“Machiavellianism” and frontal dysfunction: Evidence from Parkinson’s disease

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Introduction. A number of reports have identified significant personality differences in patients with Parkinson’s disease (PD) when compared with age-matched controls. We hypothesised that these differences may be related to impairment in prefrontal inhibitory functions resulting in the expression of new “Machiavellian” personality traits.

Methods. Thirty-five patients with PD and 17 age-matched controls were assessed with a set of neuropsychologic, personality and mood tests as well as the Mach IV scale, which measures a set of “Machiavellian” personality characteristics.

Results. PD patients with elevated Machiavellian traits (“high Machs”) were selectively impaired on tests of prefrontal function relative to “low Mach” patients. In addition, while high Machs did not differ from low Machs in terms of age, educational level, Hoehn-Yahr stage, mood function, or Mini Mental State Exam score, they indicated greater willingness to affiliate with a fictional Machiavellian character and scored significantly lower on the “cooperativeness” and “self-directedness” subscales of the Cloninger Temperament and Character Inventory.

Conclusions. We suggest that (1) PD patients with frontal impairment are vulnerable to dramatic personality change, and (2) the frontal lobes are required for maintenance of prosocial personality traits.

INTRODUCTION

Studies of personality in Parkinson’s disease (PD) suggest that PD patients are less talkative, less flexible, more socially dominant and conformist, suspicious, and cautious compared with age-matched healthy controls as well as controls with other chronic diseases (Eatough, Kempster, Stern, & Lees, 1990; Hubble & Koller, 1995; McNamara, Durso, & Brown, 2003; Menza, Sage, Marshall, Cody, & Duvoisin, 1990; Poewe, Gerstenbrand,
Ransmayr, & Plorer, 1983). There is some evidence that this personality profile may actually precede onset of PD signs and symptoms and thus might be predictive of PD (Hubble & Koller, 1995; Poewe et al., 1983), though the claim remains controversial (Glosser et al., 1995; Poewe, Karamat, Kemmler, & Gerstenbrand, 1990).

In studies using Cloninger et al.'s tridimensional personality questionnaire or its more recent variant, the Temperament and Character Inventory (TCI; Cloninger, Svrakic, & Przybeck, 1993), patients with Parkinson's disease show less "novelty-seeking" activity, greater "harm-avoidance" behaviour, and less consistency in performance on "reward dependence" tasks than controls (Fujii, Harada, Ohkoshi, Hayashi, & Yoshizawa, 2000; Menza, Golbe, Cody, & Forman, 1993; Menza et al., 1990). It has been suggested that the reduction in novelty seeking, elevation in harm avoidance, and inconsistent findings on reward dependence might all be related to the damage of nigrostriatal and mesocortical dopaminergic systems as well as the resultant frontal dysfunction that occurs in association with the disorder.

In a recent study of personality and self-concept in patients with PD, we (McNamara et al., 2003) found a link between personality change and frontal dysfunction in PD patients. We asked PD patients to respond to the stem-completion task of Loevinger, Wessler, and Redmore (1970). In this task, subjects are asked to describe themselves by completing sentence stems such as "I am . . ." or, "I believe . . .", etc. Based on studies of these stem completions with hundreds of individuals (both children and adults), Loevinger et al. described several categories or stages of typical responding and, by inference, ego development. The stages progressed from simplistic, dependent, and narrowly egocentric views of self and world to "integrated", autonomous, complex, and other-oriented descriptions of self-concept. In our study using these Loevinger et al. materials, we noticed that some patients exhibited a shift towards socially conformist, opportunistic, and suspicious responses. Most of these patients were also impaired on tests of executive cognitive function, thus linking the personality change to frontal dysfunction. On the stem completion task these patients clustered into Loevinger et al.'s early and mid-stages of ego development. Individuals in these mid-level stages of ego development are said to be suspicious, self-protective, and opportunistic. They are preoccupied with getting others to behave in ways that they prefer or approve of. They are socially conformist but interpersonally aggressive and manipulative.

Some of these latter personality traits are characteristic of an interesting behavioural strategy known as "Machiavellianism". We therefore decided to more directly examine Machiavellian personality strategies in PD.

