self-serving response, ERPs at 320 ms post-stimulus were smaller than those preceding a non-self serving attribution. This peak was localized to left medial prefrontal cortex, evidence that prefrontal activity in this region was greater before a non-self-serving attribution. This supports the notion that it requires greater controlled processing associated with greater prefrontal recruitment to make an unbiased attribution. Due to the small number of non-self serving attributions, the number of trials was not sufficient to examine differential brain responses to attributions based on the type of feedback during the task. Moreover, the theory that self-enhancement is automatic is only partially supported by this investigation given the lack of support from reaction time data in the small sample size. The proposed study should overcome the issues related to measurement of self-serving attributions, by examining the differences in brain responses to attributions following both success and failure experiences as well as internal and external attributions. Additionally the proposed study investigates the effect of narcissism on these self-enhancement processes.

The Present Investigation

The present study extends the previous examination of the self-serving bias by Krusemark et al. (2008), concerning the nature of self-enhancement in narcissism. As outlined above, the self serving bias is a tangible phenomenon, but its neural underpinnings are not yet thoroughly understood. Self-serving attributions are made in order for individuals to bolster self-esteem, and maintain a positive self-concept. Using EEG further illuminates the neural correlates and temporal course of self-enhancement and self-protection processes. The present experiment consists of a similar facial recognition paradigm along with deceptive feedback to elicit self-serving attributions. The present paradigm consists of a greater number of trials in order to allow for additional analyses of event-related potentials. Two variables were examined during this investigation in order to extend the prior study: the effect of feedback on attributions as well as how causality is attributed: internally to the self or external attribution to circumstances or chance. Prior to the EEG experiment, participants high and low in dispositional narcissism were chosen to complete the final task. The task requires participants to match a target face to a probe after several faces are presented in sequence. Participants were given false positive or negative feedback at every trial in order to create success and failure experiences in a repeated measures design. During the task, participants made choices between attributions to describe their performance at the end of every trial. Dense array EEG was continuously recorded during the task. Several hypotheses were tested for the following experiment: 1) All participants should make more self-serving attributions overall, demonstrating the self-serving bias; 2) Given that narcissists use specific self-enhancement strategies, individuals higher in dispositional narcissism should show more self-serving attributions, particularly after experiences of success (positive feedback). 3) As evidence of automatic self-enhancement, reaction times for self-serving attributions would be faster than non-self-serving attributions; 4) Supporting the automatic self-enhancement theory, non-self-serving attributions should recruit greater prefrontal activity due to the fact that prefrontal activity is associated with cognitive control; 5) Narcissists should show differential neural responses to the attributions during the cognitive task 6) As self-enhancement is related to greater self-positivity, all individuals should demonstrate enhanced neural response to positive feedback relative to negative feedback; and finally, 7) As evidence of narcissism, event-related potentials in response to positive feedback should be enhanced among narcissists.

This is the first study, to my knowledge, to investigate the effects of dispositional narcissism upon cognition using psychophysiological methods. This study should allow for better understanding of narcissistic self-regulatory strategies, a more thorough investigation of the automatic nature of self-enhancement by means of the self-serving bias, and lead us to grasp the neural and temporal dynamics of self-enhancement processes more generally.

CHAPTER 2

METHOD

Participants

Forty students from the University of Georgia research pool received partial class credit for participation. This project was approved by the university IRB and the BioImaging Advisory Board, and participants provided written informed consent before the study. Participants were screened to ensure they were right handed and suffered no head trauma before consenting to the EEG session.

Overview of Procedure and Classification of Narcissism

Initially, participants completed a battery of personality questionnaires, including the Narcissistic Personality Inventory (NPI, Raskin & Hall, 1979). Scores on the NPI were calculated in order to determine which participants fell in the upper and lower quartiles of narcissism for the second phase of the study. Those participants scoring above 22 on the NPI and below 11 on the NPI (quartiles determined based on NPI scores during the Pilot study 1, n=137, mean NPI= 17.146) were asked to return for the second phase of the study. The average NPI score for the low narcissism group was 8.10, SD= 4.42, and the average NPI score for the high narcissism group was 26.4, SD= 3.63. Participants completed a facial recognition task administered via computer in order to elicit self-serving attributions (see Task Description below). Previous studies have determined the task to be both ambiguous and believable. Prior to testing, participants were trained on a similar task with generic stimuli, different from the task of interest. After testing, participants were thanked and debriefed.

Task Description

The Facial Working Memory (FWM) task was adapted from previous research (e.g., Sala, Rama, & Courtney, 2003). Stimuli for the task consist of 25 male and female grayscale faces (Minear & Park, 2004). The task consisted of 200 trials total presented on a monitor (see Figure 1 for timing and stimulus information). Participants were directed to fixate on the center of the screen throughout the task to reduce eye movement during EEG data acquisition. Each trial began with the presentation of a centrally located fixation dot presented for 700 ms, followed by the presentation of 5 facial stimuli. The first face presented was the target face, followed by 3 distractor faces (different from the target but of the same sex and race, presented for 380 ms), separated by a fixation cross in the center of the screen for 450 ms. After the distractor faces were presented, participants are cued with a question mark. A probe face was presented for 1200 ms that either matched or did not match the target. Participants indicated with a button press whether the probe matched the target face, and received bogus feedback on their decision ("correct" for 100 trials, "incorrect" for 100 trials). The feedback was presented for 1500 ms, followed by a cumulative score (500 ms) that increases with every trial to ensure task engagement. Before the attribution statements are presented, a 300 ms fixation cross is presented, in order to provide a baseline prior to attribution processing. The attribution choices were presented two at a time, with an internal attribution presented above an external attribution at every trial for 2500 ms. During the presentation of attribution statements following feedback, participants responded with a button press as to which of two attributions (one internal, one external) described their performance. The statements they selected were either self-serving (e.g., internal: "I am smart", "I tried hard"; external: "It was hard", "It was bad luck") or non-self-serving (internal: "I am dense", "I didn't try"; external: "It was easy", "It was luck"). Participants were informed of the possible attribution choices prior to the beginning of the task to reduce confusion about the statements, and to reduce eye movements related to reading the statements at every trial.

Analyses of Behavioral Data

Participants' responses during the facial recognition task were analyzed by group (Narcissists and Non-Narcissists) for self-serving attributions. The data were analyzed using a 2 (Feedback (i.e., correct, incorrect)) by 2 (Attribution (i.e., internal, external)) by 2 (Group (i.e., High, Low dispositional narcissism)) mixed analysis of variance. During pilot study 1 ($n=137$), narcissism moderated the self-serving bias ($\beta=.266$, $t(67) = 2.26$, $p = .027$), demonstrating that higher narcissism was associated with making more self-serving attributions after positive feedback. (Narcissism was coded for the upper and lower quartiles for NPI scores, and regressed on the difference between self-serving and non-self serving responses.) Participants' reaction times in making attributions were also analyzed using the same analysis of variance by group in order to test the hypothesis that making self-serving attributions is more automatic. (Previous data showed that using 160 trials in the facial working memory paradigm elicited the self-serving bias, but there were not enough trials in each of the 4 conditions to analyze the EEG data using a 2x2 analysis of variance. The previous EEG data was analyzed using a dependent measures t-test between self-serving and non-self-serving trials.) Pilot study 2 tested whether the self-serving bias would hold up when increasing the number of trials (from 160 to 200) in the facial working memory paradigm without causing suspicion among participants. The results of pilot study 2 ($n=20$) indicated that the self-serving bias was still evident, showing greater biased attributions ($M=125.15$, $SD=19.87$) than non-biased attributions ($M=63.3$, $SD= 16.77$), $t(19) =7.981$, $p <$ .001.

EEG Data Acquisition and Screening

Continuous EEG data were recorded during the task, vertex-referenced using a 256-sensor Geodesic Sensor Net and NetAmps 200 amplifiers (Electrical Geodesics: EGI, Eugene, OR). The sensor net was adjusted until all pedestals were properly seated on the scalp (e.g., Greischar et al., 2004). Individual sensor impedances were adjusted until they were below 50 kΩ. Data were sampled at 500 Hz with an analog filter bandpass of 0.1–200 Hz. Following data collection, 3D locations of the sensors on the head were acquired using photogrammetry (Electrical Geodesics; EGI, Eugene, OR).

Raw data were visually inspected offline for bad sensor recordings using BESA 5.1 (MEGIS Software, Gräfelfing, Germany). Bad sensors were interpolated using a spherical spline interpolation method as implemented in BESA. Artifacts such as eye-blinks and cardiac activity were removed from raw data using an independent components analysis (ICA) approach with EEGLAB (Matlab, Version 7.0, Mathworks, Natick, MA). Trials with pre-saccadic EEG activity greater than 120 μV and/or other artifacts were eliminated from further processing. The data were transformed to an average reference and digitally bandpass filtered from 1–40 Hz (12 dB/octave rolloff). All ERP averages were baseline-adjusted.

Analyses of ERP Data

Two different approaches were used to investigate whether neural activities differed as a function of group, condition and stimuli. Initially, data were analyzed in sensor-space to quantify differences in the strength and spatial distribution of brain activity at specific ERP peaks. In order to identify above-baseline ERP peaks and determine their latencies, global field power (GFP) plots for grand averages were derived for every subject and condition. Statistical comparisons were made for the peak latencies of each relevant condition and group.

Statistical comparisons of voltage data at the individual sensors were conducted for ERP peaks found to be above baseline (±20 ms). Traditional Bonferroni correction to account for the multi-comparison problem is inappropriately conservative with brain activity data. In order to account for the multiple-comparison problem associated with these types of analyses, another method was used that has been conventional in the neuroimaging literature (e.g., Worsley, 2003). The cluster thresholding method (e.g., Forman et al., 1995) integrates the probability of significance for an individual source or sensor location with that for a cluster of locations. Cluster thresholding is useful because real brain activations are likely to result in correlated changes in clusters of sources and/or sensors. The following statistical rules were determined based on the noise level of the data (estimated from the prestimulus baseline) and Monte Carlo simulations calculated using AlphaSim in AFNI (Cox, 1996). To maintain the familywise alpha lower than .01: (1) an individual test for an ERP peak for a sensor was significant at $p<.035$; (2) at least six neighboring sensors were statistically significant at $p<.035$.

To validate the adequacy of ERP data collection, the average responses to all the facial stimuli were evaluated. Given that the visual evoked response to facial stimuli is well understood in physiological recordings, these responses were inspected for topographical and peak latencies to determine the quality of the ERP data. As expected, peaks for the initial visual evoked response and the face-specific response were evident at 120 ms and 170 ms post-stimulus (See Figure 5).

To test the fourth and fifth predictions, a 2 (Feedback (i.e., correct, incorrect)) by 2 (Attribution (i.e., internal, external)) by 2 (Group (i.e., high and low dispositional narcissism) analysis of variance was used to identify ERP peaks relating to the self-serving bias and narcissism. To test the sixth and seventh predictions, a 2 (Feedback) by 2 (Group) analysis of variance was used to test the ERPs in response to positive and negative feedback related to narcissism, respectively.

Second, following any significant ERP effects at the sensors, standardized low-resolution brain electromagnetic tomography (sLORETA; Pascual-Marqui, 2002) or another appropriate source model algorithm was used to estimate the brain activations (in source-space) accounting for those effects. Calculations were performed using CURRY (Version 5.0, Neuroscan, Inc.). An averaged magnetic resonance image (Collins et al., 1994) was used to construct a standard three-compartment realistic head model (Fuchs et al., 2002) prior to source localization. Prior to source analysis, fiducial locations from EEG data collection were matched to fiducial locations on the averaged segmented skin surface (using a least squares fitting procedure in CURRY). The sLORETA solutions were restricted to the brain compartment (source structure defined by grids with sources distributed every 5 mm).

CHAPTER 3

RESULTS

Attribution Responses

Using a 2 (Feedback) by 2 (Attribution) analysis of variance, self-serving attributions were quantified as an interaction between the two factors feedback and attribution type. Overall, individuals showed evidence of the self-serving bias $F(1,39)=73.13$, $p=.000$, $\eta^2=.652$, meaning that individuals made more external than internal attributions after negative feedback (external: $M=72.23$, $SD=14.93$; internal: $M=20.28$, $SD=13.92$) $t(39)= -11.675$, $p<.001$, but no more internal attributions relative to external attributions after positive feedback (internal: $M= 52.83$, $SD=20.0$; external: $M=43.33$, $SD=19.44$) $t(39)= 1.533$, $p=.133$ (See Table 1, Figure 2). Examination of the self-serving bias with Narcissism as a third factor also revealed a significant 3-way interaction ($F(1,38)=4.965$, $p=.032$, $\eta^2=.116$). Simple effects analyses demonstrated that individuals high in narcissism make more internal (biased) attributions after positive feedback ($t(38)$-1.938=, $p=.06$), and attribute fewer trials to external causes ($t(38)=1.945$, p=.059), compared with individuals low in narcissism (See Figures 3a and 3b). There were no effects of gender on the self-serving bias $F(1,38)=.413$, $p=.524$. Also, groups did not differ on their overall accuracy on the task $t(38)=-.059$, $p=.953$ (Low narcissism: $M= .7768$, $SD=.078$; High narcissism: $M=.778$, $SD= .053$) (quantified by the number of correct responses on the facial recognition task). Each group also answered a similar proportion of the trials during the task $t(38)=.061$, $p=.952$, (Low narcissism: $M=.94$, $SD=.058$; High narcissism: $M=.935$, $SD=.044$).

Response Times

For analysis of response times during the task, a 3 (Feedback x Attribution x Narcissism) way analysis of variance examined the effects of Narcissism on self-serving responses. Response times were transformed using a natural log transformation that is common with reaction time analyses (Keppel & Wickens, 2004). Overall, there was a marginally significant three-way interaction on response times during the task $F(1,38)=2.851$, $p=.099$ (See Figures 4a and 4b for means and standard errors). Simple effects analyses revealed that for the high narcissism group, response times were significantly faster for an external (biased) attribution following negative feedback (M= 6.68, SE= 0.050) in comparison with an internal (unbiased) attribution (M= 6.78, SE=0.042) $t(19) = 3.277$, $p =.004$. There was a significant main effect of feedback on response times $F(1,38)=9.768$, $p=.003$, revealing that responses were faster following positive feedback among all participants (positive: M= 6.628, SE= .031; negative: M=6.693, SE=.036). There was no significant main effect of narcissism, nor was there a significant interaction between feedback and attribution.

ERP Responses to the Attribution

Differences in ERPs to attribution choices were analyzed using a 3 way analysis of variance (Narcissism x Feedback x Attribution Type) for each peak (120, 200, and 320 ms post-stimulus, see Figure 6a). There were no significant sensor clusters at the 120 ms peak or the 320 ms peaks.

