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Mario F. Mendez and Jill S. Shapira

Departments of Neurology and Psychiatry & Biobehavioral Sciences, University of California at Los Angeles, V. A. Greater Los Angeles Healthcare Center, Los Angeles, USA

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Altered emotional morality in frontotemporal dementia

Mario F. Mendez and Jill S. Shapira

Departments of Neurology and Psychiatry & Biobehavioral Sciences, University of California at Los Angeles, and V. A. Greater Los Angeles Healthcare Center, Los Angeles, USA

Introduction. Frontotemporal dementia (FTD), a disorder characterised by abnormal social behaviour and potential sociopathy, provides a window to the neurobiology of moral behaviour. This study investigated the basis of altered moral judgements in patients with FTD.

Methods. We administered an inventory of moral knowledge, five “reasoned” moral dilemmas, and five “emotional” moral dilemmas where subjects may cause direct harm to another through their own actions, to 21 patients with FTD compared to 21 comparably mildly impaired patients with Alzheimer’s disease (AD) and 21 normal controls. Among the FTD patients, the results were compared to findings on functional neuroimaging.

Results. All groups showed retention of knowledge for moral behaviour and the ability to make reasoned moral judgements. In contrast to the other groups, the FTD patients were altered in their ability to make emotional moral judgements. Among the FTD patients, the altered moral judgements corresponded to right hemisphere frontotemporal involvement.

Conclusions. In FTD patients, these findings suggest a decreased emotional responsiveness to others and a tendency to respond to moral dilemmas in a calculated fashion. Such a disturbance may result from ventromedial frontal dysfunction in FTD and supports the presence of a “morality” network in the brain, predominantly in the right hemisphere.

Keywords: Brain; Ethics; Frontotemporal dementia; Morality

INTRODUCTION

Frontotemporal dementia (FTD) is a neurodegenerative disorder that produces alterations in social and emotional behaviour. FTD results in progressive deterioration of the frontal and anterior temporal lobes,
particularly the ventromedial prefrontal cortex (VMPFC), but also the orbitofrontal and anterior temporal cortex. In contrast to the memory and cognitive deficits of Alzheimer’s disease (AD) and other dementias, the core features of FTD are transgression of social norms including sociopathic behaviour, a loss of empathy or appreciation of the feelings of others, and a loss of insight for their behaviour and its consequences (Mendez, Lauterbach, Sampson, & Committee on Research, 2008).

These core features of FTD may be a window into the neurobiological basis of moral behaviour (Mendez, Anderson, & Shapira, 2005). Morality is about ideals of human conduct based on values shared with other members of society. Disturbed social behaviour in FTD suggests an underlying disturbance in moral behaviour. Investigations show that lesions in the orbitofrontal and ventromedial prefrontal cortex impair moral judgement, and early lesions of these areas impair the development of moral knowledge and judgement (Anderson, Barrash, Bechara, & Tranel, 2006). Moreover, functional magnetic resonance imaging (fMRI) in normals show activation of these areas during tasks of moral reasoning (Moll, de Oliveira-Souza, & Eslinger, 2003; Moll et al., 2002).

Recent investigations point to an automatic and emotion-based process for moral judgement involving the VMPFC (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001), a core area of pathology in FTD. Greene and colleagues (2001) have proposed that medial prefrontal areas mediate strong emotional reactions to moral dilemmas, which prevent individuals from implementing morally impermissible acts. Moral dilemmas are situations in which persons face a conflict between opposing moral demands. In “reasoned” moral dilemmas, the conflicts do not result in direct harm to others unless it is due to a logical, nonpersonal deflection of any existing threat onto fewer people. In contrast, “emotional” moral dilemmas involve directly harming others through one’s own actions, and this possibility of harming others causing distress in most people (Greene, Nystrom, Engell, Darley, & Cohen, 2004; Haidt, 2007).