People scoring high on an inventory of Machiavellianism ("high Machs"; Christie & Geis, 1970) are characterised by a propensity for interpersonal manipulation and cynicism with respect to views about human nature (Fehr,
Samsom, & Paulhus, 1992; McHoskey, Worzel, & Szyarto, 1998). High Machs can also be charming, good leaders, and aggressive and successful salespeople. We are interested here, however, in negative associations of Machiavellianism as they might help us understand negative personality profiles in PD. Negative personality traits in both high Machs and in PD patients have been associated with a range of neuropsychiatric problems including lack of interpersonal empathy (Gurtman, 1992; Wiggins & Broughton, 1985), egocentricity or narcissism (Ickes, Reidhead, & Patterson, 1986; McHoskey, 1995), schizotypal spectrum disorder and psychopathy (McHoskey et al., 1998), and high levels of social anxiety (Christoffersen & Stamp, 1995; Fehr et al., 1992).

To our knowledge, no studies have yet examined Machiavellianism in patients with PD—despite the high incidence of neuropsychiatric problems in PD (Starkstein & Merello, 2002). Given our recent findings (McNamara et al., 2003) that some patients with PD and frontal dysfunction exhibit a shift towards socially conformist, opportunistic and suspicious personality dispositions we hypothesised that (1) some proportion of PD patients would exhibit high Mach scores, and (2) that these high Mach PD patients would also evidence significant frontal lobe dysfunction. This second hypothesis was motivated by several considerations: (1) Some PD patients perform poorly on tests that are traditionally understood to tap prefrontal functions (Starkstein & Merello, 2002); (2) prefrontal impairment can be associated with changes in personality—specifically an increase in socially inappropriate behaviours (Berlin, Rolls, & Iversen, 2005); and (3), as mentioned above in our previous study (McNamara et al., 2003), we found a significant correlation between the shift in sense of self and performance on executive function neuropsychologic tests.

Our overall strategy was first, to get some picture of the level of Machiavellianism in PD patients relative to age-matched control participants without neurologic disease. We expected greater variability of Mach levels among PD patients relative to controls but no absolute differences between the two groups. As is common in studies of Mach personality strategies, we then planned to compare “high Mach” individuals to “low Mach” individuals within the target (PD) group itself in order to identify clinical characteristics of those patients who may be vulnerable to dramatic personality change as the disease progresses.

METHOD

Participants

Thirty-five patients with PD (34 males, 1 female) were recruited from the outpatient Movement Disorders Clinic at the VA Boston Healthcare System,
Boston, MA. Patients were individually diagnosed by Dr Raymon Durso, director of the clinic. All were right-handed. One patient was at Hoehn-Yahr (H-Y) Stage I, 14 at Stage II, 17 at Stage III, and 3 at Stage IV. Mean H-Y stage score for the entire group was 2.6 (standard deviation = 0.69). None of the patients were demented according to clinical examinations and DSM-III criteria. All were on some form of dopaminergic medication and were tested while on medications with optimal effects (i.e., motor signs were well controlled). Patients with a history of substance abuse or head injury were excluded.

Seventeen age-matched control subjects (seven female) were also recruited from the VA community. All of these control participants had some form of chronic disease, with the majority reporting low back chronic pain syndromes.

While the two groups did not differ significantly in terms of age, PD mean 70.4 (11.1), controls mean 65.6 (7.5), p = .11, the age-matched controls reported higher levels of education, PD mean 13.3 (2.7) years, controls mean 15.2 (2.0), p = .01. Mean Mini Mental State Exam (MMSE) score was 26.1 (2.5) for PD patients and 27.8 (1.5) for controls (p < .001). Patients with PD were also more stressed, more anxious and more depressed than controls (all p-values < .05; see Table 1). Demographic and neuropsychologic characteristics of the two groups are summarised in Table 1.