Differences in peak latencies were examined separately for each peak, using a repeated measures analysis of variance with factors Group (high and low narcissism), Feedback (positive and negative), and Attribution Type (internal and external). Examination of GFP plots revealed that peak latencies at 120 ms differed as a function of narcissism (Low narcissism: M= 122.35, SE=2.967; High Narcissism: M=111.67, SE=2.967) $F(1,38)=6.473$, $p = .015$. There was also a significant feedback by attribution type interaction for peak latencies at 120 ms (Positive-Internal: M=113.65, SE= 2.501, Positive-External: M= 118.75, SE= 2.149; Negative-Internal: M= 118.0, SE= 2.576, Negative-External: M= 117.65, SE = 2.183) $F(1,38)= 5.347$, $p = .026$, indicating that peak latencies were earlier for internal attributions following positive feedback and external attributions following negative feedback. There were no significant differences by group or condition in peak latencies at 200 ms. However, there was a main effect of feedback on peak latencies around 320 ms $F(1,38)= 5.714$, $p =.022$, indicating that event-related potentials in response to the attribution presentation peaked earlier following positive feedback (M= 307.43 ms, SE= 3.51) relative to negative feedback (M= 313.4 ms, SE= 2.86) (See Table 2 for mean and standard deviations of all peak latencies).

Analysis of the ERP responses to the attribution presentation revealed several significant results at the 200 ms peak. Two sensor clusters over frontal and left occipital regions differed for narcissism group at the 200 ms peak (See Figure 6b). For both of these regions, amplitude was higher for the high narcissism group than for the low narcissism group. Source analysis conducted on the waveform difference between high and low narcissism indicated this difference was associated with greater neural activity in middle occipital cortex for high narcissists.

There were two sensor clusters over frontal and occipital regions that differed by preceding feedback type (See Figure 6c). For both of these clusters of sensors, amplitude was higher for attributions following negative feedback relative to attributions following positive feedback. Source analysis on this waveform difference revealed greater neural activity in middle occipital cortex for attributions following negative feedback.

The interaction between narcissism and feedback revealed two clusters of sensors over frontal and occipital regions (See Figure 6d). For both of these regions, amplitude was higher for attributions following negative feedback-low narcissism, attributions following negative feedback-high narcissism, and attributions following positive feedback-high narcissism relative to attributions following positive feedback-low narcissism, respectively. Source analysis on the waveform difference between the average of negative feedback-low narcissism, negative feedback-high narcissism, and positive feedback-high narcissism relative to positive feedback-low narcissism revealed greater activity in occipital and bilateral temporal cortices for the first three conditions relative to attributions following positive feedback for low narcissists.

There were two clusters of sensors over frontal and occipital regions that differed for attribution type (See Figure 6e). Amplitude for these two regions was greater for external attributions relative to internal attributions. Source analysis on the waveform difference indicated this difference was associated with greater neural activity in right occipital cortex for external attributions.

Two clusters of sensors over frontal and occipital regions also differed as a function of narcissism and attribution type (See Figure 6f). Amplitude for these two regions was greater for high narcissism-internal attributions, low narcissism-external attributions, and high narcissism-external attributions relative to low narcissism-internal attributions. Source analysis on the waveform difference between the average of high narcissism-internal attributions, low narcissism-external attributions, and high narcissism-external attributions relative to low narcissism-internal attributions indicated this difference was associated with greater neural activity in occipital and bilateral temporal cortex, as well as and precuneus for the first three conditions, respectively.

The interaction between feedback and attribution type revealed two clusters of sensors over frontal and occipital regions (See Figure 6g). Amplitude for these two regions was greater for negative feedback-internal attributions, negative feedback-external attributions, and positive feedback-external attributions relative to positive feedback-internal attributions. Source analysis on the waveform difference between the average of negative feedback-internal attributions, negative feedback-external attributions, and positive feedback-external attributions relative to positive feedback-internal attributions indicated this difference was associated with greater neural activity in bilateral occipital, bilateral temporal and left superior parietal cortical regions for the first three conditions, respectively.

The three-way interaction between narcissism, feedback, and attribution type revealed two clusters of sensors over frontal and occipital regions (See Figure 6h). Amplitude for these two regions varied between high and low narcissists only preceding the positive-internal attributions; with absolute amplitude being different from other conditions for low narcissists. Source analysis on the waveform difference between the high and low narcissism groups at only the positive-internal attribution conditions indicated this difference was associated with greater neural activity in bilateral occipital cortex, bilateral temporal cortex, left posterior parietal cortex, right dorsomedial prefrontal cortex, and bilateral ventromedial prefrontal cortex for low narcissism.

ERP Responses to the Feedback

Differences in ERPs to feedback presentation were analyzed using a 2 way analysis of variance (Narcissism x Feedback) for each peak (120, 180, 300, 375, and 460 ms post-stimulus, see Figure 7a).

Differences in latencies were examined separately for each peak, using a repeated measures analysis of variance with factors Feedback (positive and negative) and Group (high and low narcissism). Examination of GFP plots revealed that peak latencies varied at 120 ms and 180 ms (See Table 3). There was a difference in peak latency at 120 ms for narcissism (Low narcissism: M=125.5 ms, SE=2.07; High Narcissism: M=117.15 ms, SE=2.07) $F(1,38)=8.133$, $p = .007$. Peak latency differed as a function of feedback at 180 ms, with positive feedback (M=180.9 ms, SE=2.29) resulting in earlier peaks relative to negative feedback (M=187.5 ms, SE=2.176) $F(1,38) = 6.715$, $p = .013$. There was also a difference in peak latency at 300 ms for feedback type (positive: M=295.15, SE=2.98; negative: M=303.55, SE=2.508), $F(1,38)= 7.117$, $p = .011$. Peak latencies did not vary as a function of narcissism or feedback at 375 or 460 ms post-stimulus.

Analysis of the ERP responses to the feedback presentation revealed several significant results at 4 of the 5 peaks (120 ms, 180 ms, 300 ms, 375 ms, and 460 ms). One sensor cluster over the right temporo-parietal region differed for feedback at the 120 ms peak (See Figure 7b). For this region, amplitude was higher for the negative feedback than for positive feedback. Source analysis conducted on the waveform difference between negative feedback than for positive feedback indicated this difference was associated with greater neural activity in left medial temporal cortex for negative feedback.

One sensor cluster over the superior parietal region differed for narcissism group at 180 ms (See Figure 7c). For this region, amplitude was higher for high narcissism relative to low narcissism. Source estimation conducted on the waveform difference between the high and low narcissism groups revealed that this difference was associated with greater activity in left precuneus for high narcissism.

There were no significant sensors that differed by narcissism group or feedback type at 300 ms in response to feedback presentation.

Two clusters of sensors over superior parietal and left frontal regions differed as a function of feedback at 375 ms (See Figure 7d). For both of these regions, amplitude was higher for positive feedback relative to negative feedback. Source analysis conducted on the difference between positive and negative feedback demonstrated that this difference was associated with greater activity in left temporal cortex for positive feedback.

The interaction between feedback and narcissism revealed one cluster of sensors over the left frontal region at 375 ms (See Figure 7e). Amplitude for this region was greater for negative feedback in the high narcissism group relative to negative feedback for the low narcissism group, and positive feedback in the low and high narcissism groups. Source analysis on the waveform difference between the negative feedback in the high narcissism group and the average of negative feedback for the low narcissism group, and positive feedback in the low and high narcissism groups indicated this difference was associated with greater neural activity in left medial temporal cortex for positive feedback in high and low narcissism groups as well as for negative feedback in the low narcissism group.

One cluster of sensors over the left superior parietal region varied as a function of narcissism at 460 ms (See Figure 7f). Amplitude for this region was higher for the high narcissism group relative to the low narcissism group. Source estimation conducted on the waveform difference between high and low narcissism revealed that this difference was associated with greater activity in left medial temporal cortex for the high narcissism group.

Three cluster of sensors over the left temporo-occipital, superior parietal, and left frontal regions varied as a function of feedback at 460 ms (See Figure 7g). Amplitude for these regions was stronger for positive feedback relative to negative feedback. Source estimation conducted on the waveform difference between positive and negative feedback indicated this difference was associated with greater activity in left medial temporal cortex for positive feedback.

CHAPTER 4

DISCUSSION

Self-Serving Attributions and Narcissism

One goal of the present research was to further understand the nature of the self-serving bias by attributions during experiences of both success and failure. As expected, participants made more self-serving attributions, primarily after negative feedback. This finding is consistent with previous research examining self-serving attributions using a similar task (Krusemark, Campbell, & Clementz, 2008).

In addition, narcissism moderated self-serving attributions as predicted, with individuals high in narcissism making more self-serving attributions following success (positive) feedback. The tendency for narcissists to display self-serving attributions has been documented in the literature (Campbell et. al., 2000; Rhodewalt & Morf, 1995). Another aim of the present study sought to examine to what extent self-serving attributions are automatic, and whether narcissists use similar self-enhancement strategies to nonnarcissists. It is possible that narcissism results in amplified self-aggrandizement, and self-serving attributions are one example of this behavior. Due to the notion that narcissism results in self-enhancement biases rather than self-diminishment biases (John & Robins, 1994), narcissists may automatically behave in ways that portray themselves in a positive light. Conversely, research has shown that self-presentation requires effort that can be depleted under certain circumstances (Vohs, Baumeister, & Ciarocco, 2005). Findings from Vohs and colleagues show that presenting oneself in a manner inconsistent with self-views requires effort. The present study did not directly address the context of self-presentation, but making a non self-serving attribution (presenting the self in an unbiased manner) in the face of failure feedback (as in the case with negative feedback during the present task) should require more effort. Based on findings from Paulhus & Levitt (1987), it requires more effort for all individuals to endorse negative self-descriptive traits. These results support the notion that self-enhancement is more automatic than effortful. Narcissists should have to employ more self-control in order to make an unbiased attribution, particularly in response to negative feedback. Response times did not differ for self-serving and non-self serving attributions. However, there was a marginally significant 3-way interaction of narcissism, feedback, and attribution type on response times. This result was due to the tendency for high narcissists to respond faster when making an external (biased) attribution following failure (negative) feedback. Even though all participants made more external attributions following failure, narcissists did so faster in comparison to when they made an internal attribution following negative feedback. Perhaps this reaction time difference is due to enhanced defensive responding following failure among high narcissists. Contrary to predictions, reaction times did not differ between biased and unbiased attributions following success, nor did reaction times differ following success between narcissism groups.

Neural Correlates of the Self-Serving Bias

One goal of the present research was to identify whether non-self serving attributions elicited greater prefrontal cortex activity in comparison with self-serving attributions. Examining the stimulus-locked ERP responses to the attribution presentation during the following conditions revealed several differences at 200 milliseconds post-stimulus: (internal (unbiased attributions following negative feedback, external (biased) attributions following negative feedback, internal (biased) attributions following positive feedback, and external (unbiased) attributions following positive feedback).

The interactive effect of feedback type and attribution type demonstrated that brain activity differed for conditions of internal (unbiased) attributions following negative feedback, external (biased) attributions following negative feedback, and external (unbiased) attributions following positive feedback relative to internal (biased) attributions following positive feedback. Neural activity associated with the negative internal, negative external, and positive external conditions was greater in occipital, bilateral temporal, and left superior parietal cortical regions relative to internal attributions following positive feedback. Activity in occipital cortex is associated with visual processing, and this effect was enhanced preceding internal-negative, external-negative, and external-positive attributions. Activity in bilateral inferior temporal cortex is part of the ventral visual processing stream (Cohen & Dehaene, 2004; Martín-Loeches, Hinojosa & Rubia, 1999), and is associated with the attention to words (Nobre, Allison, & McCarthy, 1994; Mischkin, Ungerleider, & Macko, 1983). Activity in inferior temporal cortex has also been associated with automatic semantic categorization in face processing (Lieberman, Gaunt, Gilbert & Trope, 2002; Hoffman & Haxby, 2000) and word meaning (Price, Moore, Humphreys, & Wise, 1997). Activity in left superior parietal cortex was also greater in these conditions, and is associated with intentional self-processing and trait judgments (Kircher et al., 2002). Enhanced activity in these regions suggests facilitated neural processing of attributions preceding biased attributions following negative feedback and unbiased attributions following positive and negative feedback at relatively early stages of visual processing. It is possible to speculate that preceding unbiased attributions (following both success and failure) as well as biased attributions following failure result in more self-referential processing relative to biased attributions following the experience of success given the tendency for individuals to make self-enhancing trait attributions more rapidly (Paulhus & Levitt, 1987). Contrary to predictions, differences in neural activity cannot be associated with biased (negative-external and positive-internal) versus unbiased (negative-internal and positive-external) attributions. However, internal attributions following positive (success) feedback showed lesser activity in these regions, suggestive of unique neural activity preceding a biased attribution at early stages of visual processing. Taken together, these results point toward a facilitation effect at early stages of processing for biased attributions following negative feedback and unbiased attributions following both positive and negative feedback. Diminished activity in the positive internal condition is also suggestive of lesser semantic processing of the words presented in the attribution choices preceding biased attributions following positive feedback, perhaps due to less attention to semantic information.

There was additional influence of preceding feedback type (success or failure) on brain activity in response to the attribution presentation, revealing enhanced occipital cortex activity for attributions following negative feedback relative to positive feedback. This enhancement is in accordance with previous findings demonstrating greater activity for attention to negative information relative to positive information in early stages of visual processing (Smith, Cacioppo, Larsen, & Chartrand, 2003).

External attributions also elicited greater activity in occipital cortex in comparison with internal attributions. This finding is consistent with neural circuitry including occipital cortex associated with making judgments about agents other than the self (Ochsner et al., 2004).

