



Neural systems of social comparison and the “above-average” effect

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ABSTRACT

Extant neural models of self-evaluation are dominated by associations with medial prefrontal cortex (MPFC) and posterior cingulate cortex (PCC) function and have mostly been developed from studies differentiating self-evaluation from evaluation of other people. Although self-evaluation is robustly characterized by systematic biases, current neural models of self-evaluation cannot speak to their neurobiology because of a lack of research. The few extant studies have made claims about associations between bias and ventral anterior cingulate cortex (vACC) function but have confounded bias with the valence of experimental stimuli. In study 1, fMRI was used to examine the neurobiology of the “above-average” effect, a robust self-evaluation bias. The majority of people judge their personality to be more desirable (i.e., more positive and less negative traits) than their peers’ personalities. MPFC and PCC were significantly more activated by a condition that reduced susceptibility to “above-average” judgments. However, MPFC and PCC activity were not modulated by individual differences in “above-average” judgments. VACC activity distinguished positive from negative valence but did not predict individual differences in “above-average” judgments. Instead, the extent to which participants viewed themselves as “above average” was negatively correlated with orbitofrontal cortex (OFC) and, to a lesser extent, dorsal anterior cingulate cortex (dACC) activation. A complementary study found that mental load increases “above-average” judgments (study 2). These findings are the first to directly examine the neural systems involved in social judgment bias and have implications for the association between frontal lobe dysfunction and poor insight.

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Neural research on the self has mostly focused on identifying neural regions that are used to evaluate social targets such as the self or other people (for a review, see Ochsner et al., 2005; Uddin et al., 2007). These studies most often associate self-judgment with medial prefrontal cortex (MPFC) and posterior cingulate cortex (PCC) activity (e.g., Johnson et al., 2002; Kelley et al., 2002; Moran et al., 2006 and see Ochsner et al., 2005 for a review). While these studies provide an important foundation of knowledge for developing neural models of social cognition, they do not address a central feature of self-evaluation. Specifically, self-evaluations tend to be flawed. These flaws are not random errors. Instead, decades of behavioral research have shown that self-evaluations are predictably more positive than indicated by external criteria (Alicke, 1985; Chambers and Windschitl, 2004; Dunning et al., 1989; Taylor and Brown, 1988). Furthermore, self-evaluations are most susceptible to inflated positivity; judgments of most other people often do not show such an effect (Epley and Dunning, 2000; Suls et al., 2002a). Therefore, understanding the neural systems that underlie these biases is necessary for gaining a more complete picture of how the brain computes social judgments about the self. For example, studies of the neurobiology of the optical

illusions that characterize normative human vision have deepened both neural and psychological models of vision (Eagleman, 2001). By the same token, research on the neurobiology of the self-flattering nature known to normatively characterize self-evaluation is an important complement to current research on the neural systems supporting social judgments (Beer, 2007).

Researchers have characterized numerous ways in which self-evaluations tend to be self-flattering (Alicke, 1985; Chambers and Windschitl, 2004; Dunning et al., 1989; Taylor and Brown, 1988). One of the most robust examples is the “above-average” effect in social comparison (i.e., how the self compares to other people). People often assess how they measure up to their peers whether it be at school, work, or any other number of social environments (Kruglanski and Mayselless, 1990; Suls et al., 2002b). The majority of people report that they have more desirable traits and fewer undesirable traits than their average peer. Although each individual is likely to have some unique characteristics, it is unlikely that so many people in a random sample would be significantly more desirable than an average peer across such a large number of traits. Instead, it is expected that self-ratings across a large number of traits should be centrally distributed around the average peer (Chambers and Windschitl, 2004).

In fact, people will report more similarity between the self and the average peer in certain contexts. For example, the breadth of a trait’s construal affects the degree to which people view themselves as

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“above average” (Dunning et al., 1989). Trait breadth is a classic principle of personality structure research; breadth refers to the diversity of behavioral manifestations that characterize a trait (e.g., Buss and Craik, 1983; Hampson et al., 1986; Mischel and Peake, 1982). The trait of ‘talented’ reflects abilities in one or more of a wide variety of potential domains (e.g., academics, athletics, artistic ability), whereas ‘tidiness’ is characterized by a more restricted set of behaviors. Traits with less breadth such as ‘tidiness’ tend to reduce the degree to which participants rate themselves as “above average” in comparison to judgments of broadly construed traits (Alicke, 1985; Dunning et al., 1989). One explanation for this effect comes from general models of judgment, which suggest that people often rely on easily available information when making a judgment. From this perspective, trait breadth may affect “above-average” judgments by manipulating the availability of self-association making the self seem to have a unique standing on more broadly construed traits (Dunning et al., 1989). Information about some kind of talent is likely to be available whereas it may be difficult for people who are not tidy to come up with a relevant self-association. Other researchers take a different view and suggest that broad traits increase the opportunities to find some aspect of the trait that can be idiosyncratically used to confirm or refute the self-descriptiveness of the trait. Finding idiosyncratic evidence to selectively emphasize or deemphasize the descriptiveness of a trait is more likely to be successful for traits that have a wide variety of associated behaviors.

Although many neural studies of self-evaluation have examined judgments of personality traits, they have not examined how neural systems are modulated by trait breadth or the degree to which people view themselves as “above average” in relation to their peers. Two fMRI studies have found behavioral evidence of self-flattering judgments of personality traits and life events but without respect to social comparison (Moran et al., 2006; Sharot et al., 2007). In these studies, people tended to claim more positive personality traits and positive future events as self-descriptive and these judgments were associated with ventral anterior cingulate cortex (vACC) activity. However, the self-flattering judgments in these studies were not distinguishable from the valence of the judgment stimuli (i.e., the judgments of positive traits or future events were contrasted with judgments of negative traits or future events). As mentioned above, people tend to claim more positive traits and dismiss more negative traits when characterizing themselves (Chambers and Windschitl, 2004; Taylor and Brown, 1998). Therefore, valence is not always a reliable proxy for bias. Research that independently manipulates bias and valence is needed to draw strong conclusions about the role of vACC in social-cognitive judgments.