### TABLE 1
Demographic and neuropsychological variables on PD subjects and controls

<table>
<thead>
<tr>
<th></th>
<th>PDs (SD)</th>
<th>Controls (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>70.4 (11.1)</td>
<td>65.6 (7.5)</td>
<td>.11</td>
</tr>
<tr>
<td>Education (years)</td>
<td>13.3 (2.7)</td>
<td>15.2 (2.0)</td>
<td>.01**</td>
</tr>
<tr>
<td>H-Y stage</td>
<td>2.6 (0.69)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Stress</td>
<td>6.0 (4.6)</td>
<td>2.2 (1.9)</td>
<td>.002**</td>
</tr>
<tr>
<td>Anxiety</td>
<td>5.6 (4.2)</td>
<td>1.5 (1.5)</td>
<td>.001**</td>
</tr>
<tr>
<td>Depression</td>
<td>4.9 (4.6)</td>
<td>1.9 (2.5)</td>
<td>.003**</td>
</tr>
<tr>
<td>MMSE</td>
<td>26.1 (2.5)</td>
<td>27.8 (1.5)</td>
<td>.02*</td>
</tr>
<tr>
<td>Stroop interference</td>
<td>65.7 (40.1)</td>
<td>38.1 (22.6)</td>
<td>.004**  (Mann-Whitney U)</td>
</tr>
<tr>
<td>FAS letter fluency</td>
<td>28.1 (12.3)</td>
<td>43.6 (11.7)</td>
<td>.0001** (Mann-Whitney U)</td>
</tr>
<tr>
<td>Category fluency (animals)</td>
<td>13.4 (4.3)</td>
<td>18.2 (5.5)</td>
<td>.008**  (Mann-Whitney U)</td>
</tr>
<tr>
<td>Alternating fluency</td>
<td>9.5 (4.4)</td>
<td>13.8 (2.8)</td>
<td>.0001** (Mann-Whitney U)</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01.

PDs = Parkinson’s disease patients; SD = standard deviation; H-Y stage = Hoehn-Yahr (higher score indicates greater disease severity); MMSE = Mini Mental Status Exam; fluency = number of words produced in letter, category, and alternating conditions.

Stroop interference time = total time (s) taken to read through the interference card of the Stroop test; higher scores indicate greater impairment.
Measures

Mood tests. We assessed depression, stress, and anxiety with the Depression Anxiety and Stress Scale (DASS) developed by Lovibond and Lovibond (1995). Antony, Bieling, Cox, Enns, and Swinson (1998) and Crawford and Henry (2003) have reported excellent reliability, validity, and other psychometric properties for the three subscales of the DASS. The test includes 21 questions, 7 in each of the depression, anxiety, and stress subscales.

Mach IV scale. We used the Mach IV scale (Christie & Geis, 1970) to assess Machiavellianism in participants. This is a self-report Likert-type scale, with scores ranging from 1 to 7 (where 1 = “I totally disagree”, 4 = “no opinion”, and 7 = “I totally agree”), composed of 20 items, each consisting of a statement with which the respondent is to indicate his or her level of agreement. The 20 statements of the Mach IV scale are traditionally classified into three subscales: (1) nine items concerning opinions about human nature, i.e., “Most people are basically good and kind” (“views”); (2) nine items describing manipulative or duplicity tactics, i.e., “It is wise to flatter important people” (“tactics”); and (3) two items concerning themes of abstract morality, i.e., “All in all, it is better to be humble and honest than important and dishonest” (“morality”). The total Mach score sums these three subscales. Recent factor analytic studies of the Mach IV (Corral & Calvete, 2000), however, have revealed that the psychometric structure of the questionnaire yields four dimensions: two orthogonal (positive and negative) views of human nature and two dimensions (positive and negative) of interpersonal tactics. We therefore present our results in terms of these four dimensions.

The Temperament and Character Inventory (TCI). The TCI (Cloninger et al., 1993) was based on the Cloninger Personality Inventory, sometimes called the Tri-dimensional Personality Questionnaire or TPQ (Cloninger, 1987). The original TPQ yielded three basic personality dimensions that have been reliably linked to dopaminergic and serotonergic neurochemical behavioural systems and behavioural responding. These were called “novelty seeking”, “harm avoidance”, and “reward dependence”. In the TCI, these three basic personality dimensions are still assessed. In addition, the TCI also yields character scale scores on “persistence”, self-directiveness”, “cooperativeness”, and “self-transcendence”. The TPQ and TCI scales have been used in hundreds of studies of clinical populations (see Starkstein & Merello, 2002, for a review of such studies with PD patients).

Machiavellianism is essentially a noncooperative, exploitative, and interpersonally manipulative personality strategy (Wilson, Near, & Miller, 1998) and thus we predicted that, in addition to the above reviewed changes on harm avoidance, novelty seeking, and reward dependence, PD patients with
high Mach scores would score significantly lower than their low Mach counterparts on the cooperative character scale of the TCI.

**Procedures for assessment of personality changes.** The two personality questionnaires (the Mach IV and the TCI) and the DASS mood scales were mailed to the participant in advance of their scheduled test session so that all personality questionnaires were completed at home. When the participant arrived at the scheduled test session, they were given the neuropsychologic tests and the following experiment in order to assess the participant’s willingness to associate with a high Mach-type person. Results from this experiment would allow us to test the extent to which participants felt that a high Mach person was undesirable, antisocial, or exploitative.

