Specialization in Relational Reasoning:

The Efficiency, Accuracy and Neural Substrates of Social versus Non-Social Inferences

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Abstract

Although deduction can be applied both to associations between non-social objects and to social relationships among people, we hypothesize that social targets elicit specialized cognitive mechanisms that facilitate inferences about social relations. Consistent with this view, in Experiments 1a and 1b we show that participants are more efficient and more accurate at inferring social relations compared with non-social relations. In Experiment 2, we find direct evidence for a specialized neural apparatus recruited specifically for social relational inferences. When making social inferences, fMRI results indicate that the brain regions that play a general role in logical reasoning (e.g., hippocampi, parietal cortices, and DLPFC) are supplemented by regions that specialize in representing people's mental states (e.g., pSTS/TPJ and mPFC).

Keywords: social inferences; social cognition; social network; reasoning; social neuroscience

Social creatures depend on a number of skills to ensure their safety and to accomplish their goals. One important social skill is determining how individuals relate to each other and form cliques or social networks (Cheney, Seyfarth, & Smuts, 1986; de Waal, 2007). Quickly and accurately learning the intricacies of the relational landscape—inferring who is friends with whom, identifying which people have conflicting personalities or interests, and anticipating shifts in the dynamics among existing social factions—is vital to behaving appropriately in the presence of potential allies and possible enemies (Flynn, Reagans, Amanatullah, & Ames, 2006; Kilduff & Krackhardt, 1994; Krackhardt & Kilduff, 1999). This, however, can be a daunting task since social networks grow exponentially in complexity as they increase in size. Evidence suggests that people simplify this challenge by using inference rules to encode, represent, and infer information about interpersonal relationships (Freeman, 1992; Heider, 1958; Hummert, Crocker & Kemper, 1990; von Heckler, 1997; Janicik & Larrick, 2005; Sentis & Burnstein, 1979; Zajonc, 1960; Zajonc & Burnstein, 1965). Given the enormous value in inferring and representing dynamics among people, we suspect that social relations are deduced more quickly and more accurately than are non-social relations. We further contend that this performance enhancement reflects the involvement of specialized mechanisms, which evolved to improve performance on a survival-related social problem (Cheney, Seyfarth & Smuts, 1986; Cheney & Seyfarth, 1990), rather than facile application of an all-purpose solution to a familiar context. The present investigation seeks behavioral and brain imaging evidence consistent with this possibility.

Deduction—the integration of a set of premises to yield a latent conclusion—is a fundamental strategy that people use to reason about everyday relationships (Evans, 1982;

Johnson-Laird & Byrne, 1991; Maki, 1981; Wason & Johnson-Laird, 1972). Using deduction, people can synthesize information to infer novel relationships, thereby extending their storehouse of knowledge on the basis of indirect evidence. For example, an aspiring chemist can infer that hydroxide is insoluble in water, provided he or she has knowledge of both the solubility of sodium with hydroxide and sodium with water. Similarly, having never previously met Andy, Janet can base their potential for friendship on her knowledge of Andy's loyalty to her nemesis.

Although deduction can be applied both to associations between non-social objects and to social relationships among people, an open question is whether deduction is accomplished through the application of a single, all-purpose inference strategy, or whether non-social relational inferences involve qualitatively different cognitive mechanisms than relational inferences involving people (Cosmides, 1989; Cosmides & Tooby, 2000; Canessa et al., 2005; Goel et al., 2004). Cosmides (1989) argues that human cognition includes processes specialized for reasoning about the dynamics of social exchange between people. In the current research we extend this perspective to reasoning about the *structure* of social relations, demonstrating that social relations are not only processed to yield inferences more quickly and accurately than non-social relations, but also that they elicit specialized neural mechanisms that facilitate the deduction process.