Neural Correlates for Narcissism and the Self-Serving Bias

The primary aim of the present study also sought to determine whether the brain activity between low and high narcissism groups differed preceding self-serving and non-self serving attributions. Of special interest was the condition in which high and low narcissists made an internal (biased) attribution of success. A significant 3-way interaction revealed differences in amplitude for low narcissism relative to high narcissism for self-serving attributions following success (positive) feedback. The between group difference in response to attribution choices preceding an internal positive attribution revealed increased activity in bilateral occipital cortex, bilateral temporal cortex, left posterior parietal cortex, right dorsomedial prefrontal cortex, and bilateral ventromedial prefrontal cortex for low narcissism. Activity in occipital cortex is associated with visual processing, and activity in temporal cortex is associated with word encoding (Kelley et al., 1998). Activity in left posterior parietal cortex is associated with preparatory signals for attending and responding to stimuli (Astafiev et al., 2003). Activity in dorsomedial prefrontal cortex is associated with self-referential processing (Craik et al., 1999; Fossati et al., 2003, 2004; Heatherton et al., 2006; Johnson et al., 2002; and Luo et al., 2004) and trait judgments in valenced words (Fossati et al., 2003).Activity in right dorsomedial prefrontal cortex is stronger when describing self-relevant words when they are positive (Fossati et al., 2003). Increased ventromedial prefrontal cortex activation is associated with anticipatory evaluative processing (Cunningham, Johnson, Gatenby, Gore, & Banaji 2003). Damage to the ventromedial prefrontal cortex results in poor decision making related to the inability to integrate affective information from external stimuli (Bechara, Damasio, Damasio & Lee, 1999). It is likely that the increased ventromedial activity in low narcissists represents an affective response to reward preceding a biased (internal) attribution following success feedback contrasted with lesser activity among individuals high in narcissism preceding a similar response. Based on the notion that narcissism is similar to psychopathy due to decreased physiological responses to arousing stimuli (Kelsey, Ornduff, McCann, & Reiff, 2001), these results suggest that narcissists show less physiological reactivity preceding a rewarding (biased) attribution. These findings suggest that low narcissists show stronger stimulus registration, encoding of the verbal stimuli, enhanced attention and stronger self-referential processing relative to high narcissists preceding a biased (internal) attribution following success. Overall, these results suggest that narcissism modulates brain activity and influences behavior preceding a biased (internal) attribution following success, indicating narcissists process attributional intentions in a unique manner before they make a self-serving attribution. The pattern of brain activity associated with group differences during only the condition in which individuals make an internal attribution following success is consistent with behavior: individuals high in narcissism make more self-serving (internal) attributions following success than individuals low in narcissism.

The interactive effect between narcissism and preceding feedback type on neural activity in response to attribution presentation revealed greater activity in occipital and bilateral temporal cortical regions for high narcissists across preceding feedback types and for negative feedback for low narcissists. These findings reveal that there are no differences between narcissism groups following failure (negative) feedback, but that low narcissists show less activity following positive feedback relative to high narcissists. These results suggest that narcissism influences how individuals process attributions following experiences of success, perhaps due to increased attention and facilitated processing at early stages in high narcissism. However, low narcissists show similar neural enhancement in response to attributions following failure (negative) feedback as do high narcissists. This could be associated with increased activity at early stages of visual processing related to negative information signaling threat (Smith, Cacioppo, Larsen, & Chartrand, 2003). Activity in temporal cortex has been associated with processing of valenced words (Isenberg et al., 1999), and could represent differential processing of attributions among high and low narcissism following positive feedback.

The interactive effect of narcissism and attribution type revealed greater activity in occipital and precuneus regions for high narcissism groups across attribution types (internal and external) as well as for low narcissism with external attributions. Again, enhanced visual processing of attributions seen in precuneus (Kircher et al., 2002) may be related to greater self-referential processing of both internal and external attributions among high narcissists and facilitation for external attributions in low narcissists. There were also independent effects of narcissism on brain activity, evidenced by enhanced activity in occipital cortex for high narcissists following attribution presentation. These findings are consistent the notion that there is enhanced stimulus registration for all attribution stimuli among high narcissists.

Feedback-Related Neural Activity

Another issue related to the examination of narcissism sought to better understand how narcissists process evaluative feedback. ERP results in response to feedback presentation revealed group differences in narcissism from early stimulus registration to later stages of processing. While there were no group differences related to narcissism at 120 ms post-stimulus, there were significant differences in peak latencies, demonstrating earlier peak latencies for high narcissism. Neural activity differed between high and low narcissism groups at 180 ms following feedback presentation, demonstrating enhanced activity for high narcissists in left precuneus, a region associated with attention to verbal stimuli and self-relevant trait evaluation (Cavanna & Trimble, 2006; Kircher et al., 2002). Greater activity in left precuneus could be greater due to greater attention to feedback among narcissists. Based on these results, it is also possible to speculate that individuals high in narcissism are processing the feedback as more self-relevant than low narcissists. The interactive effect of narcissism group and feedback type at 375 ms revealed that the neural activity in left temporal cortex for high narcissists subsequent to negative feedback differed from that of low narcissists in response to negative feedback and low narcissists in response to either positive or negative feedback. Activity in left temporal cortex is associated with verbal encoding (Kelley, et al., 1998), and could be interpreted as enhanced verbal encoding for negative feedback in high narcissism. Activity in left temporal cortex differed as a function of narcissism group 460 ms following feedback, demonstrating greater activity for individuals high in narcissism. Again, activity in this region suggests enhanced processing of verbal information for those higher in narcissism.

There were also influences of feedback type apparent in neural activity from early to later stages of stimulus processing. Neural activity differed between positive and negative feedback at 120 ms following feedback presentation, demonstrating enhanced activity following negative feedback in left medial temporal cortex, a region associated with attention to words at early stages of visual processing (Kuriki, Takeuichi, & Hirata, 1998). These findings corroborate with previous research, demonstrating valenced words elicit differential neural response in medial temporal regions including left parahippocampal/lingual gyrus, fusiform gyrus, and left amygdala indicating danger or threat (Isenberg et al., 1999). There is also evidence for a negativity bias at early stages of visual processing (Smith, Cacioppo, Larsen & Chartrand, 2003). However, left temporal cortex activity was also found 375 ms and 460 ms following feedback, showing greater activity following positive feedback. Left medial temporal cortex is associated with word encoding (Kelley et al., 1998), and differences in neural activity suggest enhanced word encoding for positive feedback.

Is the Self-Serving Bias an Automatic Process?

One of the goals of the present research sought to determine whether the self-serving bias is an automatic process. Automatic processes vary in the degree to which they are uncontrollable, efficient, and unconscious responses to stimuli (Bargh, 1997). Self-serving attributions are certainly not made outside of awareness, as the experiences of success and failure are salient parts of the experimental manipulations examining these attributional biases. However, there is a possibility that the experiences of success and failure individuals experience in everyday life consciously prime individuals to internalize their own behavior as reflective of dispositional traits. If an individual consistently and repeatedly makes trait inferences about their own successes over time, the resulting practice effect of these dispositional inferences reflects a type of proceduralization (Smith & Lerner, 1986). For instance, making internal attributions following experiences of success results in proceduralization and/or practice effects relating to self-esteem maintenance and self-enhancement processes. Perhaps narcissists are the most ideal case of proceduralized judgments about the self: they consistently attribute their own success and the success of those with which they are associated to their own abilities. If some self-serving attributions reflect automatic dispositional inferences, then are non self-serving attributions reflective of controlled processes? Situational attributions may reflect more deliberate and controlled processing, according to some proponents of stages models of attribution. These models include both a spontaneous, automatic inference that is followed by a more controlled attribution that takes additional information into account.

Several models of attributional processes suggest that there are both automatic and controlled components in making causal attributions. According to several stage models of the attribution process, dispositional inferences are made spontaneously and situational inferences follow as the result of a more deliberate correction process (Fiske & Taylor, 2008). Trope developed a two-stage model of attribution composed of an initial automatic identification phase in which individuals use information about an actor's immediate behavior, the situation in which it occurs, and other information that is relevant to the actor's disposition (Trope, 1986). This phase is followed by another stage in which situational expectancies are subtracted from the implied dispositional information by the identified behavior. This subtractive rule utilizes situational information to attenuate or augment the value of behavior and influence dispositional inferences in one direction or another. In one study by Trope (1986), individuals saw ambiguous or unambiguous emotional facial reactions to different situations and were asked to identify the facial expression or infer the disposition of the individual. Individuals could identify the unambiguous facial expressions when given situational information, and situational information biased the identification of ambiguous faces as expressing anger in a situation justified by a provocation.

Another stage model of attribution processes by Gilbert (1998) consists of three stages. The first stage is the categorization stage in which the individual utilizes information about a relevant behavior. The second stage is the characterization stage, in which individuals attribute dispositional qualities to the action. The final stage is called the correction stage in which other sources of information (including situational information) is used to discount or facilitate the initial dispositional attribution. Gilbert, Pelham, and Krull investigated whether cognitive load would affect more controlled situational attributions, preventing individuals from correcting their automatic dispositional attributions (1988). Their findings revealed that individuals who were in the busy condition were unable to use situational information in contrast with individuals who were not busy and utilized situational information.

According to these models of attribution, individuals would make more internal, dispositional attributions under situations that impose greater cognitive load. However, these models refer to dispositional and situational inferences made about other individuals rather than the self. The self-serving bias involves individuals making both dispositional and situational attributions about the self that are motivated to present them in the most positive light. So would increasing cognitive load result in individuals making more self-serving attributions or result in individuals making more internal, dispositional attributions? The experimental parameters of this investigation require individuals to make attributions under time-constrained circumstances due to the nature of the continuous computer task. The results of this study and previous investigations using the same paradigm have shown that individuals consistently make more self-serving attributions overall, and do not make more internal relative to external attributions. More importantly, the fact that individuals make more self-serving attributions alone does not provide support that this is an automatic process. However, under circumstances of increased urgency and cognitive load as are apparent during this task, individuals make self-serving attributions. Measuring response times during self-serving and non self-serving attributions was employed in order to detect whether self-serving attribution responses occurred faster than non-self serving attributions. The data did not support this prediction, with the exception that individuals high in narcissism made faster self-serving attributions in response to failure. In addition, brain activity in specific networks has been argued to coincide with automatic and controlled processing. Lieberman (2007) developed a model of neural correlates related to controlled and automatic processing, arguing that controlled and automatic processes activate unique neural circuitry. One of the regions argued to be associated with controlled processes is the dorsomedial prefrontal cortex (dmPFC). In a previous investigation of the self-serving bias, non self-serving attributions were associated with dmPFC activity (Krusemark, Campbell, & Clementz, 2008). The present research, however, did not reveal neural activity in dmPFC related to non self-serving attributions. Self-serving attributions following negative feedback and non self-serving attributions following both negative and positive feedback were associated with greater activity in occipital, bilateral temporal, and left superior parietal cortical regions relative to self-serving (internal) attributions following positive feedback. These findings do not support the notion that self-serving attributions are more automatic, but reveal a distinction in brain activity between biased attributions following success. It is probable that individuals attend to the attributions more preceding biased attributions following threat (failure) than preceding a biased attribution following success. Based on these same findings, individuals also attend to the attributions more preceding unbiased attributions. An interesting finding resulting from this investigation is the difference in behavior and brain activity related to self-serving attributions in response to success among high and low narcissists.

Unique Brain Activity and Behavior Associated with Narcissism

As stated previously, past research has shown the strong tendency for narcissists to show a self-enhancement bias relative to others low in narcissism (John & Robins, 1994). Individuals low and moderate in narcissism showed a self-diminishment bias or no bias in self-ratings at all (John & Robins, 1994). Narcissists are more likely to overestimate their abilities and performance on tasks (Robins & Beer, 2001; Farwell & Wohlwend-Lloyd, 1998; Gosling, John, Craik, & Robins, 1998; John & Robins,1994), and the present research shows support for these conclusions. Individuals high in narcissism were more likely to make self-serving attributions following success than those low in narcissism. In addition, narcissists demonstrated unique neural activity in response to the attributions as well as to the positive and negative feedback during the facial working memory task. This is some of the first evidence that narcissists show differences in brain activity in an evaluative context, as well as show distinctive behavior related to the self-serving bias. While the response times and neural activity do not support the notion that narcissists exhibit more automatic processing related to self-serving attributions, the results of this study converge with previous conclusions that narcissism is associated with self-regulatory strategies used for purposes of self-enhancement. These findings are just the beginning of a line of research that can shed light on the unique behavior and cognitive processing related to narcissism, and future studies examining the social, cognitive and neural mechanisms related to narcissism will add to the current literature.

Conclusions

In conclusion, the self-serving bias was apparent among all individuals during the task, and specific self-serving attributions following success had unique influence over brain activity. Narcissists showed a stronger tendency to make a biased attribution following the experience of success, and this was accompanied by a different pattern of brain activity relative to those lower in narcissism. Individuals low in narcissism demonstrated activity in neural circuitry involved in stimulus encoding, evaluative processing, and self-relevant information processing, suggesting deeper processing preceding a biased attribution following success relative to those high in narcissism. Narcissists exhibited enhanced neural activity to the feedback itself, evidence of preferential processing of evaluative information. These findings may indicate that narcissism modulates brain activity in response to valenced feedback and leads to different attributions as a result. This research provides additional information regarding the self-serving bias and the processes underlying the responses among those high and low in narcissism and aids in understanding the mechanisms associated with the interaction between cognition and personality.

Figure Captions

Figure 1. Example trial for Facial Working Memory Task.

Figure 2. Overall Attribution responses for Task (N=40).

Figure 3a. Attribution responses for Low narcissism group (n=20).

Figure 3b. Attribution responses for High narcissism group (n=20).

Figure 4a. Response times for Low narcissism group.

Figure 4b. Response times for High narcissism group.

Figure 5. Top meridian projections for face stimuli (averaged over target, distractor, and probe faces) at 120 milliseconds (ms) and 180 ms after stimulus onset.

Figure 6a. Butterfly plot for Attribution presentation (ERPs over all sensors, 500 ms baseline). Epoch includes score presentation for 500 ms (onset: 0 ms), followed by fixation presentation for 300 ms (onset: 500 ms). Attribution presentation (onset: 800 ms). Peaks identified by red arrows indicate peaks of interest for sensors space analyses.

Figure 6b. Effect of Narcissism (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown on the left. Clusters of sensors with significant results (main effect of narcissism in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-group difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6c. Effect of Feedback (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown to the left. Clusters of sensors with significant results (main effect of feedback in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6d. Effect of Narcissism and Feedback (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown to the left. Clusters of sensors with significant results (narcissism by feedback interaction in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-and within-group differences in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6e. Effect of Attribution type (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown to the left. Clusters of sensors with significant results (main effect of attribution in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition differences in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6f. Effect of Narcissism and Attribution type (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown to the left. Clusters of sensors with significant results (narcissism by attribution interaction in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-group and within-condition differences in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6g. Effect of Feedback and Attribution type (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown at the top left. Clusters of sensors with significant results (feedback by attribution interaction in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading at the top right, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition differences in scalp topographies is shown at the bottom for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 6h. Effect of Narcissism, Feedback, and Attribution type (in response to Attribution presentation) on neural activity. Topographies at the second peak in response to the attribution are shown at the top left. Clusters of sensors with significant results (narcissism by feedback by attribution interaction in 3-way ANOVA) 200 ms post-stimulus, indicated in gray shading in two the top right figures, mean and standard error voltages in those clusters between high and low narcissism groups are shown in the bar chart. The sLORETA estimated location of neural activity generating the between-group and within-condition differences in scalp topographies is shown at the bottom for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7a. Butterfly plot for Feedback presentation (ERPs over all sensors, 100 ms baseline). Epoch includes feedback presentation for 500 ms (onset: 0 ms). Peaks identified by red arrows indicate peaks of interest for sensors space analyses.