Study 1 examined social-comparative judgments using a paradigm that made it possible to tease apart the neural systems underlying valence and “above-average” judgments. Participants compared themselves to their average peer on personality trait words that were equally distributed across valence (positive, negative) and normative susceptibility to “above-average” judgments based on trait breadth (broad, specific). At the behavioral level, valence and breadth should interact. When comparing themselves to their average peer, participants’ average self-judgment is likely to deviate in different directions depending on whether the traits are socially desirable. Average self-judgments should be significantly greater for positive-broad words and significantly lower for negative-broad words when compared to their respective specific conditions (Dunning et al., 1989). However, the psychological mechanism underlying ‘above-average’ judgments should hold across both positive and negative traits. That is, a consistent mechanism should account for why people inflate their standing on positive traits and lower their standing on negative traits. Therefore, neural regions that are modulated by “above-average” judgments are best characterized by neural differences between the broad and specific conditions rather than interactions with valence.

Study 1

Methods

Participants

Twenty right-handed participants (9 female, M age = 20.7 years, $SD = 1.9$ years) were recruited in compliance with the human subjects regulations of the University of Texas at Austin and were compensated \$15 per hour or course credit for their participation. All participants were native English speakers and screened for medications or psychological and/or neurological conditions that might influence the measurement of cerebral blood flow.

Behavioral paradigm

Participants completed a modified version of a social comparative task used in previous research (Dunning et al., 1989). To ensure that there was a comparable “average peer” across our sample, participants were all students at the University of Texas at Austin and judged their personality characteristics in relation to the average University of Texas student of their same gender and age. In each trial, participants rated how they compared on a personality trait using a 5-point scale ($-2 =$ much less than the average UT student; $0 =$ about the same as the average UT student; $2 =$ much more than the average UT student). After each judgment, a screen depicting a fixation point indicated that participants should clear their minds (screens were jittered with lengths of 2 s (50%), 4 s (25%), or 6 s (25%) to maximize independence across experimental conditions: Donaldson et al., 2001).

Trait words were equally distributed across valence and trait breadth. Stimuli were selected from trait word lists that have been standardized for valence, breadth, familiarity, and number of syllables (Anderson, 1968; Kirby and Gardener, 1972) and used in many previous behavioral and neural studies of self-processing (Alicke, 1985; Dunning et al., 1989; Kelley et al., 2002; Moran et al., 2006; Ochsner et al., 2005). To ensure that this information was not outdated, a sample of 10 student judges who would be representative of study 1 and study 2’s population rated 250 words for social desirability, trait breadth, familiarity, and judgment certainty. Ratings were consistent with standardized information (Anderson, 1968; Kirby and Gardener, 1972). The 200 words used for the experiments were selected using several constraints. Words that were not familiar to at least one of our judges were eliminated. Four sets of 50 words based on the published norms and our student judges were equated for (a) social desirability within valence level (e.g., positivity of positive-broad vs. positive-specific traits, negativity of negative-broad vs. negative-specific traits, $p > 0.05$) and (b) judgment certainty ($p > 0.05$) but (c) differed in trait breadth (positive-broad vs. positive-specific, $t = 11.4$, $p < 0.05$; negative-broad vs. negative-specific, $t = 26.7$, $p < 0.05$). These criteria ensured that traits differed in their breadth but not in additional factors such as familiarity, social desirability, or self-descriptiveness (measured by certainty: Sedikides, 1993, 1995).

The positive-specific condition included words such as prompt, talkative, tactful, cool-headed, mathematical, well-spoken, witty, modest, energetic, and light-hearted. The positive-broad condition included words such as likable, mature, decent, positive, capable, understanding, educated, competent, disciplined, and ethical. The negative-specific condition included words such as stingy, materialistic, bashful, high-strung, rigid, gullible, timid, jumpy, boastful, and messy. The negative-broad condition included words such as lacking, bad, weak, maladjusted, irritating, unreliable, phony, narrow-minded, aggressive, and showy.

Participants completed 50 randomly intermixed trials of each of the positive-specific, positive-broad, negative-specific, and negative-broad conditions equally divided across 2 runs lasting 9 min and 10 s. Stimuli were projected onto a screen mounted on the bed of the scanner. Participants’ head motion was limited using foam padding. Stimulus presentation and response collection were controlled by the program E-prime running on a Windows 98 Computer.

MRI data acquisition

All images were collected on a 3.0-T GE Signa EXCITE scanner at the University of Texas at Austin Imaging Research Center. Functional images were acquired with a GRAPPA sequence (TR=2000 ms, TE = 30 ms, FOV = 240, voxel size 2.5 × 2.5 × 3 mm) with each volume consisting of 35 axial slices in line with the AC–PC line. These parameters were implemented to optimize coverage of the orbito-frontal cortex without sacrificing whole-brain acquisition. A high-resolution SPGR T1-weighted image was also acquired from each subject so that functional data could be normalized to the Montreal Neurological Institute (MNI) atlas space.

MRI data analysis

All statistical analyses were conducted using SPM2 (Wellcome Department of Cognitive Neurology). Functional images were reconstructed from *k*-space using a linear time interpolation algorithm to double the effective sampling rate. Image volumes were corrected for slice-timing skew using temporal sinc interpolation and for movement using rigid-body transformation parameters. Structural and functional volumes were normalized to T1 and EPI templates, respectively, using a 12-parameter affine transformation together with a nonlinear transformation involving cosine basis functions that resampled the volumes to 2-mm³ voxels. Images were then smoothed with an 8-mm FWHM Gaussian kernel. To remove drifts within sessions, a high-pass filter with a cutoff period of 128 s was applied.

