March 2007

The neural processing of moral sensitivity to issues of justice and care.

Diana Robertson
University of Pennsylvania, robertsd@wharton.upenn.edu

John Snarey
Emory University

Opal Ousley
Emory University

Keith Harenski
Emory University

F. Dubois Bowman
Emory University

See next page for additional authors

Follow this and additional works at: https://repository.upenn.edu/neuroethics_pubs

Recommended Citation

The neural processing of moral sensitivity to issues of justice and care.

Abstract

The empirical and theoretical consideration of ethical decision making has focused on the process of moral judgment; however, a precondition to judgment is moral sensitivity, the ability to detect and evaluate moral issues [Rest, J. R. (1984). The major components of morality. In W. Kurtines & J. Gewirtz (Eds.), Morality, moral behaviour, and moral development (pp. 24–38). New York, NY: Wiley]. Using functional magnetic resonance imaging (fMRI) and contextually standardized, real life moral issues, we demonstrate that sensitivity to moral issues is associated with activation of the polar medial prefrontal cortex, dorsal posterior cingulate cortex, and posterior superior temporal sulcus (STS). These activations suggest that moral sensitivity is related to access to knowledge unique to one's self, supported by autobiographical memory retrieval and social perspective taking. We also assessed whether sensitivity to rule-based or "justice" moral issues versus social situational or "care" moral issues is associated with dissociable neural processing events. Sensitivity to justice issues was associated with greater activation of the left intraparietal sulcus, whereas sensitivity to care issues was associated with greater activation of the ventral posterior cingulate cortex, ventromedial and dorsolateral prefrontal cortex, and thalamus. These results suggest a role for access to self histories and identities and social perspectives in sensitivity to moral issues, provide neural representations of the subcomponent process of moral sensitivity originally proposed by Rest, and support differing neural information processing for the interpretive recognition of justice and care moral issues.

Keywords

Comments

Author(s)

Diana Robertson, John Snarey, Opal Ousley, Keith Harenski, F. Dubois Bowman, Rick Gilkey, and Clinton Kilts

The neural processing of moral sensitivity to issues of justice and care

Diana Robertson[a], John Snarey[b], Opal Ousley[c], Keith Harenski[c], F. DuBois Bowman[d], Rick Gilkey[a] and Clinton Kilts[c],

[a]Goizueta Business School, Emory University, Atlanta, GA 30322, United States

[b]Candler School of Theology, Emory University, Atlanta, GA 30322, United States

[c]Department of Psychiatry and Behavioral Sciences, Emory University School of Medicine, Atlanta, GA 30322, United States

[d]Department of Biostatistics, Emory University School of Public Health, Atlanta, GA 30322, United States

Referred to by:
Corrigendum to "The neural processing of moral sensitivity to issues of justice and care" [Neuropsychologia 45 (2007) 755–766]
Neuropsychologia, *Volume 45, Issue 8*, *2007, Page 1985*,
Diana Robertson, John Snarey, Opal Ousley, Keith Harenski, F. DuBois Bowman, Rick Gilkey, Clinton Kilts
PDF (47 K)

Abstract

The empirical and theoretical consideration of ethical decision making has focused on the process of moral judgment; however, a precondition to judgment is moral sensitivity, the ability to detect and evaluate moral issues [Rest, J. R. (1984). The major components of morality. In W. Kurtines & J. Gewirtz (Eds.), Morality, moral behaviour, and moral development (pp. 24–38). New York, NY: Wiley]. Using functional magnetic resonance imaging (fMRI) and contextually standardized, real life moral issues, we demonstrate that sensitivity to moral issues is associated with activation of the polar medial prefrontal cortex, dorsal posterior cingulate cortex, and posterior superior temporal sulcus (STS). These activations suggest that moral sensitivity is related to access to knowledge unique to one's self, supported by autobiographical memory retrieval and social perspective taking. We also assessed whether sensitivity to rule-based or "justice" moral issues versus social situational or "care" moral issues is associated with dissociable neural processing events. Sensitivity to justice issues was associated with greater activation of the left intraparietal sulcus, whereas sensitivity to care issues was associated with greater

activation of the ventral posterior cingulate cortex, ventromedial and dorsolateral prefrontal cortex, and thalamus. These results suggest a role for access to self histories and identities and social perspectives in sensitivity to moral issues, provide neural representations of the subcomponent process of moral sensitivity originally proposed by Rest, and support differing neural information processing for the interpretive recognition of justice and care moral issues.

Article Outline

1. Introduction

Ethics refers to the body of moral values and principles held by an individual or group. The ability to engage in ethical decision making is central to human social behavior and encompasses the detection and interpretation of moral issues, as well as the ability to reason and act based on moral principles. The determinants and underlying processes of moral thought and action have long been the subject of theorizing and debate. Early emphasis was placed on a cognitive-developmental model based on stages of moral reasoning ability that emphasized moral reasoning as a conscious, deliberative process (Kohlberg, 1958, Kohlberg, 1984, Piaget, 1932 and Piaget, 1965). Later, neo-Kohlbergian theorists advanced theories emphasizing a context-dependent process

involving components of moral decision making in addition to reasoning (Greene & Haidt, 2002; Haidt, 2001 and Rest, 1994). These theorists proposed that moral conflicts engage the automatic, implicit recruitment of cognitive structures, such as the activation of social schemas or tacit knowledge (Narvaez & Bock, 2002), that allow the detection and interpretation of a moral issue or situation (Rest, 1994). These processes may occur below the level of conscious awareness (Narvaez & Bock, 2002; Rest, Narvaez, Bebeau, & Thoma, 1999), and are generally analogous to the processes of moral sensitivity and moral intuition, which have been described by Rest (1994) and Haidt (2001), respectively. In particular, moral sensitivity refers to the detection and interpretation of a moral issue or situation, including awareness of how different individuals may be affected by an action taken in response to the issue (Rest, 1994). This interpretative awareness is the first component of ethical decision making in that it gives rise to the need to make a moral judgment, select a moral action, and other component processes of moral behavior. Understanding the process of moral sensitivity is important, given its theoretical distinction from deliberative moral reasoning (Brabeck & Rogers, 2000), its potential for improvement by training and education (Bebeau, 2002), since individuals vary dramatically in their ability to detect moral issues (Rest, 1984), and because moral failure can result from a lack of moral sensitivity (Narvaez & Rest, 1995).

Additional advances in moral theory emphasized the distinction between moralities of justice and care. Justice issues and ethics apply to moral conflicts that are solved by universal ethical principles in the form of rules, rights, obligations and codes in the pursuit of fairness and impartiality. Justice issues rest on an ideal of reciprocity and equal respect and an injunction not to treat others unfairly. In the workplace, examples of justice dilemma issues are common (e.g., turning down a request to falsify information for a report; admitting responsibility for an error being blamed on someone else; declining a friend's offer to provide classified, insider information). Care issues and ethics apply to moral conflicts solved by a focus on the situational variable needs and relationships of the people involved and guided by social emotions such as empathy and altruism (Gilligan, 1982). Care issues rest on an ideal of attention and response to individuals' needs and an injunction not to turn away from someone in need (Gilligan & Attanucci, 1988). In the workplace, examples of care dilemmas also are common (e.g., setting limits on work hours in order to spend time with one's children; visiting the gym instead of working late; mentoring a difficult employee). Nevertheless, different professions are differentially associated with justice (e.g., police) and care (e.g., nursing) modes of moral thinking. Sex differences in justice and care thinking have been proposed by Gilligan (1982), who contended that justice and care moral orientations, due to their consideration of different facts, perspectives, and experiences, drive decision making behaviors by relying on distinct cognitive processes. The research has, however, been only partially supportive of such sex differences. On the one hand, women tend to have an elective affinity for the voice of care and men for the voice of justice. On the other hand, both men and women are able to and do use both ethical voices with equal levels of dexterity and complexity—that is, they are not significantly different.

Defining the neural information processing related to moral thought may inform these theories and their debate and provide useful inferences as to the bases of immoral actions.

The relationship between brain states and states of moral thought and behavior has been informed by neurological case studies. Such studies, perhaps most famously represented by that of Phineas Gage in the 19th century (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994), indicate that moral thought and behavior are mediated, in large part, by the prefrontal cortex in that damage to this area results in impaired social and moral judgment (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999). Recent *in vivo* functional neuroimaging studies have provided an elaborated model of the neural representations of moral cognitions, implicating a distributed cortical network involving diverse frontal and posterior cortical areas including the anterior medial prefrontal and orbital frontal (OFC) cortex, posterior cingulate cortex, anterior temporal lobes, posterior superior temporal sulcus (STS), and limbic regions (e.g., amygdala) (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Moll et al., 2002; see Moll, Zahn, de Oliveira-Souza, Krueger, & Grafman, 2005 for an excellent review).