The process of deductive reasoning has captivated scientists and other scholars for centuries. Valid inferences are *formally* derived when people abstract premises and explicitly apply a set of general logic rules to arrive at a novel conclusion (Braine, 1978; Rips, 1983). Although the formal approach yields logical inferences in any context, evidence suggests that, when making deductions in domains about which they have knowledge, people tend toward an alternative, content-dependent approach (Johnson-Laird & Byrne, 1991). People extract relationships implicit in premises more quickly and more accurately when the premises contain familiar and concrete material (Bracewell & Hidi, 1974; Evans, Barston & Pollard, 1983; Evans, Evans, Newstead & Byrne, 1993; Evans & Pollard, 1983; Johnson-Laird, Legrenzi, & Legrenzi, 1972; Wason & Shapiro, 1971; Wilkins, 1928). These performance enhancements are purported to reflect facile application of a single, all-purpose algorithm to relationships that people are accustomed to considering in their everyday lives. We propose that another factor affecting the efficacy of deduction is whether or not the premises describe relations that are social.

Social neuroscience research reveals that attributing sentiments, beliefs, or other mental states to people involves three brain regions: the posterior superior temporal sulcus (pSTS), the temporo-parietal junction (TPJ), and the medial prefrontal cortex (mPFC; Gallagher, 2002; Harris, Todorov & Fiske, 2005; Mitchell, Banaji & Macrae, 2005; for review see Amodio & Frith, 2006; Frith & Frith, 2006; Mitchell, 2009). This kind of mental state attribution is essential when reasoning about the relations among people because these relationships reflect people's sentiments toward one another (Heider, 1958). We therefore hypothesize that the pSTS, the TPJ, and the mPFC are uniquely recruited when people make a novel inference about a social relation based only on available knowledge of other relevant social relations.

The present investigation demonstrates that humans are particularly adroit at inferring relationships among people and that this aptitude reflects the involvement of specialized social-cognitive mechanisms. In Experiments 1a and 1b, we measure the relative speed and accuracy with which people deduce social versus non-social relations. Using functional magnetic resonance imaging (fMRI), in Experiment 2 we determine whether the mental manipulation of information about relationships among people, but not relationships among objects, is associated with recruitment of brain regions that support mental state attribution—the pSTS, TPJ and mPFC.

Experiment 1a

Methods

Participants and Design

Thirty-seven individuals from the Columbia University community (18 females) participated in the experiment in return for monetary compensation ($10). The experiment had a single-factor (relational type: social or physical) repeated-measures design.

Materials and Procedure

Social stimuli consisted of 30 names (15 male) from the 1990 United States Social Security Register. Physical stimuli were names of 30 familiar metals. All stimuli were presented in a red font on a black background.

Upon arrival in the laboratory, each participant was greeted by a female experimenter and directed to sit in front of a Dell PC computer where written, informed consent was obtained. The experimenter then proceeded to explain that the study was designed to investigate how individuals reason about the relationships among people and objects in their environment; specifically, whether they "attract" or "repel" each other, in the broad sense of those terms. Participants were told that they would judge the relationships among metals that had been divided into two groups and that metals from the same group attracted one another while those from different groups repelled one another. Participants were also told that they would be making similar judgments about people. It was explained to participants that, like the metals, each person belonged to one of two groups and that those belonging to the same group attracted one another while those from different groups repelled one another. Participants were informed that on each trial they would see three names of metals or three names of people on the screen and two of the possible three relationships between them. Their task would be to infer the third relationship on the basis of the two provided. It was emphasized that they should register a response as quickly and accurately as possible using the keys labeled "attract" and "repel".

Trials consisted of the following sequence of events: Two names (both people, or both metals) appeared on the screen for 400ms at which point an arrow representing the relationship between the targets appeared between the names. After 400 ms a third name appeared, followed 400ms later by a second arrow illustrating the relationship. After a final 400ms interval, a "?" appeared on the screen in the remaining position, prompting participants to determine the missing relationship. The items appeared in a triangular formation (see Figure 1 for an example).

After 10 practice trials, the computer began recording the speed and accuracy of responses. Each participant completed 40 trials (20 social and 20 non-social). Upon finishing participants were thanked, debriefed, paid, and dismissed.

Results

Participants made inferences more quickly when they involved social (M RT = 1838ms, SD = 718ms) relative to non-social relationships (M RT = 1949ms, SD = 742ms), $t(36) = 2.08$, $p < .05$, $d = .15$. A difference in accuracy (proportion hits) as a function of relational type also emerged, $t(36) = 2.24$, $p < .05$, $d = .28$. Participants performed significantly more accurately on trials involving social relationships (M = .87, SD = .14) than on trials involving non-social relationships (M = .83, SD = .15). Thus, both the measure of speed and the measure of accuracy supported our hypotheses.