In FTD, altered “emotional” morality could account for defective moral judgement and many of the clinical manifestations of this disorder. Our preliminary work suggested a lack of moral emotional reactions in patients with FTD (Mendez, Anderson, & Shapira, 2005). This study investigated the response to moral knowledge questions, reasoned moral dilemmas, and emotional moral dilemmas among patients with FTD compared to those with AD and normal controls.
METHODS

Subjects
All FTD and AD participants in this study presented for evaluation to university-affiliated specialty clinics in dementing disorders. The patients were community-based, mildly impaired patients who underwent a comprehensive neurobehavioural evaluation, laboratory assessment, and magnetic resonance imaging. The study excluded patients on medications, particularly antipsychotic drugs, or with medical, neurological, or psychiatric disorders that could otherwise account for stereotypical movements. Study participation included written informed consent according to institutional review board guidelines.

All 21 FTD patients presented with progressive behavioural changes consistent with a decline in social interpersonal conduct, impairment in regulation of personal conduct, emotional blunting, and loss of insight for their disease. The clinical diagnosis of FTD was based on Consensus Criteria for FTD (Neary et al., 1998) plus frontotemporal-predominant changes on positron emission tomography (PET) or single photon emission computer tomography (SPECT).

The FTD patients were compared to 21 AD patients who met NINCDS-ADRDA criteria for clinically probable AD (McKhann et al., 1984). These patients were derived from the same clinic as those with FTD. The AD patients were relatively early onset patients chosen to match the FTD patients, as close as possible, in age, gender, education, and dementia severity. In order to ensure that the FTD and AD patients could complete this study, they had to be mildly impaired, defined as a Mini-Mental State Examination (MMSE) score of ≥23 and a Clinical Dementia Rating (CDR) score of ≤1.0 (Folstein, Folstein, & McHugh, 1975; Morris, 1993). Neuropsychological measures included verbal fluency, the Boston Naming Test (15-item version), constructions (copy of a circle, rhombus, overlapping rectangles, cube), a verbal list learning test, auditory comprehension, and the Frontal Assessment Battery (Dubois, Slachevsky, Litvan, & Pillon, 2000; Kiernan, Mueller, Langston, & van Dyke, 1987; Welsh et al., 1994). Additional normal controls (NC) were recruited primarily from spouses of patients. They were chosen so as to correspond with the overall age, gender, and education of the FTD and AD patients. None of the controls had a history of neurological or psychiatric disease.

Procedures
Part 1. Participants were administered the Moral Behaviour Inventory, a questionnaire consisting of 24 items originally based on the Moral Behaviour Scale (see Table 1; Rettig & Pasamanick, 1959). This instrument minimises
cultural and religious influences and maximises the content validity of empathy and the sense of fairness. The individual items are simple and have been previously administered to a series of normal adults and dementia patients (Mendez, Anderson, & Shapira, 2005). In order to facilitate administration and comprehension in dementia patients, the items were read aloud to the participants. The items were repeated as many times as necessary to assure comprehension. The participants were then asked if the item was “not wrong,” “mildly wrong,” “moderately wrong,” or “severely wrong,” a 4-point Likert scale. In our preliminary study, the split-half reliability (Cronbach’s coefficient alpha) for 78 participants was $r_{kk} = .73$ (.72–.76 for individual groups) (Mendez, Anderson, & Shapira, 2005).

**Part 2.** Participants were administered ten moral dilemmas (five reasoned and five emotional) modified from Greene and colleagues (2001;
available in original form at www.sciencemag.org/cgi/content/full/293/5537/2105/DC1). For this study, the dilemmas were simplified for administration to dementia patients. Our preliminary study was limited to the first reasoned (“Standard Trolley”) and the first emotional (“Footbridge”) dilemmas administered to an overlapping but not identical group of subjects (Mendez, Anderson, & Shapira, 2005).

Participants were read the dilemmas in the form of vignettes. In order to facilitate administration to dementia patients, these dilemmas were read aloud while simultaneously presented on a laptop screen. Because the patients had a dementia with variable baseline rates of comprehension and response speed, their responses were not timed, and the dilemmas could be reread, as necessary. In order to reduce fatigue, patients received the dilemmas in five blocks of two with breaks in-between. The dilemmas were administered in a counterbalanced fashion, both in terms of reasoned versus emotional and in the direction of response (“yes” vs. “no”).