A fixed-effects analysis modeled event-related responses for each participant. Responses related to judgment in the positive-specific, positive-broad, negative-specific, and negative-broad conditions were modeled as events using a canonical hemodynamic response function with a temporal derivative. A general linear model analysis created contrast images for each participant summarizing differences of interest. Contrasts from each participant were used in a second-level analysis treating participants as a random effect. Group average SPM{t} maps were created for contrasts of interest (specific > broad; broad > specific; positive > negative; negative > positive).

Interpretation of results from main contrasts was limited to regions that had previously been associated with valence, self-referential processing bias, availability heuristics, or emotional reappraisal (e.g., Beer, in press; Ochsner et al., 2005; DeMartino et al., 2006; Krusemark et al., 2008; Moran et al., 2006; Sharot et al., 2007). Activation clusters were corrected for the size and shape of the relevant neuroanatomical VOI in the automated anatomical labeling map (Tzourio-Mazoyer et al., 2002) (corrected *p* < 0.05 threshold, search volumes: IOFC (23 mm³), mOFC (17 mm³), dMPFC (19 mm³), vACC (22 mm³), dACC (22 mm³), PCC (15 mm³), insula (25 mm³). Parameter estimates were extracted from significant clusters using Marsbar (Brett et al., 2002).

Multiple regression tested whether individual differences in ratings in the specific and broad trait conditions predicted neural differentiation in the specific > broad contrast or the positive > negative contrast (ratings positive-specific and positive-broad, *r* = 0.81, *p* < 0.05; ratings negative-specific and negative-broad, *r* = 0.86, *p* < 0.05). Ratings for negative traits were reverse-scored so they could be collapsed with ratings of positive traits to reflect average deviation from the average peer. Results from the regression analyses were corrected based on the activation clusters from the group contrasts of the specific > broad and positive > negative contrasts (*p* < 0.05 FWE, 8-mm³ volume around main effect peaks).

Results

Task performance

No gender differences were found in responses or reaction times (*F* values < 1) so all results are reported collapsed across gender. Consistent with previous behavioral research (Dunning et al., 1989), self-evaluations were characterized by a significant interaction

between the valence (positive, negative) and breadth (broad, specific) factors (*F*_(1,19) = 108.75, *p* < 0.05; Fig. 1) that qualified a main effect of valence (*F*_(1,19) = 74.80, *p* < 0.05). In comparison to the average peer, participants on average viewed themselves as significantly more likely to have the positive-broad traits (*t*₍₁₉₎ = 5.45, *p* < 0.05) and significantly less likely to have negative-broad traits (*t*₍₁₉₎ = -7.94, *p* < 0.05) when compared to their respective specific conditions. Participants did not just claim positive traits and downplay negative traits; they tended to view themselves as most distinct for positive and negative words for traits with broader construals.

Participants' reaction times were characterized by main effects of valence (*F*_(1,19) = 15.4, *p* < 0.05) and breadth (*F*_(1,19) = 10.0, *p* < 0.05) but their interaction did not reach significance (*F*_(1,19) = 2.6, *p* > 0.05). Judgments in the positive condition (*M* = 1426.62 ms, *SE* = 25.9) were made more quickly than judgments in the negative condition (*M* = 1466.21 ms, *SE* = 22.8). Judgments in the broad condition (*M* = 1432.58 ms, *SE* = 25.6) were made more quickly than judgments in the specific condition (*M* = 1460.25 ms, *SE* = 23.1).

MPFC, OFC, and dACC are engaged for social-comparative judgments of specific vs. broad traits

Although valence and breadth interact at the behavioral level, the same psychological mechanism should account for why people evaluate themselves as having *more* positive-broad traits and *fewer* negative-broad traits than their average peer. Therefore, a direct comparison between the specific condition and the broad condition (collapsed across valence) was used to examine neural regions associated with susceptibility to “above-average” judgments (rather than an interaction between breadth and valence, see Table 1, see Figs. 2, 3A and B). In contrast to the broad trait condition, judgments of specific traits were associated with activation in MPFC (peaks = 8, 64, 24: BA 10, *F*_(1,19) = 12.8, *p* < 0.05 and 12, 54, 34: BA 9; *F*_(1,19) = 16.0, *p* < 0.05; Fig. 2). Additionally, the specific > broad contrast revealed significant activation in medial OFC (peak = -4 46 -10: left BA 11, *F*_(1,19) = 13.3, *p* < 0.05; peak = -2, 56, -14: left BA 11, *F*_(1,19) = 13.3, *p* < 0.05), lateral OFC (peak = -32, 34, -14: left BA 47, *F*_(1,19) = 22.7, *p* < 0.05; peak = 28, 28, -20: right BA 47; *F*_(1,19) = 20.9, *p* < 0.05) and dACC (peak = 10, 26, 34: right BA 24, *F*_(1,19) = 10.8, *p* = 0.056; Figs. 3A, B). No significant activation was found for the main contrast of broad > specific.

OFC and dACC are negatively modulated by individual differences in “above-average” judgments

Neural regions that differentiate the specific and broad conditions have two possible interpretations: they might be related to the differences in social-comparative judgments or they might be related to the fact that participants were processing relatively specific or broad traits irrespective of social-comparative judgments. Therefore,

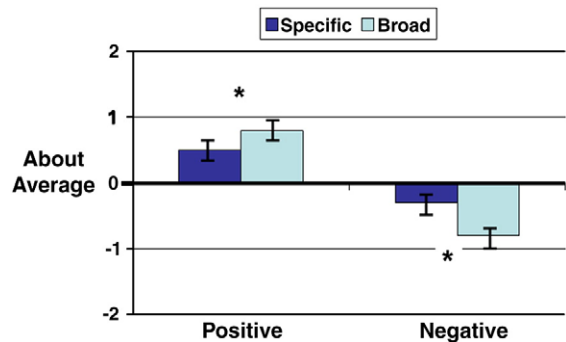


Fig. 1. Means and standard errors of self-evaluation of positive and negative traits in comparison to an average peer. On average, the sample should estimate their traits at the midpoint of the scale (0) for unbiased evaluations. Asterisk (*) indicates significant differences.

