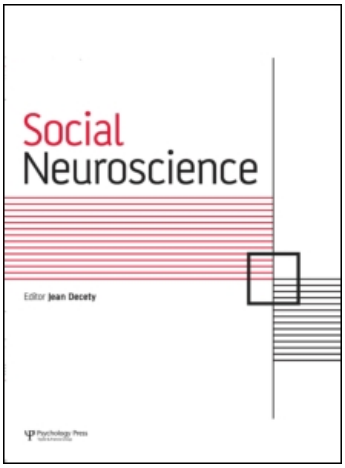
This article was downloaded by: *[Gleichgerrcht, Ezequiel]*
On: *12 August 2010*
Access details: *Access Details: [subscription number 925719193]*
Publisher *Psychology Press*
Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK




**Social Neuroscience**
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t741771143

# The role of social cognition in moral judgment in frontotemporal dementia

Ezequiel Gleichgerrcht[a]; Teresa Torralva[b]; María Roca[b]; Mariángeles Pose[b]; Facundo Manes[b]
[a] Institute of Cognitive Neurology (INECO), Buenos Aires, Argentina [b] Institute of Cognitive Neurology (INECO), and Favaloro University, Buenos Aires, Argentina

First published on: 12 August 2010

**To cite this Article** Gleichgerrcht, Ezequiel , Torralva, Teresa , Roca, María , Pose, Mariángeles and Manes, Facundo(2010) 'The role of social cognition in moral judgment in frontotemporal dementia', Social Neuroscience,, First published on: 12 August 2010 (iFirst)
**To link to this Article: DOI:** 10.1080/17470919.2010.506751
**URL:** http://dx.doi.org/10.1080/17470919.2010.506751

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

SOCIAL NEUROSCIENCE, 2010, i*First*, 1–10

Psychology Press
Taylor & Francis Group

# The role of social cognition in moral judgment in frontotemporal dementia

**Ezequiel Gleichgerrcht**
*Institute of Cognitive Neurology (INECO), Buenos Aires, Argentina*

**Teresa Torralva, María Roca, Mariángeles Pose, and Facundo Manes**
*Institute of Cognitive Neurology (INECO), and Favaloro University, Buenos Aires, Argentina*

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

Patients with behavioral variant frontotemporal dementia (bvFTD) exhibit a set of behavioral disturbances that have been strongly associated with involvement of the prefrontal cortex (PFC). Many such disturbances have been linked to impaired moral behavior, especially in regard to "personal" or "emotionally driven" moral dilemmatic judgment, which has been demonstrated to also depend on the integrity of the PFC. In this study, we administered a personal moral dilemma (the footbridge dilemma) and social cognition measures to patients with early bvFTD, who were also assessed with an extensive neuropsychological battery, including moral knowledge, cognitive and emotional empathy, and affective decision-making. BvFTD patients who would push a man off a footbridge (knowing this would kill him) to save the life of five workers who would have been otherwise killed by the train showed significantly lower scores on affective Theory of Mind (ToM) relative to those bvFTD patients who responded negatively. No significant differences were found on other sociodemographic, neuropsychological or social cognition variables. This study reveals that altered dilemmatic judgment may be related to impaired affective ToM, which has important clinical and theoretical implications.

***Keywords:*** Frontotemporal dementia; Moral judgment; Social cognition; Theory of mind; Empathy.

## INTRODUCTION

Frontotemporal dementia (FTD) is a neurodegenerative disease that affects particular structures within the frontal and temporal lobes or both (for review, see Josephs, 2008). Prefrontal dysfunction is often more noticeably evident through the behavioral disturbances typical of the behavioral variant FTD syndrome (bvFTD), which include deficits in impulse control, loss of insight, lack of empathy, altered social interaction with disinhibition, lack of responsibilities, apathy, and withdrawal, as well as compulsive behavior, perseverations, or stereotyped and repetitive acts (Bozeat, Gregory, Ralph, & Hodges, 2000; Hodges & Miller, 2001; Neary et al., 1998). Patients with bvFTD also show marked deficits on tasks of executive functions, while memory and language are relatively spared (Neary et al., 1998; Kipps, Knibb, Patterson, & Hodges, 2008; Hodges & Miller, 2001). It is not unusual for these disturbances to occur well before structural abnormalities become evident on neuroimaging (Davies et al., 2006; Kipps et al., 2007; Mendez, Shapira, McMurtray, Licht, & Miller, 2007; Rascovsky et al., 2005), which often delays early diagnosis, as bvFTD patients tend to be misdiagnosed with psychiatric disorders.

Impaired moral judgment and moral behavior, decision-making, and social cognition are at the heart of the problem faced by patients with bvFTD (e.g., Mendez, Anderson, & Shapira, 2005; Mendez & Shapira, 2009). In particular, moral behavior refers to the ideals of human actions, manners and conduct based on values

Correspondence should be addressed to: Ezequiel Gleichgerrcht, Institute of Cognitive Neurology (INECO), Castex 3293 (1425), Buenos Aires, Argentina. E-mail: egleichgerrcht@ineco.org.ar

This study was funded by a FINECO grant. We thank Lucila Balduzzi for her assistance in reviewing possible measures.

© 2010 Psychology Press, an imprint of the Taylor & Francis Group, an Informa business
www.psypress.com/socialneuroscience DOI: 10.1080/17470919.2010.506751

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

that are shared by society, embracing concepts of deed and duty, fairness and self-control (Wilson, 1993).