Experiment 1b

Consistent with our hypothesis, in Experiment 1a participants were more accurate and faster at drawing inferences from premises describing social versus non-social relations. One limitation of Experiment 1a is that participants may be more familiar with the names of people than with the names of metals. We therefore repeated the procedures in Experiment 1b, substituting names of people with unfamiliar faces and names of metals with abstract shapes. We were interested in whether or not participants would continue to have enhanced performance on trials involving social targets, even after controlling for familiarity by using novel stimuli.

Method

Participants and Design

Forty-seven individuals from the Columbia University community (25 females) participated in the experiment in return for monetary compensation ($10). The experiment had a single-factor (relational type: social, physical) repeated-measures design.

Materials and Procedure

The procedure in Experiment 1a was identical to Experiment 1b with the exception of a change in stimuli. Social stimuli consisted of grayscale images of 30 faces that were unfamiliar to participants and were displaying neutral expressions. Non-social stimuli were 30 shapes on a black background. All files were standardized to 200 x 200 pixels and matched for luminance and contrast. Like the participants in Experiment 1a, participants were administered 10 practice trials before completing 40 experimental trials (see Figure 2 for an example).

Results

Consistent with Experiment 1a, participants made inferences more quickly when the trial involved faces (M = 1714ms, SD = 801ms) rather than shapes (M = 1924ms, SD = 921ms), $t(47) = 4.49$, $p = .001$, $d = .24$. Accuracy also depended on the relational type, $t(47) = 2.29$, $p < .05$, $d = .22$; participants performed significantly more accurately on trials involving social relations (M = .87, SD = .13) than on trials involving physical relations (M = .84, SD = .14).

Discussion

Across two studies we found that individuals made inferences involving social relations more accurately and more quickly than those involving non-social (physical) relations. This basic effect held regardless of whether the social relations were depicted using names or unfamiliar faces. It is possible, however, that the observed performance differences simply reflect motivational differences or greater ease of applying deductive logic in a familiar context. In Experiment 2, we thus tested a different mechanism, namely, that brain regions involved in representing sentiments and other mental states—the mPFC, TPJ and the pSTS—facilitate inferences about sentiment relations.

Experiment 2

To directly test our claim that superior performance with social relations reflects a qualitative difference in how the solutions are reached and not greater efficacy applying the same reasoning approach to social contexts, we measured blood-oxygenated-level-dependent (BOLD) activity while participants inferred social and physical relations. Consistent with previous brain-imaging work on deductive inference (Acuna, Eliassen, Donoghue & Sanes, 2002; Goel, Buchel, Frith & Dolan, 2000; Goel & Dolan, 2001), we predicted that both social and non-social relational inferences would be associated with recruitment of cortical regions implicated in manipulating and integrating facts (e.g., the parietal and the DLPFCs) and associating information (e.g., hippocampi). Instead of finding BOLD magnitude differences within these areas, as the explanation based on familiarity would predict, we instead hypothesized that BOLD signal differences would emerge in distinct cortical regions. Given their role in representing sentiments and attitudes, we predicted that the pSTS, TPJ, and the mPFC would be uniquely recruited when participants manipulated their knowledge of relationships among people to make inferences about social relationships for which they lacked direct knowledge.

Method

Participants

Seventeen participants (8 females) from the Columbia University community completed the experiment for monetary compensation ($45). All participants were strongly right-handed as measured by the Edinburgh Handedness Inventory (Raczkowski, Kalat, & Nebes, 1974), reported no significant abnormal neurological history, and had normal or corrected-to-normal visual acuity. Data from one participant could not be used because they contained sizable signal artifacts.

Materials and Procedure

Stimuli were the same names and images used in Experiments 1a and 1b**.** As in the previous two studies, the experimenter explained that the study was designed to investigate how individuals reason about the relationships among people and things in their world; specifically, whether they “attract” or “repel” one another. The participants were informed that they would be asked to make judgments about the missing relationship between metals and between people. Prior to entering the scanner, participants completed 10 practice trials to ensure that they understood the directions.