Table 1
Parameter estimates from significant activation clusters main effects and interaction.

Brain region (MNI coordinates)	Trait breadth X Valence ANOVA		
	Breadth	Valence	Interaction
	Specific > Broad		
MPFC (BA 10) (8, 64, 24)	12.8*	2.1	0.5
MPFC (BA 9) (12, 54, 34)	16.0*	3.8	0.1
Medial OFC (BA 11) (-2, 54, -16)	19.4*	10.0*	0.5
Medial OFC (BA 11) (-4, 46, -10)	13.3*	20.0*	0.8
Left OFC (BA 47) (-32, 34, -14)	22.7*	2.3	1.0
Right OFC (BA 47) (28, 28, -20)	20.9*	0.8	1.8
dACC (BA 24) (10, 26, 34)	10.8*	0.5	3.2
PCC (BA 23) (-4, -38, 28)	11.9*	10.5*	2.2
	Broad > Specific		
No significant regions			

BA, Brodmann's area.

*Indicates $p < 0.05$.

we conducted a regression analyses to examine whether the neural activation associated with the specific condition was driven by individuals who tended to rate themselves as similar to the average peer. The more participants viewed themselves like their average peer in the specific condition, the more they recruited regions of the OFC and dACC activation identified in the main contrast of specific > broad (see Figs. 3B, C). Individual differences in "above-average" judgments were negatively correlated with activation in medial OFC (regression peak = -6, 46, -10; $t = 2.96$, $p < 0.05$ FWE) and left lateral OFC (regression peak = -34, 34, -16; $t = 2.83$, $p < 0.05$ FWE). Similarly, there was a trend for negative correlation between individual differences in "above-average" judgments and dACC activation (regression peak = 10, 26, 32; $t = 2.51$, $p = 0.07$ FWE). The regression analysis findings cannot be accounted for by reaction time. Reaction times did not significantly correlate with ratings (r values range from -0.15 to 0.19, p values range from 0.39 to 0.89) nor did reaction times modulate activity in neural regions identified in the main contrasts.

Valence: ventral anterior cingulate cortex and insula

vACC activated significantly in relation to positive valence (peak = 14, 38, -4; BA 25; $F_{(1,19)} = 53.6$, $p < 0.05$; Fig. 4A) (see Table 2). Insula activity was associated with negative valence (peak = -38, 14, 6; $F_{(1,19)} = 20.4$, $p < 0.05$, see Fig. 4B, Table 2). Individual differences in social-comparative ratings did not modulate vACC or insula activity. Although participants were not asked to explicitly rate

if a trait was desirable, vACC was recruited more for judgments of positive traits and insula was recruited more for judgments of negative traits.

Main effects of breadth and valence: posterior cingulate cortex

An overlapping region of PCC significantly activated in relation to the specific breadth (peak = -4, -38, 28, BA 23; $F_{(1,19)} = 11.9$, $p < 0.05$, see Table 1) and positive valence (peak = -8, -50, 28; $F_{(1,19)} = 37.6$, $p < 0.05$, see Table 2).

Study 2

Study 1 found that OFC and, to a lesser extent, dACC are negatively modulated by the degree to which people view themselves as more desirable than the average person. How should future research proceed in understanding why self-flattering judgments are reduced in relation to OFC and dACC activation? Previous research cannot be used to inversely infer the role of OFC and dACC in the current study but it is a helpful guide for thinking about possible interpretations to shape future research. One possibility is that OFC and dACC support cognitive control processes that modulate "above-average" judgments (e.g., Beer et al., 2006a,b; Botvinick et al., 2004; DeMartino et al., 2006). If future research did want to investigate the possibility that OFC and dACC reduce self-flattering judgments through effortful processing, what mechanism is being modulated by the effortful processing? On the one hand, an effortful processing view of the OFC and dACC activation in study 1 might be consistent with the view that some kind of heuristic accounts for "above-average" judgments (e.g., Chambers and Windschitl, 2004; Dunning et al., 1989). OFC and dACC may be associated with reductions in "above-average" judgments because they support information processing that is deeper than heuristics. However, the effortful processing interpretation makes it equally possible that the deeper processing putatively associated with OFC and dACC activation reflects searches for idiosyncratic, self-serving exemplars. In comparison to judgments of broad traits, judgments of specific traits might make it more difficult to find a self-serving exemplar and increase search efforts. Despite increased efforts, the search may often fail because the restricted range of exemplars makes it difficult to find one that can be used to define the trait in a self-flattering manner. In this case, judgments of specific traits may reflect increased search efforts that ultimately result in reduced 'above-average' judgments.

As a way of better understanding how increased cognitive effort may affect "above-average" judgments, study 2 tested the effect of mental load on the judgments of broad and specific traits included in study 1. If "above-average" judgments are reduced when information processing goes deeper than heuristics, then mental load should increase "above-average" judgments. If "above-average" judgments are reduced when searches for self-serving exemplars fail, then mental

