Selective Attention and Facial Expression Recognition in Patients with Parkinson’s Disease

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Abstract

Parkinson’s disease (PD) has been associated with facial expression recognition difficulties. However, this impairment could be secondary to the one produced in other cognitive processes involved in recognition, such as selective attention. This study investigates the influence of two selective attention components (inhibition and visual search) on facial expression recognition in PD. We compared facial expression and non-emotional stimuli recognition abilities of 51 patients and 51 healthy controls, by means of an adapted Stroop task, and by “The Face in the Crowd” paradigm, which assess Inhibition and Visual Search abilities, respectively. Patients scored worse than controls in both tasks with facial expressions, but not with the other nonemotional stimuli, indicating specific emotional recognition impairment, not dependent on selective attention abilities. This should be taken into account in patients’ neuropsychological assessment given the relevance of emotional facial expression for social communication in everyday settings.

Keywords: Attention; Emotional processing; Executive function; Mild cognitive impairment; Movement disorder; Parkinson’s disease

Introduction

Parkinson’s disease (PD) is a neurodegenerative, chronic and progressive condition associated with a loss of dopaminergic neurons in the substantia nigra (pars compacta) of the basal ganglia (Hammond, Bergman, & Brown, 2007). It is predominantly characterized by motor impairments such as tremor, bradykinesia, rigidity, and postural instability (Jankovic, 2008). In addition to these motor symptoms, patients often suffer from cognitive impairments, especially those relating to visuospatial perception, memory and executive functions (Alonso-Recio, Martín, Carvajal, Ruiz, & Serrano, 2013; Barone et al., 2011; Kehagia, Barker, & Robbins, 2010). Most of this cognitive symptomatology seems to be similar to that shown by individuals with frontal lobe damage (Lezak, Howieson, & Loring, 2004).

In addition to cognitive symptoms, emotional disturbances have also been described in patients with PD. These difficulties seem to be reflected in their global mood state, increasing the risk of anxiety or depressive disorders (for a review see Chaudhuri, Healy, & Schapira, 2006; Merello, 2008); but they may also involve more specific abilities to express and recognize emotions (Ariatti, Benuzzi, & Nichelli, 2008; Dara, Monetta, & Pell, 2008; Schröder et al., 2006; Simons, Ellgring, & Pasqualini, 2003). Thus, together with general difficulties in prosodia and emotional facial expression (EFE), more specific EFE recognition disabilities have been found in PD (Gray & Tickle-Degnen, 2010; Péron, Dondaine, LeJeune, Grandjean, & Verin, 2012). Facial expressions play a very relevant role in social interaction, as an important and very common way to communicate and recognize other people’s intentions and desires (Adolphs, 2002). Hence, to establish the possible decline in these abilities in PD may be important to assess and, eventually, design specific intervention programs to prevent their communication difficulties.

Several controversial aspects to this EFE recognition disability have been identified, such as whether it concerns all the emotions or whether it is predominant in some, in particular the negative ones (Assogna et al., 2010; Beatty et al., 1989; Breitenstein,
Participants were comprised of 51 individuals (31 women) with idiopathic PD, diagnosed by neurologists on the basis of international guidelines (Hughes, Ben-Shlomo, Daniel, & Lees, 2001), and 51 healthy controls (HC; 29 women). Common exclusion criteria for PD patients and HC group were the presence of major neurological disorders, major psychiatric disorders, visual deficits, and suspected dementia or cognitive impairment (MMSE < 27; Folstein, Folstein, & Mchugh, 1975). Specific exclusion criteria for PD patients were the presence of an unclear history of chronic dopaminergic treatment responsiveness. Background data for the two groups are summarized in Table 1 where it can be observed that both groups did not significantly differ for sex, age, educational level, and general cognitive abilities, as estimated by the Spanish version of National Adult Reading Test.
and by the MMSE. However, groups showed a statistically significant difference with regard to the Spanish version of Geriatric Depression Scale, GDS-R (Izal, Montorio, Nuevo, Perez-Rojo, & Cabrera, 2010). However, neither PD patients nor HC had scores compatible with depression (GDS-R ≤ 5).