The five reasoned moral dilemmas included the following:

1. “Standard Trolley”: Imagine that you are at the wheel of a runaway trolley quickly approaching a fork in the tracks. On the tracks going to the left is a group of five railway workmen. On the tracks going to the right is a single railway workman. If you do nothing, the trolley will proceed to the left, causing the deaths of the five workmen. The only way to avoid the deaths of these workmen is to hit a switch on your dashboard that will cause the trolley to proceed to the right, causing the death of the single workman. Would you hit the switch in order to avoid the deaths of the five workmen?

2. “Résumé”: You have a friend who has been trying to find a job for a long time but without success. He has a family to support, and he is desperate. It occurs to him that he would be more likely to get a job if he just had a more impressive résumé. He decided to put some false information on his résumé in order to make it more impressive. By doing this he ultimately got a job, beating out several other more qualified candidates. Was it OK for your friend to put false information on his résumé in order to help him get the job?

3. “Taxes”: You are the owner of a small business worried about surviving, making ends meet, and paying your taxes. It occurs to you that you can lower your taxes by pretending that some of your personal expenses are business expenses. For example, you could pretend that the stereo in your home is being used in your business office, or that your dinners out with your wife are dinners with clients. Is it OK for you to report personal expenses as business expenses in order to survive and make ends meet?
4. “Standard Fumes”: You are the night watchman in a hospital. There is an accident and deadly fumes in the ventilation system are travelling to the hospital rooms. In one room there are three patients. In another room there is a single man. If you do nothing the fumes will go into the room with the three patients and kill them. The only way to avoid this is to hit a switch that will reroute the fumes into the other room with the single man, killing him instead. Is it appropriate for you to hit the switch in order to avoid the deaths of the three patients?

5. “Lost Wallet”: You are walking down the street when you come across a wallet lying on the ground. You open the wallet and find that it contains several hundred dollars in cash. From the credit cards and other items in the wallet, it’s clear that it belongs to a very wealthy man. You, on the other hand, are very poor and need money. You consider sending the wallet back to the owner without the money, keeping the money for yourself. Would you keep the money you found in the rich man’s wallet?

The five emotional moral dilemmas included the following:

1. “Footbridge”: Imagine that a runaway trolley is heading down the tracks toward five workmen who will be killed if the trolley keeps going. You are on a footbridge over the tracks, in between the approaching trolley and the five workmen. Next to you on this footbridge is a stranger who happens to be very large. The only way to save the lives of the five workmen is to push this stranger off the bridge and onto the tracks below where his large body will stop the trolley. The stranger will die if you do this, but the five workmen will be saved. Would you to push the stranger onto the tracks in order to save the five workmen?

2. “Transplant”: You are a doctor. You have five patients, each of whom is about to die due to a failing organ of some kind. You have another patient, a young man who is healthy. The only way that you can save the lives of the first five patients is to transplant five of this young man’s organs (against his will) into the bodies of the other five patients. If you do this, the young man will die, but the other five patients will live. The families and staff beg you to do this. Would you refuse their requests to do the transplants that would save five of your patients?

3. “Smother for dollars”: You are in the hospital visiting a sick friend. A young man sitting next to you is visiting his very sick father who has only a week to live. He tells you that his father has a large life insurance policy that runs out at midnight. If his father dies before midnight, this young man gets millions of dollars. The money would mean a great deal to him, and he sees no value in his father’s suffering for a few more
days. He offers you a million dollars to go up to his father’s room and smother his father with a pillow. Would you to smother this man’s father in order to get money for yourself and this young man?

4. “Crying Baby”: Enemy soldiers have taken over your village. They have orders to kill everyone. You have hidden in the basement of a large house along with other people. Outside you hear the voices of soldiers who have come to search the house. Your baby begins to cry loudly. You cover his mouth to block the sound. If you remove your hand from his mouth the soldiers will hear his crying and will kill you, your baby, and the other people hiding in the basement. To save yourself and the others you must smother your child to death. Would you smother your child in order to save yourself and the other people?

5. “Modified Lifeboat”: You are on a cruise ship when there is a fire on board, and the ship has to be abandoned. Unfortunately, the lifeboat that you get in has too many people and may sink. Your lifeboat is beginning to fill with water. If nothing is done your lifeboat will sink before the rescue boat arrives and everyone may die. However, there is a seriously injured person in the lifeboat. The other passengers ask you to help them throw that person overboard so that the lifeboat will not sink. Would you refuse to help the others throw this person overboard in order to save as many passengers as possible?