Participants were instructed to listen to 20 statements about a man named Tom to get a feel for what type of person Tom was. There were 10 statements that list things Tom believes and 10 statements about things he does not believe. All of these statements were taken directly from the Mach IV questionnaire, i.e., “Tom believes that the best way to handle people is to tell them what they want to hear” or “Tom does not believe that honesty is the best policy in all cases.” After participants heard the statements about Tom, they were asked seven questions about how willing or unwilling they would be to engage in social interactions with Tom. Here we used Wilson et al.’s (1998) six social situations. We used a 7-point Likert scale (−3 = very unwilling, 0 = indifferent, 3 = very willing) with 0 as the indifferent anchor point. The social situations were: (1) partner in a small business, (2) sharing an apartment, (3) confidante (someone with whom to share problems and secrets), (4) member of your debating team, (5) employer (someone who directly supervises your work), and (6) someone to whom you would loan money.

After participants answered these questions, they were then presented with a list of 26 character traits that might be advantages (13 traits) or disadvantages (13 traits) when associating with Tom, the high Mach person in a social situation. Here again, we followed Wilson et al. (1998) in the list of advantages and disadvantages in associating with a high Mach person. We tallied the total number of advantages and disadvantages each participant checked off when considering associating with Tom.

The above procedure would allow us to test the extent to which PD patients considered a high Mach’s behaviour as inappropriate. If the patient was aware of the inappropriateness of the behaviour, then he would presumably indicate an unwillingness to affiliate with Tom. We assumed that the patients’ willingness to affiliate with Tom would also depend on whether the patient was classified as a high or a low Mach.

It is standard in the literature on Machiavellianism to divide individuals into high or low Machs based on their total scores on the Mach IV. We used the median split procedure to do so for purposes of our analyses. The
median Mach IV score we obtained among our PD patients was 64. Using Christie and Geis's (1970) original procedure of adding 20 points to each participant’s score, this would yield a PD group median score of 84. Our PD group median, therefore, is comparable to median and mean total scores obtained by other groups (e.g., see McHoskey, 1995; McHoskey et al., 1998; Wilson et al., 1998). We do not use Christie and Geis’s scoring procedure in this paper, but, to compare our scores to theirs, simply add 20 points to each of our reported means (see Tables 2–5).

**Neuropsychologic “frontal” measures**

**Stroop colour-word interference procedure.** This test requires the subject to name the colour of the ink or to name the word of a colour-word that is printed. The task involves four test cards: The first contains rows of coloured rectangles with the task being to name the colours as quickly as possible; the second contains rows of colour words (printed in black ink) with the task being to read the words as quickly as possible; the third “interference” test card consists of rows of colour words printed in ink colours incongruent with the word represented, with the task being to name the ink colours as quickly as possible; and the fourth card is the “switching card” where subjects are prompted to either name the colour of the ink or to read the word, depending on whether the item is in a box or not. For both the interference card and some of the switching card, the subject must ignore the word and name the colour. In this paper, we focus on the score derived from the fourth or “switching” task. Susceptibility to cognitive interference is calculated as the total time taken to name the colours and read the words. PET studies show that orbitofrontal cortex is activated in healthy subjects during the interference condition (Bench et al., 1993).

**Verbal fluency.** In this task, participants are asked to generate words to a stimulus and have 1 minute to produce as many words as they can. The stimuli are letters and then categories. The three letters are F, A, and S. The category stimulus was “animals”. In the alternating condition, subjects are asked to alternate between letter and category generation. For each fluency test, the number of correct words (i.e., total words minus repetitions and proper names), and number of correct alternations per minute are tallied. For our three verbal fluency outcome measures, we took the mean number words per minute averaged across all three letter conditions—the one category condition and the number of alternations per minute. Numerous investigations have shown that poor performance on verbal fluency tasks is reliably associated with frontal dysfunction (Henry & Crawford, 2004).
Statistical analysis

Preliminary analysis revealed that several of the neuropsychologic measures departed from normality. Accordingly, a Mann-Whitney U test was used instead of the two-sample t-test to quantify the statistical significance of group differences, and Spearman correlation was used instead of Pearson correlation for bivariate relationships involving these variables. For all other comparisons, Bonferroni-corrected two-sample t-test was used to assess group differences and Pearson’s r for bivariate correlations. For some of the comparisons involving the Mach items, only 14 control individuals completed the tests.