Previous reports (Anderson, Bechara, Damasio, Tranel, & Damasio, 2002; Ciaramelli, Muccioli, Ladavas, & di Pellegrino, 2007; Moll et al., 2002) have suggested that moral judgment strongly depends on the orbital and medial regions of the prefrontal cortex (PFC). In fact, it has been further argued that there is a "morality network" involving (a) the right ventromedial PFC, which may bias moral judgment by associating external stimuli with socioemotional value; (b) the orbitofrontal cortex, which seems to inhibit immediate/automatic responses and processes social prompts; and (c) the amygdalae, which are involved in moral learning and threat response (for review see Mendez, 2006). Moll, de Oliveira-Souza, and Eslinger (2003) went beyond these structures and proposed a model that contemplates brain–behavior relationships looking at the interactions between emotional, behavioral, and cognitive components. Accordingly, the authors also targeted the anterior cingulate cortex, the superior temporal sulcus, the insula, the precuneus, the thalamus, and the basal forebrain, among others. Anatomofunctional models of this kind reveal the complexity of moral behavior in humans and highlight the need to understand moral judgment as the result of complex processes that span across multiple and highly interconnected brain structures.

One of the most consistently used methods in looking at morality and moral judgment has been the use of moral dilemmas. When faced with a moral dilemma, the person must make a choice between two conflicting courses of action involving a moral violation. According to Greene, Nystrom, Engell, Darley, & Cohen (2004) and Greene, Sommerville, Nystrom, Darley, and Cohen (2001), this moral violation is considered "personal" if it causes severe physical harm to a particular person or group of persons, not resulting from the deflection of an existing threat onto a different party. Otherwise, the moral dilemma is "impersonal" and involves deflection of an existing threat, hence it is driven more by reasoning than by emotional responses. In fact, different patterns of brain activation have been described for each type of dilemma. Responses for personal moral dilemmas have been associated with increased activity in medial prefrontal regions, supposedly regulating the emotional reactions involved in moral judgment. However, during the response to impersonal dilemmas, brain areas associated with abstract thinking and working memory were activated, such as the dorsolateral prefrontal cortex (Greene et al., 2001). Accordingly, studies looking at patients with damage to the ventromedial PFC have shown that they are more willing to judge moral violations in personal dilemmas as acceptable behaviors, although impersonal dilemmatic judgment was comparable to that of healthy controls (Ciaramelli et al., 2007; Koenigs et al., 2007).

Based on the abovementioned evidence, the involvement of medial prefrontal brain areas in bvFTD pathology may shed light on the issue of defective social behavior typical of this disease. Mendez et al. (2005) showed that while moral knowledge (as measured by a moral behavior inventory) and impersonal dilemmatic judgment were comparable between controls and bvFTD patients, the latter showed impaired judgment in a personal and emotionally driven moral dilemma. Subsequent replications of these results using other impersonal and personal moral dilemmas (Mendez & Shapira, 2009) have reinforced the idea that behavioral abnormalities in bvFTD such as blunted emotion and diminished regard for others may be linked to impaired emotional moral judgment, besides expected responses for impersonal/reasoned moral dilemmas.

Naturally, not all bvFTD patients respond to moral dilemmas similarly. For example, previous reports have reported a ratio of "Yes" and "No" responses to a personal moral dilemma (the footbridge dilemma, detailed in the Methods section) of approximately 1:1 (57% "Yes") in bvFTD patients (Mendez et al., 2005), and affirmative responses as low as 29% and as high as 71% have been found on other emotionally driven dilemmas (Mendez & Shapira, 2009).

Among the mechanisms that could account for disturbed moral behavior in bvFTD are: cognitive or emotional empathy, abnormal somatic marker, and abnormal aspects of social cognition. In this sense, understanding response patterns in bvFTD patients relative to controls and other types of dementia, such as Alzheimer disease, has been crucial to get a clearer picture of how moral judgment is impaired in this disease and how it impacts behavior. Nonetheless, to the best of our knowledge, no previous study has investigated what makes different bvFTD patients respond affirmatively or negatively to emotionally driven, personal moral dilemmas. The present study sought to understand what demographic, clinical, neuropsychological, or social cognition variables could be related to different responses of bvFTD patients to moral dilemmas.

# METHODS

## Participants

Twenty-two patients with early/mild stages of bvFTD were recruited if they fulfilled Lund and Manchester

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

criteria for bvFTD diagnosis (Neary et al., 1998). Patients presented with prominent changes in personality and social behavior verified by a caregiver during initial assessment. Dementia severity was assessed using the Clinical Dementia Severity Rating Scale (CDR) (Hughes, Berg, Danziger, Coben, & Martin, 1982) and only patients with CDR ≤ 1 were included. Diagnosis was initially made by two experts in FTD (FM and TT). Each patient was reviewed, individually, in the context of a multidisciplinary clinical meeting, where cognitive neurologists, psychiatrists, and neuropsychologists discuss each patient's case in particular. BvFTD patients were recruited as part of a broader ongoing study on fronto-temporal dementia. All patients underwent a standard examination battery including neurological, neuropsychiatric and neuropsychological examinations and a magnetic resonance imaging (MRI) scan. Although current criteria for bvFTD do not require frontal atrophy for diagnosis, in the present study patients were included only if they showed frontal atrophy on MRI. Inter-rater reliability for diagnosis was excellent (Cohen's kappa = .94). The patients described in the present study did not meet criteria for specific psychiatric disorders, as assessed by psychiatric examination.

## Procedure

The study was initially approved by the ethics committee at the Institute of Cognitive Neurology (INECO) in accordance with the Declaration of Helsinki. All participants were assessed with a comprehensive classical cognitive battery and a social cognition battery, both of which are detailed below.

### *Standard cognitive battery*

General cognitive status was assessed with the Mini Mental State Examination (MMSE) (Mendez, 2006) and the Addenbrooke's Cognitive Examination – Revised (ACE-R) (Mioshi, Dawson, Mitchell, Arnold, & Hodges, 2006). Verbal memory was examined with the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1941); nonverbal memory was assessed with the delayed and recognition scores of the Rey-Osterrich Complex Figure (ROCF) (Rey, 1941). Language measures included the adapted version of the Boston Naming Test (BNT) (Kaplan, Goodglass, & Weintraub, 1983) for naming, the Token Test (Spreen & Benton, 1977) for comprehension, and semantic category (animals) for verbal fluency (Lezak, Howieson, & Loring, 2004). Attention was assessed with the forward digit span task of the WAIS-R (Wechsler, 1981) and Part A of the Trail Making Test (TMT-A) (Partington & Leiter, 1949) and visuospatial abilities with the copy score of the ROCF (Rey, 1941). Executive functions were evaluated with the backward digit span task (Wechsler, 1981), Part B of the Trail Making Test (TMT-B) (Partington & Leiter, 1949), phonological (letter "P") fluency (Lezak et al., 2004), the modified version of the Wisconsin Card Sorting Test (WCST) (Nelson, 1976), and the INECO Frontal Screening (Torralva, Roca, Gleichgerrcht, López, & Manes, 2009), a brief, sensitive screening tool for executive functions.

