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Intraparietal Sulcus Activity During Explicit Self-Referential Social Status Judgments about Others

Actividad del Surco Intraparietal Durante Juicios de Estatus Sociales Auto-Referenciales De Otros

Research

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ABSTRACT

Previous research has suggested that the intraparietal sulcus (IPS) supports judgments of social distance, with greater activity observed in response to targets judged to be closer to each other (Yamakawa, Kanai, Matsumura, & Naito, 2009). Amongst other stimuli, activity in the IPS appears to be responsive to targets varying in social status (Chiao et al., 2009; Cloutier, Ambady, Meagher, & Gabrieli, 2012). The current project examined brain responses during explicit self-referential social status judgments of targets varying in either financial or moral status. Using an event-related fMRI design, participants viewed photographs of male faces paired with distinct levels of financial or moral status. During the task, participants were asked to explicitly identify each target's status in relation to their own. Focusing on IPS activity, results from whole-brain and region of interest analyses revealed an interaction between social status types and levels. The implications of these results are discussed with respect to our current understanding of the impact of social status on the neural substrates of person perception.

Key Words:
IPS, fMRI, social distance, social status, person perception

RESUMEN

Investigación previa ha sugerido que el surco intraparietal (IPS) respalda juicios de distancia social, con mayor actividad observada en respuesta a objetivos juzgados para estar más cerca de otros (Yamakawa, Kanai, Matsumura, & Naito, 2009). Entre otros estímulos, la actividad en el surco intraparietal parece ser receptiva a objetivos variando en estatus sociales (Chiao et al., 2009; Cloutier, Ambady, Meagher, & Gabrieli, 2012). El presente proyecto examinó las respuestas cerebrales durante juicios de estatus sociales auto-referenciales de objetivos variando tanto en estatus morales como financieros. Usando un diseño de resonancia magnética asociada a evento, los participantes observaron fotografías de rostros masculinos emparejadas con distintos niveles de estatus financieros o morales. Durante la tarea, se les pidió a los participantes identificar explícitamente el estatus de cada objetivo en relación al de ellos. Enfocándose en la actividad del surco intraparietal, los resultados de los análisis del cerebro entero y de regiones de interés revelaron una interacción entre los tipos y niveles de estatus sociales. Las implicaciones de estos resultados son discutidas con respecto a nuestro entendimiento actual del impacto del estatus social en los substratos neuronales de la percepción de las personas.

Palabras Clave:
Surco intraparietal, distancia social, estatus social, percepción de las personas

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1. INTRODUCTION

Hierarchies are omnipresent in a wide range of social organizations and appear to shape much of the social lives of many species; from ants, fish, and birds (Grosenick, Clement, & Fernald, 2007; Tinbergen, 1936; Wilson, 2000), to non-human primates and humans (Cheney & Seyfarth; 2008; Fiske 2010; Hare & Tomasello, 2004; Magee & Galinsky, 2008; Stephens, Markus, & Townsend, 2007). Human hierarchies influence social behavior within professional, domestic, and recreational social settings (Cummins, 2000). These formal and informal hierarchies are believed to serve two broad sets of functions: 1) they provide social roles guiding the behavior of group members, which in turn facilitate order, coordination, and interactions, and 2) they incentivize those at the bottom of the hierarchy to progress and achieve higher relative standings (Anderson & Kilduff, 2009; Flynn, Reagans, Amanatullah, & Ames, 2006; Henrich & Gil-White, 2001; Hogg, 2001; Huberman, Loch, & Önccüler, 2004; Magee & Galinsky, 2008).

Across species, individuals of relatively higher social status tend to have privileged access to precious resources (i.e., food, territory, and mates) and greater reproductive success (Ellis, 1993; Fiske, 1992; Fiske, 2010). Social status has also been linked to increased wellbeing, better health, and lower morbidity rates (Adler, Epel, Castellazzo & Ickovics, 2000; Boyce, 2004; Sapolsky, 2004, 2005). Therefore, it is not surprising that humans possessing higher status are generally believed to be evaluated more positively and to enjoy greater prestige (Anderson & Kilduff, 2009; Fiske, 2010; Flynn et al., 2006; Ridgeway & Walker, 1995; but see Cloutier, Ambady, Meagher, & Gabrieli, 2012).