We first tested for PD versus control differences and then we divided the PD group into high versus low Mach responders using the median (median = 64.0) split procedure to do so. Patients who scored above 64 on the Mach IV were considered high Machs and those scoring below were considered low Machs.

RESULTS

PD versus control differences on neuropsychologic function

Using the Mann Whitney test, the two groups differed significantly on Mini Mental State Exam (MMSE), verbal fluency measures, and Stroop interference score (Table 1), with the controls performing better than the patients on these neuropsychologic measures.

PD versus control differences on Mach IV

There were no significant differences in the mean total score on the Mach IV between the PD group, 65.0 (17.5), and the elderly control group, 62.0 (20.4), \( t(47) = -0.37, p = .73 \) (Table 2). There was a trend for the PD patients to score higher than the controls on the positive tactics subscale, PD mean = 19.4 (6.8) versus controls mean = 15.1 (8.3), \( t(47) = -1.83, p = .07 \), and none of the four differences on the subscales reached significance.

PD versus control differences on the TCI scales

PDs were significantly more likely to evidence harm avoidance than controls, \( t(50) = -2.99, p = .004 \) (Table 2). PDs were also marginally less likely to be self-directed than controls, \( t(50) = 1.99, p = .051 \).
High versus low Mach comparisons on background and neuropsychologic tests

After we split the PD group into high versus low Machs using the median split procedure described above, we found that the high Mach group contained 17 individuals and the low Mach 18. The two groups did not differ significantly (Table 3) in terms of age, education, Hoehn-Yahr disease stage, mood functions, or Mini Mental State Exam scores. The only area where the high Machs differed from the low Machs was on tests sensitive to frontal function. Specifically, high Mach patients performed more poorly on the Stroop: high Mach mean 138.7 (163.7) versus low Mach mean 57.3 (19.4), \( p < .04 \) by the Mann Whitney U test and the verbal (letter) fluency tests; high Mach mean 23.3 (12.5) versus low Mach mean 32.7 (10.5), \( p < .02 \) by the Mann Whitney U test.

High versus low Mach comparisons on Mach tests

Not surprisingly, high Machs scored significantly higher than the low Machs on both total Mach IV score and on all four subscales (Table 4). Interestingly, high Machs indicated that they were more willing to associate with “Tom” our fictitious high Mach person than were the low Machs.

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>PDs (SD)</th>
<th>Controls (SD)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCI subscales</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novelty seeking</td>
<td>17.4 (6.1)</td>
<td>15.1 (4.8)</td>
<td>.16</td>
</tr>
<tr>
<td>Harm avoidance</td>
<td>15.6 (6.0)</td>
<td>10.4 (5.4)</td>
<td>.004</td>
</tr>
<tr>
<td>Reward dependence</td>
<td>14.6 (4.4)</td>
<td>15.4 (5.0)</td>
<td>.54</td>
</tr>
<tr>
<td>Perseverance/persistence</td>
<td>5.3 (1.9)</td>
<td>4.2 (2.1)</td>
<td>.07</td>
</tr>
<tr>
<td>Self-directedness</td>
<td>31.8 (6.1)</td>
<td>36.0 (8.7)</td>
<td>.051</td>
</tr>
<tr>
<td>Cooperativeness</td>
<td>33.0 (5.2)</td>
<td>34.5 (5.7)</td>
<td>.34</td>
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<tr>
<td>Self-transcendence</td>
<td>14.1 (5.5)</td>
<td>14.5 (7.6)</td>
<td>.86</td>
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<td>Mach scales</td>
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<tr>
<td>Mach total</td>
<td>65.0 (17.5)</td>
<td>62.9 (20.4)</td>
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<td>Positive views</td>
<td>13.9 (4.4)</td>
<td>12.0 (5.6)</td>
<td>.14</td>
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<td>Cynical views</td>
<td>19.0 (6.3)</td>
<td>20.3 (6.2)</td>
<td>.52</td>
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<tr>
<td>Positive tactics</td>
<td>19.4 (6.8)</td>
<td>15.1 (8.3)</td>
<td>.07</td>
</tr>
<tr>
<td>Negative tactics</td>
<td>12.7 (4.4)</td>
<td>15.3 (5.6)</td>
<td>.08</td>
</tr>
</tbody>
</table>