In the present functional magnetic resonance imaging (fMRI) study, we sought to isolate the neural correlates of one specific component of moral thought, the ability to recognize and interpret moral issues (i.e., moral sensitivity), and to compare the neural processing related to moral sensitivity to two different types of moral content represented by issues of justice and care. We hypothesized that the social and personal implications related to the interpretive detection of moral issues are associated with distinct neural information processing events when compared to the same task for nonmoral problems encountered in everyday decisions. To test this possibility, we developed narratives that depicted issues (both moral and nonmoral) encountered by a hypothetical individual in a typical work setting. These narratives were designed to adhere to the principles of modern moral theory and its instruments and to enhance ecological validity by presenting contexts and issues highly familiar to our sample of research volunteers. We also hypothesized that their relatedness to differing facts, suppositions and perspectives would result in dissociable neural correlates of moral sensitivity to justice versus care issues. Thus, we tested a topology of moral cognition that included the isolation of moral sensitivity and the distinction between the ethics of justice and care. At the neural processing level, we hypothesized that moral sensitivity would be associated with orbitofrontal cortex and perhaps amygdala activations related to social cognitions, and that care and justice issues would differ in this regard.

2. Materials and methods

2.1. Subjects

The participants were 16 right-handed men (35 ± 5.1 years of age, range 27–42) (means ± 1 S.D.) enrolled in the Executive Masters in Business Administration (EMBA) degree program at the Goizueta Business School of Emory University. Subjects had an average duration of occupation in business settings of 13.5 ± 4.8 years prior to matriculation into the program.

Subjects had no personal history of psychiatric or neurologic disorders by self-report and were financially compensated for their participation. Subjects were pre-tested for reading

speed using the Sight Word Efficiency subtest of the Test of Word Reading Efficiency (Torgesen et al., 1999). The mean estimated standard score for the subject pool was 94.3 ± 7.1, indicating average sight word efficiency for the group. The study was conducted in the Biomedical Imaging Technology Center at Emory Hospital. Following thorough discussion of the intent and risks associated with the study, subjects gave written informed consent to participate in a study protocol approved by the Institutional Review Board of Emory University.

2.2. Stimuli and tasks

We sought to adhere to a test of major elements of modern moral theory and therefore incorporated into the task stimuli features common to instruments used in this field. Our choice of stimuli was driven by five key considerations, each of which we discuss further below. The stimuli needed to meet the following criteria: (i) be constructed by experts in the field of ethics and moral reasoning, (ii) be ecologically valid for our sample, (iii) provide contrast between moral and nonmoral issues, (iv) provide contrast between the moral issues of justice and care, and (v) satisfy criteria for content validity.

The base context of the stimuli was a revised version of the business case scenario developed by marketing ethicists Sparks and Hunt (1998) in their study of ethical sensitivity. The characteristics of the Sparks and Hunt case scenario of greatest import to the design of the present study are that (i) the scenario develops both ethical and nonethical issues, and (ii) the issues are realistic and commonly faced in business settings. This case scenario consists of a description of a workday in the life of "Bob," a fictional marketing research analyst. As Bob goes through his day, he reflects on the issues and decisions he faces. Using this base context, the scenario content was modified to mirror situations in which MBA students are typically taught to problem solve, i.e., they are presented with a business case scenario, which usually contains a wealth of information, much of it irrelevant. The student's task is to determine which issues and facts in the case are important and which are unimportant. The revised scenario was written in the passive voice. Although Bob's thoughts and actions, and preferences and concerns about particular situations were described, he did not exhibit intense displays of primary emotions (happiness, sadness, fear, surprise, anger, disgust).

We specifically adapted this revised case scenario by modifying and expanding it to reflect five types of discrete issues or events: strategic, tactical, justice, care, and neutral. The justice issues inherent in the Sparks and Hunt scenario were modified and the care, strategic and tactical issues, and neutral events, were created within the business situational context. The sequence of issues and events was developed as evolving "story segments" that comprised the overall case scenario or story. We developed a total of 41 story segments, 12 contained moral issues (describing six justice and six care issues), 12 contained nonmoral issues (describing six strategic and six tactical issues), and 17 contained neutral events (see Appendix A for examples). A greater number of neutral events was developed to allow their interspersion with the other story segment types, and to generate sufficient numbers of responses to neutral events to support their use in an event-related image analysis. Each story segment was 2–3 sentences (and 23–35 words)

in length and was written at approximately the ninth grade level of reading comprehension, according to the Flesch–Kincaid scale that assesses readability based on the average number of syllables per word and the average number of words per sentence. The 41 story segments were presented visually one at a time for 15 s each without interruptions between them. Story segments were presented in a block design in which two segments of a given type were separated by a neutral story segment, e.g., two care issues, followed by a neutral story segment, followed by two strategic issues, etc. (Fig. 1).

 Full-size image (34K)

Fig. 1. A schematic illustration of the fMRI study design for the moral sensitivity task. An example of a sequential presentation of the different types of story segments processed for the identification of "important" issues or events is shown. The fMRI response and its statistical analysis focused on a "floating window" related to the subject's response.

Story segment content conformed to the following definitions:

• Justice concerns fairness and impartiality. A just or fair person aims to treat another person as an end rather than simply as a means to an end. Justice means liberating others from injustice.

• Care concerns benevolence and compassion. A caring person treats another person with sensitive discernment of, and response to, his or her contextually embedded need. Care means liberating others from their state of need and actively promoting their welfare.

• Strategic decisions in organizations are typically concerned with the overall well-being of the organization and involve long-range planning. Strategic decisions may require the use of substantial resources, be characterized by uncertainty, and involve multiple participants in the decision process.

• Tactical decisions tend to be concerned with one part of the organization and with immediate and routine day-to-day operations. Tactical decisions require few resources, are well structured, and are not expected to have long-term effects.

• Neutral story segments described an event related to Bob or more general information (e.g., the location of a vendor's office) that did not pose a justice or care moral issue or a strategic or tactical problem.

The story segments were examined for descriptions of social interactions for the protagonist, Bob. Social interaction refers to Bob directly interacting or communicating with others, e.g., "Bob telephoned a friend." The incidence of social interaction was similar in the justice (5 of 6), care (4 of 6), and strategic (3 of 6) story segments; the tactical story segments, by design, did not include social interaction.

The developed story segments were subjected to content validation by expert raters. A prototype set of 12 story segments (3 of each of the 4 types of moral and nonmoral issues) was initially developed collaboratively by the authors, drawing upon their collective expertise related to ethical reasoning and business decision making. The moral and nonmoral issues were then evaluated through the use of 10 graduate students who had completed advanced course work in the psychology of moral reasoning and who received brief supplemental training on strategic and tactical reasoning. The student experts independently rated each of the 12 dilemmas as primarily representing justice, care, strategic or tactical issues. The experts showed a moderate level of agreement at this stage of story segment development. When their rating differed from the intended category, each rater was unblinded as to the construct the story segment was intended to address and they were asked to write a brief explanation of why they had rated the story segment as they did and how the story segment might be improved to better reflect the intended issue type. This feedback was used to revise the story segments. The final set of prototype issues used in this study was again rated independently by 10 additional graduate student expert raters. The experts showed a high level of agreement in their ratings. All raters completely agreed on 112 of the 120 ratings and the eight errors (6.6%) were evenly distributed across the four story segment types. Overall, average agreement among the 10 raters was 93.3%, which supported the content validity of the story segments used in this study.

During fMRI acquisitions, story segments were presented through rear projection to a screen placed at the end of the magnet bore and viewed by the subject via mirrors mounted on the head coil. Subjects were told that they would read a story about a workday in the life of Bob. They were instructed to read the content of the story segments and respond using an MRI compatible button box to indicate with a right hand button press when they were able to "identify an important point or issue" in the story. These instructions were intentionally general, so as not to bias the subjects toward identifying one particular type of issue included in the story. Subjects were instructed to respond as often as they wished for each story segment, or not at all if no issue seemed important. Later in the task protocol, three story segments within each category were sequentially represented, and subjects were asked to rate their level of importance on a four-point scale; a rating of one indicated an issue that was "not important," and a score of four indicated an issue that was "very important." Before imaging, subjects were familiarized with the stimuli and task and response requirements of the study by identifying "important" items in a practice story segment involving the purchase of an automobile by a separate fictional character, Joel.

2.3. Behavioral data analysis

The total number and mean number of important issues detected for each story segment were calculated for the group, and pairwise comparisons across story segment categories were made using the Wilcoxon Signed ranks test. Mean importance ratings were also averaged for the story segment categories. Behavioral measures were compared between the neutral story segment and the moral and nonmoral story segment categories, and between the moral and nonmoral issue categories, with significant differences defined at a $p < 0.05$ level.