Figure 7b. Effect of Feedback (in response to Feedback presentation) on neural activity. Topographies at the first peak in response to the feedback are shown to the left. Clusters of sensors with significant results (main effect of feedback in 2-way ANOVA) 120 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7c. Effect of Narcissism (in response to Feedback presentation) on neural activity. Topographies at the second peak in response to the feedback are shown to the left. Clusters of sensors with significant results (main effect of narcissism in 2-way ANOVA) 180 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-group difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7d. Effect of Feedback (in response to Feedback presentation) on neural activity. Topographies at the third peak in response to the feedback are shown to the left. Clusters of sensors with significant results (main effect of feedback in 2-way ANOVA) 375 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7e. Effect of Narcissism and Feedback (in response to Feedback presentation) on neural activity. Topographies at the third peak in response to the feedback are shown at the top left. Clusters of sensors with significant results (narcissism by feedback interaction in 2-way ANOVA) 375 ms post-stimulus, indicated in gray shading in the top right figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-group and within-condition differences in scalp topographies is shown at the bottom for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7f. Effect of Narcissism (in response to Feedback presentation) on neural activity. Topographies at the fourth peak in response to the feedback are shown to the left. Clusters of sensors with significant results (main effect of narcissism in 2-way ANOVA) 460 ms post-stimulus, indicated in gray shading in the middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the between-group difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

Figure 7g. Effect of Feedback (in response to Feedback presentation) on neural activity. Topographies at the fourth peak in response to the feedback are shown to the left. Clusters of sensors with significant results (main effect of Feedback in 2-way ANOVA) 460 ms post-stimulus, indicated in gray shading in middle figure, mean and standard error voltages in those clusters shown in bar chart. The sLORETA estimated location of neural activity generating the within-condition difference in scalp topographies is shown to the right for axial, sagittal, and coronal views on an averaged brain used for source estimation.

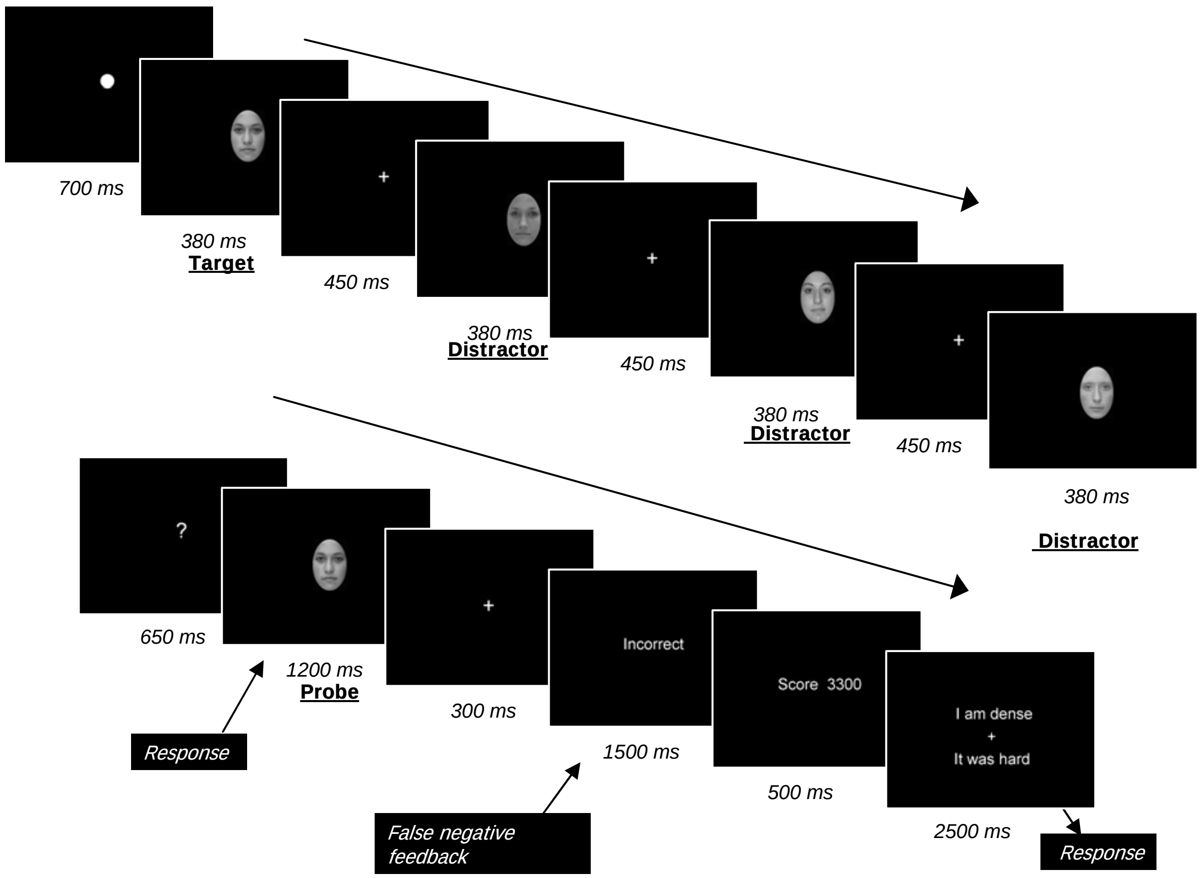
700 ms
380 ms
Target
450 ms
380 ms
Distractor
450 ms
380 ms
Distractor
450 ms
380 ms
Distractor
?
650 ms
1200 ms
Probe
Response
300 ms
Incorrect
1500 ms
False negative feedback
Score 3300
500 ms
I am dense
+
It was hard
2500 ms
Response

Figure 1.

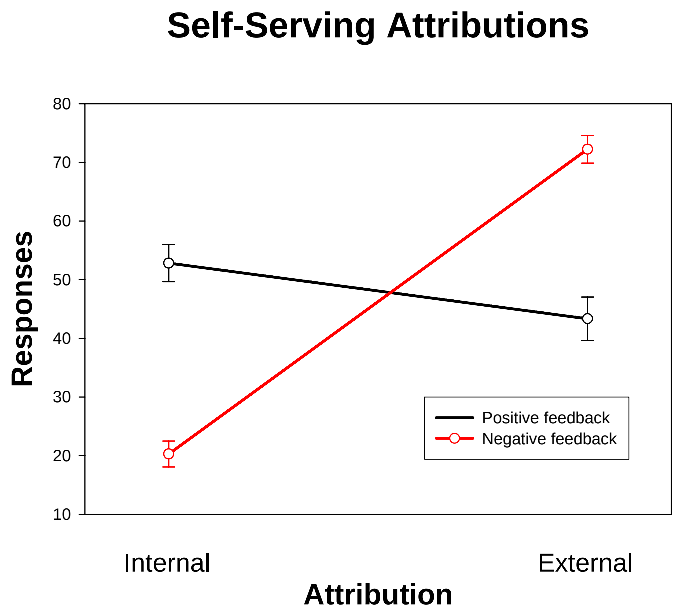

Figure 2.

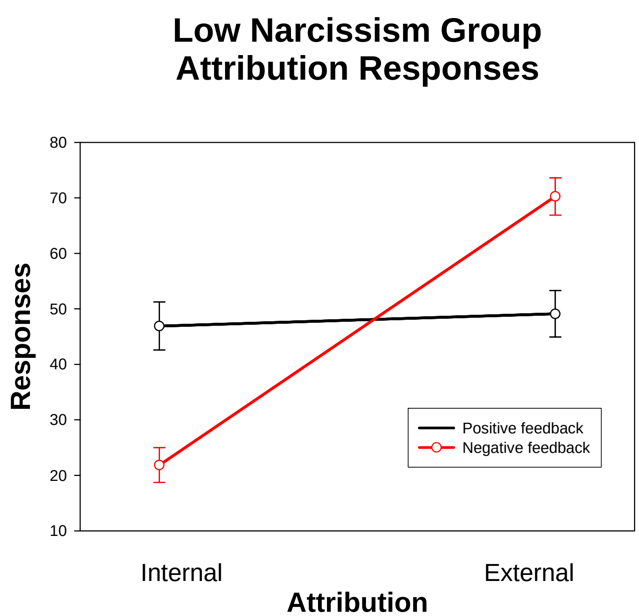

Figure 3a.

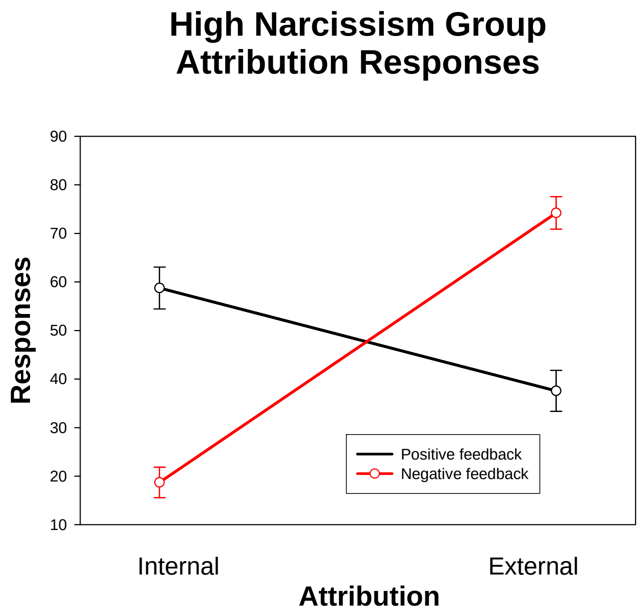

Figure 3b.

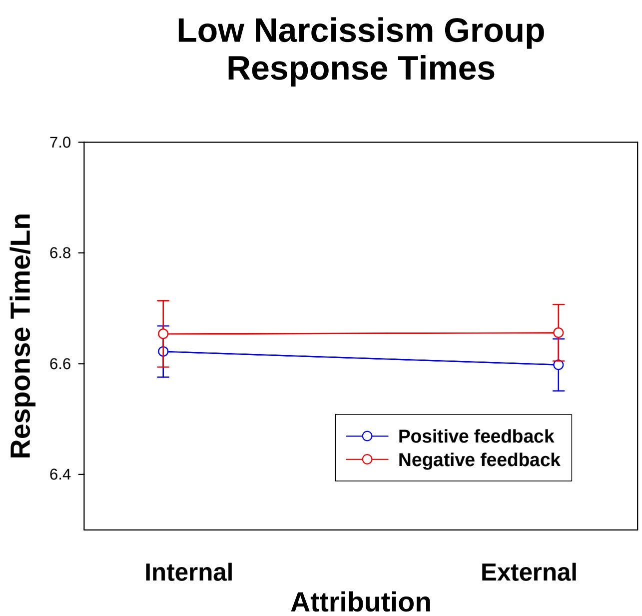

Figure 4a.

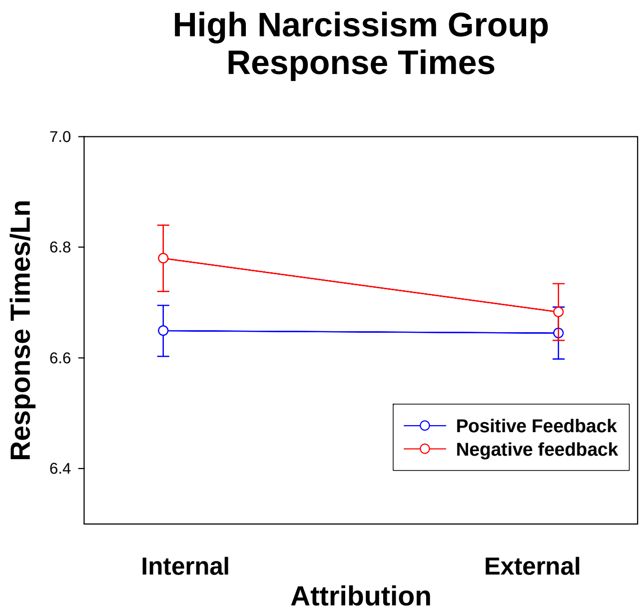

Figure 4b.

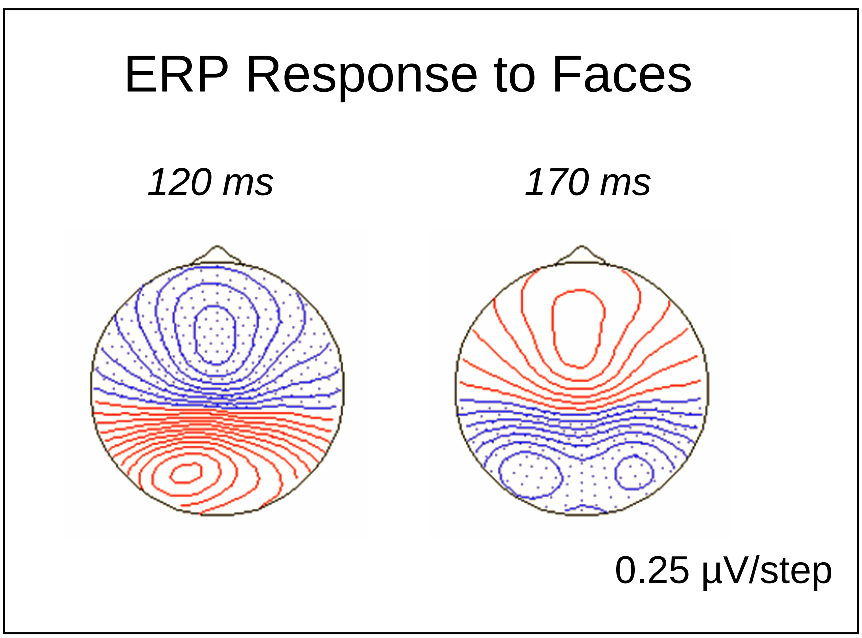

Figure 5.