### *Social cognition battery*

The social cognition battery used in this study included experimental tasks as well as self-administered questionnaires, and assessed moral behavior, Theory of Mind (ToM), decision-making, and empathy.

1. *Moral knowledge and personal dilemmatic judgment.* Participants were administered the Moral Behavior Inventory (MBI), a 24-item scale that presents an array of situations that the patient must label as "not wrong," "mildly wrong," "moderately wrong," or "severely wrong" on a 4-point Likert scale. Patients were also presented with the footbridge dilemma (Thomson & Parent, 1986), in which a trolley is going down the tracks and threatens to kill five people. The patient is asked to imagine that he/she is standing next to a large stranger on a footbridge that spans the tracks, between the oncoming trolley and the five people. The patient is instructed that the only way to save the five people is to push this stranger off the bridge, onto the tracks below; the stranger will die, but his large body will stop the trolley from killing the five men. The dilemma is read aloud to the participants in the form of a story vignette. In order to minimize the need for working memory loading, the story vignettes were placed in front of the patient and they were asked to repeat back the dilemma in their own words. The examiner repeated and explained the dilemma as necessary until it was clear that the patient understood the situation. Then, patients were asked whether they would push the large man onto the tracks, which would save the five men but would kill him. Their answer was recorded as either "Yes" or "No." The vast majority of controls respond negatively to the dilemmatic question. This moral dilemma was administered together with two other moral dilemmas, although those data exceed the purposes of the present analysis. Detailed instructions and

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

scoring of the MBI and the moral dilemmas can be found elsewhere (Mendez et al., 2007).

2. *Theory of Mind.* We assessed this domain with two widely used ToM tasks: the Reading the Mind in the Eyes Test (MIE) (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) and the Faux Pas Test (Stone, Baron-Cohen, & Knight, 1998). The MIE consists of a series of photographs of the ocular region of different human faces and patients were required to choose between two options (adjectives) that best described what the individuals in the picture were feeling. The score was determined by adding up the total number of correctly chosen adjectives (maximum: 17 points). In this Faux Pas, participants are read stories that may contain a social faux pas. After each story, participants are asked whether something inappropriate was said, and if so, asked to give an explanation as to why it was inappropriate. In order to understand that a faux pas has occurred, the participant has to represent two mental states. First, that the person committing the faux pas is unaware that they have said something inappropriate and, second, that the person hearing it might feel hurt or insulted. Each story is presented in front of the patient in order to decrease working memory load. A memory question is used as a control to check that certain aspects of the stories are retained and scoring is computed (out of 20 total points) by adding the number of correctly detected faux pas (maximum 10 points) and the number of correctly detected non-faux pas scenarios (maximum 10 points).
3. *Decision-making.* We assessed decision-making using the Iowa Gambling Task (IGT) (Bechara, Damasio, Damasio, & Anderson, 1994). The computerized version of the IGT mimics real-life personal decision-making activities in real time that include reward and punishment. Participants are asked to continuously select cards from four decks (A, B, C, and D) in order to make as much money as possible in the game. The task is completed after 100 selections. Following card selection, participants receive a certain amount of reward, but some choices also result in loss of money (penalties). Decks A and B are ultimately risky (large rewards and large punishments) while C and D are more conservative (small rewards and small penalties). Under this paradigm, net earnings may only be obtained by consistently selecting from low-yield decks (C and D). The dependent variable on this task is the Net Score, calculated by subtracting the number of choices to the risky decks (A + B) from the choices to the safe decks (C + D). In order to quantify the progression of decision-making preference profiles throughout the task, the 100 choices are split into five blocks of 20 consecutive cards. A net score is then calculated for each block.
4. *Empathy.* Patients were asked to complete the Interpersonal Reactivity Inventory (IRI) (Davies et al., 2006), which is a 28-item self-report questionnaire consisting of four 7-item subscales, assessing specific aspects of empathy, namely: Perspective Taking (PT; the tendency to adopt the point of view of other people), Fantasy (F; the tendency to transpose oneself into the feelings and actions of fictitious characters), Empathic Concern (EC; the tendency to experience feelings of warmth, compassion, and concern for other people), and Personal Distress (PD; one's own feelings of personal unease and discomfort in reaction to the emotions of others).

## Statistical analysis

BvFTD patients were divided into two groups depending on their answer to the footbridge moral dilemma: YES patients said they would push the man into the tracks; NO patients said they would not push him. Demographic, neuropsychological, and experimental data were compared between the groups using Student's *t*-test or Mann Whitney *U*-tests as needed depending on the homogeneity of the data set. When analyzing categorical variables (e.g., gender), the Fisher exact probability test for $2 \times 2$ contingency tables was used. Inter-rater reliability for bvFTD diagnosis was determined using Cohen's kappa. Correlations between variables were analyzed using Spearman's rank correlation within both groups. The $\alpha$ value for all statistical tests was set at 0.05, two-tailed.