Thus, in order to successfully navigate the complexities intrinsic to the multitude of social groups to which an individual belongs, one benefits from possessing knowledge of the relative ranks of other group members (Fiske, 1992; Fiske, 2010; Wilson, 2000). In many instances, status cues can be visually identified; this is the case with the size of ants and bees (Wilson, 2000) and a variety of dominance-related cues displayed by non-human primates (Cheney & Seyfarth; 2008; Hare & Tomasello, 2004). However, humans can also infer social status from a range of socially valued dimensions that may not always be perceptually identifiable, such as the financial resources or moral character of others (Berger, Cohen, & Zelditch, 1972; Boehm 2012; Fiske, 2010; Hamlin & Wynn, 2011; Hamlin, Wynn, & Bloom, 2010; Magee & Galinsky, 2008).

Whether others' social status is accessible from perceptually available cues or prior knowledge (e.g., information conveying financial or moral standing), perceivers may be spontaneously mapping the distance between their status and that of others in order to represent the relative rank of group members (Cloutier, et al., 2012). Previous research has defined social distance (Festinger, 1954; Wheeler, 1966) in terms of the similarity between the self and others, the degree of perceived reciprocity in social interactions, or the level of explicit prejudice held towards out-group members (Akerlof, 1997, Bogardus, 1959, Henry & Hardin, 2006; Hoffman, McCabe, & Smith, 1996; Liviatan, Trope, & Liberman, 2008; Magee, & Smith, 2013). The ability to assess relative social distances is believed to be an important aspect of social intelligence, which can be defined as an individual's capacity to navigate and manage daily interactions with others and social environments more generally (Frith & Wolpert, 2004; Goleman, 2006). For example, it has been found that minimizing the social distance between two participants favors increased cooperative behavior in the context of dictator and ultimatum games, two tasks that examine participants' inclination to share valuable resources (Charness & Gneezy, 2008; Hoffman et al., 1996; Jones & Rachlin, 2006). In contrast, when primed with the concept of financial resources (i.e., money), participants show a tendency to increase the social distance between themselves and others (Vohs, Mead, & Goode, 2006). Taken together, these findings suggest that hierarchical differentiations among individuals varying in social status may indeed rely on spontaneous assessments of social distances (see Chiao et al., 2009; Chiao, Bordeaux, & Ambady, 2004).

Additionally, across a variety of cultural contexts, social relationships tend to be discussed as if they belonged to a physical space. This is exemplified by expressions such as "close friends" or "distant relatives" (Bottero & Prandy, 2003; Ossowski, 1963). Such expressions are also commonly used when referring to an individual's or a group's social status, such as "those who are at the top or at the bottom of a ladder or hierarchy." Interestingly, a region of the parietal cortex, demonstrated to be involved in the representation of numerical magnitudes (Cohen-Kadosh, Cohen Kadosh, Kaas, Henik, & Goebel, 2007; Dehaene, Piazza, Pinel, & Cohen, 2003; Pinel, Dehaene, Riviere, & LeBihan, 2001; Pinel, Piazza, Le Bihan, & Dehaene, 2004; Shuman & Kanwisher, 2004), may also support the assessment of social distances. From this perspective, the mental representations of numbers, physical space, and social distances are hypothesized to share common neural substrates, including the intraparietal sulcus (IPS) (Chiao et al., 2009; Ramachandran & Hubbard, 2001; Yamakawa, Kanai, Matsumura, & Naito, 2009). Indeed, directly comparing brain regions involved in judgments of physical and social distances reveals overlapping activity in this region of the parietal cortex (Yamakawa et al., 2009). Furthermore, the superior parietal lobule (SPL), a parietal brain region adjacent to the IPS, has been found to be involved in egocentric representations of spatial information relating external objects to the self (Naito et al., 2008; Neggers, Van der Lubbe, Ramsey, & Postma, 2006). Such findings suggest that the perception of self-referential distance may recruit various areas of the parietal cortex.

In the social domain, the IPS has been shown to be responsive to information conveying the social status of others (Chiao et al., 2009; Cloutier et al., 2012; Zink et al., 2008). In one such study, viewing higher status individuals preferentially activated the right inferior parietal cortex (Zink et al., 2008). In another study, where participants were asked to explicitly compare the social status of individuals (i.e. military rank) (Chiao et al., 2009), increased IPS activity was found for judgments based on pairs of military individuals closer in ranks; a similar effect was obtained with numerical comparisons. Echoing the findings of Zink and colleagues, a recent study (Cloutier et al., 2012) found that social targets paired with higher financial status, as denoted by salary information, elicited preferential activity in the right IPS of perceivers (who themselves had relatively low financial status).