2.4. fMRI acquisition and processing

All studies were conducted on a Siemens 3T whole body MRI scanner sited in Emory Hospital. Brain imaging involved the acquisition of 25 axial slices of 4 mm thickness, acquired parallel to the AC-PC line with a matrix size of 64×64 over a field of view of 22 cm $\times$ 22 cm. Blood oxygenation level dependent (BOLD) contrast images were acquired (TE of 30 ms) using T2*-weighted gradient echo, echo-planar pulse sequences with a TR of 4 s for a total of 154 scans. In addition, a 3-D MP-RAGE sequence was collected at an isotropic resolution of 1 mm $\times$ 1 mm $\times$ 1 mm for 3-D anatomic analysis and visualization of task-related activations. Head movement was limited by padding and restraint. After discarding the first five scans to allow longitudinal relaxation to equalize, images were resliced and corrected for motion by registration to the first functional image acquired for each subject using a six parameter transformation. Images were then spatially normalized to the Montreal Neurological Institute (MNI) template by applying a 12 parameter affine transformation followed by nonlinear warping using basic functions. Images were smoothed using a Gaussian kernel of 8 mm full width at half maximum to enhance signal to noise ratios and facilitate the within group analysis. Differences in global BOLD signal were controlled by proportional scaling. Low frequency noise was removed using a high-pass filter, and an autoregressive model was used to account for serial correlations in the data.

2.5. fMRI data analysis

The data were analyzed in a two-stage, random effects procedure. In the first stage, the BOLD response for each story segment category for each subject was modeled with the standard canonical hemodynamic response function (cHRF). Parameter estimates of the cHRF were created via within subject contrasts collapsed across conditions. The resulting summary statistic images were then entered into a second stage analysis that treated each subject as a random variable. In this way, both within and between subject variance is accounted for in the model. Image analysis was conducted using MATLAB and Statistical Parametric Mapping software (SPM2; Wellcome Department of Cognitive Neurology, http://www.fil.ion.ucl.ac.uk/spm). A "window" of time bracketing a subject's recognition of an important issue that included 2 s prior to and 1 TR after the subject's button response (a total of 6 s) was used for the statistical analysis (Fig. 1). In this way, the analysis is not a conventional event related design, but rather models the neural response related to moral sensitivity as a temporally extended "event" involving both issue awareness and interpretive evaluation (Rest, 1984). Thus, the process of moral sensitivity is implicitly captured by the explicit task of identifying "important" issues by

button presses; as few as 27 and as many as 86 button responses were made for the neutral and justice issue categories, respectively. Isolating the neural response to moral issues involved contrasting the response to moral issues to that of multiple control conditions. In planned comparisons to the moral (care and justice) issues, neutral story segments were used to correct for neural activations related to attention, reading and comprehension, context processing and sensorimotor aspects of task performance. Nonmoral (strategic and tactical) issues were used as additional control conditions to correct for activations related to temporally extended decisions involving multiple response options and that impact others. Responses to neutral story segments were included in the data analysis as 14 of 16 individuals identified an important issue within at least one neutral story segment. For the remaining two individuals, an event window within one neutral story segment was selected at random in order to retain all subjects in the data analysis. Unless otherwise indicated, all activations were assessed at a significance level of $p < 0.001$ (uncorrected) and an extent threshold of $k > 5$ voxels. In addition, functional volumes-of-interest (VOI) were defined based on activations from the moral-nonmoral issue contrast and included all significant voxels ($p < 0.001$, uncorrected) within an eight mm radius of the peak voxel at an activation location. Time courses for these VOI were plotted using finite impulse response functions (Burock & Dale, 2000; Ollinger, Shulman, & Corbetta, 2001) as implemented in SPM within the ROI toolbox created by Poldrack (SPM ROI Toolbox, http://spm-toolbox.sourceforge.net).

3. Results

3.1. Behavior

Table 1 displays the total number and the average number of issues per story segment perceived as "important" for each story segment category. A significantly greater number of issues was detected as important for all issue categories (i.e., justice, care, strategic, tactical) compared to neutral events. More justice that care issues were identified, a finding consistent with the notion that men, and perhaps business professionals, have a greater affinity for an ethic of justice. The mean level of importance ratings are also displayed in Table 1. Statistically significant differences in mean level of importance ratings were obtained for all issue categories compared to neutral events, and for strategic versus tactical issues. Overall, these behavioral data support the intended greater salience of the care, justice, strategic and tactical story segments relative to the neutral story segments.

Table 1.

Behavioral ratings for the number of identified "important" issues and the level of their perceived importance for the study story segment

Task	Story segment category

	Care	Justice	Strategic	Tactical	Neutral
Total number[a]	54 ± 3.3[b]	86 ± 5.1	85 ± 4.9	66 ± 3.9	27 ± 1.6[c]
Mean number per story segment[d]	0.59 ± 0.27	0.89 ± 0.19	0.85 ± 0.2	0.67 ± 0.18	$0.12 \pm .08$[c]
Range[e]	0.17–1.00	0.67–1.33	0.50–1.33	0.33–1.00	0–0.23
Mean level of importance[e,f]	2.7 ± 0.6	3.0 ± 0.7	3.4 ± 0.7	2.8 ± 0.6[g]	1.4 ± 0.7[c]

[a] Data represent the mean ± 1 S.D. number of identified issues of importance across subjects for the 13 neutral story segments and for six in each of the other categories.
[b] $p < 0.005$ compared to justice story segments.
[c] $p < 0.005$ for pairwise comparisons for identified issues in neutral story segments vs. the other story segment categories.
[d] Data represent the mean number of issues identified as important per story segment, within each category.
[e] As indicated by the range data, subjects sometimes identified multiple issues within one story segment as important or failed to recognize such an issue in a story segment. Data represent the mean ratings on a four point scale, with 1 = not important and 4 = very important for three selected story segments in each category.
[f] Data based on ratings for 15 of the 16 subjects.
[g] $p < 0.005$ compared to strategic story segments.

3.2. fMRI

To identify the neural correlates of moral sensitivity, an implicit processing task involving the BOLD fMRI response immediately preceding and following the recognition of an "important" issue was considered in the data analyses. In the initial analysis of moral sensitivity, we compared the neural response to the combined story segments involving justice and care moral issues to the response to combined story segments involving strategic and tactical problems. This contrast indicated the differential activation of the medial prefrontal cortex, bilateral posterior superior temporal sulcus (STS), dorsal posterior cingulate cortex, and medial orbitofrontal cortex for sensitivity to moral issues (Table 2). The medial frontal cortical activation for this contrast spanned polar (BA 9) and ventral (BA 10) prefrontal sites, and the orbitofrontal cortex. The combined response to the justice and care story segments was also compared to the response to the neutral story segments. This contrast was associated with relative activation of the dorsal posterior cingulate cortex, insula, polar medial (BA 9) prefrontal cortex, and bilateral posterior STS for the combined moral issues (Table 2, Fig. 2). Relative to the neutral story segments, the implicit recognition of moral issues was associated with decreased activation in distributed lateral frontal cortical sites, and the right STS (Table 2).

Table 2.

Anatomical and stereotaxic locations of neural activations related to the implicit recognition of moral and nonmoral issues

Brain region (Brodmann area)	Voxel T	Coordinates		
		x	*y*	*z*
Increases				
Care/justice (moral) > neutral (nonmoral)[a]				
Posterior cingulate gyrus (31)	7.43	6	−49	30
Insula	6.26	−30	−20	19
Medial frontal cortex (9)	5.75	2	48	29
Posterior STS (L22)	4.75	−59	−50	14
Posterior STS (R22)	4.21	65	−52	14
Care/justice (moral) > strategic/tactical (nonmoral)[a]				
Medial frontal cortex				
Polar (9)	7.69	4	62	32
Ventral (10)	6.27	2	59	6
Posterior STS (R22)	7.2	65	−52	17
Posterior STS (L22)	7.05	−59	−50	17
Precuneus (7)	6.71	8	−50	45
Orbital frontal cortex (11)	4.14	2	58	−11
Decreases				
Neutral (nonmoral) > care/justice (moral)[a]				
STS (R22)	7.28	65	−30	16
Inferior frontal gyrus (R45)	5.68	48	35	2

Brain region (Brodmann area)	Voxel T	Coordinates		
		x	y	z
Middle frontal gyrus (R9)	5.55	48	17	27
Middle frontal gyrus (L10)	5.18	−46	53	3
Middle frontal gyrus (R10)	4.67	44	54	−6
Ventrolateral prefrontal cortex (11)	4.36	24	48	−16

[a] $p < 0.001$, uncorrected. Stereotaxic locations are defined in Talairach coordinate space (Talairach and Tournoux, 1988) in millimeters relative to the midsagittal plane (x), anterior/posterior to the anterior commissure (y), and superior/inferior to the anterior commissure–posterior commissure (AC–PC) plane (z).
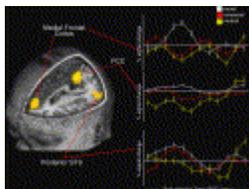
[Full-size image](#) (125K)

Fig. 2. Location of significant ($p < 0.001$, uncorrected) neural activations related to sensitivity to moral (i.e., care and justice) vs. nonmoral (strategic and tactical) issues in the study story segments. The left side of the figure depicts the results of the random-effects group analysis and illustrates those brain regions that were differentially activated by the moral vs. nonmoral story segments superimposed on the standard MNI brain. The activation map and standard brain were imported from SPM2 into the Analysis of Functional Neuroimaging (AFNI) software and subsequently rendered. The right side of the figure depicts, for each story segment type, the time course of the hemodynamic response for three brain activations of interest computed as the impulse response function (IRF) for a 3D volume centered on the peak voxel. PCC = Posterior Cingulate Cortex, Posterior STS = Posterior Superior Temporal Sulcus.