**TCI** = Temperament and Character Inventory; **PDs** = Parkinson’s disease patients; **SD** = standard deviation.

Mach total score = total score on the self-administered Mach IV scale; higher score indicates greater Machiavellianism.
(Table 5). This was the case for all six social opportunities except sharing an apartment and having Tom as a confidante. It is important to note, however, that none of the high Machs indicated an enthusiasm in associating with

### TABLE 3

High versus low Machs on background and neuropsychologic variables

<table>
<thead>
<tr>
<th></th>
<th>High Mach (SD)</th>
<th>Low Mach (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>70.7 (13.0)</td>
<td>70.1 (9.3)</td>
<td>.87</td>
</tr>
<tr>
<td>Education (years)</td>
<td>12.5 (2.7)</td>
<td>13.9 (2.7)</td>
<td>.15</td>
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<td>H-Y stage</td>
<td>2.5 (0.79)</td>
<td>2.6 (0.59)</td>
<td>.74</td>
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<td>Stress</td>
<td>7.5 (5.0)</td>
<td>4.6 (3.9)</td>
<td>.06</td>
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<tr>
<td>Anxiety</td>
<td>5.8 (4.7)</td>
<td>5.3 (3.7)</td>
<td>.70</td>
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<tr>
<td>Depression</td>
<td>6.0 (5.7)</td>
<td>3.8 (2.9)</td>
<td>.16</td>
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<td>MMSE</td>
<td>25.5 (2.8)</td>
<td>26.7 (2.2)</td>
<td>.20</td>
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<tr>
<td>Stroop interference</td>
<td>138.7 (163.7)</td>
<td>57.3 (19.4)</td>
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<td>FAS letter fluency</td>
<td>23.3 (12.5)</td>
<td>32.7 (10.5)</td>
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<tr>
<td>Alternating fluency</td>
<td>8.1 (5.2)</td>
<td>10.8 (3.0)</td>
<td>.07</td>
</tr>
</tbody>
</table>

*SD = standard deviation; H-Y stage = Hoehn-Yahr stage of disease (higher scores indicate greater severity); MMSE = Mini Mental Status Exam; fluency = number of words produced in letter, category, and alternating conditions.

Stroop interference time = total time (s) taken to read through the interference card of the Stroop test; higher scores indicate greater impairment.

### TABLE 4

PD patients high versus low Machs on personality scales and Mach items

<table>
<thead>
<tr>
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<th>High (X, SD)</th>
<th>Low (X, SD)</th>
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<td>Mach scales</td>
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<tr>
<td>Mach total</td>
<td>79.0 (13.1)</td>
<td>51.9 (8.6)</td>
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<tr>
<td>Positive views</td>
<td>16.4 (3.6)</td>
<td>11.5 (3.8)</td>
<td>.0001**</td>
</tr>
<tr>
<td>Cynical views</td>
<td>23.1 (5.5)</td>
<td>15.2 (4.3)</td>
<td>.0001**</td>
</tr>
<tr>
<td>Positive tactics</td>
<td>23.9 (5.2)</td>
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<tr>
<td>Cooperativeness</td>
<td>30.5 (5.4)</td>
<td>35.3 (3.9)</td>
<td>.006**</td>
</tr>
<tr>
<td>Self-transcendence</td>
<td>15.1 (5.6)</td>
<td>13.2 (4.5)</td>
<td>.33</td>
</tr>
</tbody>
</table>

*SD = standard deviation; TCI = Temperament and Character Inventory.

Mach total score = total score on the self-administered Mach IV scale; higher score indicates greater Machiavellianism.

**p < .01.
All of their mean ratings fell below the 0 indifferent point. The high Machs were merely less adverse to Tom than were the low Machs. High Machs also were marginally more inclined to believe that advantages accrued when associating with Tom, PD mean 5.5 (4.6) versus control mean 2.9 (3.0), \( p = .057 \).