Although there is increasing evidence suggesting that the IPS is involved in computing or representing social distances between the relative social status of targets, to our knowledge, no studies have explored how explicit self-referential judgments of other's social status may modulate IPS activity. Accordingly, building on previous attempts to investigate the impact of social status on the neural substrates of person perception (Cloutier et al., 2012), the current event-related design fMRI experiment was designed to uncover the impact of explicit self-referential financial and moral status judgments on IPS activity. Furthermore, in contrast to previous studies using various forms of person-knowledge to convey status (Chiao, et al., 2009; Cloutier et al., 2012; Zink et al., 2008), the current study explicitly assigned distinct levels (Low, Average and High) and types (Moral and Financial) of social status to the targets. This approach ensured that targets were not characterized by person-knowledge other than their social status. Based on past research, we expected to find differences in IPS activity as a function of the self-relevance of the judgments provided by perceivers, such that targets of equal status level would be associated with greater IPS activity.

2. METHODS

2.1. Participants

Eighteen male participants between the ages of 19 and 31 (mean age=23.8) were recruited from the greater Chicago area. Two participants were excluded due to excessive head movement during scanning, and 3 were excluded due to failure to comply with the task requirements. Analyses were performed on the remaining thirteen participants. 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.

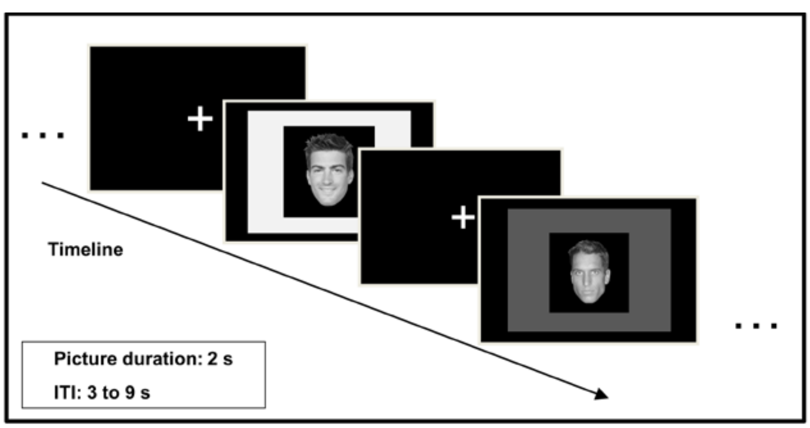
2.2. Stimuli and Procedure

Participants first answered a series of questionnaires including fMRI pre-screening material, demographic information, and measures of objective and subjective status. Subjective measures of financial and moral status were modifications of the ladder scale extensively used and validated to evaluate subjective socio-economic status (SES) (Adler et al., 2000; Singh-Manoux, Adler, & Marmot, 2003; Singh-Manoux, Marmot, & Adler, 2005), and it assessed the participants' subjective financial and moral status amongst the university undergraduate population of the greater Chicago area. Participants were informed that their status ostensibly fell in the middle of the distribution of the social status of other participants in the study. Importantly, participants were told that the distribution of the financial and moral status of 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.

Participants completed a computer-based training task (adapted from Cloutier, Norman, Li, & Berntson, 2013) to learn the association between colors (Blue and Red) and specific social status types (Financial and Moral). Shades of each color (Darker, Medium, and Lighter) were associated with different levels of social status (High, Average, and Low). For example, light blue may indicate high moral status whereas dark red may indicate low financial status (the association between color and status was counterbalanced across participants). During encoding, participants were presented with the backgrounds of the different shades (without any faces) with a text box indicating the social status type and level with which the shade of each color was paired. 70 trials were presented for each of the six conditions. The status types and levels associated with the backgrounds were counterbalanced across participants (i.e., Red or Blue indicating Financial or Moral status and darker shades indicating either Higher or Lower status). Following the encoding phase, the participants took part in a testing phase during which they were required to accurately identify at least 30 sequential presentations of the backgrounds with the correct status level and type. Participants were informed that they would later be presented with faces paired with these color backgrounds and were reminded that these individuals would also be participants in the study to emphasize the fact that they belonged to the same group.