The time course of the peristimulus hemodynamic response function for each story segment category for a VOI centered on the voxel maxima for the polar medial prefrontal cortex, dorsal posterior cingulate cortex, and left posterior STS (Table 2) is illustrated in Fig. 2. These plotted relationships indicate that polar medial prefrontal cortex activation associated with sensitivity to moral issues was related to both increases in activity for the recognition of moral issues and decreases in activity for the recognition of non-moral

(strategic and tactical) problems or neutral events (Fig. 2). Activations in the dorsal posterior cingulate cortex (Table 2) were apparently similarly attributable to both recognition-related increases for moral issues and decreases for non-moral problems or neutral events. Observed left posterior STS activations were the result of greater recognition-related increases for moral issues.

Justice and care moral issues were also considered separately. A direct comparison of justice and care moral issues indicated that sensitivity to care moral issues was associated with greater activation ($p < 0.001$, uncorrected) in the ventral posterior cingulate cortex, medial orbitofrontal cortex, right middle and inferior frontal gyri, left posterior STS, and thalamus (Table 3; Fig. 3). Relative to care issues, sensitivity to justice moral issues was associated with greater activation of the left intraparietal sulcus (IPS) extending into the dorsal bank of the posterior STS, albeit at a less stringent statistical threshold. Compared to issue recognition in neutral story segments, sensitivity to care moral issues was associated with activation of the dorsal posterior cingulate cortex, polar and ventral medial prefrontal cortex, bilateral posterior STS, and insula (Table 3). Sensitivity to justice moral issues, relative to neutral events, similarly activated the dorsal posterior cingulate cortex, insula, polar medial prefrontal cortex, and left posterior STS (Table 3; Fig. 3).

Table 3.

Anatomical and stereotaxic locations of differential neural activations related to the implicit recognition of care and justice moral dilemmas

Brain region (Brodmann area)	Voxel T	Coordinates		
		x	y	z
Care > neutral[a]				
Posterior cingulate gyrus (31)	6.55	8	-51	30
Medial frontal cortex				
Polar (9)	6.77	4	56	32
Ventral (10)	4.84	4	58	3
Posterior STS (L 22)	5.44	−61	−52	15
Insula	4.92	−30	−22	20
Posterior STS (R22)	4.84	65	−52	14

Brain region (Brodmann area)	Voxel T	Coordinates		
		x	y	z
Care > justice[a]				
Retrosplenial cortex (31)	7.62	−6	−61	16
Orbital frontal cortex (11)	5.27	2	46	−16
Middle frontal gyrus (R8)	4.88	36	33	48
Posterior STS (L22)	4.74	−67	−33	9
Inferior frontal gyrus (R46)	4.26	50	32	11
Thalamus	4.03	8	−11	13
Justice > neutral[a]				
Posterior cingulate gyrus (31)	6.91	6	−49	30
Insula (L)	5.47	−30	−22	21
Medial frontal gyrus (9)	5.09	2	48	29
Posterior STS (L 22)	4.05	−57	−42	9
Justice > care[b]				
Posterior STS (left 22)	6.43	−59	−40	22

Stereotaxic locations are defined in Talairach coordinate space (Talairach and Tournoux, 1988) in millimeters relative to the midsagittal plane (x), anterior/posterior to the anterior commissure (y), and superior/inferior to the anterior commissure–posterior commissure (AC–PC) plane (z).

[a] $p < 0.001$, uncorrected.
[b] $p < 0.005$, uncorrected.
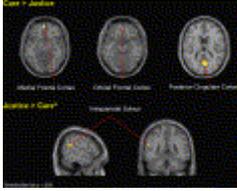
 Full-size image (122K)

Fig. 3. Location of significant ($p < 0.001$, uncorrected) neural activations related to sensitivity to care vs. justice moral issues in the study story segments. The results from the SPM2 analyses are shown superimposed on axial images of the MNI brain standard.

4. Discussion

Theoretical accounts of moral decision making distinguish between the component processes of moral sensitivity or intuition, judgment, motivation, and character related to moral behavior (Rest, 1984 and Haidt, 2001). The primary goal of the present *in vivo* functional neuroimaging study was to localize those neural activations that are related to moral sensitivity, a component process proposed to involve both the detection and interpretation of a moral issue or situation. Moral behavior and its cognitive and neural processing correlates are strongly dependent on stimulus variables such as situational context and familiarity, and subject variables such as beliefs, cultural affiliations, sex and occupation (Casebeer, 2003 and Gilligan, 1982; Moll, Zahn et al., 2005). In addressing these demands of ecological validity, this study design focused on the implicit recognition of real life ethical challenges encountered by male business professionals in a typical business setting. The value of this study lies, however, not in its ability to inform the neural representations of moral sensitivity in business professionals, but rather to inform this process using ecologically relevant tasks to render the results meaningful to everyday behavior for other subject samples in familiar contexts. We speculate that similar results would be obtained related to the neural processing of moral issues in nurses confronting such issues in a hospital care setting or police functioning in a law enforcement setting. Such comparisons would perhaps represent an informative assessment of the influence of different affinities for care versus justice moralities on the neural representation of the sensitivity or interpretive awareness of care and justice moral issues. This contention, however, needs to be evaluated.

4.1. Moral sensitivity as a special case of self-referential thinking?

The results of this study implicated three brain areas as critical to moral sensitivity: the medial prefrontal cortex, the posterior cingulate cortex, and the posterior STS. Despite remarkable variability in stimuli and tasks between studies, these findings are strikingly consistent with the results of prior fMRI studies of implicit and explicit moral judgments (Greene et al., 2001; Heekeren, Wartenburger, Schmidt, Schwintowski, & Villringer,

2003; Moll et al., 2002a and Moll et al., 2002b; Moll, Zahn et al., 2005) that revealed primary neural activations in mesial cortical regions and the posterior STS.

4.1.1. Medial prefrontal cortex

In the current study, greater activation of the polar medial prefrontal cortex was associated with sensitivity to moral issues versus either neutral events or nonmoral issues. The medial prefrontal cortex has been implicated in diverse brain functions including imitation (Chaminade, Meltzoff, & Decety, 2002), processing rewarded behavioral outcomes (Knutson, Fong, Bennett, Adams, & Hommer, 2003), emotion response monitoring (Lane, Reiman, Ahern, Schwartz, & Davidson, 1997), error detection (Garavan, Ross, Murphy, Roche, & Stein, 2002), evaluative judgments (Zysset, Huber, Ferstl, & Yves von Cramon, 2002), pain perception, and the temporal sequencing of behavior (Dreher, Koechlin, Ali, & Grafman, 2002). All of these functions are arguably linked to self-monitoring behavior. Recent fMRI studies of neural activations related to the concept of "self" have demonstrated activation of the anterior medial prefrontal cortex during self-referential processing (Fossati et al., 2003, Johnson et al., 2002, Kelley et al., 2002 and Phan et al., 2004). Similar to self referential processing (Kelley et al., 2002) and the proposed role of the medial prefrontal cortex in spontaneous self referential mental activity as a default mode of brain function (Gusnard, Akbudak, Shulman, & Raichle, 2001), the implicit recognition of moral issues was associated with medial prefrontal cortex "activations" that were, in significant part, the result of deactivations of this area by the contrasted control conditions (i.e., strategic and tactical or neutral story segments). Also, polar medial prefrontal cortex activation associated with moral judgments was observed for the comparison of personal versus impersonal moral issues—essentially a self-reference task (Greene et al., 2001). Thus, a plausible functional inference is that access to knowledge of self is critical to moral sensitivity. This interpretation is consistent with a proposed role of temporally extended representations of event sequence knowledge in moral cognitions (Moll, Zahn et al., 2005), but emphasizes the specific involvement of self semantic knowledge perhaps akin to the temporally extended, relatively context-independent "narrative" self (Gallagher et al., 2000). Such an overarching role for the polar medial prefrontal cortex in moral cognition explains its common activation across diverse moral cognition tasks.