Participants completed a total of 80 trials (40 social) across two separate runs, each lasting 5000ms in duration. A trial consisted of the same sequence of events described in the previous two experiments. A total of 170 volumes were collected in each EPI run. The TR was 2 seconds in duration, which meant that each trial lasted for 2.5 TRs. The remaining 70 EPI volumes were jittered catch trials (i.e., fixation symbols, "+") used to optimize estimation of the event-related BOLD response. The stimuli were presented using Presentation (version 12.1) and back projected with an LCD projector onto a screen at the end of a magnet bore, which participants viewed by way of a mirror mounted on the head coil. Pillow and foam cushions were placed within the head coil to minimize head movements.

Image Acquisition

All images were collected using a GE scanner with standard head coil. T1-weighted anatomical images were collected using a 3-D sequence (SPGR; 180 axial slices, TR = 19 ms, TE = 5 ms, flip angle = 20°, FOV = 25.6 cm, slice thickness = 1 mm, matrix = 256 x 256). Functional images were collected with a gradient echo EPI sequence (each volume comprised 27 slices; 4 mm thick, 0 mm skip; TR = 2 s, TE = 35 ms, FOV = 19.2 cm, 64 x 64 matrix; 84° flip angle).

fMRI Analysis

Functional MRI data were analyzed using Statistical Parametric Mapping software (SPM5, Welcome Department of Cognitive Neurology, London, UK). For each functional run, data were preprocessed to remove sources of noise and artifact. Preprocessing included slice timing and motion correction, co-registration to each participant's anatomical data, normalization to the ICBM 152 brain template (Montreal Neurological Institute), and spatial smoothing with an

8 mm (full-width-at-half-maximum) Gaussian kernel. Analyses took place at two levels: formation of statistical images and regional analysis of hemodynamic responses.

For each participant, a general linear model with 26 regressors was specified (Friston et al., 1995). The model included a regressor for each of the four conditions of interest (names, metals, shapes, faces), a regressor for each of the first four volumes collected in the two EPI series (eight total), six motion-related regressors for each series (12 total) and the two SPM constant terms. The general linear model was used to compute parameter estimates (β) and t-contrast images for each comparison at each voxel. These individual contrast images were then submitted to a second-level, random-effects analysis to obtain mean t-images.

Results

Regions that play a general role in deductive logic

To identify cortical regions that play a general role in deductive inference, we compared the average activity associated with inference judgments to activity during baseline periods (fixation '+'), $p < .001$; $k = 10$. This revealed an extensive network of regions, including a cluster that extended across bilateral inferior and middle occipital (BAs 18/19) and fuisform (BA 37) gyri, bilateral inferior (BA 40) and superior (BA 7) parietal lobules, across the thalamus and hippocampi, bilaterally, and into bilateral medial (BA32) and bilateral dorsolateral (BAs 6/9/44) prefrontal cortices. Two other clusters, one in the left and one in right lateral orbital frontal (BAs 10/11) gyri, also emerged from this analysis (see Table 1).

Regions sensitive to relational type

To test our claim that superior performance with social relations reflects a qualitative difference in how the solutions are reached and not greater efficacy applying the same reasoning approach to social contexts, we compared activity when the judgment involved social relations to activity when the judgment involved non-social relations, $p < .001$; k = 10. This revealed greater activity in several regions, including the following: bilateral clusters that extended across the middle occipital (BAs 18/19; 45, -79, -9; -36, -85, -9) and fusiform gyri (BA37 39, -56, -17; -42, -65, -14); bilateral clusters that extended across the pSTS (BAs 39/22 -45, -69, 18; 62, -46, 17) and the TPJ (BAs 19/39 -45, -78, 19; BAs 22/40 48, -59, 14); and a cluster in the left middle (BA21 -45, -29, -2) and left superior temporal gyrus (BA22; -45, -17, 16). Two clusters in the dorsal mPFC—one in BA8 (0, 32, 50) and another in BA9 (-3, 49, 38)—emerged at a slightly reduced threshold of $p < .005$, k = 10; see Table 2; Figure 3. The opposite contrast, regions that were more active when the judgment involved non-social relations, revealed statistically stronger activity in an aspect of the left hippocampus (BA30; 18, -37, 13) at a reduced threshold of $p < .005$, k =10.