Following an initial fMRI session which involved forming impressions of the stimuli superimposed on the colored background, participants took part in an event-related design fMRI session during which they were presented with all targets paired with the colored backgrounds and asked to explicitly identify the status of the targets in relation to their own (see Figure 1). The stimuli were composed of 30 color photographs of white males, ostensibly from the same participant pool from which participants were recruited. The face stimuli were of college age males (approximately 18-25 years old) who displayed neutral facial expression and wore gray shirts. Stimuli were presented with E-prime software (Psychology Software Tools, Inc., Pittsburgh, PA) using a back-projection system. The event-related session consisted of 6 runs. During each run, participants were presented with five faces from each status condition, for a total of 180 trials (30 in each run). Each face was paired with a color, presented against a black background, and remained on the screen for 2000 ms. Faces were followed by a centrally presented white crosshair against a black background for 500 ms. Stimulus presentation was jittered with a mean ITI of 6000 ms (range = 3000 to 9000 ms). Participants were instructed to indicate via button press the status of the target in relation to their own (Lower, Equal, or Higher). Once the fMRI session ended, participants were asked to fill out additional questionnaires and took part in a short computer-based task as part of a larger project. They were asked to provide ratings of all the targets presented during the scanning session. Among these ratings, judgments of similarity were relevant to the current project.

Figure 1.



Schematic representation of stimulus presentation during the self-referential status judgment task. In an event-related fMRI session, participants were presented with targets paired with colored backgrounds indicative of status types and level and were asked to explicitly identify the status of the targets in relation to their own.

2.3. fMRI Data Acquisition and Analysis

MRI was performed on a 3 T Philips Achieva Quasar scanner at the University of Chicago Brain Research Imaging Center. The fMRI pulse sequence parameters include time repetition/time echo (TR/TE) 3000/25 ms, flip angle = 85°, contiguous slices with 3 mm thickness, gap 0.3 mm, 212 × 212 mm field of view (FOV), approximately 72 × 70 matrix. High resolution structural images were acquired in the sagittal plane using a T1-weighted 3D Turbo Field Echo (TFE/MP-RAGE) anatomical scan with the following parameters: TR = 8.5 ms, TE = 4.0 ms, FOV = 240 × 228 mm, 1.0 mm slice thickness, no gap, 240 × 228 mm matrix, 1.0 × 1.0 × 1.0 mm voxel size.

fMRI data were analyzed by using the general linear model (GLM) for event-related designs in SPM8 (Welcome Department of Cognitive Neurology, London, UK). For each functional run, data were preprocessed to remove sources of noise and artifact. Images were realigned within and across runs via a rigid body transformation in order to correct for head movement. Images were then unwarped to reduce residual movement-related image distortions not corrected by realignment. Functional data were normalized into a standard stereotaxic space (3 mm isotropic voxels) based on the SPM8 echo planar imaging template that conforms to the ICBM 152 brain template space (Montreal Neurological Institute) and approximates the Talairach and Tournoux (1988) atlas space. Finally, normalized images were spatially smoothed (8-mm full-width at half-maximum) using a Gaussian kernel to increase the signal to noise ratio and to reduce the impact of anatomical variability not corrected for by stereotaxic normalization.

For each participant, a GLM was constructed to investigate status condition specific brain activity. This GLM, incorporating task effects and covariates of no interest (a session mean, a linear trend to account for low-frequency drift, and 6 movement parameters derived from realignment corrections), was convolved with a canonical hemodynamic response function (HRF) and used to compute parameter estimates (β) and contrast images (containing weighted parameter estimates) for each status condition at each voxel. The six condition onsets were based on the participants' explicit self-referential judgments of the targets varying in status level (Lower, Equal, and Higher) and types (Financial and Moral).

The data were subjected to an exploratory whole brain analysis, where the contrast images from each condition were compared to baseline (a fixation control condition). These images were used to compute a whole brain voxelwise ANOVA, yielding F-statistical maps for the status level main effect, the status type main effect, and the interaction between status level and status type.

Finally, a region of interest (ROI) analysis was conducted to identify a potential dissociation in IPS responses to social targets varying on levels of financial and moral status. The eight millimeters spherical IPS ROI (MNI: 48, -62, 46) was based on coordinates taken from a previous study of the impact of social status on person perception (Cloutier et al., 2012). Parameter estimates for each condition were extracted and submitted to an offline 2 (Status Type: Financial, Moral) by 3 (Status Level: Lower, Equal, Higher) repeated measures analysis of variance (ANOVA).