The medial prefrontal cortex has, however, also been associated with performance on "theory of mind" tasks, which require an ability to imagine or predict another's perspective, intentions, or actions (Castelli, Happe, Frith, & Frith, 2000; Vogeley et al., 2004; but see Bird, Castelli, Malik, Frith, & Husain, 2004). Although participants in the current study were not instructed to consider the mental states of others in the story segments, the observed medial prefrontal cortex activation may reflect an implicit theory of mind process. Thus, a seemingly competing interpretation is that medial prefrontal cortex activations related to moral sensitivity represent the involvement of third-person, rather than first-person, perspective taking. While recent fMRI studies have sought to dissociate the neural correlates of first- and third-person perspectives, their attribution of observed medial prefrontal cortex activations to either the first- or third-person perspective are remarkably discordant (Ruby & Decety, 2003; Vogeley et al., 2004). This discrepancy may reflect differences between studies in the object of perspective (e.g.,

inanimate objects, their mothers), or the belief that self perspective is an integral process in assessing the perspective of others (e.g., Gilovich, Medvec, & Savitsky, 2000). Consistent with this belief, recent reviews (Frith, 2001; Wicker, Ruby, Royet, & Fonlupt, 2003) concluded that medial prefrontal cortex activations observed when mental states are attributed to others overlap those associated with the monitoring of one's own mental state. We therefore propose that the medial prefrontal cortex activation observed in this study is consistent with moral sensitivity as a perspective-taking process involving access to both self and social semantic knowledge. This interpretation is consistent with theoretical models of moral thinking that propose that moral decisions and actions are related to self-identity and self-interests (Bersoff, 1999; Haviv & Leman, 2002) and that moral thinking is dependent on understanding others' perspectives (Rest, 1984).

4.1.2. Dorsal posterior cingulate cortex

Sensitivity to moral issues was associated with activation of posterior cingulate cortex located on the dorsal bank of the cingulate gyrus. This activation was observed in prior studies of moral reasoning and was specifically associated with evaluating the appropriateness of solutions to personal moral dilemmas (Greene et al., 2001). The posterior cingulate cortex has been implicated in seemingly diverse functions including the experience of emotion (Mayberg et al., 1999), recall of emotional memories (Maratos, Dolan, Morris, Henson, & Rugg, 2001; Maddock, Garrett, & Buonocore, 2003), reward processing (Knutson et al., 2003), forgivability (Farrow et al., 2001), and self-reference (Fossati et al., 2003, Johnson et al., 2002 and Kelley et al., 2002; Ruby and Decety, 2003). The posterior cingulate cortex is also activated by the successful recall of autobiographical memories (Maddock, Garrett, & Buonocore, 2001; Piefke, Weiss, Zilles, Markowitsch, & Fink, 2003). Anderson et al. (1999) have argued that moral judgments are related to access to memories of outcomes of past moral decisions. Thus, the observed posterior cingulate cortex activation may reflect the dependence of moral sensitivity on access to one's emotional, cognitive and somatic experiences related to previous moral conflicts. In particular, the posterior cingulate cortex may mediate the process by which knowledge of past experiences is used to guide an interpretive awareness of moral situations. Furthermore, the posterior cingulate cortex may contribute to moral evaluations made by taking a first-person perspective (Ruby & Decety, 2003) and predicting one's own responses, emotional or otherwise, to a specific moral action. This interpretation is consistent with the posterior cingulate cortex as an interface between emotion and cognition (Bush, Luu, & Posner, 2000; Vogt, Finch, & Olson, 1992) and with the social intuitionist model proposed by Haidt (2001) and Greene and Haidt (2002).

4.1.3. Posterior STS

Brain regions bordering the STS, particularly its posterior extent, have been implicated in perceptions related to social cognition (Adolphs, 2003). Cortex within and adjacent to the STS is activated by social signals involving expressive movements of the face, hands, mouth and eyes, and referred to as "biological motion" (Allison, Puce, & McCarthy, 2000; Grèzes et al., 2001; Haxby, Hoffman, & Gobbini, 2000; Kilts, Egan, Gideon, Ely, & Hoffman, 2003). The posterior STS is also activated during effort related to assessing

the intentions of other individuals or violations of expectation, often modeled in theory of mind paradigms (Castelli et al., 2000 and Gallagher et al., 2000; Grèzes, Frith, & Passingham, 2004). Its demonstrated roles in social perception and maintaining social behavioral representations are consistent with a role of the posterior STS in social perspective taking in the service of moral sensitivity. This interpretation is consistent with the view of moral decision making as a social process attentive to the actions of external audiences (Carpendale & Krebs, 1995). Even in Kohlberg's (1984) theory of moral judgment, the ability to perceive the perspectives of others and social role taking were deemed essential to moral decision making, particularly for individuals at higher stages of moral reasoning ability. Posterior STS activation is consistent across tasks that require perceptual, cognitive, and emotional perspective taking (Frith, 2001; Ruby & Decety, 2001). The role of the posterior STS in multimodal sensory integration (Karnath, 2001; Taylor, Moss, Stamatakis, & Tyler, 2006) suggests that its further role may be to integrate perspectives taken from these different vantage points.

Two brain areas implicated in prior functional neuroimaging studies of moral cognitions – the amygdala (Moll et al., 2002; Greene et al., 2001) and anterior temporal cortex (Moll, Zahn et al., 2005) – were not activated by this moral sensitivity task. Similar to the results of an fMRI study of moral judgments for non-emotional stimuli (Moll, Oliveira-Souza et al. 2002), amygdala activation was not observed in the present study of moral and non-moral story segments that were devoid of overt emotion content. Absent amygdala and anterior temporal cortex activations may reflect the omission of overt emotional responses in the story segments and the resulting lack of processing demands for evaluating emotional salience and motivation, or for access to the representations of social emotions (Moll et al., 2005).

4.2. Common and distinct neural representations of sensitivity to moral issues of justice and care

Moral sensitivity to either care or justice issues was associated with activation of the dorsomedial prefrontal cortex, posterior STS and posterior cingulate cortex. However, the results of this study also support a distinction between neural information processing related to sensitivity to justice and care moral issues. The ethics of justice relies on processing issues based on rules, and social codes and mores. In contrast, the ethics of care emphasizes feeling rather than thinking in processing moral issues, presumably drawing on social and primary emotions in evaluating moral conflicts. The direct comparison of responses to care and justice moral issues revealed activation of the medial orbitofrontal cortex, a paralimbic sensory association area implicated in social and emotional behavior (Adolphs, 2003, Anderson et al., 1999 and Brothers, 1990) and in the processing of social emotions (Decety & Chaminade, 2003; Moll et al., 2002; Moll et al., 2002b and Moll et al., 2005b) for sensitivity to care moral issues. The role of social emotions in sensitivity to care issues is supported by the additional engagement of the ventromedial prefrontal cortex, relative to the neutral condition, an area involved in social and emotional semantic representations (Moll, Zahn et al., 2005) and in emotional empathy (Saxe, 2006). The medial orbitofrontal cortex has also been implicated in third-person perspective taking (Ruby & Decety, 2004). With the thalamus, the medial

orbitofrontal and ventromedial prefrontal cortex may comprise a neural pathway by which affective, somatosensory, and autonomic representations are used to detect and evaluate care issues. Sensitivity to moral issues of care was also associated with differential activation of the ventral posterior cingulate cortex, suggesting that its role in the integration of emotion and memory-related processes (Maddock et al., 2003) is distinctly involved in the interpretive awareness of care versus justice moral issues. Sensitivity to moral issues of care may thus involve emotion processing at both the first-person and third-person perspective, and the recall of social-emotional representations of past moral conflicts. This interpretation is consistent with the conceptualization of the "ethics of care" proposed by Gilligan (1977) and reinforced by Noddings (1984), that emphasizes considerations of emotional response and a balance of self-perspective versus other perspectives.

The direct comparison of sensitivity to justice relative to care moral issues revealed a preferential activation for justice issues in only the left IPS, and only at a less stringent statistical threshold. Left IPS activations have been associated with the processing of categorical representations (Saneyoshi, Kaminaga, & Michimata, 2006), of behavioral actions and their intentions (Fogassi et al., 2005), and the processes of imitation (Iacoboni, 2005) and heteromodal association for crossmodal binding of features to form coherent object or situational representations (Taylor et al., 2006). Thus, greater left IPS activation observed in the current study for justice versus care issues may reflect integrating situational features and simulating their representation for reference to categorical properties of laws, mores and rules. These implied functional attributes of a differential left IPS activation associated with an interpretive awareness of justice moral issues are consistent with the application of a standard set of rules to the evaluation of justice moral issues (Colby & Kohlberg, 1987), though this inference is highly speculative based on the limited available evidence.