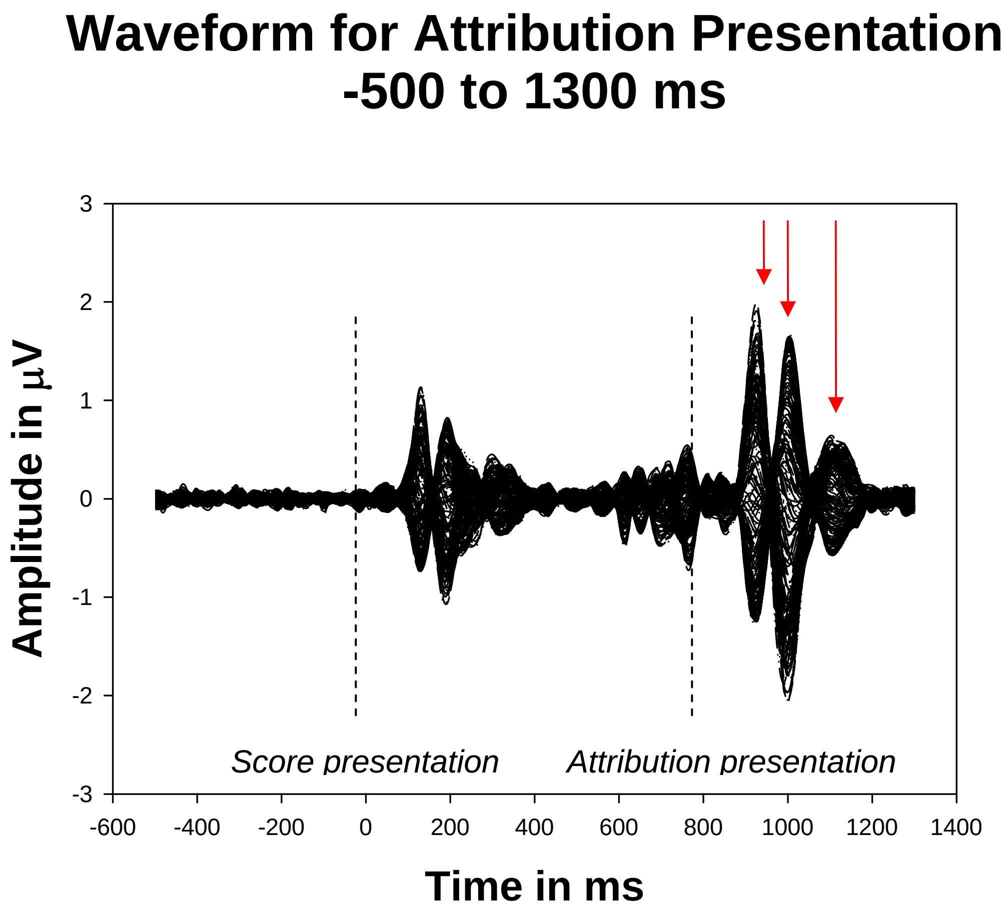
Waveform for Attribution Presentation
-500 to 1300 ms
Amplitude in µV
Time in ms
Score presentation
Attribution presentation
3
2
1
0
-1
-2
-3
-600
-400
-200
0
200
400
600
800
1000
1200
1400

Figure 6a.

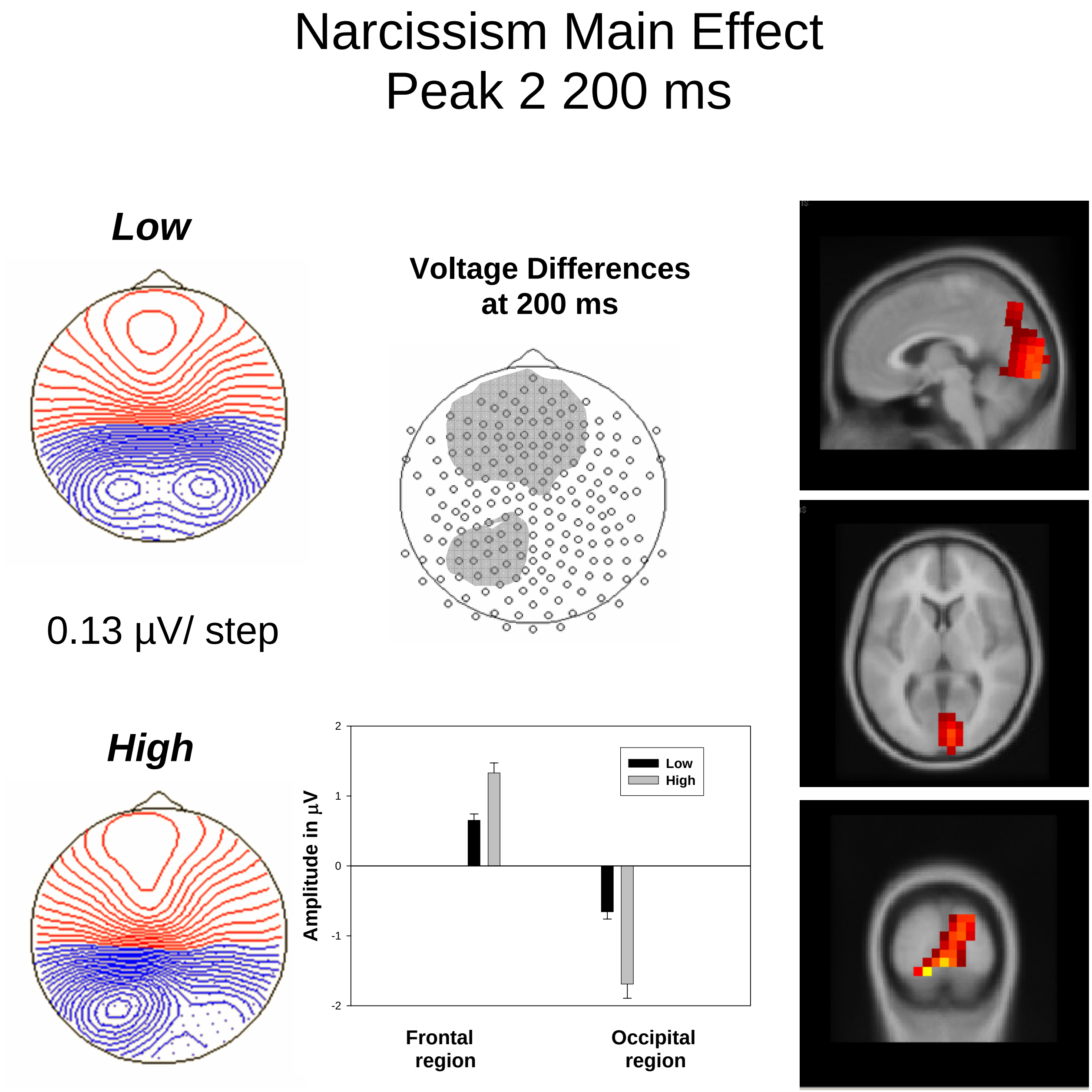
Narcissism Main Effect
Peak 2 200 ms
Low
0.13 µV/ step
High
Voltage Differences
at 200 ms
Amplitude in µV
2
1
0
-1
-2
Low
High
Frontal
region
Occipital
region

Figure 6b.

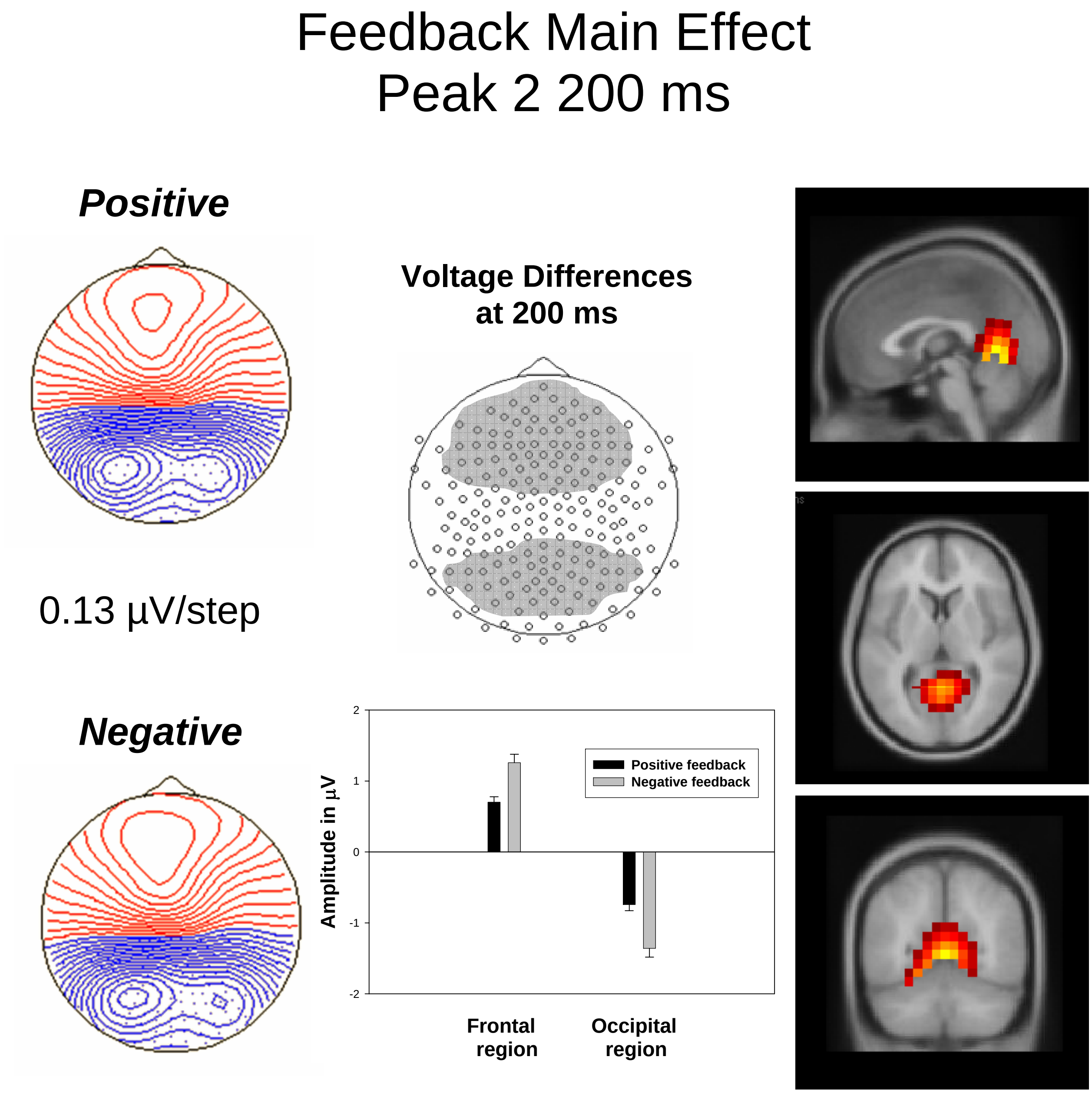
Feedback Main Effect
Peak 2 200 ms
Positive
0.13 µV/step
Negative
Voltage Differences
at 200 ms
Positive feedback
Negative feedback
Amplitude in µV
2
1
0
-1
-2
Frontal
region
Occipital
region

Figure 6c.

Narcissism by Feedback Interaction
Peak 2 200 ms

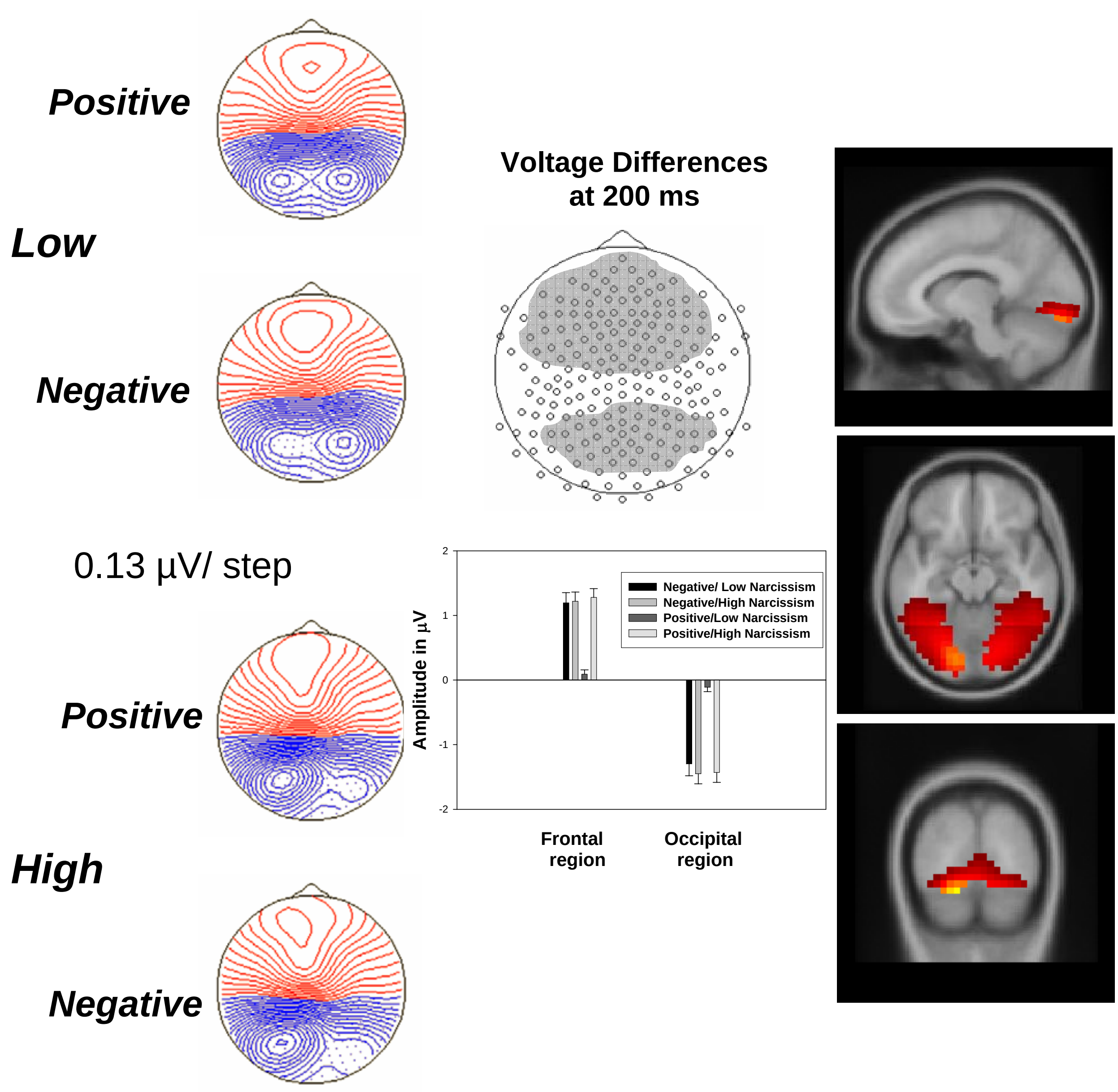

Figure 6d.