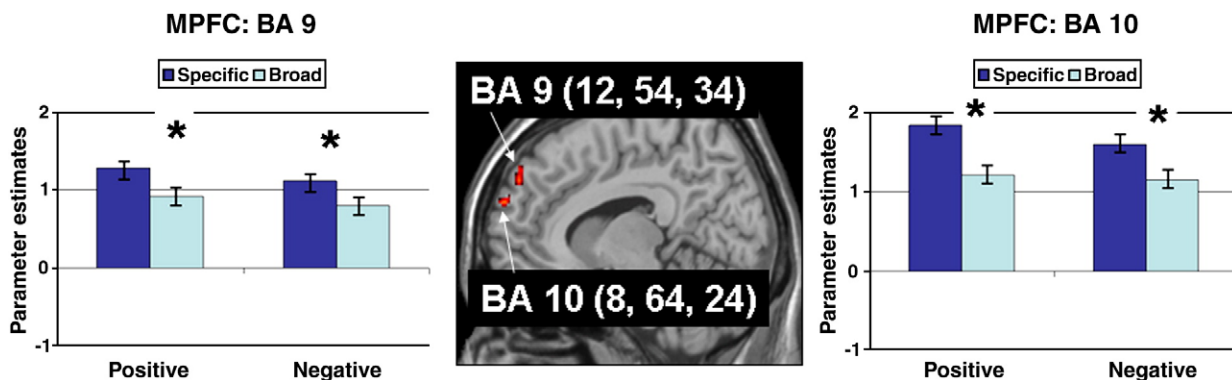


Fig. 2. MPFC activation associated with Specific versus Broad traits and parameter estimates in relation to baseline ($x = -2$). Asterisk (*) indicates significant differences.

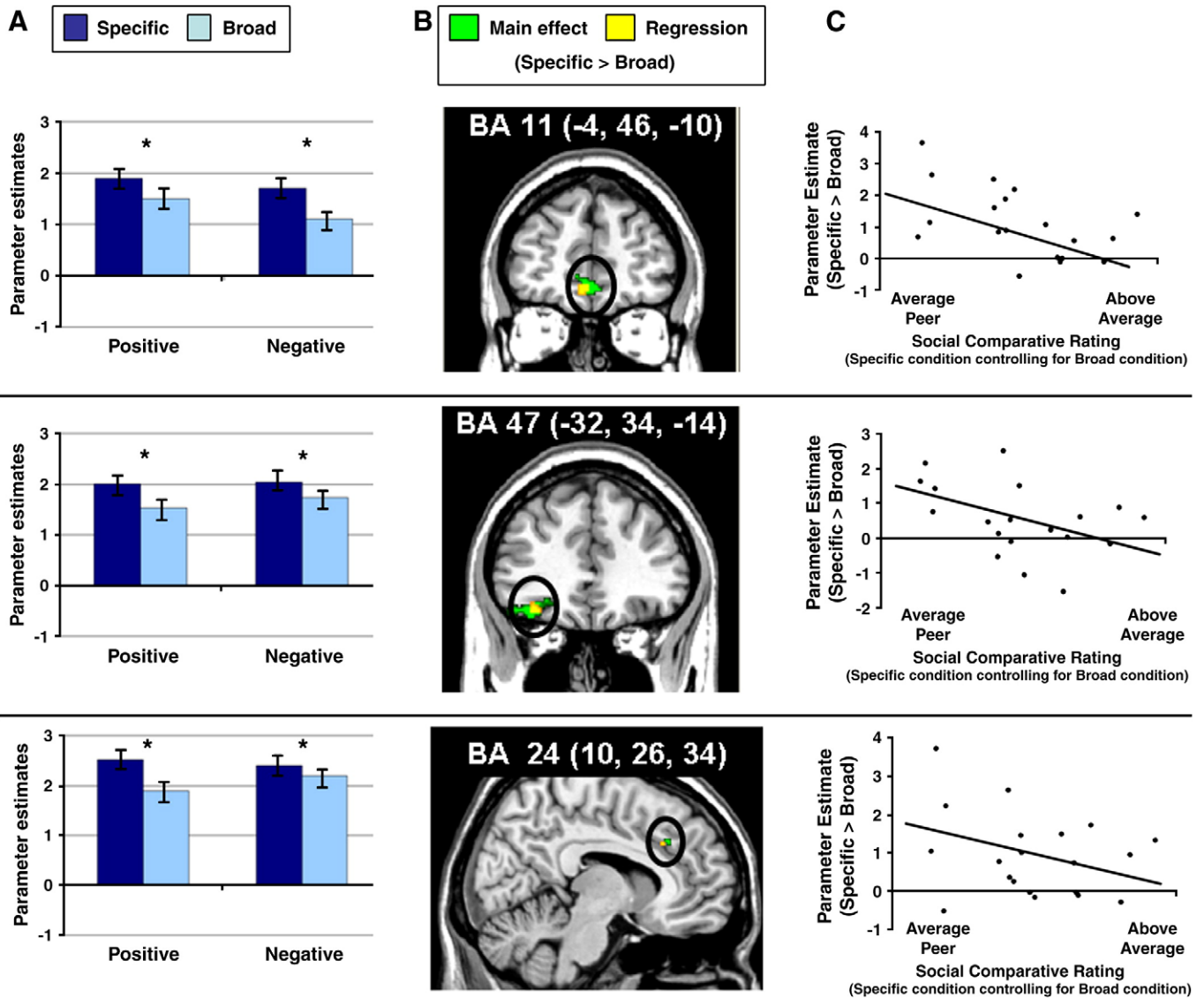


Fig. 3. Neural regions associated with reduced “above average” judgment. (A) Parameter estimates for the Specific > Broad contrast. Asterisk (*) indicates significant differences. (B) Neural activation associated with main effect and the overlap of the regression analysis for Specific > Broad contrast: mOFC: $y = 46$; IOFC: $y = 34$; dACC: $x = 10$. (C) Scatter plots depict the regression analysis of individual differences in social-comparative ratings on neural activation.

load should *reduce* “above-average” judgments because participants will have even less time than usual to find an idiosyncratic exemplar.

Methods

Participants

Fifty-six participants (37 females, M age = 19.1 years, $SD = .85$ years) who had not participated in study 1 were recruited in compliance with the human subjects regulations of the University of Texas at Austin and completed the experiment to partially fulfill course credit.