3. RESULTS

3.1. Behavioral results

On average, participants reported possessing a higher moral subjective status (*M*=7.15, *SD*=1.21) than financial subjective status (*M*=4.38, *SD*=2.78), $t_{(12)}$=2.899, *p*=0.013, η^2=0.411.

Participants' responses during the self-referential fMRI task were used to generate the onsets in the current study. Their responses indicated that, on average, participants judged Financial status targets as having relatively lower status 25.84 times (*SD*=6.03), equal status 36.38 times (*SD*=8.57), and higher status 26.61 times (*SD*=9.63). Similarly, participants' responses indicated that on average they judged Moral status targets as having relatively lower status 24.30 times (*SD*=7.81), equal status 41.84 times (*SD*=11.83), and higher status 22.46 times (*SD*=8.52).

A 2 (Status Type: Financial, Moral) by 3 (Status Level: Low, Average, High) repeated measures ANOVA was performed on post-scan similarity ratings of the faces. There was no main effect of status type, $F_{(1,12)}$=0.10, *p*=0.924, η^2=0.001, and no significant status type by status level interaction, $F_{(2,24)}$=0.894, *p*=0.422, η^2=0.069, was observed. However, a significant Status Level main effect, $F_{(2,24)}$=3.872, *p*=0.035, η^2=0.244 revealed that participants rated targets of Average status as more similar to themselves (*M*=3.85, *SD*=0.738) than Lower moral status targets(M=3.26, SD=0.529), $t_{(12)}$=-2.49, *p*=0.028, η^2=0.340.