Attribution Main Effect
Peak 2 200 ms

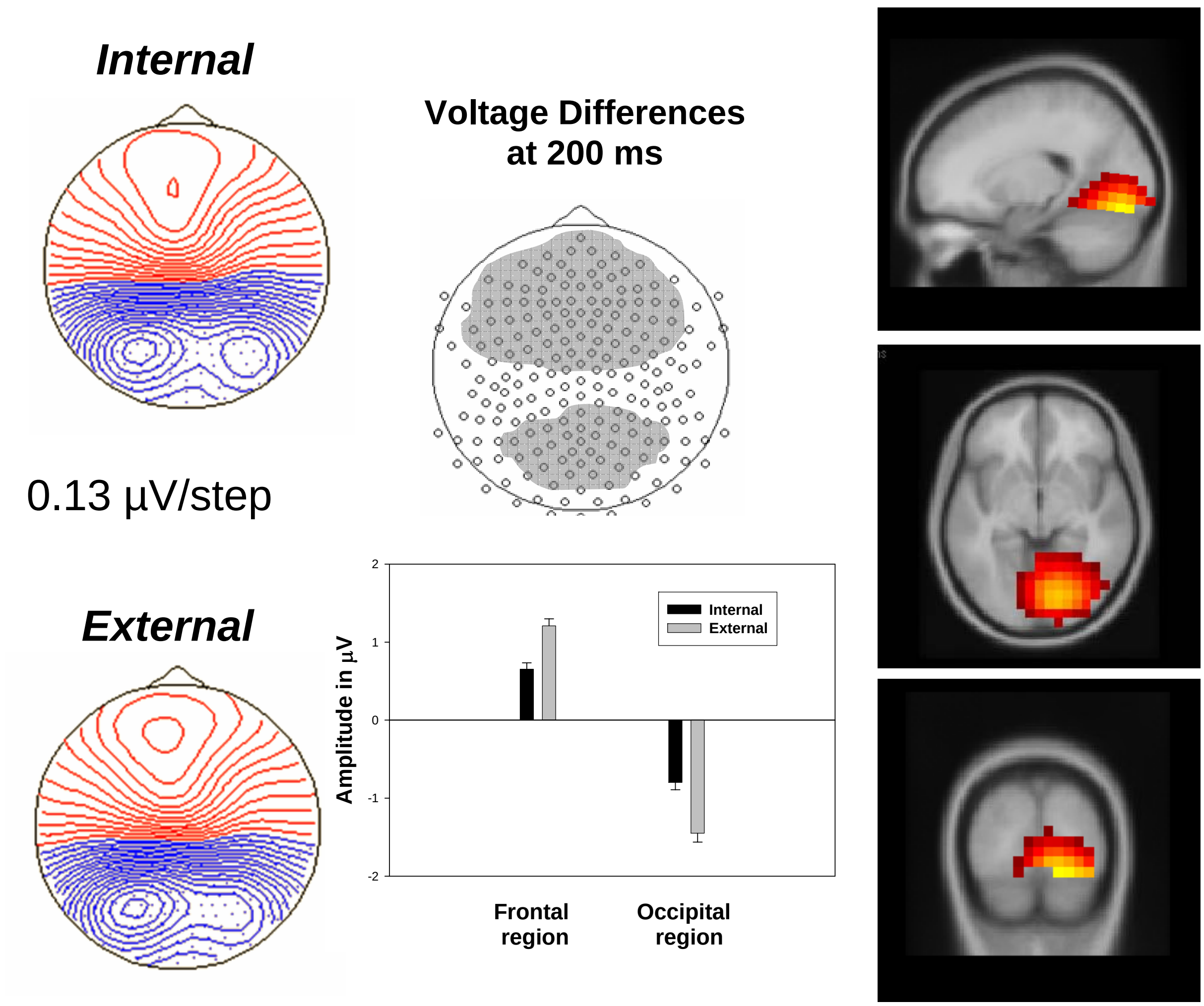

Figure 6e.

Narcissism by Attribution Interaction
Peak 2 200 ms

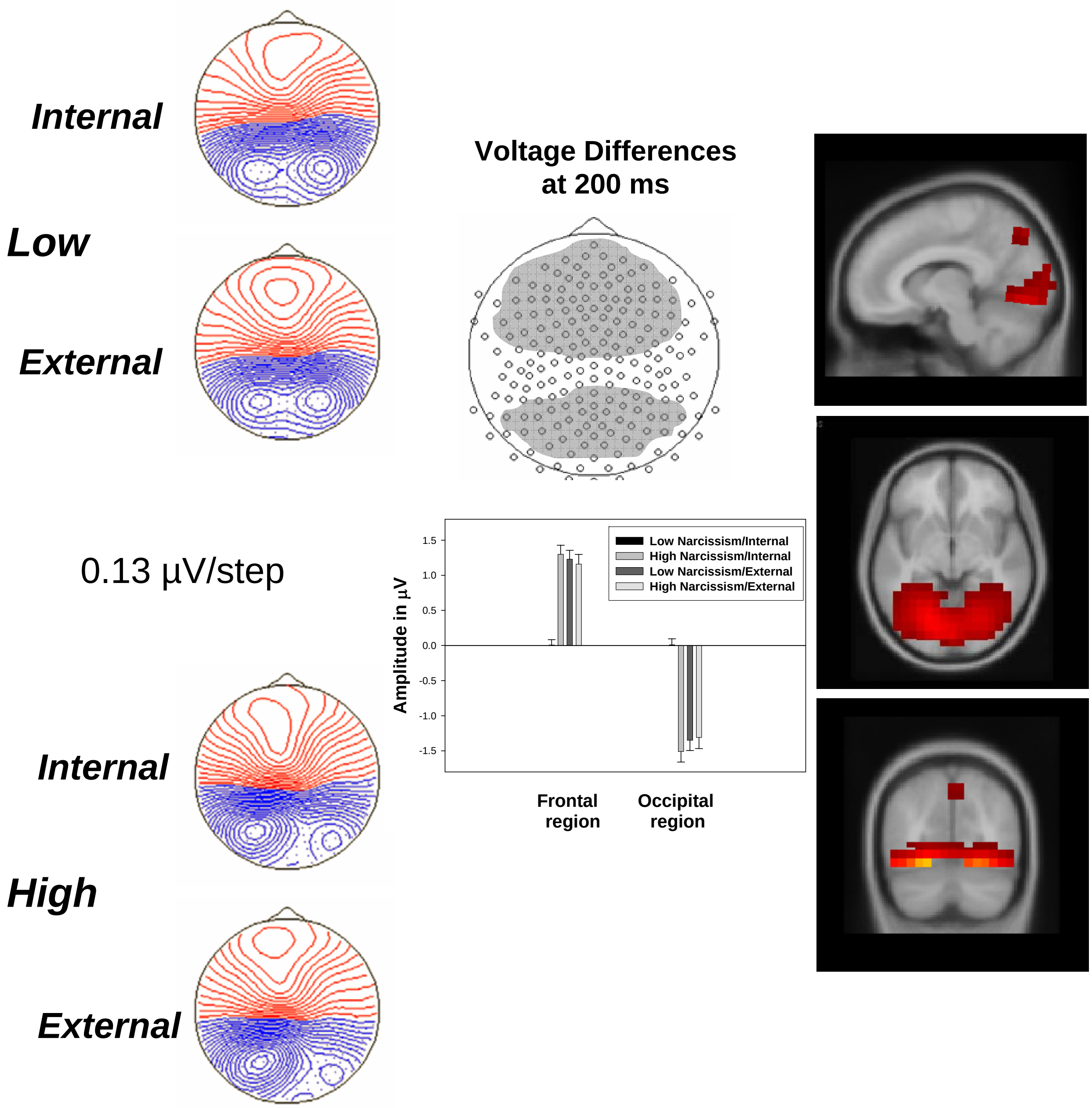

Figure 6f.

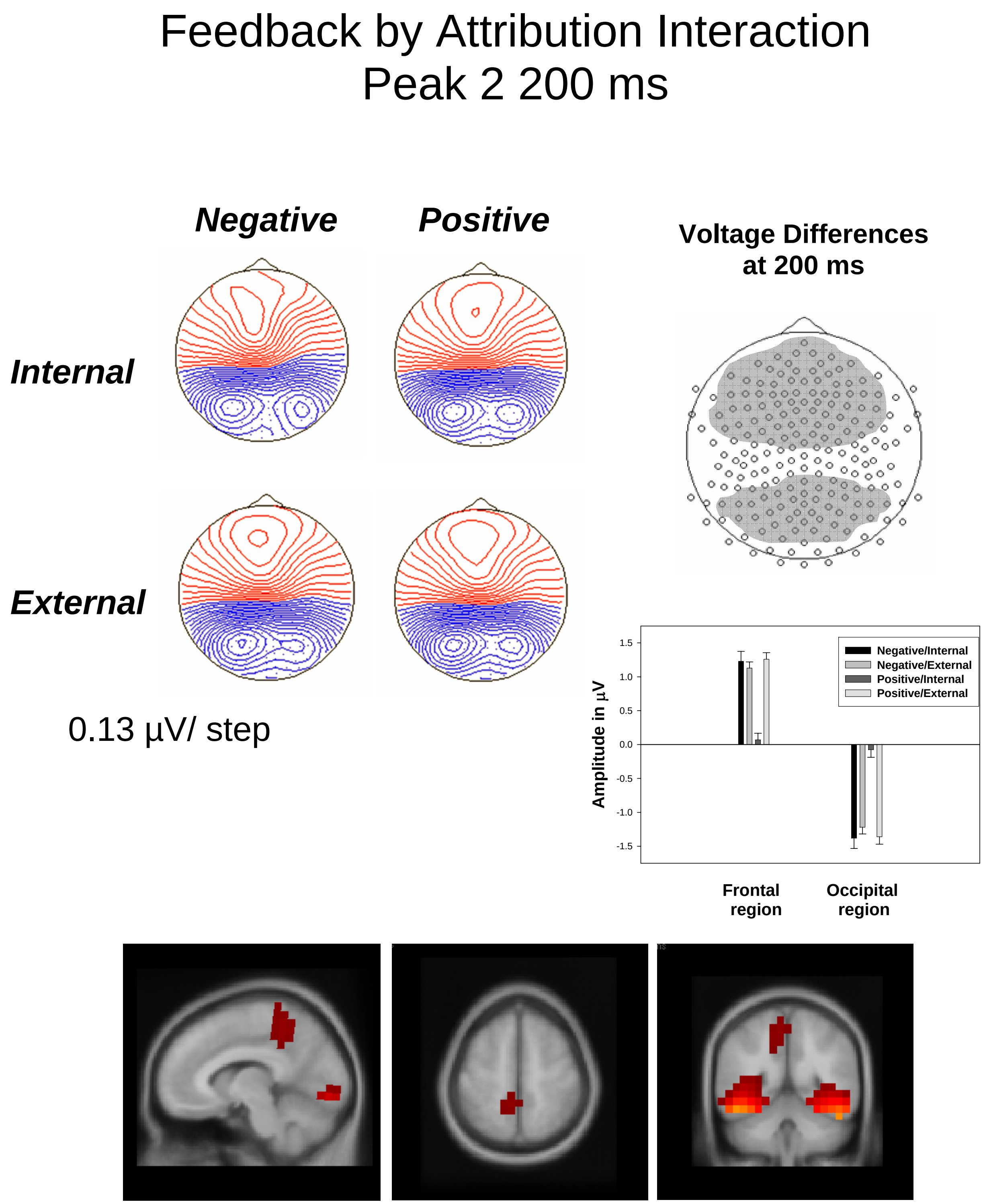
Feedback by Attribution Interaction
Peak 2 200 ms
Negative
Positive
Internal
External
0.13 µV/ step
Voltage Differences
at 200 ms
Negative/Internal
Negative/External
Positive/Internal
Positive/External
Amplitude in µV
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
Frontal region
Occipital region

Figure 6g.

3 way Interaction
(Narcissism by Feedback by Attribution)
Peak 2 200 ms

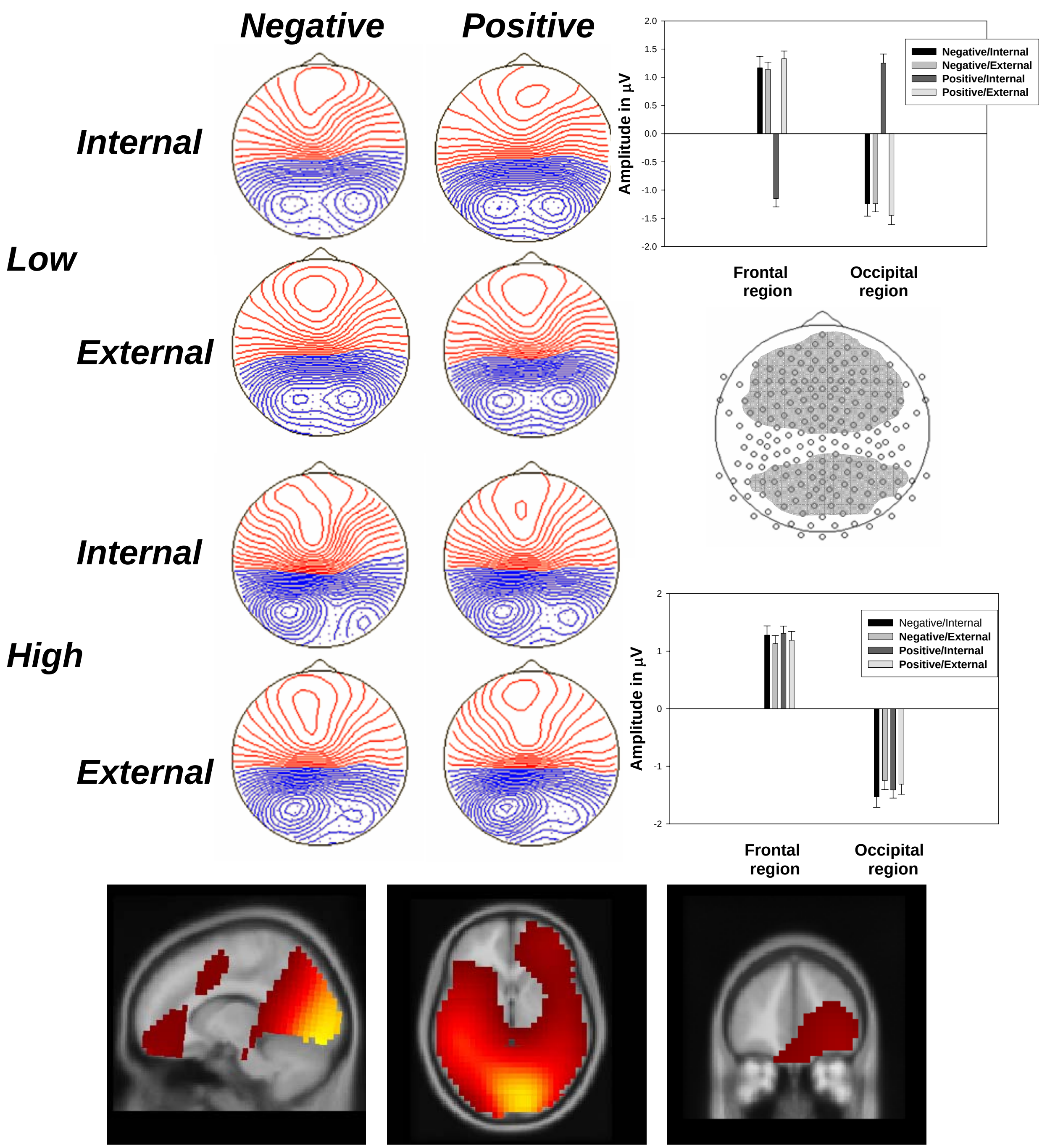

Figure 6h.