# RESULTS

## Demographic and neuropsychological profile

Nine patients were included in the YES group and 13 patients in the NO group based on their answer to the footbridge moral dilemma. General demographic information and neuropsychological test results are summarized in Table 1. No significant differences were found for any of the demographic variables including age, gender, education, age at onset, or

**TABLE 1**
Demographic and neuropsychological profile of bvFTD patients who would not push the man onto the tracks (NO) and those who would (YES)

| | *NO (n = 13)* | | *YES (n = 9)* | | *NO vs. YES* | |
|---|---|---|---|---|---|---|
| | *Mean* | *SD* | *Mean* | *SD* | *Test* | *P* |
| Age | 71.4 | 5.46 | 71.2 | 6.80 | $t = 0.08$ | .94 |
| Gender | 5 F : 8 M | | 6 F : 3 M | | $\chi^2 = 0.25$ | .31 |
| Education (years) | 14.4 | 5.68 | 13.7 | 4.13 | $t = 0.27$ | .79 |
| Age at onset | 67.6 | 5.48 | 67.0 | 7.78 | $t = 0.17$ | .86 |
| *CDR* | | | | | | |
| TS | 0.8 | 0.53 | 0.8 | 0.67 | $t = –0.18$ | .91 |
| SOB | 4.5 | 2.38 | 4.6 | 1.54 | $t = –0.04$ | .97 |
| MMSE Total Score | 22.7 | 5.96 | 23.2 | 4.32 | $t = –0.17$ | .87 |
| ACE-R Total Score | 66.7 | 19.28 | 68.0 | 19.04 | $t = –0.12$ | .90 |
| *RAVLT* | | | | | | |
| Immediate | 19.4 | 8.55 | 26.3 | 13.72 | $t = –1.15$ | .27 |
| Delayed | 1.5 | 2.80 | 3.0 | 2.71 | $t = –0.91$ | .38 |
| Recognition | 9.2 | 4.92 | 8.0 | 5.29 | $t = 0.41$ | .69 |
| ROCF | | | | | | |
| Delayed | 6.6 | 10.11 | 10.0 | 6.42 | $t = –0.63$ | .54 |
| Recognition | 40% correct | | 50% correct | | $\chi^2 = 0.18$ | .55 |
| Boston naming test | 15.0 | 2.53 | 17.0 | 3.36 | $U = 24.0$ | .95 |
| Token test | 22.6 | 6.91 | 15.7 | 7.23 | $t = 1.47$ | .18 |
| Semantic fluency | 10.6 | 8.02 | 12.8 | 10.59 | $t = –0.45$ | .66 |
| Forward digit span | 5.7 | 1.42 | 4.6 | 1.14 | $t = 1.50$ | .16 |
| TMT-A | 92.1 | 84.20 | 132.3 | 152.85 | $t = –0.62$ | .55 |
| ROCF Copy | 25.7 | 10.24 | 25.4 | 15.93 | $t = 0.04$ | .97 |
| Backward digit span | 3.7 | 2.06 | 2.3 | 0.50 | $t = 1.36$ | .21 |
| TMT-B | 207.0 | 145.48 | 220.3 | 153.58 | $t = –0.13$ | .90 |
| Phonological fluency | 9.5 | 5.64 | 8.4 | 7.23 | $t = 0.33$ | .75 |
| WCST categories | 3.7 | 2.34 | 3.0 | 1.98 | $U = 6.00$ | .55 |
| IFS | 14.4 | 9.13 | 11.0 | 9.35 | $t = 0.67$ | .52 |

No significant differences were found on any of the variables assessed. CDR = Clinical Dementia Rating Scale (TS- Transformed Score, SOB- Sum of Boxes); MMSE = Mini Mental State Examination; ACE-R = Addenbrooke's Cognitive Examination – Revised; RAVLT = Rey Auditory Verbal Learning Test; ROCF = Rey-Osterrich Complex Figure; TMT = Trail Making Test (Parts –A and –B); WCST = Wisconsin Card Sorting Test; IFS = INECO Frontal Screening.

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

dementia severity (as assessed with the CDR transformed score and sum of boxes). Similarly, the performance of the groups did not differ significantly on any of the tasks of the standard neuropsychological battery.

## Social cognition

As shown in Table 2, no significant differences were found between the YES and NO patients on moral knowledge, the Faux Pas Test, decision-making or different aspects of empathy. Nonetheless, patients who would push the man onto the train tracks showed significantly lower scores on the MIE task ($U = 9.00$, $p = .02$) than bvFTD patients who would not push the stranger off the bridge, revealing that impaired affective ToM may be related to the different answers following personal moral judgment. MIE scores correlated significantly with Faux Pas scores ($r = .61$, $p = .01$). Nonetheless, no significant correlations were found between the MIE and the IGT (block 5: $r = .11$, $p = .69$), the MBI total score ($r = –.06$, $p = 86$), or the various subdomains of the IRI (PT: $r = –.17$, $p = .64$; F: $r = –.38$, $p = .35$; EC: $r = –.11$, $p = .78$; PD: $r = –.30$, $p = .43$).

# DISCUSSION

In the present study, we compared the clinical, demographic, neuropsychological, and social cognition profile of bvFTD patients based on their response to a classical personal moral dilemma. Our investigation raises a number of provocative findings, both negative and positive. Out of 22 patients with early bvFTD,

**TABLE 2**
Social cognition battery test scores

| | | | *NO (n = 13)* | | *YES (n = 9)* | | *NO vs. YES* | |
|---|---|---|---|---|---|---|---|---|
| *Social cognition domain* | *Task* | | *Mean* | *SD* | *Mean* | *SD* | *Test* | *p* |
| Moral behavior | MBI | | 73.50 | 13.90 | 63.40 | 17.80 | $t = 1.06$ | .32 |
| Theory of Mind | MIE | | 14.00 | 4.38 | 9.67 | 2.94 | $U = 9.00$ | .02 |
| | Faux pas | | 14.25 | 2.82 | 13.80 | 4.38 | $U = 19.5$ | .94 |
| Affective decision-making | IGT | 1–20 | –0.33 | 3.45 | –3.20 | 4.38 | $t = 1.22$ | .25 |
| | | 21–40 | –0.33 | 4.08 | –1.40 | 3.84 | $t = 0.44$ | .67 |
| | | 41–60 | –3.00 | 6.03 | –2.00 | 4.47 | $t = –0.31$ | .77 |
| | | 61–80 | –5.00 | 7.98 | 1.60 | 10.70 | $t = –1.17$ | .27 |
| | | 81–100 | –3.00 | 7.16 | 2.80 | 11.50 | $t = –1.03$ | .33 |
| Empathy | IRI total | | 49.30 | 8.62 | 58.60 | 6.22 | $t = –1.78$ | .13 |
| | PT | | 11.70 | 8.38 | 17.60 | 2.41 | $t = –1.38$ | .39 |
| | F | | 6.00 | 7.21 | 10.40 | 4.16 | $t = –1.12$ | .31 |
| | EC | | 18.30 | 12.10 | 21.20 | 3.35 | $t = –0.52$ | .62 |
| | PD | | 13.30 | 9.87 | 9.40 | 6.23 | $t = 0.71$ | .51 |