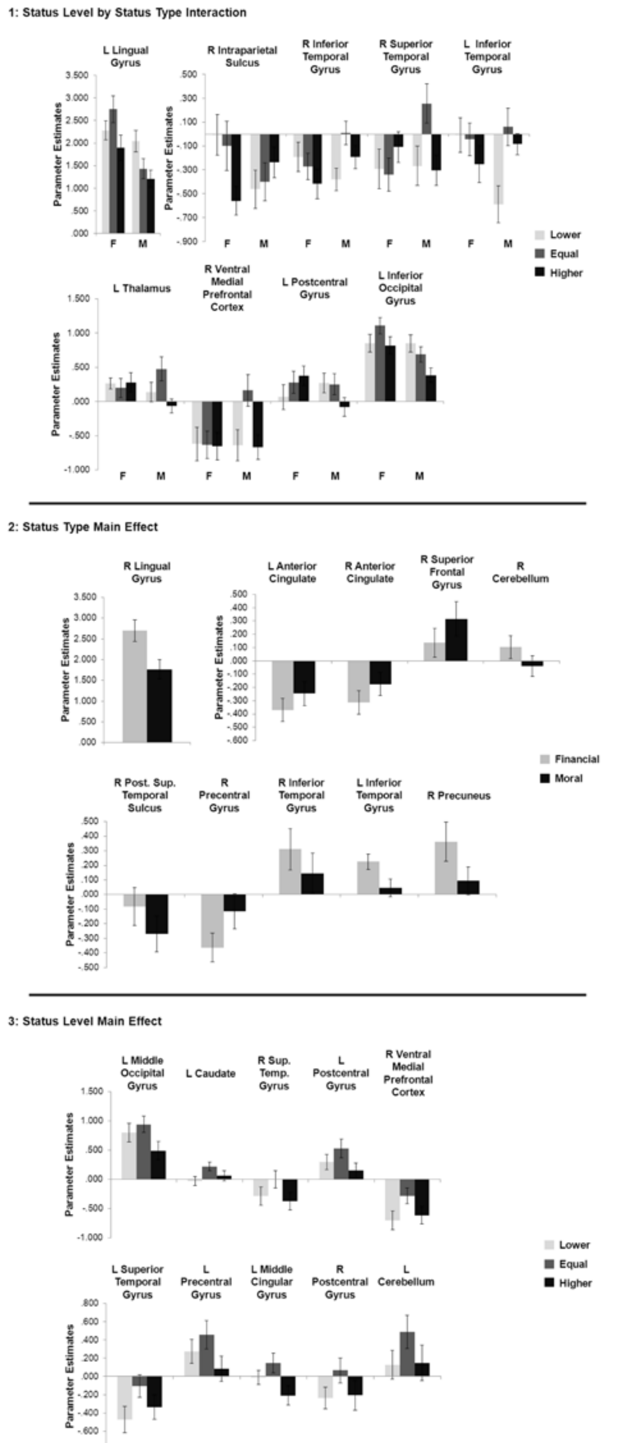
3.2. Brain imaging results

Exploratory whole-brain analysis. A whole-brain exploratory analysis of variance was performed to identify additional brain regions differentially recruited by social targets varying in social status. The results indicated a significant interaction of IPS activity in response to targets differing in types and levels of social status (see Table 1 and Figure 3). Additionally, temporal and parietal areas were revealed in the interaction of status type by status level. This concurrent brain activity may reflect operations related to the computation of egocentric representations of socially salient stimuli (Naito et al., 2008; Neggers et al., 2006) or the involvement of attention networks (Corbetta & Shulman, 2002; Desimone & Duncan, 1995; Klein, Shepherd, & Platt, 2009; Posner & Rothbart, 2007; Raz & Buhle, 2006). Conceivably, such processes could operate in support of relative social distance judgments (Chiao, et al., 2009; Cloutier et al., 2012; Yamakawa et al., 2009)

Table1. **Exploratory Whole Brain Analyses. MNI Coordinates are reported at an uncorrected threshold of p <0.005 with extend clusters of 5 voxels.**

BA	Brain Region	P	K	F	x	y	Z
Status Type by Status Level Interaction							
BA 17	L Lingual Gyrus	0.000	102	12.03	-12	-93	-6
BA 40	R Intraparietal Sulcus	0.000	70	10.32	54	-51	39
BA 20	R Inferior Temporal Gyrus	0.001	22	9.36	51	-9	-42
BA 38	R Superior Temporal Gyrus	0.001	12	8.99	48	6	-24
BA 20	L Inferior Temporal Gyrus	0.001	21	8.85	-60	-24	-21
	L Thalamus	0.001	10	8.75	-9	-15	0
BA 9	R Ventromedial Prefrontal Cortex	0.002	13	7.60	6	42	-15
BA 2	L Postcentral Gyrus	0.002	6	7.46	-54	-27	36
BA 19	L Inferior Occipital Gyrus	0.002	7	7.30	-33	-81	-6
Status Type Main Effect							
BA 18	R Lingual Gyrus	0.000	2184	47.02	15	-93	-3
BA 32	L Anterior Cingulate	0.000	65	32.09	-15	51	-3
BA 31	R Anterior Cingulate	0.000	9	20.77	12	-27	51
BA 6	R Superior Frontal Gyrus	0.000	21	19.96	9	6	63
	R Cerebellum	0.000	21	19.96	15	-63	-36
BA 21	R Post. Sup. Temporal Sulcus	0.001	30	18.12	54	-45	9
BA 4	R Precentral Gyrus	0.001	12	16.12	42	-12	57
BA 36	R Inferior Temporal Gyrus	0.002	5	12.78	30	-6	-39
BA 20	L Inferior Temporal Gyrus	0.003	6	12.31	-48	-33	-24
BA 31	R Precuneus	0.003	5	12.26	12	-66	36
Status Level Main Effect							
BA 18	L Middle Occipital Gyrus	0.000	918	24.63	-24	-96	15
BA 23	L Caudate	0.000	68	12.37	-18	24	0
BA 22	R Superior Temporal Gyrus	0.001	9	9.39	54	0	3
BA 3	L Postcentral Gyrus	0.001	48	9.23	-39	-21	51
BA 32	R Ventromedial Prefrontal Cortex	0.001	48	8.69	3	36	-12
BA 21	L Superior Temporal Gyrus	0.001	11	8.42	-66	-42	3
BA 4	L Precentral Gyrus	0.001	43	8.25	-33	-27	63
BA 24	L Middle Cingular Gyrus	0.001	117	7.96	-9	0	42
BA 1	R Postcentral Gyrus	0.001	117	7.96	51	-18	45
	L Cerebellum	0.002	15	7.71	-27	-45	-24

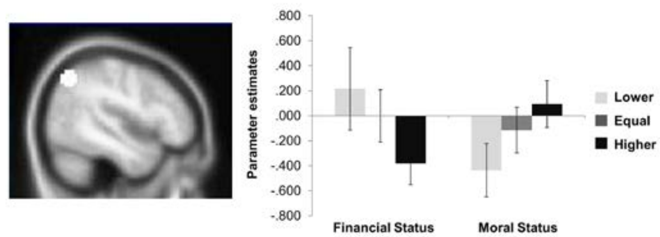
Figure 3.