General Discussion

Three decades of social cognition research have identified a number of specialized cognitive mechanisms that exist to help reason specifically about people (see Fiske & Taylor, 1991; Ostrom, 1984; Wyer & Srull, 1984). Results of the present investigation suggest that the current list of specialized social processes, which includes those involved in impression formation (Hamilton, Katz, & Leirer, 1980), person memory (Hastie & Kumar, 1979; Ostrom, 1989), causal attribution (Heider, 1958), and many others, should be extended to include relational inferences. Participants deduced social relations more quickly and more accurately than non-social relations. To investigate whether this difference can be explained by something other than more facile application of deductive logic to social versus non-social relations, we used fMRI to examine differences in brain activity. The results suggest that underlying this discrepancy in both the speed and accuracy of inference about social versus non-social relations is a qualitative difference in how the solutions were reached. Whereas inferences involving both social and non-social relations were dependent on brain areas that play a general role in deductive reasoning—the DLPFC, parietal cortices, and hippocampi—inferences involving social relations were uniquely associated with recruitment of brain regions involved in mental state representation (e.g., TPJ/pSTS and mPFC).

We suggest that these cortical areas enhance performance of social inferences by helping people represent social targets' mental states while they make inferences about interpersonal dynamics. This explanation is consistent with a wealth of brain imaging (e.g., Frith & Frith, 2003), lesion (e.g., Stuss, Gallup, Alexander, 2001) and functional connectivity (e.g., Lombardo et al., 2009) data which implicate these brain areas in mentalizing. Although this body of findings is compelling, it would be remiss of us to ignore the handful of studies that suggest these regions might be involved in thinking about people more generally (e.g., Mitchell, Heatherton & Macrae, 2002). It is theoretically possible that the recruitment of these cortical regions during the social inference task reflects the retrieval of social knowledge from memory, rather than the process of mentalizing, and that this enriched semantic information facilitates relational inferences involving people. Given that social relationships are primarily mentalistic in nature (Heider, 1958) and that the social inference task involved representing and inferring sentiments, we prefer the mentalizing explanation to this alternative.

Although it may seem less parsimonious than the alternative account that people are simply more experienced at social than non-social inferences, postulating the existence of a specialized social mechanism to explain superior performance makes intuitive sense when one considers the enormous survival value such a mechanism would confer on a species. Effective social interactions require the consideration not only of the directly observable features of one's interaction partner (e.g., their physical size) but also the status of and strength of that person's relationships with others (Datta, 1983; Chapais, 1992; Smuts, 1985; Bachmann & Kummer, 1980). Keeping track of alliances and kinship networks, and knowing where one fits in the social order become overly time-consuming and dangerous if assessed purely from direct evidence (Cheney, Seyfarth & Smuts, 1986; Cheney & Seyfarth, 1990). With sophisticated inference skills, one can make more informed decisions about whom to associate with, to mate with, and form an alliance with, which enhances access to resources like food and maximizes the success of offspring, thereby improving the species' survival in the long run (Silk, 2007). Thus, our findings converge with past research (e.g. Cosmides 1989) suggesting that primates evolved inference strategies specifically for managing the complexities of their social environments.

Our experiments suggest important questions for future research. For example, future research could clarify more precisely the conditions under which the cognitive mechanism for inferring social relations is employed. Future research could also examine the role this mechanism plays in the deduction of relations between people and non-social targets (e.g., "How does Mary feel about Tom's poem?"). It is also not clear whether this mechanism facilitates all relational inferences among social entities or if the relations themselves have to be social in nature. We suspect that this mechanism is invoked when people deduce social relations (e.g., "who has greater status?") but not physical relations (e.g., "who is heavier?") between people. We encourage researchers to explore these and related questions in future studies.