A significant difference was found between those patients who would push the man onto the tracks (YES) and those who would not (NO) on the affective theory of mind task. ToM = Theory of Mind; MBI = Moral Behavior Inventory; MIE = Mind in the Eyes; IGT = Iowa Gambling Task; IRI = Interpersonal Reactivity Inventory; PT = Perspective Taking; F = Fantasy; EC = Empathic Concern; PD = Personal Distress.

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

nine decided they would push an innocent man off a footbridge, thus murdering him, in order to save the lives of five working men who would otherwise have been killed by an approaching train. Our results showed that, relative to bvFTD patients who replied negatively, patients who responded affirmatively to the question had significantly lower scores on a task of ToM—the MIE task. Our results also showed important negative findings including the fact that no other significant differences were found between the groups regarding moral knowledge, empathy, and decision-making.

The use of personal dilemmas in studying moral judgment has been extremely fruitful in identifying the prefrontal nature of moral behavior (Anderson et al., 2002; Ciaramelli et al., 2007; Moll et al., 2002) and the way impaired dilemmatic judgment can be related to social disturbances in bvFTD (Mendez et al., 2005; Mendez & Shapira, 2009). The footbridge story is particularly useful as a personal moral dilemma because it features the essential components proposed by Greene et al. (2001) needed for a moral violation to be emotionally driven, rather than "reasoned" (impersonal). The proportion of bvFTD patients in our study who would push the man off a footbridge (41%) was similar to the proportions reported by other authors (57%–58%) using similar patient populations (Mendez et al., 2005; Mendez & Shapira, 2009). This finding in and of itself is interesting, as it may raise questions concerning the universality of moral judgments—an issue that has captured increasing attention in recent years (see Hauser, 2006).

The identification of impaired personal moral judgment in bvFTD patients with spared knowledge of right from wrong has been investigated in relation to the response patterns of healthy controls and patients with AD (Mendez et al., 2005; Mendez & Shapira, 2009). But exploring what makes bvFTD patients respond differently to a moral dilemma can also help elucidate part of the complex nature of morality in human beings. This idea became the rationale for the present study, as we sought to understand which factors accounted for the different responses to a personal moral dilemma.

Clinical and demographic variables were assessed in order to ensure that the differences in responses were not the result of distinct patient profiles or varying disease characteristics. Patients who would and who would not push the man off the footbridge were comparable in terms of age, gender, years of education, age at onset, and severity of dementia. It was also important to determine whether cognitive performance differences could account for an affirmative or a negative answer to the moral dilemma, especially executive functions such as inhibitory control, which could have a direct impact on the choice of action. We found no significant differences between the groups on screening tests of general cognitive functioning, nor on classical and widely used tests of memory, language, attention, or executive functions. Specifically to inhibitory control, we found no significant differences on the tasks of the INECO Frontal Screening (IFS; Torralva et al., 2009) measuring this cognitive process, which include both verbal (Hayling Test) and

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

motor (go/no go) tasks. This finding was essential because it revealed that the nature of the response could not be the result of differences between the groups in their capacity to understand the dilemma (language comprehension), focus on the task (attention), maintain information online, and follow the sequence of events (executive functions) or inhibit impulsive answers (inhibitory control), or even differences in their overall cognitive status. While this does not imply that the groups were not impaired on these domains (e.g., relative to normative data), it reveals that performance on standard neuropsychological tests *per se* cannot explain the differences in personal moral judgment.

Mendez's (2006) proposed mechanisms that could explain impaired moral judgment in bvFTD patients such as moral agnosia, altered empathy, somatic marker disturbances, and abnormal ToM, were considered in this study in trying to understand what would make bvFTD patients push the man in the moral situation off the footbridge. For that reason, we assessed bvFTD patients with tests that have been previously shown to tackle these processes.

The Moral Behavior Inventory (Mendez et al., 2005) provides a measure of moral knowledge. We hypothesized that since this mechanism was shown to be preserved in bvFTD patients relative to both controls and AD patients (Mendez et al., 2005; Mendez & Shapira, 2009), significant differences should not be found between the YES and NO groups either. Our findings confirmed this hypothesis, revealing that moral knowledge was comparable across groups, so knowing right from wrong could not explain the act of pushing the man off the footbridge. Moreover, as previously stated by Mendez (2006), many early bvFTD patients may know right from wrong and understand the nature of their acts.

In order to assess empathy, which refers to "the processes enabling the use by the observer of information about the internal state of the observed" (Blair & Blair, 2009), we administered the IRI scale, as it presents four subscores that provide information on both cognitive (fantasy and perspective-taking) and emotional (empathic concern and personal distress) empathy. Lack of empathy is characteristic of some bvFTD patients, especially if they exhibit right hemisphere involvement predominantly (Perry et al., 2001). In the present study, we did not find significant differences in the cognitive or emotional empathy of patients who would and who would not push the man onto the tracks. Whether empathy disturbances relative to controls account for the higher frequency of affirmative answers to the moral judgment in bvFTD patients is still a matter of controversy, and more studies are needed to determine the relationship between these variables. Yet, as highlighted by Mendez (2006), loss of moral behavior in bvFTD is more general than a mere loss of empathy, and should disturbances in empathy exist, they would not account for sociopathic acts that do not involve other people.