4.3. Limitations of the study

Several limitations of this study of moral sensitivity exist and provide direction for future studies of moral behavior. First, this study included only male subjects. The selection of a single sex was motivated by a prominent, though controversial, contention that sex differences exist in moral orientation (Gilligan, 1982). A clear need exists to replicate this study with female subjects, particularly a study of possible sex effects on the neural correlates of care and justice moral judgments. Second, this study focused on the implicit recognition of moral versus non-moral issues as a measure of moral sensitivity. The dissociation of neural information processing related to implicit versus explicit tasks has been the subject of recent functional neuroimaging studies (e.g., Critchley et al., 2000) and would be of interest here in assessing whether the putative topology of moral behavior (Narvaez & Rest, 1995; Rest, 1994) includes dissociable neural correlates for moral sensitivity versus post-hoc reasoning. Third, the definition of a functional neuroanatomy of moral sensitivity would benefit from the consideration of individual variation in ability. Structured instruments and interviews (i.e., Moral Judgment Interview and the Ethics of Care Interview) were used to assess this variance, but yielded an insufficient dynamic range of scores to permit their use in regression models analyzing

the fMRI data. Although the functional inferences from this study provide testable hypotheses for such future research, much remains to be done in elaborating a more definitive model of the neural basis of moral cognition. Fourth, the study focused on business professionals enrolled in an executive MBA degree program and thus the results could be considered to be informative of this sample only. However, research has shown that the moral reasoning of business graduate students and business professionals is comparable to that of college students and adults in general (Rest, 1994) and more representative of the general population than that of other professional groups (e.g., law, medicine).

In summary, the results of this study are consistent with the involvement of a network of brain regions in moral sensitivity which perhaps subserve complementary roles related to first-person perspective taking, access to autobiographical memories and knowledge related to self and social cognition and third-person attributions of mental states. We found a distinction between the neural representation of care and justice moral sensitivity that emphasizes differences in the roles of social and emotional information in their interpretive awareness. Our results provide support at the level of neural processing models for the contentions of the theorists Rest and Kohlberg that self- and other-perspective taking is an important component of moral thought, as well as support for Gilligan's distinction between justice and care issues and her emphasis on the importance of emotion in the "ethics of care." Future research may focus on corollaries of these findings—that immoral actions may reflect an exaggerated or dysfunctional self-representation, inaccessibility of internal models of behavior formed by past experiences, a faulty perspective of the outcome of actions on others, or their combination. Our findings also have implications for the development of moral sensitivity, suggesting that efforts to sensitize individuals to moral issues focus on methods that tap into introspection based on personal experiences, as well as the use of perspective taking techniques such as role playing.

Acknowledgments

References

Adolphs, 2003 R. Adolphs, Cognitive neuroscience of human social behaviour, *Nature Reviews: Neuroscience* **4** (2003), pp. 165–178. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (243)

Brothers, 1990 L. Brothers, The social brain: A project for integrating primate behavior and neurophysiology in a new domain, *Concepts in Neuroscience* **1** (1990), pp. 27–51.

Allison et al., 2000 T. Allison, A. Puce and G. McCarthy, Social perception from visual cues: Role of the region, *Trends in Cognitive Sciences* **4** (2000), pp. 267–278. Abstract | PDF (1478 K)

Anderson et al., 1999 S.W. Anderson, A. Bechara, H. Damasio, D. Tranel and A.R. Damasio, Impairment of social and moral behavior related to early damage in human prefrontal cortex, *Nature Neuroscience* **2** (1999), pp. 1032–1037. View Record in Scopus | Cited By in Scopus (377)

Bebeau, 2002 M.J. Bebeau, The defining issues test and the four component model: Contributions to professional education, *Journal of Moral Education* **31** (2002), pp. 271–295. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (18)

Bersoff, 1999 D.M. Bersoff, Explaining unethical behaviour among people motivated to act prosocially, *Journal of Moral Education* **28** (1999), pp. 413–428. **Full Text** via CrossRef

Bird et al., 2004 C.M. Bird, F. Castelli, O. Malik, U. Frith and M. Husain, The impact of extensive medial frontal lobe damage on "theory of mind" and cognition, *Brain* **127** (2004), pp. 914–928. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (69)

Brabeck and Rogers, 2000 M. Brabeck and L. Rogers, Human rights as a moral issue: Lessons for moral educators from human rights work, *Journal of Moral Education* **29** (2000), pp. 167–182. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (4)

Burock and Dale, 2000 M.A. Burock and A.M. Dale, Estimation and detection of event-related fMRI signals with temporally correlated noise: A statistically efficient and unbiased approach, *Human Brain Mapping* **11** (2000), pp. 249–260. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (106)

Bush et al., 2000 G. Bush, P. Luu and M.I. Posner, Cognitive and emotional influences in anterior cingulate cortex, *Trends in Cognitive Sciences* **4** (2000), pp. 212–215.

Carpendale and Krebs, 1995 J.I.M. Carpendale and D.L. Krebs, Variations in level of moral judgment as a function of type of dilemma and moral choice, *Journal of Personality* **63** (1995), pp. 289–313. **Full Text** via CrossRef

Casebeer, 2003 W.D. Casebeer, Moral cognition and its neural constituents, *Nature Reviews: Neuroscience* **4** (2003), pp. 840–846. View Record in Scopus | Cited By in Scopus (22)

Castelli et al., 2000 F. Castelli, F. Happe, U. Frith and C. Frith, Movement and mind: A functional imaging study of perceptions and interpretation of complex intentional movement patterns, *NeuroImage* **12** (2000), pp. 314–325. Abstract | PDF (168 K) | View Record in Scopus | Cited By in Scopus (265)

Chaminade et al., 2002 T. Chaminade, A.N. Meltzoff and J. Decety, Does the end justify the means? A PET exploration of the mechanisms involved in human imitation, *NeuroImage* **15** (2002), pp. 265–272.

Colby and Kohlberg, 1987 A. Colby and L. Kohlberg, The measurement of moral judgment, volume I: Theoretical foundations and research validation, Cambridge University Press, New York, NY (1987).

Critchley et al., 2000 H.D. Critchley, E.M. Daly, E.T. Bullmore, S.C. Williams, T. Van Amelsvoort and D.M. Robertson *et al.*, The functional neuroanatomy of social behaviour: Changes in cerebral blood flow when people with autistic disorder process facial expressions, *Brain* **123** (2000), pp. 2203–2212. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (228)

Damasio et al., 1994 H. Damasio, T. Grabowski, R. Frank, A.M. Galaburda and A.R. Damasio, The return of Phineas Gage: Clues about the brain from the skull of a famous patient, *Science* **264** (1994), pp. 1102–1105. View Record in Scopus | Cited By in Scopus (284)

Decety and Chaminade, 2003 J. Decety and T. Chaminade, Neural correlates of feeling sympathy, *Neuropsychologia* **41** (2003), pp. 127–138. **Article** | PDF (279 K) | View Record in Scopus | Cited By in Scopus (68)

Dreher et al., 2002 J.C. Dreher, E. Koechlin, S.O. Ali and J. Grafman, The roles of timing and task order during task switching, *NeuroImage* **17** (2002), pp. 95–109. Abstract | PDF (793 K) | View Record in Scopus | Cited By in Scopus (60)

Farrow et al., 2001 T.F.D. Farrow, Y. Sheng, I.D. Wilkinson, S.A. Spence, J.F. Deakin and N. Tarrier *et al.*, Investigating the functional anatomy of empathy and forgiveness, *Neuroreport* **12** (2001), pp. 2433–2438. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (79)

Fogassi et al., 2005 L. Fogassi, P.F. Ferrari, B. Gesierich, S. Rozzi, F. Chersi and G. Rizzolatti, Parietal lobe: From action organization to intention understanding, *Science* **308** (2005), pp. 662–667. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (186)

Fossati et al., 2003 P. Fossati, S.J. Hevenor, S.J. Graham, C. Grady, M.L. Keightley and F. Craik *et al.*, In search of the emotional self: An fMRI study using positive and negative emotional words, *American Journal of Psychiatry* **160** (2003), pp. 1938–1945. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (108)

Frith, 2001 U. Frith, Mind blindness and the brain in autism, *Neuron* **32** (2001), pp. 969–979. **Article** | PDF (326 K) | View Record in Scopus | Cited By in Scopus (116)

Gallagher et al., 2000 H.L. Gallagher, F. Happé, N. Brunswick, P.C. Fletcher, U. Frith and C.D. Frith, Reading the mind in cartoons and stories: An fMRI study of 'theory of mind' in verbal and nonverbal tasks, *Neuropsychologia* **38** (2000), pp. 11–21. **Article** | PDF (327 K) | View Record in Scopus | Cited By in Scopus (353)

Garavan et al., 2002 H. Garavan, T.J. Ross, K. Murphy, R.A.P. Roche and E.A. Stein, Dissociable executive functions in the dynamic control of behavior: Inhibition, error detections, and correction, *NeuroImage* **17** (2002), pp. 1820–1829. Abstract | PDF (178 K) | View Record in Scopus | Cited By in Scopus (223)

Gilligan, 1977 C. Gilligan, In a different voice: Women's conception of the self and of morality, *Harvard Educational Review* **47** (1977), pp. 481–517. View Record in Scopus | Cited By in Scopus (157)

Gilligan, 1982 C. Gilligan, In a different voice: Psychological theory and women's development, Harvard University Press, Cambridge, MA (1982).