After reading the dilemmas, the participants were asked several questions. First, they were asked to repeat back the dilemma in their own words. If they could not describe the dilemma, the vignette was reread, clarified, and simplified. The patients were asked again to explain the dilemma. This process was repeated as much as necessary until they could sufficiently remember and understand the nature of the dilemma. Second, they were required to commit to a “yes” or “no” answer, whichever they were most comfortable with. They were given as much time as they needed to think about the dilemma before committing to their response. During this process, the examiner was not allowed to prompt a response in any way. Reading all the dilemmas took about 1 hour. Finally, after completion, the participants were asked their impressions of the study. The participants did not express any discomfort or emotional conflict with their decisions on the dilemmas.

The clinical PET and SPECT scans on the FTD patients, which were obtained from different scanners and medical centres, were reread by two independent and experienced raters, blind to the clinical diagnosis. This technique has been previously reported (Mendez et al., 2006). The raters initially graded the scans for hypometabolism or hypoperfusion as absent, mild, moderate, or severely present (0–3 point scale) for each of left frontal, right frontal, left anterior temporal, and right anterior temporal regions. The combination of the two raters led to determinations of whether the scans
had significant or nonsignificant involvement of each of the four regions of interest. Our prior interrater reliability for this method of regional PET/SPECT ratings was high ($r_s = .714$ for 296 ratings; $p < .001$) (Mendez et al., 2006).

**Data analysis**

The comparison of the three groups on basic characteristics, dementia measures, and the Moral Behaviours Inventory used analysis of variance (ANOVA). Because of the nonparametric nature of the dilemma responses, the analysis of group differences on the dilemmas used chi-square and the Kruskal-Wallis (H) test. Finally, among the FTD patients, the relationship of the dilemma responses to the functional neuroimaging changes used the Wilcoxon ($W$) test and Spearman ($r_s$) correlations. For the functional neuroimaging variables, the study evaluated left hemisphere, right hemisphere, frontal region, and temporal region scores.

**RESULTS**

There were no statistically significant differences between the FTD patients and normal control groups on age, sex, or education. The two dementia groups did not differ statistically on the MMSE and the global CDR; both were mildly impaired on these measures. There were no differences on the reasoned and emotional dilemmas based on age, gender, education, or MMSE and CDR score; however, consistent with their diagnoses, the AD patients were significantly worse than the FTD patients on memory tests and constructions and better on the FAB (Table 2). On the Moral Behaviour Inventory, the three groups did not show significant differences, consistent with intact knowledge of right or wrong among all three groups.