Graphical displays of signal change (parameter estimates) provided to interpret the results of the whole brain analysis. Panel 1: interaction between Status Level and Status Type; Panel 2: main effect of Status Type; Panel 3: main effect of Status Level.

ROI Analyses. A 2 (Status Type: Financial, Moral) by 3 (Status Level: Lower, Equal, Higher) repeated measures ANOVA was performed on parameter estimates extracted from an IPS ROI used in previous studies (Chiao et al., 2009; Cloutier et al., 2012). No main effect of status type, $F_{(1,12)}$=0.449, p=0.516, η^2=0.036, or Status Level $F_{(2,24)}$=0.099, p=0.906, η^2=0.008 were obtained, but, once again, a significant status type by status level interaction, $F_{(2,24)}$=3.576, p=0.044, η^2=0.230, was observed. Although subsequent comparisons trended in the right direction (Cloutier et al., 2012) [(Lower vs. Higher moral status: $t_{(12)}$ > -1.854, p=0.088), (Lower vs. Higher financial status: $t_{(12)}$=1.577, p=0.141, η^2=0.170)], additional analysis only revealed significantly less IPS activity to Lower (M=-0.435, SD=0.771) compared to Equal (M=-0.114, SD=0.656) Moral Status Targets, $t_{(12)}$=-2.200, p=0.048, η^2=0.287 (see Figure 2).

Figure 2.



Sagittal section (left) illustrating the spherical ROI in IPS hypothesized to support the assessment of the relative social status of others. The graph to the right of the image displays signal change (parameter estimates) for each trial type (Lower, Equal, and Higher Financial and Moral Status) for this brain region. Inspection of these figures reveals an interaction between status types and levels.

4. DISCUSSION

The current study presents further evidence of the differential involvement of IPS during the perception of others varying in social status. The obtained results suggest more IPS activity in response to targets of equal and higher moral status relative to those with lower moral status, whereas a reversed trend was observed in response to different levels of financial status (with relatively greater response to lower financial status targets). Greater IPS activity may occur in response to social targets deemed to be “socially closer” to the self (Chiao et al., 2009; Yamakawa et al., 2009), however the limited behavioral evidence available prevent from drawing strong conclusions in that regard. This interpretation would nonetheless be in line with results from a previous study demonstrating greater IPS activity when perceivers were presented with targets closer in military ranks (Chiao et al., 2009) or with targets with a financial status similar to their own (Cloutier et al., 2012).

Contrary to the arguments for a domain-specific role related to number processing operations (Cohen-Kadosh et al., 2007; Dehaene et al., 2003; Pinel et al., 2001; Pinel et al., 2004), the current data provide additional evidence of the region's sensitivity to the social status of others (Chiao et al., 2009; Cloutier et a., 2012; Zink et al., 2008). This suggests that the IPS may support domain-general operations (Shuman & Kanwisher, 2004) recruited when perceivers engage in implicit or explicit discriminations across a variety of social and non-social targets. Accordingly, the IPS may subserve critical functions as a part of a greater person perception network. Within such network, the IPS might be involved in assessing the relative positions of individuals comprising a given social hierarchy. Such cognitive mapping of relative social standing may guide subsequent behavior towards successful interactions with members of the group (Frith & Wolpert, 2004; Goleman, 2006). This process could represent an essential component of the creation and maintenance of social hierarchies (Cummins, 2000; Magee & Galinsky, 2008), and support various forms of social comparison processes (Festinger, 1954; Wheeler, 1966).

Interestingly, a whole-brain analysis revealed that areas of the VMPFC were responsive when perceivers judged targets as possessing equal social status (see Table 1 and Figure 3). These results are in line with previous research demonstrating VMPFC involvement in self-referential processing (Gusnard, Akbudak, Shulman, & Raichle, 2001; Johnson et al., 2002; Kelley et al, 2002; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006). However, a region of the VMPFC was also previously found to be responsive to social status information (Cloutier et al., 2012). Additional research will be needed to further clarify the role of different VMPFC areas potentially supporting person evaluation and self-referential processing (Cloutier et al., 2012; Krienen, Tu, & Buckner, 2010; Mitchell et al., 2006).