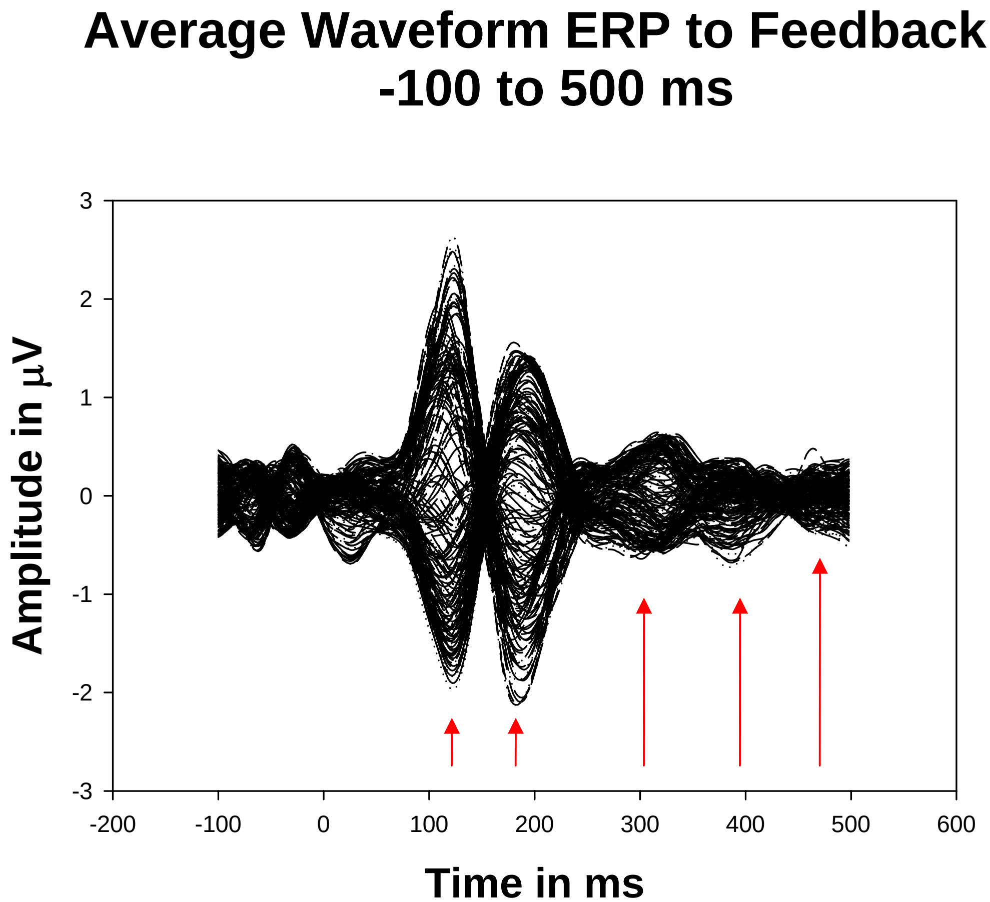
Average Waveform ERP to Feedback
-100 to 500 ms
Amplitude in μV
3
2
1
0
-1
-2
-3
-200
-100
0
100
200
300
400
500
600
Time in ms

Figure 7a.

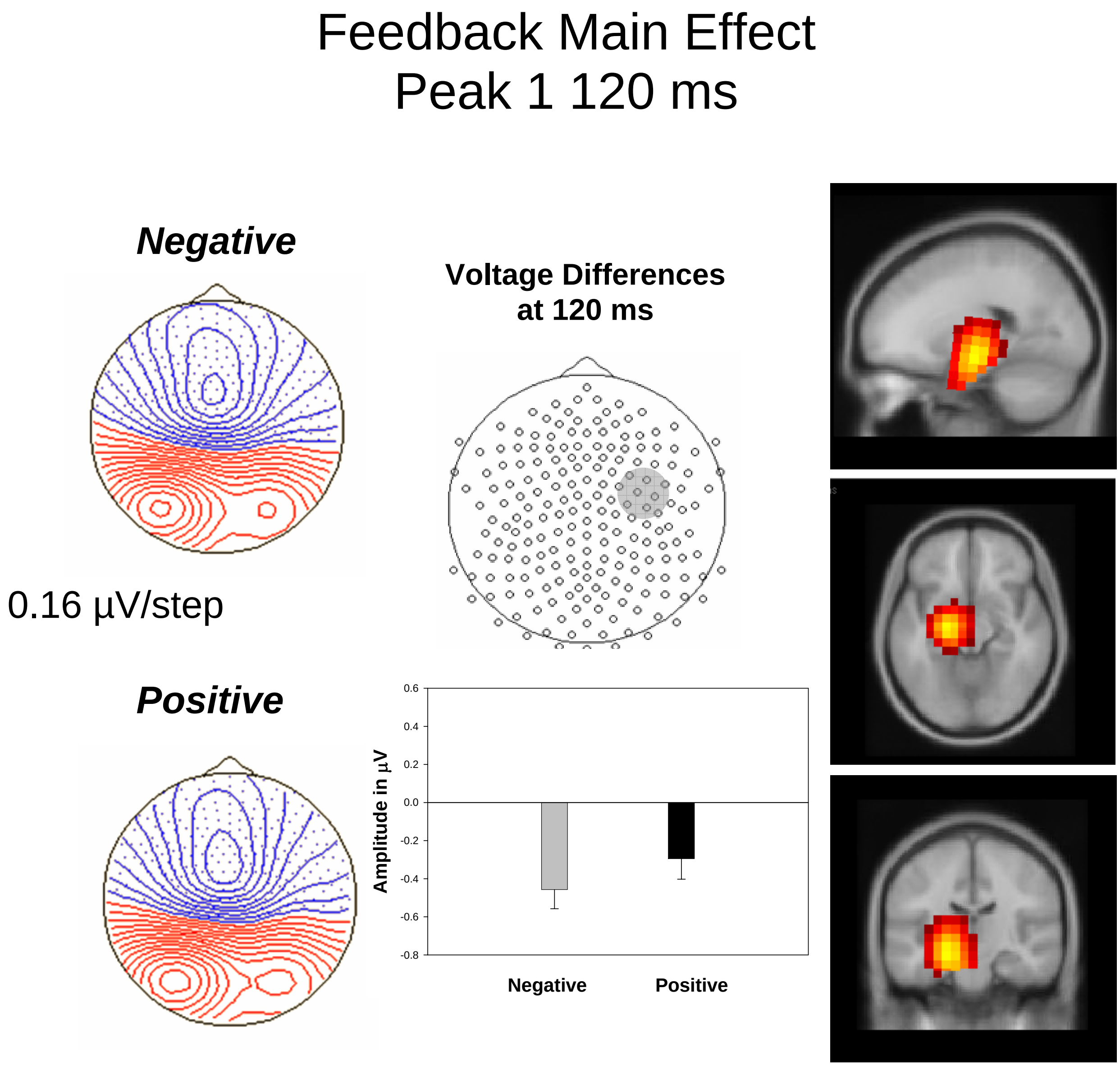
Feedback Main Effect
Peak 1 120 ms
Negative
0.16 µV/step
Positive
Voltage Differences
at 120 ms
Amplitude in µV
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
Negative
Positive

Figure 7b.

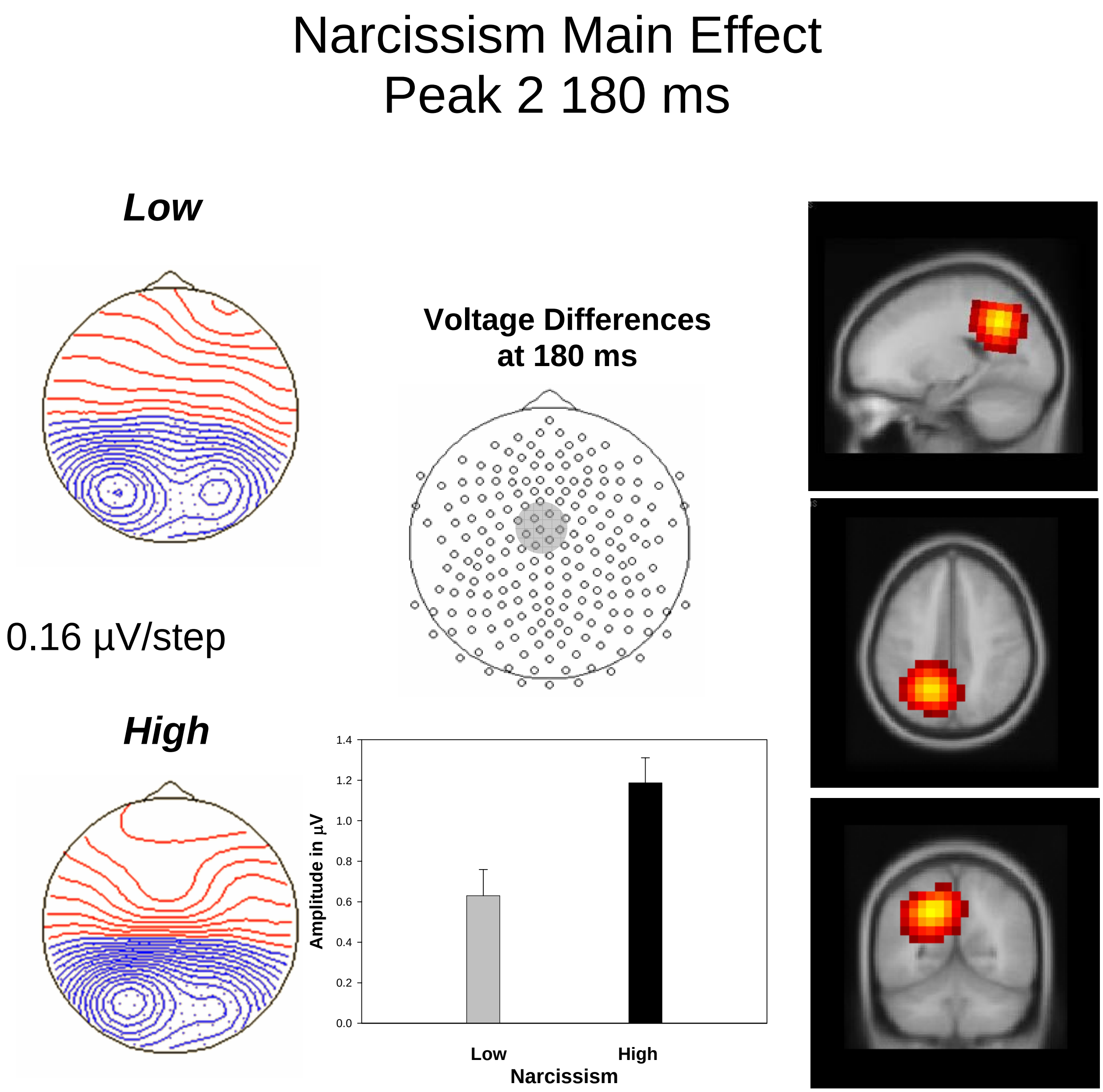
Narcissism Main Effect
Peak 2 180 ms
Low
0.16 µV/step
High
Voltage Differences
at 180 ms
Amplitude in µV
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Low
High
Narcissism

Figure 7c.

Feedback Main Effect
Peak 4 375 ms

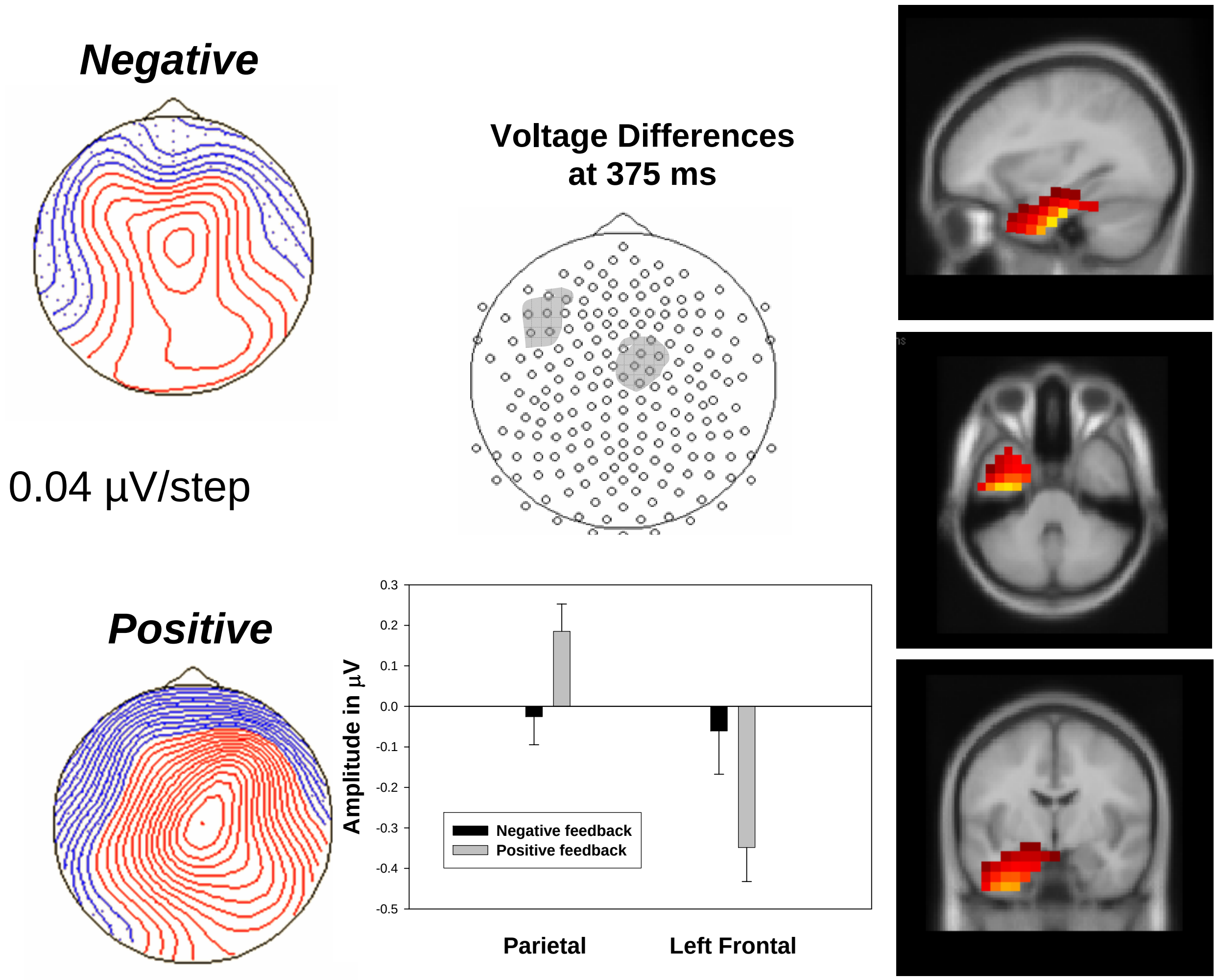

Figure 7d.