The FTD patients diverged from the other groups on the emotional moral dilemmas but not on the reasoned moral dilemmas. When analysed individually, there were no group differences on the reasoned moral dilemmas between the FTD, AD, and normal control groups (Table 3). When analysed as total “reasoned” or “emotional” dilemma scores, both dementia groups were more likely to endorse an opposite moral response compared to the normal controls. This was true for both reasoned dilemmas, $H = 14.17$ overall; $H = 17.85$ FTD vs. NC; $H = 14.44$ AD vs. NC (all $ps < .001$) and emotional dilemmas, $H = 51.45$ overall; $H = 32.43$ FTD vs. NC; $H = 18.74$ AD vs. NC (all $ps < .001$). Further analysis did not show differences between the FTD and AD groups on the reasoned dilemmas, $H = 1.02$, ns; however, the FTD and AD groups differed significantly on the emotional dilemmas, $H = 32.96$, $p < .001$. Many FTD patients responded in a “logical” way to
<table>
<thead>
<tr>
<th></th>
<th>FTD, n=21, 10M, 11F</th>
<th>AD, n=21, 10M, 11F</th>
<th>NC, n=21, 10M, 11F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>59.9 (8.1)</td>
<td>63.2 (8.9)</td>
<td>61.4 (8.4)</td>
<td>ns</td>
</tr>
<tr>
<td>Education (years)</td>
<td>14.2 (4.4)</td>
<td>14.4 (4.2)</td>
<td>14.6 (3.8)</td>
<td>ns</td>
</tr>
<tr>
<td>MMSE A</td>
<td>25.19 (1.25)</td>
<td>24.62 (1.36)</td>
<td>29.7 (0.90)</td>
<td>ns</td>
</tr>
<tr>
<td>CDR B</td>
<td>0.62 (0.35)</td>
<td>0.86 (0.23)</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Moral Behavior Inventory C</td>
<td>62.54 (10.41)</td>
<td>65.11 (9.09)</td>
<td>64.22 (9.10)</td>
<td>ns</td>
</tr>
<tr>
<td>Verbal Digit Span</td>
<td>6.62 (1.02)</td>
<td>6.29 (0.96)</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Verbal Fluency-“animals”</td>
<td>11.71 (2.61)</td>
<td>10.33 (2.82)</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Mini-Boston Naming Test</td>
<td>13.29 (1.62)</td>
<td>13.43 (1.63)</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>NCSE D Aud. Comprehension</td>
<td>5.33 (0.80)</td>
<td>5.29 (0.78)</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>CERAD D Savings score</td>
<td>7.24 (1.26)</td>
<td>5.43 (1.66)</td>
<td>—</td>
<td>$t = 3.98$, $p &lt; .001$</td>
</tr>
<tr>
<td>CERAD D Recognition score</td>
<td>8.81 (1.08)</td>
<td>7.57 (1.80)</td>
<td>—</td>
<td>$t = 2.70$, $p &lt; .01$</td>
</tr>
<tr>
<td>Constructions score</td>
<td>9.67 (0.66)</td>
<td>7.52 (1.44)</td>
<td>—</td>
<td>$t = 6.22$, $p &lt; .001$</td>
</tr>
<tr>
<td>FAB E Total score</td>
<td>15.38 (1.50)</td>
<td>16.33 (1.39)</td>
<td>—</td>
<td>$t = -2.13$, $p &lt; .05$</td>
</tr>
</tbody>
</table>

FTD = frontotemporal dementia; AD = Alzheimer’s disease; NC = normal controls.

MMSE = Mini-Mental State Examination. No difference between the two dementia groups.

CDR = Global Clinical Dementia Rating scores based on Washington University scoring rules.

Total scores may vary between 24 and 72.

Neurobehavioral Cognitive State Exam (Kiernan et al., 1987).

CERAD: Consortium to Establish a Registry in Alzheimer’s Disease memory tests: Savings Score (Delayed Recall/Trial III proportion of 10 words) and Recognition (Welsh et al., 1994).

Frontal Assessment Battery (Dubois et al., 2000).
emotional moral dilemmas even at the cost of inflicting direct harm on another. All of these alternative emotional moral response came from 17 (81%) of the FTD patients, and the majority (59%) came from just 12 (57%) of the FTD patients.

PET/SPECT findings
Among the FTD patients, the total imaging ratings for the two raters included means of 2.57 (1.08) for left hemisphere, 3.71 (1.68) for right hemisphere, 3.33 (1.24) for frontal regions, and 3.00 (1.00) for temporal regions. The FTD patients had greater right hemisphere involvement than the other groups, $W = 109.0$, $p \leq .05$, but there were no frontal versus temporal regional differences, $W = 47.0$, $ns$.

Responses on the reasoned and emotional dilemmas correlated with each other, $r_s = .99$, $p < .001$, and with right hemisphere changes on PET/SPECT, $r_s = .47$ for reasoned and $r_s = .49$ for emotional dilemmas (both $ps < .05$). Neither significantly correlated with left hemisphere involvement, $r_s = .31$ and $r_s = .28$, respectively. Finally, greater alternative moral responses on both reasoned and emotional dilemmas were associated with both greater frontal, $r_s = .66$ and .65, $p < .01$, and temporal, $r_s = .70$ and .71, $p < .001$, involvement.

DISCUSSION
This study evaluated emotionally-based moral behaviour in FTD using a moral behaviour inventory and moral dilemmas to distinguish between reasoned and emotionally based moral judgements (Greene et al., 2001; Thomson, 1986). The patients with FTD were more likely to approve emotional moral violations compared to the patients with AD and the normal controls. Yet, they retained knowledge about moral values and conventional rules. The results of this study support an impairment in emotional moral judgement in FTD in the face of relatively preserved moral knowledge and the ability to tell right from wrong.