Behavioral paradigm

Participants were randomly assigned to complete the social comparative task from study 1 without mental load (No Load: unlimited time) or with mental load (Load: 1 s to make a judgment).

Results

No gender differences were found in responses or reaction times (F values < 1) so all results are reported collapsed across gender. Study 2

replicated the behavioral effects from study 1 and further showed that mental load increases “above-average” judgments. In the No-Load condition, participants were most likely to judge themselves as significantly better than the average peer in the broad trait condition (valence \times breadth: ($F_{(1,54)} = 162.54, p < .05$; see Fig. 5). Mental load increased the extent to which participants rated themselves as better than their average peer. Participants in the Load condition reported having significantly more positive traits and significantly fewer negative traits than participants in the No-Load condition (Load \times Valence: $F_{(1,54)} = 7.53, p < .05$; see Fig. 5). Judgments of specific traits had been closer to the average peer in the No-Load condition (i.e., closer to the “average peer” referent). In the Load condition, judgments of specific traits were similar to the judgments of broad traits in the No-Load condition (positive: $t_{(54)} = .24, p > .05$; negative: $t_{(54)} = -0.65, p > .05$). Under mental load, both positive-broad ($t_{(54)} = -2.84, p < .05$) and positive-specific ($t_{(54)} = -2.38, p < .05$) traits were rated as more self-descriptive but they remained significantly different from each other ($t_{(27)} = 8.10, p < .05$). Judgments of negative traits showed the same pattern (negative-broad: $t_{(54)} = 2.06, p < .05$; negative-specific: $t_{(54)} = 1.94, p = 0.056$; Load negative-broad vs. Load negative-specific: $t_{(27)} = -6.57, p < .05$).

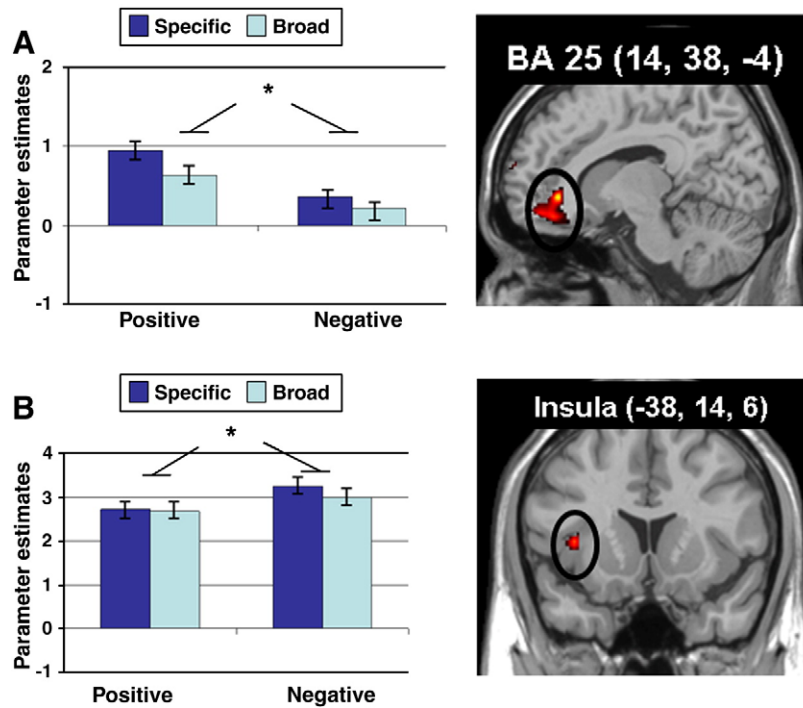


Fig. 4. Neural regions associated with valence. (A) Positive valence (vACC $x = 14$). (B) Negative valence (insula: $y = 14$). Asterisk (*) indicates significant differences.

A manipulation check found that judgments were significantly faster under Load compared to No Load (positive–broad: $t_{(54)} = 7.12$, $p < 0.05$; positive–specific: $t_{(54)} = 7.75$, $p < 0.05$; negative–specific: $t_{(54)} = 7.75$, $p < 0.05$; negative–broad: $t_{(54)} = 8.32$, $p < 0.05$; see Table 3). In the No-Load condition, there was a marginally significant interaction between valence and breadth ($F_{(1,27)} = 3.46$, $p = 0.07$) but no main effects for breadth ($F_{(1,24)} = 1.23$, ns) or valence ($F_{(1,24)} = 0.77$, ns). This marginal interaction was driven by the faster reaction times in the positive–broad ($M = 2601.57$, $SE = 196.35$) compared to positive–specific: $M = 2797.85$, $SE = 234.35$; $t_{(27)} = -1.95$, $p = 0.06$). There were no significant differences in reaction time within the negative condition (negative–broad: $M = 2781.45$, $SE = 254.04$; negative–specific: $M = 2753.45$, $SE = 227.32$; $t_{(27)} = .30$, $p > 0.05$). In the Load condition, there was a significant main effect of breadth ($F_{(1,24)} = 4.79$, $p < 0.05$), but not a main effect of valence ($F_{(1,27)} = .71$, ns) nor an interaction of valence and breadth ($F_{(1,27)} = .03$, ns). Reaction times in the broad condition (positive–broad: $M = 959.51$, $SE = 19.95$, negative–broad: $M = 970.94$, $SE = 12.86$) were significantly faster than the specific condition (positive–specific: $M = 977.59$, $SE = 17.67$, negative–specific: $M = 985.43$, $SE = 18.63$).