### Table 5

<table>
<thead>
<tr>
<th>Scenario</th>
<th>High Mach (SD)</th>
<th>Low Mach (SD)</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partner in business</td>
<td>−0.88 (2.1)</td>
<td>−2.4 (1.1)</td>
<td>.01**</td>
</tr>
<tr>
<td>Share apartment</td>
<td>−1.2 (2.2)</td>
<td>−1.9 (1.3)</td>
<td>.24</td>
</tr>
<tr>
<td>Confidante</td>
<td>−1.2 (2.2)</td>
<td>−1.9 (1.4)</td>
<td>.24</td>
</tr>
<tr>
<td>Member debate team</td>
<td>−1.4 (1.5)</td>
<td>−2.4 (0.87)</td>
<td>.022*</td>
</tr>
<tr>
<td>Employer</td>
<td>−0.82 (1.9)</td>
<td>−0.88 (1.8)</td>
<td>.012*</td>
</tr>
<tr>
<td>Loan money</td>
<td>−0.11 (2.0)</td>
<td>−1.9 (1.6)</td>
<td>.007**</td>
</tr>
<tr>
<td>Total advantages</td>
<td>5.5 (4.6)</td>
<td>2.9 (3.0)</td>
<td>.057</td>
</tr>
<tr>
<td>Total disadvantages</td>
<td>7.6 (3.6)</td>
<td>8.0 (2.8)</td>
<td>.69</td>
</tr>
</tbody>
</table>

\* \( p < .05 \), ** \( p < .01 \).

PDs = Parkinson’s disease patients; SD = standard deviation.

Willingness to interact with a high Mach individual was indicated on a scale of −3 (very unwilling) to 0 (indifferent) to +3 (very willing).

Tom—all of their mean ratings fell below the 0 indifferent point. The high Machs were merely less adverse to Tom than were the low Machs. High Machs also were marginally more inclined to believe that advantages accrued when associating with Tom, PD mean = 5.5 (4.6) versus control mean 2.9 (3.0), \( p = .057 \).

### High versus low Mach comparisons on TCI scales

High Machs scored significantly lower than their low Mach counterparts on the self-directiveness, PD mean 28.9 (6.0) versus control mean 34.5 (4.9), \( t(33) = −3.0, p = .005 \), and the cooperativeness scales, PD mean = 30.5 (5.4) versus control mean 35.3 (3.9), \( t(33) = −3.0, p = .006 \) (Table 4).

### DISCUSSION

To our knowledge, this is the first study to quantitatively explore the brain basis and clinical correlates of Machiavellian traits in patients with Parkinson’s disease (PD). We found that PD patients with “high Mach” classifications were also selectively impaired on tests of prefrontal function relative to “low Mach” patients. In addition, while high Machs did not differ from low Machs in terms of age, educational level, Hoehn-Yahr stage, mood function, or Mini Mental State Exam score, they indicated greater willingness to affiliate with a fictional Machiavellian character and scored significantly lower on the “cooperativeness” and “self-directedness” characters of the Cloninger Temperament and Character Inventory. We therefore
suggest that (1) PD patients with frontal impairment are vulnerable to
dramatic personality change, and (2) intact frontal functions are required for
maintenance of prosocial personality traits.

Specific cognitive-behavioural deficits that have been linked to pre-
frontal dysfunction in PD patients include poor social planning, persevera-
tion, difficulty generating novel ideas, impaired working memory, and
decreased cognitive and behavioural inhibitory control (Troster & Woods,
2003). It is this last form of frontal dysfunction, impairment in inhibitory
control, that may be particularly relevant to high Machiavellianism and
low cooperativeness (on the TCI character scale) in PD patients. It was
those patients with poor performance on the Stroop and the verbal fluency
tasks that evidenced high Machiavellianism and low cooperativeness. The
Stroop task in particular measures the ability to inhibit prepotent
responses. Decreased inhibitory control could lead to inappropriate social
behaviours as well as to a decrease in the sense of self-directedness (as
picked up by the TCI scale scores). Low cooperativeness and low self-
directedness have been associated with psychopathology in some studies
(Mulder, Joyce, Sullivan, Bulik, & Carter, 1999). An individual with
diminished self-control is to some extent at the mercy of impulses welling-
up from limbic system networks that mediate fundamental emotional
responses as well as biologic drive states. We suggest therefore that those
PD patients who develop cognitive-behavioural disinhibition (as measured
by tasks like the Stroop) will be the most vulnerable to personality change
as the disease progresses.