FTD is a model to understand morality and the brain. FTD patients have a loss of social tact and propriety early in their course and may commit sociopathic acts (Mendez, Chen, Shapira, & Miller, 2005; Miller, Darby, Benson, Cummings, & Miller, 1997). Among FTD patients, investigators have reported shoplifting (Gustafson, 1993; Lynch et al., 1994), inappropriate or unsolicited sexual behaviour (Gustafson, 1987; Miller et al., 1997), traffic violations (Mendez, Chen, et al., 2005; Miller, et al., 1997), acts of violence (Gustafson, 1993), and even paedophilia (Mendez, Chow, Ringman, Twitchell, & Hinkin, 2000). Moreover, FTD patients often appear
unconcerned for the emotional consequences of their transgressions and appear impaired in the ability to infer others’ mental states and feelings (Gregory et al., 2002).

FTD and other brain disorders that damage the medial frontal region and its connections can impair an emotionally based moral system (Greene et al., 2004; Haidt, 2001; McNamara, Durso, & Harris, 2007). Haidt (2001) proposed a “social intuitionist model” where moral judgements result from fast and automatic emotional intuitions of the actions of themselves or others. Functional MRI studies indicate that discomfort at the prospect of causing direct harm to another drive automatic, emotionally based moral responses which are associated with increased activity in the medial VMPFC (Greene & Haidt, 2002; Greene et al., 2004). Although there are other systems for moral emotions, especially an orbitofrontostriatopallidal brain system with a reward role (Braun, Léveillé, & Guimond, 2008; Takahashi et al., 2008), this VMPFC system appears to have primacy for immediate moral decision making. The VMPFC mediates a rapid, emotional response that signals potential moral violations of social norms and that attributes feelings of blame and wrongdoing (Amodio & Frith, 2006; Kliemann, Young, Scholz, & Saxe, 2008).

Studies of patients with focal lesions of the VMPFC indicate insensitivity to emotional moral decision making (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Tranel, & Damasio, 2000; Koenigs et al., 2007; Saver &

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### TABLE 3
Proportion of subjects who gave “yes/no” responses to moral dilemmas

<table>
<thead>
<tr>
<th>Reasoned dilemmas</th>
<th>FTD</th>
<th>AD</th>
<th>NC</th>
<th>$\chi^2$ 3-Grps $\chi^2$ 3-Grps</th>
<th>p 3-Grps $p$ 3-Grps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Trolley Car$^C$</td>
<td>18/3</td>
<td>19/2</td>
<td>21/0</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Resume</td>
<td>4/17</td>
<td>3/18</td>
<td>0/21</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Taxes</td>
<td>4/17</td>
<td>3/18</td>
<td>0/21</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Standard Fumes$^C$</td>
<td>18/3</td>
<td>19/2</td>
<td>21/0</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>Lost Wallet</td>
<td>3/18</td>
<td>2/19</td>
<td>0/21</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotional dilemmas</th>
<th>FTD</th>
<th>AD</th>
<th>NC</th>
<th>$\chi^2$ 3-Grps $\chi^2$ 3-Grps</th>
<th>p 3-Grps $p$ 3-Grps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footbridge</td>
<td>12/9</td>
<td>4/17</td>
<td>2/19</td>
<td>13.07$^A$ 4.95$^B$</td>
<td>.001$^A$ .026$^B$</td>
</tr>
<tr>
<td>Transplant$^C$</td>
<td>7/14</td>
<td>16/5</td>
<td>19/2</td>
<td>16.71$^A$ 6.15$^B$</td>
<td>&lt;.001$^A$ .013$^B$</td>
</tr>
<tr>
<td>Smother for Dollars</td>
<td>15/6</td>
<td>5/16</td>
<td>1/20</td>
<td>22.29$^A$ 7.73$^B$</td>
<td>&lt;.001$^A$ .005$^B$</td>
</tr>
<tr>
<td>Crying Baby</td>
<td>12/9</td>
<td>4/17</td>
<td>1/20</td>
<td>15.63$^A$ 4.95$^B$</td>
<td>&lt;.001$^A$ .026$^B$</td>
</tr>
<tr>
<td>Modified Lifeboat$^C$</td>
<td>6/15</td>
<td>16/5</td>
<td>19/2</td>
<td>19.42$^A$ 7.73$^B$</td>
<td>&lt;.001$^A$ .005$^B$</td>
</tr>
</tbody>
</table>

$F^D$ = frontotemporal dementia; $A^D$ = Alzheimer’s disease; $N^C$ = normal controls.