The proposal of an abnormal somatic marker explaining altered morality in bvFTD implies the impairment of a process otherwise experienced by all healthy individuals by which physiological reactions to previously learned situations reactivate in response to novel scenarios mimicking such prior instances (Damasio, 1994). The somatic marker hypothesis is inevitably associated with affective decision-making, which has been shown to depend strongly on different areas within the PFC (Manes et al., 2002). It has been well established by now that decision-making is markedly impaired in bvFTD. Our group has shown that this impairment may exist beyond normal performance on classical neuropsychological tests (Torralva et al., 2009), and that it may be distinguished from impairments in aspects of social cognition (Torralva et al., 2007). In the present study, performance on the Iowa Gambling Task, one of the most widely used tasks in the assessment of decision-making (Bechara et al., 1994) did not differ significantly between the bvFTD groups.

ToM refers to the ability to infer the mental states of others, including intentions and feelings, and is essential for healthy social interactions (Stone et al., 1998). ToM deficits have been described in patients with bvFTD (Gregory et al., 2002; Snowden et al., 2003; Torralva et al., 2007, 2009) and shown to be distinct from executive impairment (Lough, Gregory, & Hodges, 2001) and decision-making deficits (Torralva et al., 2007). While no significant differences were found on the total score of the Faux Pas Test, patients who would push the man off the footbridge were more significantly impaired on the MIE task. These results reveal that ToM may account for impaired moral dilemmatic judgment, thus contributing to the different responses (to push or not to push) observed between bvFTD patients in this study. A very likely explanation as to why we found significant differences on the MIE but not on the Faux Pas Test lies in the subcomponents of ToM. It is currently accepted that ToM is a complex domain which may be further dissected into affective and cognitive components. The MIE test (Baron-Cohen et al., 2001) is thought to be a measure of affective ToM because patients must infer another person's emotional states or feelings. The Faux Pas (Stone et al., 1998), on the contrary, asks the patient to be able to identify the beliefs, intentions, and thoughts of another person in order to

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

determine whether they committed a social faux pas, therefore demanding cognitive ToM on top of its affective components. For this reason, in considering the selective PFC involvement of patients in the early stages of bvFTD, our findings are in line with reports of patients with ventromedial PFC damage who exhibit specific impairments on affective—but not cognitive—ToM (Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005) and reports on bvFTD patients revealing impaired ToM on a cartoon test but not on a story-based task (Lough et al., 2006). It is clear that future studies will have to dissect the cognitive and affective components of this task in order to thoroughly analyze the way ToM may account for impaired moral judgment. Also important will be the assessment of emotional processing in bvFTD patients, which is known to be affected (for review, see Kipps et al., 2008). Because the stimuli of the MIE necessarily involve emotional processing, examining performance on an emotion recognition task would allow the influence of each of these processes on moral dilemmatic judgment to be dissected.

Correlation analyses of ToM scores with other social cognition variables revealed interesting results. First, the MIE and the Faux Pas Test correlated significantly, showing that the two tasks may be measuring a similar domain. This is an important finding, as it supports the idea that while both tasks measure ToM, it is a particular subcomponent (in this case, affective ToM) that explains the different responses to a personal moral dilemma. In fact, this correlation was only moderate, which further suggests that the tasks are not measuring exactly the same aspects of ToM, in accordance with the cognitive vs. affective dissection of its components. Affective ToM scores (MIE) did not correlate significantly with measures of moral knowledge, decision-making, or empathy, demonstrating that ToM impairment may be dissociated from other aspects of social cognition. Again, future studies using larger sample sizes and dissecting other subcomponents of each of these domains are needed to verify or reject this possibility, but the result seems to be in agreement with previous reports showing similar dissociations of variables in bvFTD patients (Torralva et al., 2007).

Overall, we have demonstrated that bvFTD patients who responded affirmatively to the classical personal/emotionally driven moral dilemma included in this study showed significantly lower performance on a task of affective ToM relative to bvFTD patients who gave a negative response to the dilemmatic judgment. No other significant differences were observed between the groups. In exploring the relationship between affective ToM and moral judgment, we can identify at least two levels of convergence and interaction. At the anatomical level, both functions appear to require the integrity of, at least, the ventromedial prefrontal region. This has been recognized as the area in which affective and cognitive processes are integrated (see Shamay-Tsoory, 2009 for a discussion on this topic), and may thus serve as the substrate for affective ToM, moral judgment, and their interactions. The ventromedial prefrontal region links these cognitive domains together, and therefore when it is subjected to lesions, different clinical symptoms occur, including alterations of moral judgment and social cognition. Also, relations between these two processes can be drawn at the functional level. For instance, when we exercise moral judgments about an agent's behavior based on beliefs that we infer about that agent's feelings or intentions, ToM is serving as an input for moral judgment (Knobe, 2005; Young, Cushman, Hauser, & Saxe, 2007). For this reason, the decreased ability to infer another person's feelings (as evidenced by lower affective ToM scores in bvFTD patients who would push the man off the footbridge) most likely mediates some of the subprocesses involved in moral judgment. Whether this influence is direct or whether it is mediated by other cognitive processes, such as empathy, will require future studies in which variables such as cognitive and affective empathy are measured not only through self-administered questionnaires, but also through caregiver reports, behavioral paradigms, brain activity, and autonomic/peripheral markers. Obtaining data beyond self-reports is crucial because questionnaires such as the IRI do not seem to correlate with specific neural sources (e.g., Akitsuki & Decety, 2009; Cheng et al., 2007; Jackson, Brunet, Meltzoff, & Decety, 2006). This is also a critical point worthy of further investigation, especially because labeling behavioral effects observed in various paradigms differently in order to explain the same cognitive networks and processes will lead to misunderstandings in the field.