Gilligan and Attanucci, 1988 C. Gilligan and J. Attanucci, Two moral orientations. In: C. Gilligan, J.V. Ward and J.M. Taylor, Editors, *Mapping the moral domain: A contribution of women's thinking to psychological theory education*, Harvard University Press, Cambridge, MA (1988), pp. 73–86.

Gilovich et al., 2000 T. Gilovich, V.H. Medvec and K. Savitsky, The spotlight effect in social judgment: An egocentric bias in estimates of the salience of one's own actions and appearance, *Journal of Personality and Social Psychology* **78** (2000), pp. 211–222. Abstract | **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (54)

Greene et al., 2001 J.D. Greene, R.B. Sommerville, L.E. Nystrom, J.M. Darley and J.D. Cohen, An fMRI investigation of emotional engagement in moral judgment, *Science* **293** (2001), pp. 2105–2108. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (282)

Greene and Haidt, 2002 J. Greene and J. Haidt, How (and where) does moral judgment work?, *Trends in Cognitive Sciences* **6** (2002), pp. 517–523. **Article** | PDF (161 K) | View Record in Scopus | Cited By in Scopus (110)

Grèzes et al., 2001 J. Grèzes, P. Fonlupt, B. Bertenthal, C. Delon-Martin, C. Segebarth and J. Decety, Does perception of biological motion rely on specific brain regions?, *NeuroImage* **13** (2001), pp. 775–785. Abstract | PDF (360 K) | View Record in Scopus | Cited By in Scopus (105)

Grèzes et al., 2004 J. Grèzes, C.D. Frith and R.E. Passingham, Inferring false beliefs from the actions of oneself and others: An fMRI study, *NeuroImage* **21** (2004), pp. 744–750. **Article** | PDF (276 K) | View Record in Scopus | Cited By in Scopus (68)

Gusnard et al., 2001 D.A. Gusnard, E. Akbudak, G.L. Shulman and M.E. Raichle, Medial prefrontal cortex and self-referential mental activity: Relation to a default mode of brain function, *Proceedings of the National Academy of Sciences USA* **98** (2001), pp. 4259–4264. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (413)

Haidt, 2001 J. Haidt, The emotional dog and its rational tail: A social intuitionist approach to moral judgment, *Psychological Review* **108** (2001), pp. 814–834. Abstract | **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (279)

Haviv and Leman, 2002 S. Haviv and P.J. Leman, Moral decision-making in real life: Factors affecting moral orientation and behaviour justification, *Journal of Moral Education* **31** (2002), pp. 121–140. View Record in Scopus | Cited By in Scopus (7)

Haxby et al., 2000 J.V. Haxby, E.A. Hoffman and M.I. Gobbini, The distributed human neural system for face perception, *Trends in Cognitive Sciences* **4** (2000), pp. 223–233. Abstract | PDF (1360 K) | View Record in Scopus | Cited By in Scopus (605)

Heekeren et al., 2003 H.R. Heekeren, I. Wartenburger, H. Schmidt, H.P. Schwintowski and A. Villringer, An fMRI study of simple ethical decision-making, *Neuroreport* **14** (2003), pp. 1215–1219. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (42)

Iacoboni, 2005 M. Iacoboni, Neural mechanisms of imitation, *Current Opinion Neurobiology* **15** (2005), pp. 632–637. **Article** | PDF (195 K) | View Record in Scopus | Cited By in Scopus (66)

Johnson et al., 2002 S.C. Johnson, L.C. Baxter, L.S. Wilder, J.G. Pipe, J.E. Heiserman and G.P. Prigatano, Neural correlates of self-reflection, *Brain* **125** (2002), pp. 1808–1814. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (195)

Karnath, 2001 H.O. Karnath, New insights into the functions of the superior temporal cortex, *Nature Reviews: Neuroscience* **2** (2001), pp. 568–576. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (80)

Kelley et al., 2002 W.M. Kelley, C.N. Macrae, C.L. Wyland, S. Caglar, S. Inati and T.F. Heatherton, Finding the self? An event-related fMRI study, *Journal of Cognitive Neuroscience* **14** (2002), pp. 785–794. **Full Text** via CrossRef

Kilts et al., 2003 C.D. Kilts, G. Egan, D.A. Gideon, T.D. Ely and J.M. Hoffman, Dissociable neural pathways are involved in the recognition of emotion in static and

dynamic facial expressions, *NeuroImage* **18** (2003), pp. 156–168. Abstract | PDF (839 K) | View Record in Scopus | Cited By in Scopus (39)

Knutson et al., 2003 B. Knutson, G.W. Fong, S.W. Bennett, C.M. Adams and D. Hommer, A region of mesial prefrontal cortex tracks monetarily rewarding outcomes: Characterization with rapid event-related fMRI, *NeuroImage* **18** (2003), pp. 263–272. **Article** | PDF (347 K) | View Record in Scopus | Cited By in Scopus (153)

Kohlberg, 1958 L. Kohlberg, The development of modes of thinking and choice in the years 10–16. Doctoral dissertation, University of Chicago (1958).

Kohlberg, 1984 L. Kohlberg, Essays in moral development, volume I: The psychology of moral development, Harper and Row, New York, NY (1984).

Lane et al., 1997 R.D. Lane, E.M. Reiman, G.L. Ahern, G.E. Schwartz and R.J. Davidson, Neuroanatomical correlates of happiness, sadness, and disgust, *American Journal of Psychiatry* **154** (1997), pp. 926–933. View Record in Scopus | Cited By in Scopus (352)

Maddock et al., 2001 R.J. Maddock, A.S. Garrett and M.H. Buonocore, Remembering familiar people: The posterior cingulate cortex and autobiographical memory retrieval, *Neuroscience* **104** (2001), pp. 667–676. **Article** | PDF (429 K) | View Record in Scopus | Cited By in Scopus (95)

Maddock et al., 2003 R.J. Maddock, A.S. Garrett and M.H. Buonocore, Posterior cingulate cortex activation by emotional words: fMRI evidence from a valence task, *Human Brain Mapping* **18** (2003), pp. 30–41. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (119)

Maratos et al., 2001 E.J. Maratos, R.J. Dolan, J.S. Morris, R.N.A. Henson and M.D. Rugg, Neural activity associated with episodic memory for emotional context, *Neuropsychologia* **39** (2001), pp. 910–920. **Article** | PDF (454 K) | View Record in Scopus | Cited By in Scopus (101)

Mayberg et al., 1999 H.S. Mayberg, M. Liotti, S.K. Brannan, S. McGinnis, R.K. Mahurin and P.A. Jerabek *et al.*, Reciprocal limbic-cortical function and negative mood: Converging PET findings in depression and normal sadness, *American Journal of Psychiatry* **156** (1999), pp. 675–682. View Record in Scopus | Cited By in Scopus (676)

Moll et al., 2002a J. Moll, R.D. Oliveira-Souza, P.J. Eslinger, I.E. Bramati, J. Mourao-Miranda and P.A. Andreiuolo *et al.*, The neural correlates of moral sensitivity: A functional magnetic resonance imaging investigation of basic and moral emotions, *Journal of Neuroscience* **22** (2002), pp. 2730–2736. View Record in Scopus | Cited By in Scopus (111)

Moll et al., 2002b J. Moll, R. Oliveira-Souza, I.E. Bramati and J. Grafman, Functional networks in emotional moral and nonmoral social judgments, *NeuroImage* **16** (2002), pp. 696–703. Abstract | PDF (347 K) | View Record in Scopus | Cited By in Scopus (87)

Moll et al., 2005a J. Moll, R. Zahn, R. de Oliveira-Souza, F. Krueger and J. Grafman, The neural basis of human moral cognition, *Nature Reviews: Neuroscience* **6** (2005), pp. 799–809. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (54)

Moll et al., 2005b J. Moll, R. de Oliveira-Souza, F.T. Moll, F.A. Ignácio, I.E. Bramati and E.M. Caparelli-Dáquer *et al.*, The moral affiliations of disgust, *Cognitive and Behavioral Neurology* **18** (2005), pp. 68–78. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (28)

Narvaez and Rest, 1995 D. Narvaez and J. Rest, The four components of moral behavior. In: W. Kurtines and J. Gewirtz, Editors, *Moral behavior and moral development: An introduction*, McGraw-Hill, New York, NY (1995), pp. 385–399.