We also found that high Mach PD patients were more willing (or less
unwilling) to socially interact with a (clearly identified) high Mach
individual than were low Mach individuals. Again we suspect that impaired
frontal function may impair the individual's ability to make good decisions
about who to interact with socially. On the other hand, high Mach (frontally
impaired) patients did not globally endorse interactions with “Tom” our
fictitious high Mach individual. They were just as unwilling to interact with
Tom when it came to such things as sharing an apartment or trusting him as
a confidante. It may even be argued that it is beneficial to partner with an
aggressive high Mach person in business, on a debate team, and as an
employer. Perhaps the high Mach individuals are displaying here a greater
realism here than are the low Mach PD patients.

Alternatively it may be that the high Mach Parkinson patients are
more vulnerable to fall prey to the manipulative social strategies of a high
Mach person. Frontal dysfunction is known to impair insight and judgment
and a large proportion of the PD patients in this study evidenced significant
frontal dysfunction. Clearly, future research is needed here.

Our results may also carry some relevance for debates around the so-called
Machiavellian Intelligence Hypothesis (MIH; Byrne & Whiten, 1988;
According to this hypothesis, social rather than technical skills fuelled development of extraordinary levels of intelligence in the primate lineage (Chance & Mead, 1953). In order to successfully navigate the treacherous waters of the primate social world, with its shifting alliances and frequent wars, successful individuals would need to fluently read the intentions and beliefs of others and then use this information to deceive and manipulate others for one's own benefit. Benefits that accrued to those with high Mach abilities would include control of food sources and, crucially, sexual partners (Clutton-Brock & Harvey, 1976). Genes associated with high Mach abilities would therefore be passed onto the next generation. Each generation thereafter would need to adjust to the presence of high Mach individuals in the population. The best way to do so, of course, would be to out-Mach the high Mach, thus putting a premium on skills of social intelligence. Identifying consistent brain networks associated with Mach social strategies would provide some support for the Machiavellian Intelligence Hypothesis. A number of relevant social cognitive abilities appear to be mediated by networks in the frontal cortex (Adolphs, Tranel, & Damasio, 1994; Baron-Cohen, Ring, & Wheelwright, 1999; Brunet, Sarfati, Hardy-Bayle, & Decety, 2000; Fletcher et al., 1995; Gallagher et al., 2000; Goel, Grafman, Sadato, & Hallet, 1995; Tranel & Hyman, 1990). Our data on PD patients suggests that Mach traits themselves may be controlled rather than mediated by frontal networks and when these networks are impaired Mach behavioural strategies are released from inhibition. In such a case, the high Mach behavioural strategy would be construed as a facultative strategy, kept under inhibition by optimal levels of dopaminergic tone within neostriatal and prefrontal inhibitory and behavioural control networks. When PD-related dopaminergic neuronal loss reaches a critical threshold that impacts prefrontal executive control functions, antisocial, high Mach behavioural strategies may become more easily activated. The low threshold for activation may then make it more likely that the high Mach strategy would become the default social behavioural strategy in some PD patients. Thus, mesocortical dopaminergic circuits likely play a crucial role in mediating recruitment of social behavioural strategies under normal circumstances.

A role for mesocortical dopaminergic networks in control of Machiavellian behavioural strategies is supported by recent reports of relatively low Machiavellian scores in patients with schizophrenia (Mazza, de Risio, Tozzini, Roncone, & Casacchia, 2003; Sullivan & Allen, 1999). The interesting pattern described by high mesocortical dopamine/low Mach levels in schizophrenia and low mesocortical DA/high Mach levels in PD suggests that optimal levels of dopamine in prefrontal cortex are required in order to control and to inhibit the high Mach strategy.

Our study has some important shortcomings that should be kept in mind when interpreting our results. First, with respect to patient versus
control group differences, there was a strong gender bias of 34:1 in favour of males in the patient group as compared to 10:7 in the control group. To the extent that males more often endorse high Mach behavioural strategies than females then we would expect the PD group to evidence higher mach values than the control group. The main focus of our study, however, was the comparison of high versus low Mach individuals within the patient group, where there was no gender differential. A second shortcoming of the study was that we did not control for the response styles of PD patients. The rigidity of the PD personality noted above (in the Introduction), as well as the tendency for some PD patients to emit stereotyped responses to interview questions, could have increased the likelihood that PD patients would give more Mach responses than controls. Again, this methodologic concern is somewhat ameliorated by the fact that the main focus of the study was the comparison between high and low Mach individuals within the PD patient group itself. Given that the high and low Mach patient groups were matched on measures of disease severity it is unlikely that the differences in Machiavellian scores within these two PD patient groups would be due to differing levels of stereotypes in each group.

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REFERENCES