Logically, these findings must be interpreted in the context of certain other methodological limitations. First, the sample size in the study allows only for partial generalization, and future studies should try to replicate these results using larger sample sizes. Yet the strict inclusion criteria for this study and the control for sociodemographic and clinical variables between the groups strengthen our results. Second, these findings must be also replicated with the use of other personal moral dilemmas so as to confirm the generalization of the effect. Also, the inclusion of behavioral and neuropsychiatric variables such as measures of impulsivity, irritability, and apathy may further contribute to understanding the differential

responses to dilemmatic judgments. As pointed out earlier, dissecting a complex domain such as ToM or empathy into its subcomponents will be essential to capture the disturbances in social cognition and the way they impact on moral judgment. Carrying out similar analyses in other neurodegenerative and neuropsychiatric disorders, as well as control subjects, will also be important to determine the specificity of the phenomenon. In this study, a control group was not included because the number of healthy subjects in our volunteer pool of participants who responded affirmatively to the moral dilemma was close to null. It must be pointed out that in most studies of moral judgment in normal volunteers, there is a minority that would indeed push the stranger off the footbridge to save the group of men. It is likely that this minority's decision results from (a) cognitive processes, because they have been shown to selectively interfere with utilitarian judgment (Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008), and (b) emotional/social cognition traits, as healthy volunteers who show a literal exercise of utilitarianism show decreased empathy scores (unpublished data from our group).

Apart from these limitations, we have demonstrated that the group of bvFTD patients who would push the man off the footbridge was significantly more impaired on ToM. This finding reveals the importance of including tasks of affective ToM and moral behavior in the assessment bvFTD patients.

Manuscript received 6 January 2010
Manuscript accepted 25 June 2010
First published online day/month/year

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010

## REFERENCES

Akitsuki, Y., & Decety, J. (2009). Social context and perceived agency affects empathy for pain: An event-related fMRI investigation. *NeuroImage*, *47*(2), 722–734.

Anderson, S. W., Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (2002). Impairment of social and moral behavior related to early damage in human prefrontal cortex. *Nature Neuroscience*, 2, 1032–1037.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" Test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *42*(2), 241–251.

Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition*, *50*(1–3), 7–15.

Blair, R., & Blair, K. (2009). Empathy, morality, and social convention: Evidence from the study of psychopathy and other psychiatric disorders. In J. Decety & W. Ickes (Eds.), *The Social Neuroscience of Empathy* (pp. 139–152). Cambridge, MA: MIT Press.

Bozeat, S., Gregory, C. A., Ralph, M. A., & Hodges, J. R. (2000). Which neuropsychiatric and behavioural features distinguish frontal and temporal variants of frontotemporal dementia from Alzheimer's disease? *Journal of Neurology, Neurosurgery, and Psychiatry*, *69*(2), 178–186.

Cheng, Y., Lin, C. P., Liu, H. L., Hsu, Y. Y., Lim, K. E., Hung, D., et al. (2007). Expertise modulates the perception of pain in others. *Current Biology*, *17*(19), 1708–1713.

Ciaramelli, E., Muccioli, M., Ladavas, E., & di Pellegrino, G. (2007). Selective deficit in personal moral judgment following damage to ventromedial prefrontal cortex. *Social, Cognitive, and Affective Neuroscience*, *2*(2), 84–92.

Damasio, A. R. (1994). *Descartes' error: Emotion, rationality and the human brain*. New York: Putnam.

Davies, R. R., Kipps, C. M., Mitchell, J., Kril, J. J., Halliday, G. M., & Hodges, J. R. (2006). Progression in frontotemporal dementia: Identifying a benign behavioral variant by magnetic resonance imaging. *Archives of Neurology*, *63*(11), 1627–1631.

Greene, J. D., Morelli, S. A., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2008). Cognitive load selectively interferes with utilitarian moral judgment. *Cognition*, *107*(3), 1144–1154.

Greene, J. D., Nystrom, L. E., Engell, A. D., Darley, J. M., & Cohen, J. D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*(2), 389–400.

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science*, *293*(5537), 2105.

Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L., Baron-Cohen, S., et al. (2002). Theory of mind in patients with frontal variant frontotemporal dementia and Alzheimer's disease: Theoretical and practical implications. *Brain*, *125*(4), 752–764.

Hauser, M. D. (2006). *Moral minds: How nature designed our universal sense of right and wrong*. New York: Ecco.

Hodges, J. R., & Miller, B. (2001). The neuropsychology of frontal variant frontotemporal dementia and semantic dementia: Introduction to the special topic papers. *Neurocase*, *7*(2), 113.

Hughes, C. P., Berg, L., Danziger, W. L., Coben, L. A., & Martin, R. L. (1982). A new clinical scale for the staging of dementia. *British Journal of Psychiatry*, *140*, 566–572.

Jackson, P. L., Brunet, E., Meltzoff, A. N., & Decety, J. (2006). Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain. *Neuropsychologia*, *44*(5), 752–761.

Josephs, K. A. (2008). Frontotemporal dementia and related disorders: Deciphering the enigma. *Annals of Neurology*, *64*(1), 4–14.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test*. Philadelphia: Lea & Febiger.

Kipps, C. M., Davies, R. R., Mitchell, J., Kril, J. J., Halliday, G. M., & Hodges, J. R. (2007). Clinical significance of lobar atrophy in frontotemporal dementia: Application of an MRI visual rating scale. *Dementia and Geriatric Cognitive Disorders*, *23*(5), 334–342.

Kipps, C. M., Knibb, J. A., Patterson, K., & Hodges, J. R. (2008). Neuropsychology of frontotemporal dementia.

In G. Goldenberg & J. L. Miller (Eds.), *Neuropsychology and behavioral neurology* (pp. 527–548). New York: Elsevier.

Knobe, J. (2005). Theory of mind and moral cognition: Exploring the connections. *Trends in Cognitive Sciences*, *9*(8), 357–359.

Koenigs, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., & Damasio, A. (2007). Damage to the prefrontal cortex increases utilitarian moral judgements. *Nature*, *446*(7138), 908–911.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment*. New York: Oxford University Press.