Feedback by Narcissism Interaction
Peak 4 375 ms

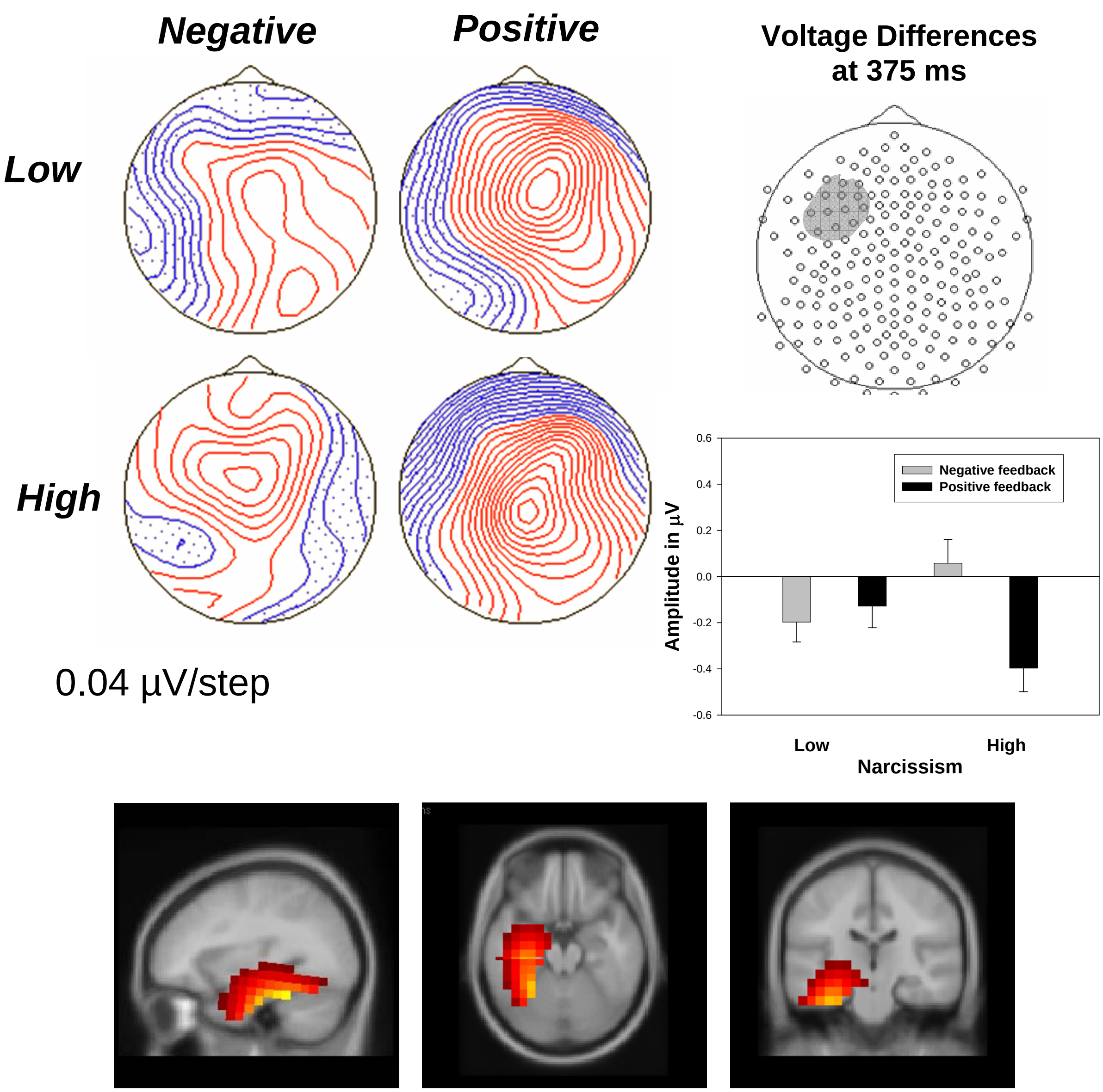

Figure 7e.

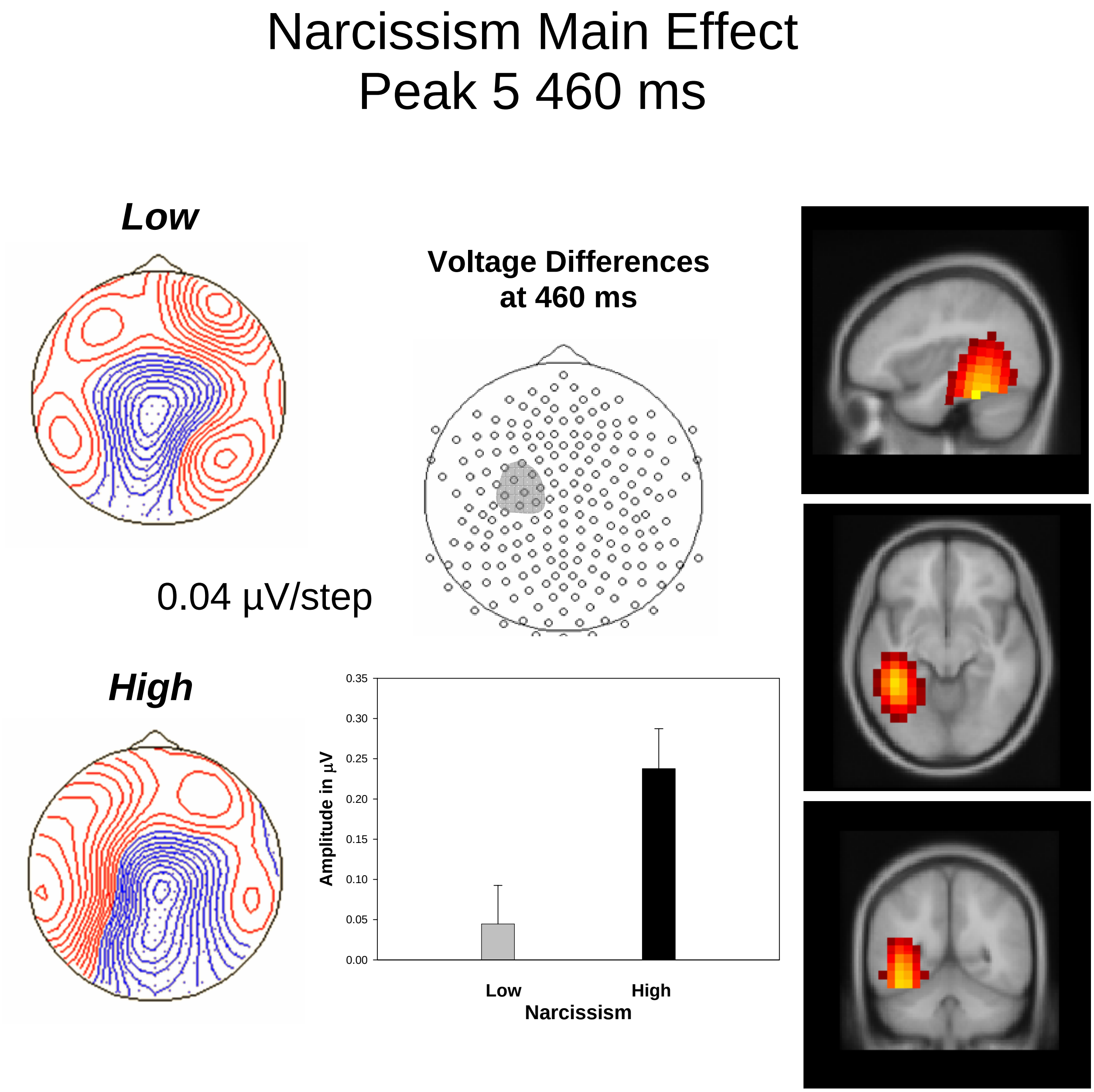
Narcissism Main Effect
Peak 5 460 ms
Low
Voltage Differences
at 460 ms
0.04 µV/step
High
Amplitude in µV
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Low
High
Narcissism

Figure 7f.

Feedback Main Effect
Peak 5 460 ms

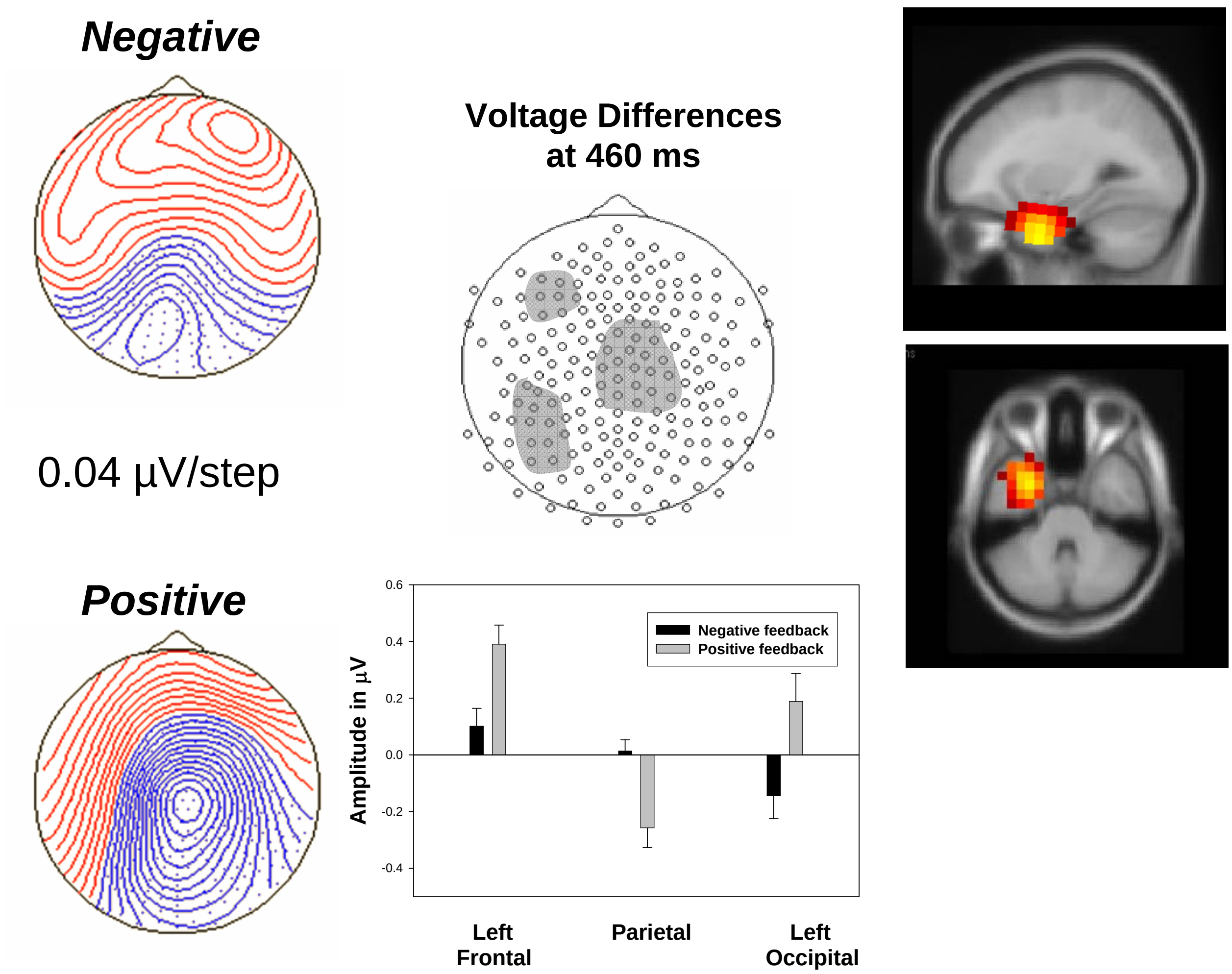

Figure 7g.

Table 1. Mean and standard deviations for Attribution responses during Facial Working Memory Task.

		Narcissism					
Feedback	Attribution Type	Low		High		Group Difference	
		M	*SD*	*M*	*SD*	*t*	*p*
Positive	Internal	46.9	20.9	58.8	17.5	-1.94	.06†
Positive	External	49.1	20.2	37.6	17.2	1.95	.06†
Negative	Internal	21.9	16.2	18.7	11.4	.711	.482
Negative	External	70.3	16.7	74.2	13.1	-.833	.410

†Between groups Simple effect shows trend.

Table 2. Peak latencies of Event related potentials in response to Attribution Presentation.

		Narcissism											
Feedback	Attribution Type	Low		High		Low		High		Low		High	
		Peak 1 120 ms				Peak 2 200 ms				Peak 3 320 ms			
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Positive	Internal	118.6	17.1	108.7	14.4	189.5	12.1	195.1	14.8	309.5	21.2	305.3	6.4
Positive	External	122.5	13.3	115.0	13.9	193.3	15.3	190.4	21.7	311.4	30.8	303.5	23.7
Negative	Internal	124.1	15.9	111.9	16.6	189.6	12.4	194.4	16.5	319.1	21.4	305.8	20.3
Negative	External	124.2	12.5	111.1	14.9	189.3	13.3	192.1	12.4	315.7	19.7	313.0	22.5

Table 3. Peak latencies of Event related potentials in response to Feedback Presentation.

	Narcissism																			
Feedback	Low		High		Low		High		Low		High		Low		High		Low		High	
	Peak 1 120 ms				Peak 2 180 ms				Peak 3 300 ms				Peak 4 375 ms				Peak 5 460 ms			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Positive	125.0	10.9	116.6	8.3	182.0	14.7	179.9	14.2	293.0	22.9	297.3	13.6	373.1	67.9	377.4	65.2	453.9	19.6	460.5	14.4
Negative	126.0	11.3	117.7	11.1	193.0	12.9	182.0	14.5	305.1	17.0	302.0	14.6	360.8	19.3	362.0	16.9	459.0	16.7	461.7	16.2

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