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Table 1. Peak coordinates of brain regions that were significantly more active during task periods relative to resting baseline, p < .001; k = 10. (L.) = Left; (R.) = Right; (BA) = Broadmann Area.

Relationship: Social > Non-social

			coordinates			
k	**Anatomical Location**	**BA**	**x**	**y**	**z**	***t*-value**
	Occipitotemporal					
11838	R. inferior occipital gyrus	18	39	-76	-6	27.52
	R. middle occipital gyrus	18	33	-87	12	11.26
	L. inferior occipital gyrus	18	-39	-85	-2	13.57
	L. lingual gyrus	17	-18	-96	1	11.09
	R. fusiform gyrus	37/19	45	-68	-10	16.22
	L. fusiform gyrus	37/19	-39	-59	-14	15.19
	Hippocampal					
	R. hippocampus	35/36	18	-32	-5	14.22
	L. hippocampus	35/36	-24	-29	-5	11.03
	Parietal					
	R. inferior parietal lobule	40	48	-32	50	14.22
	R. superior parietal lobule	7	27	-59	47	13.75
	L. inferior parietal lobule	40/7	-27	-56	51	11.45
	L. superior parietal lobule	7	-39	-38	50	11.10
	Thalamus					
	R. thalamus		15	-20	5	14.96
	L. thalamus		-15	-20	-8	14.29
	Medial frontal					
	R. medial frontal	32	9	8	44	13.65
	L. medial frontal	32	-3	5	48	11.30
	Dorsolateral-prefrontal cortices					
	L. inferior frontal gyrus	44/9	-50	4	26	11.22
	R. middle frontal gyrus	44/9	48	30	21	7.61
	L. precentral gyrus	6	-33	9	52	14.09
	R. precentral gyrus	6	50	2	37	6.80
26	R. middle frontal gyrus	10/11	42	49	-13	5.01
12	L. middle frontal gyrus	10/11	-30	52	-16	4.54

Table 2. Peak coordinats of brain regions that showed differential activity as a function of whether the inference involved social versus non-social targets, p < .001; k = 10. (L.) = Left; (R.) = Right; (BA) = Broadmann Area; (†) regions emerging at a threshold of p < .005.

Relationship: Social > Non-social

			coordinates			
k	**Anatomical Location**	**BA**	**x**	**y**	**z**	***t*-value**
	Occipitotemporal					
379	R. Middle Occipital Gyrus	18/19	45	-79	-9	7.86
	R. Fusiform Gyrus	37	39	-56	-17	4.76
297	L. Middle Occipital Gyrus	18/19	-36	-85	-9	6.40
	L. Fusiform Gyrus	37	-42	-65	-14	5.03
60	B. Lingual Gyri	17	-6	-78	11	3.96†
	Temporal and Temporoparietal					
158	L. Temporo-Parietal Junction	39/19	-45	-78	19	5.59
	L. Superior Temoral Gyrus	39/22	-45	-69	18	4.92
16	L. Middle Temporal Gyrus	21	-45	-29	-2	4.75
11	L. Superior Temporal Gyrus	22	-45	-17	16	4.19
22	R. Superior Temporal Gyrus	39/22	62	-46	17	4.16
	R. Temporo-Parietal Junction	40/22	48	-49	14	3.36†
	Medial Frontal					
17	L. Dorsal MPFC	8	-6	26	50	3.79†
	B. Dorsal MPFC	8	0	32	50	3.48†
53	B. Dorsal MPFC	9	-3	49	38	3.62†
	Motor					
105	R. Paracentral Lobule	5	9	-24	53	5.41
17	R. Postcentral Gyrus	4	30	-29	60	3.87†

Relationship: Non-social > Social

			coordinates			
k	**Anatomical Location**	**BA**	**x**	**y**	**z**	***t*-value**
	Hippocampal					
12	R. Hippocampus	30	18	-37	13	4.11

Figure Legends

Figure 1. An example of a trial composed of non-social items from Experiments 1a and 2. Here deductive logic yields the inference that the two metals attract each other.

Figure 2. An example of a trial composed of social items from Experiments 1b and 2. Here deductive logic yields the inference that the two people repel each other.