Narvaez and Bock, 2002 D. Narvaez and T. Bock, Moral schemas and tacit judgment or how the defining issues test is supported by cognitive science, *Journal of Moral Education* **31** (2002), pp. 297–314. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (14)

Noddings, 1984 N. Noddings, Caring: A feminine approach to ethics and moral education, University of California Press, Berkeley, CA (1984).

Ollinger et al., 2001 J.M. Ollinger, G.L. Shulman and M. Corbetta, Separating the processes within a trial in event-related functional MRI, *NeuroImage* **13** (2001), pp. 210–217. Abstract | PDF (195 K) | View Record in Scopus | Cited By in Scopus (104)

Phan et al., 2004 K.L. Phan, S.F. Taylor, R.C. Welsh, S.-H. Ho, J.C. Britton and I. Liberzon, Neural correlates of individual ratings of emotional salience: A trial-related fMRI study, *NeuroImage* **21** (2004), pp. 768–780. **Article** | PDF (354 K) | View Record in Scopus | Cited By in Scopus (71)

Piaget, 1932 J. Piaget, The moral judgment of the child, Kegan Paul, London, UK (1932).

Piaget, 1965 J. Piaget, The moral judgment of the child, The Free Press, New York, NY (1965).

Piefke et al., 2003 M. Piefke, P.H. Weiss, K. Zilles, H.J. Markowitsch and G.R. Fink, Differential remoteness and emotional tone modulate the neural correlates of autobiographical memory, *Brain* **126** (2003), pp. 650–668. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (116)

Rest, 1984 J.R. Rest, The major components of morality. In: W. Kurtines and J. Gewirtz, Editors, *Morality, moral behaviour, and moral development*, Wiley, New York, NY (1984), pp. 24–38.

Rest, 1994 J.R. Rest, Background: Theory and research. In: J.R. Rest and D. Narvaez, Editors, *Moral development in the professions: Psychology and applied ethics*, Erlbaum, Hillsdale, NJ (1994), pp. 1–26.

Rest et al., 1999 J.R. Rest, D. Narvaez, M.J. Bebeau and S. Thoma, Postconventional moral thinking: A neo-Kohlbergian approach, Erlbaum, Mahwah, NJ (1999).

Ruby and Decety, 2001 P. Ruby and J. Decety, Effect of subjective perspective taking during simulation of action: A PET investigation of agency, *Nature Neuroscience* **4** (2001), pp. 546–550. View Record in Scopus | Cited By in Scopus (262)

Ruby and Decety, 2003 P. Ruby and J. Decety, What you believe versus what you think you believe: A neuroimaging study of conceptual perspective-taking, *European Journal of Neuroscience* **17** (2003), pp. 2475–2480. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (61)

Ruby and Decety, 2004 P. Ruby and J. Decety, How would you feel versus how do you think she would feel? A neuroimaging study of perspective-taking with social emotions, *Journal of Cognitive Neuroscience* **16** (2004), pp. 988–999. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (76)

Saneyoshi et al., 2006 A. Saneyoshi, T. Kaminaga and C. Michimata, Hemispheric processing of categorical metric properties in object recognition, *Neuroreport* **17** (2006), pp. 517–521. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (2)

Saxe, 2006 R. Saxe, Uniquely human social cognition, *Current Opinion Neurobiology* **16** (2006), pp. 235–239. **Article** | PDF (162 K) | View Record in Scopus | Cited By in Scopus (55)

Sparks and Hunt, 1998 J.R. Sparks and S.D. Hunt, Marketing researcher ethical sensitivity: Conceptualization, measurement, and exploratory investigation, *Journal of Marketing* **62** (1998), pp. 92–109. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (53)

Taylor et al., 2006 K.I. Taylor, H.E. Moss, E.A. Stamatakis and L.K. Tyler, Binding crossmodal object features in perirhinal cortex, *Proceedings of the National Academy of Sciences USA* **103** (2006), pp. 8239–8244. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (24)

Torgesen et al., 1999 J.K. Torgesen, R.K. Wagner and C.A. Rashotte, Test of word reading efficiency (TOWRE), Pro-Ed, Austin, TX (1999).

Vogeley et al., 2004 K. Vogeley, M. May, A. Ritzl, P. Falkai, K. Zilles and G.R. Fink, Neural correlates of first-person perspective as one constituent of human self-consciousness, *Journal of Cognitive Neuroscience* **16** (2004), pp. 817–827. **Full Text** via CrossRef | View Record in Scopus | Cited By in Scopus (72)

Vogt et al., 1992 B.A. Vogt, D.M. Finch and C.R. Olson, Functional heterogeneity in cingulate cortex: The anterior executive and posterior evaluative regions, *Cerebral Cortex* **2** (1992), pp. 435–443. View Record in Scopus | Cited By in Scopus (496)

Wicker et al., 2003 B. Wicker, P. Ruby, J.P. Royet and P. Fonlupt, A relation between rest and the self in the brain?, *Brain Research Reviews* **43** (2003), pp. 224–230. **Article** | PDF (671 K) | View Record in Scopus | Cited By in Scopus (56)

Zysset et al., 2002 S. Zysset, O. Huber, E. Ferstl and D. Yves von Cramon, The anterior frontomedian cortex and evaluative judgment: An fMRI study, *NeuroImage* **15** (2002), pp. 983–991. Abstract | PDF (192 K) | View Record in Scopus | Cited By in Scopus (111)

Appendix A.

A.1. Instructions

You will read the story one paragraph at a time. You will have fifteen seconds to read each paragraph. Please take your time and read each paragraph carefully. If you believe that an important issue is raised in the paragraph, push button number (1) on the keypad with your index finger.

It was a late morning in mid-December. Bob Smith, a research analyst, was in his office at the L & H Marketing Research Company, a firm located in a metropolitan center on the East Coast. **N**[1]

Bob was working furiously to complete the marketing strategy report for his client, Standard Grooming Products. The client was in the process of introducing a new men's hair spray product. **N**

Standard Grooming needed data on the buying practices and media habits of men who use hair spray. Print, TV and radio media outlets were of particular interest. **N**

Bob began to review his current situation and his on-going history with the project. **N**

Two years ago, Bob had joined L & H, a marketing research company specializing in consumer products. Before that he had worked for another marketing research firm. **N**

A long series of problems had slowed the marketing research report that was due on Monday. Bob regretted having to leave his wife and children to come into the office today, a Saturday, to complete the report. **C**

He really did not like spending weekends away from his family. Most of all, he did not like disappointing his 12 year-old daughter by missing her Saturday morning basketball game. **C**

Bob's thoughts returned to the marketing strategy report and the client's files sitting on his mahogany desk. **N**

Bob's boss, Barry Michaels, had originally recommended that they focus on TV advertising. Barry had made it clear that he only wanted to see data that supported his thinking. Bob now knew that the survey results painted a different picture. **J**

Bob felt pressured by Barry, his boss, to "bend" the interpretation of the data. Bob, however, was reluctant to make the survey results appear more consistent with Barry's biases. **J**

A telephone call from the weekend guard served as a reminder to Bob that he had ordered a take-out lunch from the local deli. Bob told the guard to allow the delivery person access to L & H Marketing's suite of offices. **N**

Bob continued to review the history of the project. He recalled that back in September he had followed L & H Marketing's template for standard sampling procedures for projects of this type. **T**

On this basis, he had considered surveying 250 users of men's hair spray from each of 15 different cities. This would have resulted in a total sample of 3750 men. **T**

The building was almost empty. Bob found that a quiet environment facilitated his ability to think through the history of the project. **N**

Bob recalled disagreeing with Charles Chastain, from Standard Grooming's marketing department. Charles had argued for samples proportional to city sizes. This, however, would mean committing more money and resources over the life of the project. **S**

In the end, they disagreed. Charles stressed the importance of collecting more representative data that would increase the study's validity. Bob, however, was concerned about the increase in cost that would interfere with doing other studies of equal importance. **S**

While Bob was going over these issues in his mind, his lunch arrived: a beverage and sandwich in a plain cardboard container. After finishing his lunch, Bob returned to thinking about his marketing report. **N**

Corresponding author at: 4001 Woodruff Memorial Research Building, 101 Woodruff Circle, Emory University School of Medicine, Atlanta, GA 30322, United States. Tel.: +1 404 727 8262.

[1] **N**: Neutral; **C**: Care; **J**: Justice; **T**: Tactical; **S**: Strategic.