In addition to its involvement in assessing social distances, it is worth considering that the IPS may function as part of greater attention networks involving a number of parietal, temporal, and prefrontal brain areas (Corbetta & Shulman, 2002; Desimone & Duncan, 1995; Klein, Shepherd, & Platt, 2009; Posner & Rothbart, 2007; Raz & Buhle, 2006). Such networks of brain regions could be recruited when encountering socially salient stimuli, in this case based on the social status paired with the faces. In light of recent evidence demonstrating that perceivers pay differential attention to targets varying in social status (Dalmaso, Pavan, Castelli, & Galfano, 2012; Deaner, Khera, & Platt, 2005; Fiske, 2010; Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010; Maner, DeWall, & Gailliot, 2008), further research should explore this potential IPS function in the context of person perception tasks.

Surprisingly, few empirical accounts have shed light on the influence of social status on the so-called "social brain" (Chiao, 2010; Kumaran, Melo, & Duzel, 2012; Marsh, Blair, Jones, Soliman, & Blair, 2009). The current study, along with other recent reports (Cloutier et al., 2012), demonstrates the need to consider the impact of distinct status types, in addition to levels of status, to better understand how social cognition is shaped by social hierarchies (Fiske, 2010; Magee & Galinsky, 2008). In addition to financial and moral status, physical dominance and intellectual aptitudes may be salient types along which perceivers infer status (Marsh et al., 2009; Stephens et al., 2007). Examining IPS involvement in response to these diverse status types may provide further insights into how social distances are computed within hierarchies. It may be the case that social distances are "mapped" based on measurable and concrete attributes, such as physical strength or finances, differently than for more abstract attributes, such as intellect or morality. For instance, whereas individuals may have a tendency to inflate their subjective assessment of moral status, it may be more difficult to do so for financial status.

Given that social status can often be inferred from perceptually available characteristics, such as age, gender, race, attractiveness, and dominance (Fiske, 2010; Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011; Karafin, Tranel, & Adolphs, 2004; Marsh et al., 2009), it remains important to expand current efforts by examining how such perceptual cues may influence the perception of targets varying on levels of status across multiple social types. In addition to possessing knowledge of others actual status within a group (e.g., a higher rank in the military), the status typically associated with perceptually available characteristics (e.g., gender or race) may impact the assessment of social distances among the members of a particular hierarchy.

Although in the expected direction, and unlike what was previously found (Cloutier et al., 2012), no significant difference in IPS activity was identified in response to targets varying in financial status. It may be the case that morality was a more relevant dimension to participants of the current study who generally perceived themselves as possessing higher moral than financial status. It is possible that college students are less sensitive to information about financial compared to moral status. Nonetheless, the absence of significant IPS activity in responses to targets varying in financial status is likely due to the relatively small sample size available. Future research should address this issue by studying populations with adequate distribution of distinct levels of Financial and Moral status types.

Unlike previous studies (Chiao et al., 2009; Cloutier et al., 2012; Zink et al., 2008), the current study also involved status inferred from social types that are not easily quantifiable by participants. This is noteworthy because the IPS has often been presented as a region dedicated to number processing (Cohen-Kadosh et al., 2007; Dehaene et al., 2003; Pinel et al., 2001; Pinel et al., 2004). Whereas military ranks (Chiao et al., 2009) or salary information (Cloutier et al., 2012) may easily be construed numerically, it may be more difficult to do so with levels of moral status. However, by assigning Low, Average, and High levels of status to the targets, perceivers may still have co-opted representations of magnitude associated with numerical cognition to establish the relative ranks of the targets.

The current project, along with previous research (Chiao et al., 2009; Cloutier et al., 2012; Zink et al., 2008), suggests that being aware of others' social status in relation to one's own modulates activity in the IPS. Although the current findings suggest that the IPS is sensitive to information about the social status of others, more efforts are needed to understand the region's involvement in person perception and attention brain networks. To achieve this goal, it will be useful to examine how IPS activity relates to other brain regions implicated in person perception. For instance, it may be beneficial to investigate how the perception of social distances relates to processes supporting person evaluation. Ultimately, these efforts should reveal the complex mechanisms underlying social interactions within hierarchies and their neural underpinnings.

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