$^C$The direction of the “yes/no” responses are counterbalanced, so that expected normal responses would be “yes” on the these dilemmas and “no” on the others.
A major example of this are the behavioural changes described in Phineas Gage, one of neurology’s most famous patients, who sustained bilateral VMPF injury from the explosion of a railroad spike (Damasio, 1994). Patients with VMPF lesions have diminished emotional experience with loss of concern for others, decreased autonomic responsiveness, and possible “acquired sociopathy” (Barrash, Tranel, & Anderson, 2000; Brower & Price, 2001; Damasio, Tranel, & Damasio, 1990; Eslinger, 1998; Tranel, 1994). Despite this, they are aware of their actions, have preserved logical reasoning and knowledge of social and moral norms, and can anticipate future outcomes (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Koenigs & Tranel, 2007; Saver & Damasio, 1991). In a study using moral dilemmas, Ciaramelli, Muccioli, Ladavas, and di Pellegrino (2007) showed VMPFC activation during contemplation of emotional moral dilemmas (vs. reasoned and nonmoral) in seven patients with VMPFC lesions compared to twelve healthy individuals in emotional moral dilemmas. Compared to normal controls, their patients were more willing to judge emotional moral violations as acceptable behaviours in emotional moral dilemmas. Many other studies of patients with focal VMPF lesions, especially on the right, show attenuated feelings of emotional discomfort for sociomoral violations, impaired empathy, and reduced responsiveness to victims (Amodio & Frith, 2006; Bechara et al., 1994, 2000; Berthoz, Grezes, Armony, Passingham, & Dolan, 2006; Blair & Cipolotti, 2000; Cushman, Young, & Hauser, 2006; Damasio et al., 1990; Greene et al., 2004; Harenski & Hamann, 2006; Hauser, Cushman, Young, Jin, & Mikhail, 2006; Koenigs et al., 2007; Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005; Tranel, 1994; Tranel, Bechara, & Denburg, 2002).

Early FTD disproportionately affects the VMPFC (Rosen, et al., 2002), and this study shows corresponding impairments in emotionally based personal moral judgements. FTD patients who lack strong moral emotions may not be able to override drives, compulsions, disinhibitions, or tendencies, such as for paedophilia (Mendez et al., 2000). Finally, there appears to be a greater role for the right hemisphere, compared to the left hemisphere, in mediating these sociomoral responses (Tranel et al., 2002).

There are potential limitations of this study. A possible confound is whether the dementia patients could sufficiently understand the moral dilemmas. In order to assure understanding, this study included only mildly impaired patients and administered the moral vignettes in a way that maximised comprehension. Second, there may be a tendency to give the socially acceptable answers to moral vignettes. This was controlled by the reasoned versus emotional differences and the variation in yes/no valence of responses. Third, as previously noted in the literature (Braun et al., 2008), the moral vignettes are artificial situations. Nevertheless, as outlined earlier, many investigators have successfully used these moral dilemmas in fMRI
and in brain lesion studies. Finally, the moral dilemmas could not be administered in a blind fashion. The investigators, however, were extremely cognisant of the need not to prime or bias the patients’ responses.

In conclusion, this study strongly suggests impairments in emotionally based moral behaviour in FTD. In patients with FTD or focal VMPFC lesions, especially on the right, abnormalities in moral behaviour appear to result from decreased emotional moral judgements. FTD patients, however, can reason normally and make reasoned moral judgements as long as an immediate moral emotion is not required. Future investigations can further clarify the intriguing relationship between the brain and our “moral sense” (Pinker, 2008; Wilson, 1993).

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REFERENCES


