



Ventral medial prefrontal cortex and person evaluation: Forming impressions of others varying in financial and moral status



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ABSTRACT

The current study investigated ventromedial prefrontal cortex (VMPFC) activity during impression formation of individuals varying on distinct dimensions of social status. In a block-design functional magnetic resonance imaging (fMRI) experiment, participants were presented with photographs of faces paired with a colored background indicating their lower, same, or higher financial status, or lower, same, or higher moral status. Participants were asked to form an impression of the targets, but were not instructed to explicitly evaluate them based on social status. Building on previous findings (Cloutier, Ambady, Meagher, & Gabrieli, 2012), a region of interest analysis revealed the interaction of status dimension and level in VMPFC, finding not only preferential response to targets with higher compared to lower moral status as previously demonstrated, but also greater response to targets with lower compared to higher financial status. The implications of these results are discussed with an emphasis towards better understanding the impact of social status on social cognition and uncovering the neural substrates of person evaluation.

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Introduction

Knowledge of others' social status plays a central role in guiding social interactions (Cheney and Seyfarth, 2008; Fiske, 2010; Hare and Tomasello, 2004; Magee and Galinsky, 2008; Sapolsky, 2004; Stephens et al., 2007). Social status is generally believed to impact how we evaluate others, such that higher social status is associated with positive evaluations; for example being perceived as more competent, valuable to the group, prominent, generous, and reputable (Anderson and Kilduff, 2009; Fiske, 2010; Flynn et al., 2006; Ridgeway and Walker, 1995). Positive evaluations of higher status individuals are in turn believed to motivate greater achievement of group members who seek improved status and, therefore, may help maintain the relevance of social hierarchies (Henrich and Gil-White, 2001; Hogg, 2001; Huberman et al., 2004). Interestingly, however, a recent study suggests that lay theories concerning the impact of social status on personal characteristics relevant to social evaluations are not particularly accurate (Varnum, 2013).

Despite the evidence suggesting that greater status may confer greater prestige, it is still unclear whether individuals possessing high social status will be positively evaluated regardless of the social dimension upon which it is based. In contrast to several non-human primate

species, where social hierarchies are based on physical dominance (Cheney and Seyfarth, 2008; Hare and Tomasello, 2004), humans can infer social status from a variety of dimensions (Berger et al., 1972; Fiske, 2010; Magee and Galinsky, 2008). Conceivably, the impact of social status on person evaluation may depend on the social dimension from which it is inferred (Cloutier et al., 2012; Fiske et al., 2002).

Financial standing is commonly thought of as a salient dimension from which status is inferred. Possessing a higher financial status is believed to lead to better mating prospects, fewer physical and mental health problems, better education opportunities, higher living standards, greater access to scarce resources, better social support, and greater degree of control over one's life (Boushey, and Weller, 2008; Ellis, 1993; Marmot, 2004; Singh, 1995; Werner et al., 2007). However, although high status individuals may generally be evaluated more positively, as a group, rich people tend to be seen as higher in competence but lower in warmth compared to poor people (Fiske et al., 2002). Furthermore, individuals with highest financial status, such as business leaders, may often be perceived negatively (Ribstein, 2009).

On the other hand, morality is believed to have become central to the maintenance of human social hierarchies (Boehm, 2012; Rai and Fiske, 2011). Sensitivity to the relative moral standing of others is evident from an early age, and even infants have been shown to prefer pro-social individuals (Hamlin and Wynn, 2011; Hamlin et al., 2010). In adults, perceived morality guides social interactions (Miller, 2007; Rai and Fiske, 2011; Weiner et al., 2011) and shapes neural responses to others (Cloutier et al., 2012; Decety et al., 2012; Moll and de Oliveira-Souza, 2007; Moll et al., 2002; Singer et al., 2004). Taken

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together, this suggests that morality may represent a salient dimension from which social status can be inferred (see also Swencionis and Fiske, 2014).

When contrasting financial and moral status dimensions, it is conceivable that financial wealth may confer higher status, but also lead to negative evaluations by other group members (Fiske et al., 2002; Ribstein, 2009), whereas higher moral status, which confers the respect often required to maintain one's standing within hierarchies (Boehm, 2012; Ridgeway and Walker, 1995; Yzerbyt and Demoulin, 2010), may more consistently lead to positive evaluations. In sum, the association between higher levels of social status and positive evaluations (Cheng et al., 2012; Fiske et al., 2002) may depend on the social dimensions from which status is inferred (Cloutier et al., 2012).

Previous brain-imaging studies have identified a number of regions (i.e., ventromedial prefrontal cortex [VMPFC], intraparietal sulcus [IPS], and Nucleus Accumbens [NAcc]) to be responsive to cues conveying social status or dominance information about conspecifics (Chiao et al., 2009; Cloutier and Gyurovski, 2013; Freeman et al., 2011; Karafin et al., 2004; Ly et al., 2011; Marsh et al., 2009; Zink et al., 2008). Guiding the current investigation, one recent study found that perceiving individuals paired with knowledge indicating higher moral status elicits greater activity in the VMPFC (Cloutier et al., 2012).

Lesion studies have also denoted the importance of the VMPFC for social cognitive processes such as mentalizing, emotion processing, decision-making, and person evaluation (Adolphs, 2009; Gläscher et al., 2012; Leopold et al., 2012; Shamay-Tsoory et al., 2003). For instance, individuals with damage to the VMPFC show an impaired ability to perform moral judgments about unfamiliar others (Croft et al., 2010) and demonstrate deficiencies in recognizing facial expressions of emotion (Heberlein et al., 2007; Hornak et al., 1996).