Figure 3. At the top are results of the all “task > baseline” contrast, p < .001; k =10 superimposed on a representative participant’s brain. (A) left superior parietal lobule (-39, -38, 50); (B) left DLPFC (-51, 18, 29); (C) left hippocampus (-18, -32, -2); and (D) right hippocampus (-18, -32, -2). At the bottom are the results of the “social > non-social” contrast, p < .005, k =10. (E) left TPJ (-45, -69, 18); (F) right pSTS (62, -46, 17); (G) right TPJ (48, -49, 14); (H) bilateral mPFC (0, 32, 50); (I) bilateral mPFC (-3, 49, 38); (J) right fusiform (39, -56, -17). ROI analyses were conducted by dropping a 10mm sphere centered on the peak coordinate and then computing the percent signal change for each condition. These values were averaged across participants and plotted.

Figures

Figure 1.

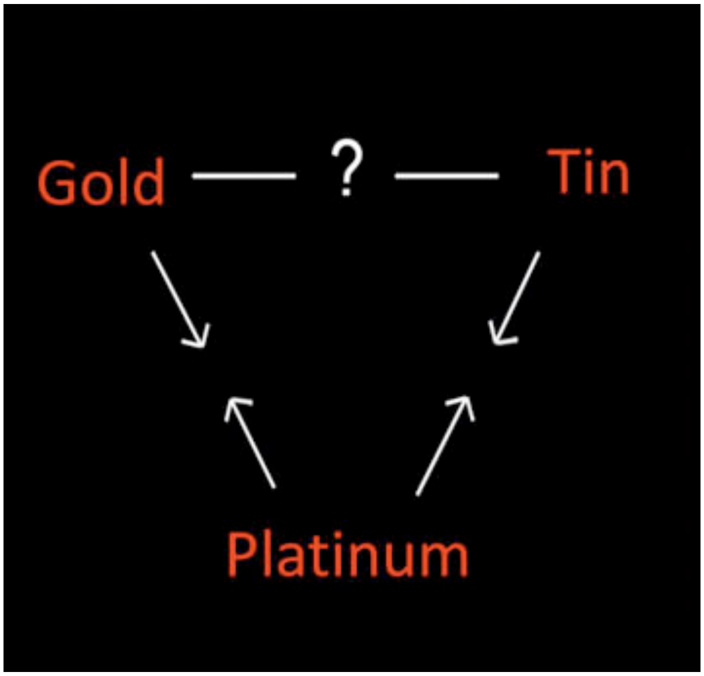


Figure 2.