Discussion

Extant neural models of social cognition are incomplete because they have failed to include the systematic judgment biases known to robustly affect normative self-evaluation (e.g., Chambers and Windschitl, 2004; Taylor and Brown, 1988). Although an association between bias and vACC is suggested by previous findings, it has not been possible to draw strong conclusions about whether this region is associated with bias or positive valence (e.g., Moran et al., 2006; Sharot et al., 2007). Behavioral research has shown that the self-serving nature of self-evaluation can affect both positive and negative characteristics (Chambers and Windschitl, 2004). The current study builds on previous research examining self-judgments of personality traits by (a) asking participants to rate themselves in comparison to their average peer and (b) manipulating susceptibility to bias independently from valence. Two regions often associated with social cognitive judgment, MPFC and PCC, were engaged significantly more for judgments of traits with less breadth (i.e., specific). However,

Table 2
Parameter estimates from significant activation clusters main effects and interaction.

Brain region (MNI coordinates)	Trait breadth X valence ANOVA		
	Breadth	Valence	Interaction
vACC (BA 25) (14, 38, -4)	Positive > Negative		
	5.9*	53.6*	1.3
PCC (BA 23) ^a (-8, -50, 28)	Positive > Negative		
	2.2	37.6*	0.9
Left insula (-38, 14, 6)	Negative > Positive		
	2.3	20.4*	0.3

BA = Brodmann's area.

^aIncludes region identified in Specific vs. Broad contrast.

*Indicates $p < 0.05$.

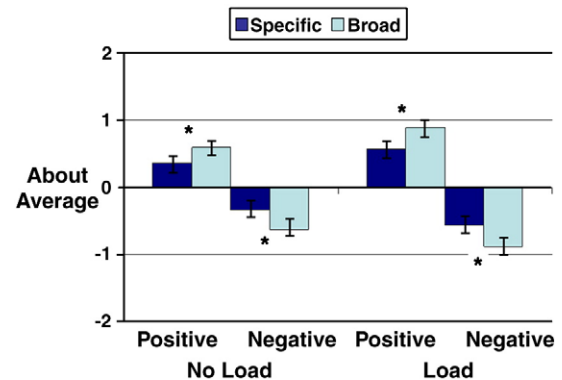


Fig. 5. Self-evaluation of traits in comparison to an average peer under conditions of No Load and Load. On average, the sample should estimate their traits at the midpoint of the scale (0) for unbiased evaluations. Asterisk (*) indicates significant differences.

Table 3
Reaction times in milliseconds for study 2.

	No Load		Load	
	Mean	SE	Mean	SE
Positive–Broad	2601.57	196.35	959.51	19.95
Positive–Specific	2797.85	234.35	977.59	17.76
Negative–Broad	2781.45	254.04	970.94	12.86
Negative–Specific	2753.45	227.32	985.43	18.63

these regions were not modulated by individual differences in “above-average” judgments. In previous research (Moran et al., 2006; Sharot et al., 2007), the vACC has been associated with judgments of positive stimuli, which were simultaneously self-serving (i.e., viewing positive events or traits as more descriptive than negative stimuli). The present research found that vACC detects the valence of judgment stimuli but does not predict individual differences in “above-average” judgments. Instead, individual differences in “above-average” judgments negatively modulated OFC and, to a lesser extent, dACC activation. Study 2 provided insight into how effortful processing modulates “above-average” judgments by showing that mental load increased “above-average” judgments. Taken together, these findings have a number of implications for understanding the neural and psychological mechanisms supporting bias in the social cognition system.

The present findings broaden neural investigations of social-cognitive evaluations. Most of this research has focused on encoding information in relation to the self versus encoding information in relation to other types of people (e.g., Johnson et al., 2002; Ochsner et al., 2005; Moran et al., 2006). These studies have concluded that MPFC and PCC activity are associated with judging the personality traits of the self and certain types of other people. The present study builds on this research by showing that MPFC and PCC activity are significantly more activated when judging personality traits that are restricted in their range of relevant behaviors. For example, the BA 9 region (12, 54, 34) found in the current study is consistent with dorsal MPFC activations found in other studies of self-evaluation (e.g., as reviewed by Ochsner et al., 2005: 6, 56, 38 and 8, 64, 34 in Johnson et al., 2002; 12, 52, 32 in Lieberman et al., 2004; and a comparable region in the left hemisphere –12, 48, 36 in Ochsner et al. 2005). Although the MPFC and PCC have shown robust involvement in judgments of personality traits, less is known about the psychological process supported by the regions. It has previously been suggested that MPFC and PCC are involved in representations that are necessary to perform self-referential tasks (Ochsner et al., 2005). One possible explanation of the association between PCC activity and judgments of specific traits is suggested by previous research implicating PCC in autobiographical memory (Maddock, Garrett, and Buonocore, 2001). It may be that people are more likely to draw on concrete, personal memories when judging specific traits, which lend themselves to a circumscribed number of contexts. It is possible that the greater MPFC activation in the specific condition also reflects differences in the contextualization of the self-representation. Previous research has shown that when relational schemas are primed, individuals are likely to recruit MPFC and PCC for judgments about the self in specific contexts rather than judgments about the self in general (Chiao et al., in press). Although relational schemas were not explicitly primed in the current study, it is possible that the social-comparative nature of the judgment acted like a relational prime. Unlike typical self-referent paradigms, the current study required participants to think about themselves in relation to another person. If relational schemas were primed, then it would be expected that MPFC and PCC would be more strongly engaged by judgments of the specific traits as they refer to a smaller range of contexts than the broad traits. Future research on the role of MPFC and PCC in self-judgment will benefit from studies that explicitly manipulate the strategies underlying self-judgments and

parametrically manipulate the range of situations applicable to the self-judgment.

The current study also shows that the MPFC and PCC are not modulated by the extent to which people view the self as more or less desirable than their average peer. Instead, the more participants viewed themselves as more desirable than other people, the less they recruited medial and lateral OFC and, to a lesser extent, dACC. This finding is consistent with research showing that patients with OFC damage tend to judge their social behavior more favorably when compared to other people's perceptions of their social behavior (Beer et al., 2006a,b). Additionally, source localization analyses from an ERP study suggest that dACC activation may be increased when people's self-evaluations are not self-serving, that is, they do not overemphasize the role of the self in task success (Krusemark et al., 2008).