Lough, S., Gregory, C., & Hodges, J. R. (2001). Dissociation of social cognition and executive function in frontal variant frontotemporal dementia. *Neurocase*, *7*(2), 123–130.

Lough, S., Kipps, C. M., Treise, C., Watson, P., Blair, J. R., & Hodges, J. R. (2006). Social reasoning, emotion and empathy in frontotemporal dementia. *Neuropsychologia*, *44*(6), 950–958.

Manes, F., Sahakian, B., Clark, L., Rogers, R., Antoun, N., Aitken, M., et al. (2002). Decision-making processes following damage to the prefrontal cortex. *Brain*, *125*(3), 624–639.

Mendez, M. (2006). What frontotemporal dementia reveals about the neurobiological basis of morality. *Medical Hypotheses*, *67*(2), 411–418.

Mendez, M. F., Anderson, E., & Shapira, J. S. (2005). An investigation of moral judgement in frontotemporal dementia. *Cognitive and Behavioral Neurology*, *18*(4), 193–197.

Mendez, M. F., & Shapira, J. S. (2009). Altered emotional morality in frontotemporal dementia. *Cognitive Neuropsychiatry*, *14*(3), 165–179.

Mendez, M. F., Shapira, J. S., McMurtray, A., Licht, E., & Miller, B. L. (2007). Accuracy of the clinical evaluation for frontotemporal dementia. *Archives of Neurology*, *64*(6), 830–835.

Mioshi, E., Dawson, K., Mitchell, J., Arnold, R., & Hodges, J. R. (2006). The Addenbrooke's Cognitive Examination Revised (ACE-R): A brief cognitive test battery for dementia screening. *International Journal of Geriatric Psychiatry*, *21*(11), 1078–1085.

Moll, J., de Oliveira-Souza, R., & Eslinger, P. J. (2003). Morals and the human brain: A working model. *NeuroReport*, *14*(3), 299–305.

Moll, J., de Oliveira-Souza, R., Eslinger, P. J., Bramati, I. E., Mourao-Miranda, J., Andreiuolo, P. A., et al. (2002). The neural correlates of moral sensitivity: A functional magnetic resonance imaging investigation of basic and moral emotions. *Journal of Neuroscience*, *22*(7), 2730–2736.

Neary, D., Snowden, J. S., Gustafson, L., Passant, U., Stuss, D., Black, S., et al. (1998). Frontotemporal lobar degeneration: A consensus on clinical diagnostic criteria. *Neurology*, *51*(6), 1546–1554.

Nelson, H. E. (1976). A modified card sorting test sensitive to frontal lobe defects. *Cortex*, *12*(4), 313–324.

Partington, J. E., & Leiter, R. (1949). Partington's Pathway Test. *Psychological Service Center Bulletin*, *1*, 9–20.

Perry, R. J., Rosen, H. R., Kramer, J. H., Beer, J. S., Levenson, R. L., & Miller, B. L. (2001). Hemispheric dominance for emotions, empathy and social behaviour: Evidence from right and left handers with frontotemporal dementia. *Neurocase*, *7*(2), 145–160.

Rascovsky, K., Salmon, D. P., Lipton, A. M., Leverenz, J. B., DeCarli, C., Jagust, W. J., et al. (2005). Rate of progression differs in frontotemporal dementia and Alzheimer disease. *Neurology*, *65*(3), 397–403.

Rey, A. (1941). L'examen physiologique dans le cas d'encephalopathie traumatique. *Archives de Psychologie*, *28*, 286–340.

Shamay-Tsoory, S. G., Tomer, R., Berger, B. D., Goldsher, D., & Aharon-Peretz, J. (2005). Impaired "affective theory of mind" is associated with right ventromedial prefrontal damage. *Cognitive and Behavioral Neurology*, *18*(1), 55–67.

Shamay-Tsoory, S. G. (2009). Empathic processing: Its cognitive and affective dimensions and neuroanatomical basis. In J. Decety & W. Ickes (Eds.), *The social neuroscience of empathy* (pp. 215–232). Cambridge, MA: MIT Press.

Snowden, J. S., Gibbons, Z. C., Blackshaw, A., Doubleday, E., Thompson, J., Craufurd, D., et al. (2003). Social cognition in frontotemporal dementia and Huntington's disease. *Neuropsychologia*, *41*(6), 688–701.

Spreen, O., & Benton, A. L. (1977). *Neurosensory center comprehensive examination for aphasia* (revised ed.). Victoria, Canada: University of Victoria.

Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience*, *10*(5), 640–656.

Thomson, J. J., & Parent, W. (1986). *Rights, restitution, and risk: Essays in moral theory*. Cambridge, MA: Harvard University Press.

Torralva, T., Kipps, C. M., Hodges, J. R., Clark, L., Bekinschtein, T., Roca, M., et al. (2007). The relationship between affective decision-making and theory of mind in the frontal variant of fronto-temporal dementia. *Neuropsychologia*, *45*(2), 342–349.

Torralva, T., Roca, M., Gleichgerrcht, E., Bekinschtein, T., & Manes, F. (2009). A neuropsychological battery to detect specific executive and social cognitive impairments in early frontotemporal dementia. *Brain*, *132*(5), 1299–1309.

Torralva, T., Roca, M., Gleichgerrcht, E., López, P., & Manes, F. (2009). INECO Frontal Screening (IFS): A brief, sensitive, and specific tool to assess executive functions in dementia. *Journal of the International Neuropsychological Society*, *15*, 777–786.

Wechsler, D. (1981). *WAIS-R Manual: Wechsler Adult Intelligence Scale – Revised*. New York: Harcourt Brace Jovanovich.

Wilson, J. (1993). *The moral sense*. New York: Free Press.

Young, L., Cushman, F., Hauser, M., & Saxe, R. (2007). The neural basis of the interaction between theory of mind and moral judgment. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(20), 8235–8240.

Downloaded By: [Gleichgerrcht, Ezequiel] At: 14:09 12 August 2010