In multiple contexts, the VMPFC also appears to play a role in assessing the value of a variety of stimuli (Berridge and Kringelbach, 2008; Bouret and Richmond, 2010; Chib et al., 2009; Fellows, 2007; Fellows and Farah, 2007; Frith and Frith, 2012; Henri-Bhargava et al., 2012; Valentin et al., 2007). Using fMRI, the VMPFC is shown to be involved when human perceivers evaluate conspecifics (Bzdok et al., 2012; Cloutier et al., 2012; Mende-Siedlecki et al., 2013). Interestingly, differential VMPFC activity is not only seen in response to the evaluation of others, but also when participants report their own affective state (Gusnard et al., 2001; Moran et al., 2006). This suggests that this region could act as an interface between affective and social information both when forming impressions of others or introspecting about oneself (Adolphs, 2009; Roy et al., 2012).

In light of the reviewed evidence for VMPFC involvement in person evaluation, the current study focuses on this region's response to the presentation of targets varying in social status. More precisely, and contrary to suggestions that prestige associated with the possession of high status may systematically lead to more positive evaluations (Anderson and Kilduff, 2009; Fiske, 2010; Flynn et al., 2006; Ridgeway and Walker, 1995), greater VMPFC activity was expected in response to targets paired with higher moral status, but not to those paired with higher financial status (Cloutier et al., 2012; Fiske et al., 2002; Ribstein, 2009).

Manipulating the person-knowledge available about others (Adolphs, 2009; Cloutier et al., 2011; Mason et al., 2004; Mitchell et al., 2002; Todorov et al., 2007) has previously added to our understanding of the impact of social status on brain responses during person evaluation (Cloutier et al., 2012; Kumaran et al., 2012; Ly et al., 2011). Nonetheless, this approach may have provided perceivers with information other than the targets' social status. Given the difficulty of disentangling social status from constructs such as power, dominance, prestige, and reputation (Anderson and Shirako, 2008; Fiske, 2010; Magee and Galinsky, 2008; Thomsen et al., 2011), such limitations deserve further consideration. In contrast to the use of elaborate forms of person-knowledge (Cloutier et al., 2012), the current study was designed to investigate the impact of distinct levels (Lower, Same, and Higher) and dimensions (Moral and Financial) of social status by simply

pairing faces with status labels and examining brain responses to these targets (Cloutier and Gyurovski, 2013; Cloutier et al., 2013).

Methods

Participants

Twenty male participants between the ages of 19 and 31 ($M_{age} = 24.3$, $SD = 3.9$) were recruited from the greater Chicago area. No participants were excluded from data analysis. All participants had normal or corrected to normal vision and none reported significant abnormal neurological history. Participants were paid \$50 for their participation and gave informed consent in accordance with the guidelines set by the Social and Behavioral Sciences Institutional Review Board at the University of Chicago.

Stimuli and procedure

Participants first answered a series of questionnaires, which included fMRI pre-screening material, demographic information and measures of objective and subjective status information. The subjective measures of financial and moral status were modifications of the MacArthur Subjective Social Status ladder scale, which has been extensively used to evaluate subjective socio-economic status (SES) (Adler et al., 2000; Singh-Manoux et al., 2003, 2005) and were designed to assess participants' subjective financial and moral status amongst the university undergraduate population of the greater Chicago area, a procedure similarly used in previous research (Cloutier and Gyurovski, 2013; Cloutier et al., 2013). The administration of this series of measures as part of the initial cover story for the experiment served in part to convey the intended meaning of the financial and moral status conditions. The measures were also meant to ostensibly assess the relative status of participants. Indeed, at the end of the pre-test session, participants were informed of their own status in relation to the other participants in the study. In reality, participants were always assigned an average status. Importantly, they were told that the distribution of the financial and moral status of all participants was not necessarily representative of the distribution of the student population of the greater Chicago area. This allowed for the subsequent presentation of social targets with higher, equal, or lower financial and moral status than the participant's.

Participants completed a computer-based training task (adapted from Cloutier et al., 2013; Cloutier and Gyurovski, 2013) to learn the association between colors (blue and red) and specific social status dimensions (financial and moral). Shades of each color (Darker, Medium, and Lighter) were associated with different levels of social status (Higher, Same, and Lower). For example, light blue may indicate higher moral status whereas dark red may indicate lower financial status. The association between color and status was counterbalanced across participants. Furthermore, the face assigned to each condition was counterbalanced across participants. Together, this eliminates the possibility that any of the subsequently observed effects on brain activation can be explained by the variation in color alone. During the encoding phase of the training task, participants were presented with the different backgrounds (without any faces) with a text box indicating the social status dimension and level with which the shade of each color was paired. Seventy trials were presented for each of the six conditions, for a total of 420 trials. Following the encoding phase, participants were again exposed to the different shades of colors and the status dimensions and levels. This time they were required to provide accurate response on at least 30 sequential trials of randomly presented different shades of colors. Participants were informed that they would later be presented with faces paired with these color backgrounds and were reminded that the depicted individuals were also participants in the study. Having an extensive training procedure of 420 encoding trials and a subsequent test, requiring 100% accuracy to proceed, ensured that

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