Furthermore, more research was needed to understand whether the vACC plays a significant role in viewing the self as especially desirable or differentiating positive versus negative information (Moran et al., 2006; Sharot et al., 2007). The present research used similar stimuli to one of the previous studies (Moran et al., 2006) but independently measured trait valence from the extent to which the self was judged as desirable (e.g., more positive and less negative than the average peer). In the current study, vACC was significantly associated with differentiating the valence of judgment. These findings are consistent with the role of vACC in the detection of valence in a number of domains (Bush, Luu and Posner, 2000; Rogers et al., 2004). For example, vACC is important for recognizing rewarding options in gambling tasks. Just as participants recruit the vACC for maximizing reward in gambling tasks, this region may be important for quickly recognizing when personality traits are likely to be rewarding if deemed self-descriptive. In this way, the vACC in the present study may reflect the theorized motivation to view the self in a rewarding manner (Chambers and Windschitl, 2004; Dunning, Meyerowitz, and Holzberg, 1989; Taylor and Brown, 1988) because it encodes whether traits are socially desirable (i.e., positive or negative) even when such encoding is not explicitly required by the task. However, the recruitment of vACC does not predict individual differences in the extent to which participants viewed themselves as more desirable than other people.

Future neural research may want to investigate how neural correlates of self-serving evaluations are modulated by reliance on heuristic judgments. “Above-average” judgments were made more quickly (study 1) and were pronounced under mental load (study 2), suggesting that these judgments require fewer cognitive resources. Perhaps, like the visual system, the social judgment system is designed to give us a quick ‘good enough’ perception for the sake of efficiency. One possible future avenue is to investigate whether self-serving evaluations are negatively related to OFC/dACC activation because the OFC/dACC are involved in the correction or suppression of heuristic approaches to self-evaluation. OFC and dACC have been implicated in a host of psychological functions; it is intriguing to note these regions have been negatively related to judgments that rely on availability heuristics (e.g., Beer et al., 2006b; DeMartino et al., 2006; Schnyer et al., 2005). For example, participants who make gambling decisions based on availability heuristics tend to recruit their medial and lateral OFC much less than participants who consider deeper information (e.g., Beer et al., 2006b; DeMartino et al., 2006). However, the parallels between the self-evaluations made under mental load in study 2 and those made in relation to reduced OFC and dACC activation in study 1 does not mean that OFC and dACC support cognitive control processes that reduce “above-average” judgments. One counterargument is that the pressure of mental load in study 2 made participants use less stringent criteria for viewing a behavior as relevant to a trait. In this way, the specific traits may have become more broadly construed and the broad traits even broader still. Future research that more precisely characterizes how neural correlates of social comparison are modulated in relation to heuristics will be

helpful in refining our understanding of the role of OFC and dACC in social cognitive judgment bias.

Finally, the current study illustrates that using a variety of methods to operationalize self-flattering evaluations will be helpful for developing neural models of social cognition. The “above-average” approach is just one standardized method that has several advantages over other methods (Chambers and Windschitl, 2004; Dunning et al., 1989; Taylor and Brown, 1988). This approach provides new information beyond the extant neural studies by unconfounding the neural associations of trait valence from the neural associations of the tendency to view the self as special. Additionally, this approach avoids the criterion problem associated with comparisons of self-ratings to peer-ratings. It is tempting to consider self-ratings to be accurate whenever they converge with peer-ratings. However, a number of empirical findings have called into question whether peer-ratings are an appropriate criterion for accuracy (Gosling et al., 1998; Kenny, 1994). Individuals often have access to more information about themselves because their peers cannot access their internal thoughts and may only interact with them in a narrow range of situations (Higgins and Bargh, 1987). This problem is not solved by identifying close peers who may be more privy to an individual's inner thoughts across more diverse situations. Like self-ratings, close-peer ratings are clouded by the motivation to view the individual in a desirable light (Suls et al., 2002a). However, the “above average” approach does not provide the strongest test of self-flattering judgments at the trial level of analysis. In the current study, the regression analyses were helpful for testing whether the OFC and dACC activation in the specific condition were driven by individuals who were most likely to rate themselves “about average.” However, it is important to note that at the level of a particular trait, it is difficult to distinguish between participants who make self-flattering evaluations and participants who truly stand out on that characteristic. Therefore, research that examines self-serving evaluations on a trial-by-trial basis may require deviation from the typical paradigm of personality trait judgments but nonetheless is helpful for providing convergent evidence for the proposed role of the OFC and dACC in self-evaluation (e.g., Beer et al., 1993).

In conclusion, the current study helps elaborate neural models of social cognition by examining the neural basis of the self-serving tendencies known to pervade self-evaluation. The study used a paradigm that maximized comparisons with previous research on self-evaluations of personality traits (Moran et al., 2006 and see Ochsner et al., 2005 for a review) by investigating the “above-average” effect in judgments of personality traits. The present research demonstrates that neural regions often associated with social-cognitive judgment, MPFC and PCC, are recruited more when judging traits that are narrowly construed but are not modulated by individual differences in the tendency to view the self as more desirable than other people. Additionally, vACC, a region previously associated with affective motivation in social cognitive judgment, is engaged for differentiating the valence of trait words but is not significantly related to individual differences in the tendency to view the self as more desirable than other people. On a broader level, research along these lines may deepen our understanding of the association of frontal lobe damage and poor insight. For example, mood disorders and substance abuse may compromise function and/or volume in frontal lobe regions (e.g., Steele et al., 2006; Volkow et al., 1991) and have often been associated with poor insight, which has important implications for treatment compliance (e.g., Aleman et al., 2006; Sanz et al., 1998). Understanding these functional and structural changes in relation to self-judgment bias may be helpful for designing therapeutic interventions for various disorders.

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