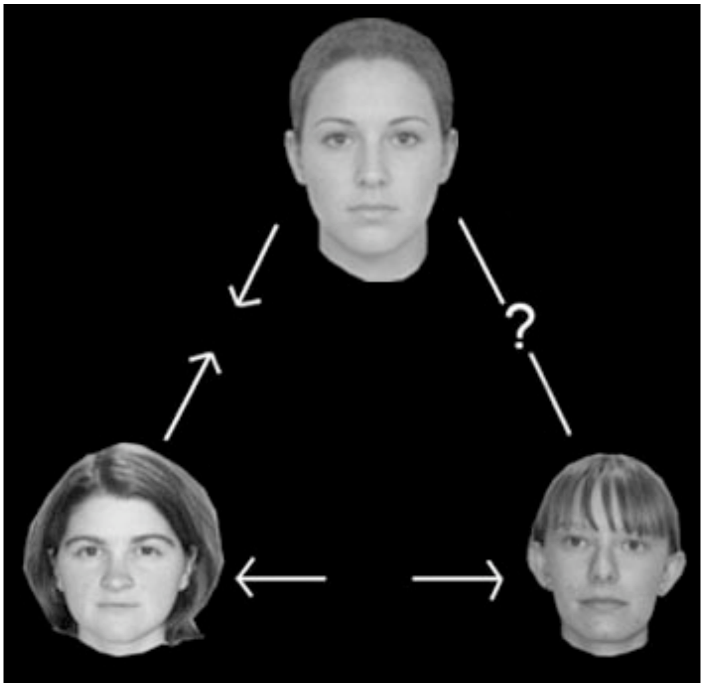
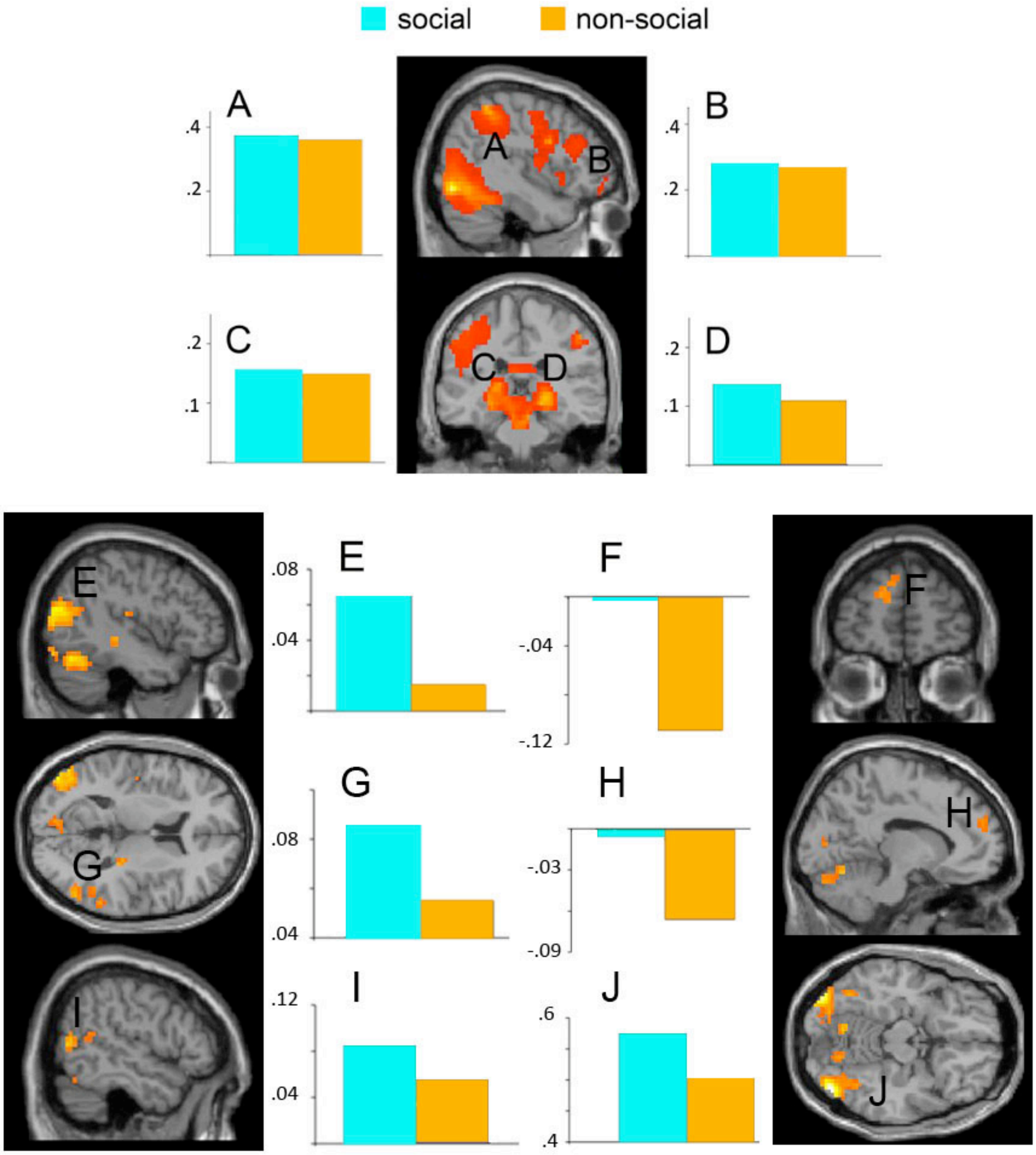


Figure 3.


social
non-social
A
.4
.2
B
.4
.2
C
.2
.1
D
.2
.1
E
.08
.04
F
-.04
-.12
G
.08
.04
H
-.03
-.09
I
.12
.04
J
.6
.4