Patients were recruited from three Parkinson Associations of Madrid (Spain). Median of PD severity on the Hoehn and Yahr Scale (Hoehn & Yahr, 1967) was 2 (range 1–4). On the Clinical Impression of Severity Index for Parkinson’s Disease (CISI-PD; Martinez-Martin, Forjaz, Cubo, Frades, & de Pedro Cuesta, 2006), the PD group mean score was 9.12 out of a possible maximum of 24 (SD = 3.49). Global functional capacity and dependence corresponded to 83.72/100 (SD = 11.82) as measured by the Schwab and England scale (Schwab and England, 1969) and to 40.16/156 (SD = 29.05) on the Spanish version of Parkinson Disease Questionnaire (PDQ-39; Martinez-Martin & Frades Payo, 1998). The mean illness duration was 6.32 years (SD = 3.87). All patients were tested after being administered anti-Parkinsonian medication, distributed as follows: carbidopa/L-DOPA (45), D2 agonists (42), MAO inhibitors (26), amantadine (3), and anticolinergic agents (1). They were tested in the morning after medication had been administered (on-state).

Participants were informed of the confidential and anonymous treatment of their data and signed the informed consent. The study was completed in accordance with the Helsinki Declaration and approved by the Ethical Committee of the Universidad Autónoma de Madrid.

Experimental Tasks

Inhibition task. We created two sets of stimuli following the “Stroop effect” paradigm, one with EFE-word and one with Color-word. For the EFE-word set, 40 pictures of males and females faces (20 men) showing happy, anger, fear, disgust, or sadness (eight faces for each emotion) were selected from the FACES Database (Ebner, Riediger, & Linderberger, 2010). The hair and background was removed from all pictures, in order to eliminate insignificant or distracting information for EFE recognition. We then composed a total of 40 trials in which EFEs appeared with a superimposed emotion category name. For the eight examples of each EFE, we generated four congruent stimuli (the emotion category name corresponded to the EFE shown) and four with an incongruent superimposed name (not corresponding to the EFE shown). In these incongruent trials, EFE and superimposed name were balanced to cover all the possible combinations (see Fig. 1, example A). Participants were instructed to identify the EFE and to ignore the superimposed emotion category name. For the Color-word set we created 40 pictures with the name of a color (eight examples of each of RED, GREEN, BLUE, YELLOW, or WHITE colors) written in capital letters and filled with a color ink. For the eight examples of each of the five names of colors, we generated four congruent examples (filled with the same color ink) and four incongruent ones (filled with a different color ink). As in the EFE-word task, the color words and the color ink were balanced (see Fig. 1, example B). Participants were instructed to identify the ink color, and to ignore the color name.

Visual search task. We designed two sets of stimuli (EFEs and nonemotional faces) following the “a face-in-the-crowd effect” paradigm. For the EFE set (EFEs crowd), 30 pictures of 15 different male and 15 female faces displaying happiness, anger, fear, disgust, and sadness (six examples of each EFE) were selected from the FACES Database (Ebner et al., 2010). We composed of 20 items with these stimuli. Each of them consisted in a matrix with 6 (horizontal) × 4 (vertical) EFEs, then showing a total of

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>HC</th>
<th>PD</th>
<th>χ2 or t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>M 64.82 SD 64.72</td>
<td>M 64.72 SD 3.98</td>
<td>0.87</td>
<td>.93</td>
</tr>
<tr>
<td>Gender (male): n (%)</td>
<td>22 (43)</td>
<td>20 (39)</td>
<td>0.16</td>
<td>.69</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>3.59</td>
<td>.61</td>
</tr>
<tr>
<td>No studies</td>
<td>7.9</td>
<td>5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic studies</td>
<td>23.5</td>
<td>13.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary studies</td>
<td>37.3</td>
<td>43.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary studies</td>
<td>19.6</td>
<td>17.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher studies</td>
<td>11.8</td>
<td>19.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAP</td>
<td>22.29 SD 2.61</td>
<td>22.12 SD 5.95</td>
<td>0.15</td>
<td>.88</td>
</tr>
<tr>
<td>MMSE</td>
<td>29.17 SD 1.03</td>
<td>29.06 SD 1.01</td>
<td>0.58</td>
<td>.56</td>
</tr>
<tr>
<td>GDS-R</td>
<td>1.63 SD 1.62</td>
<td>2.59 SD 2.64</td>
<td>−2.21</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

Note: M = mean; SD = standard deviation, TAP = Test de acentuación de Palabras, MMSE = Mini-Mental State Examination; GDS-R = Geriatric Depression Scale.
24 examples of EFEs. Half of the trials comprised 24 copies of the same example (target-absent trials), and the remaining were composed of 23 copies of the same EFE plus another one showing a different EFE (target trials) (Example A on Fig. 2). Participants were instructed to decide whether all the 24 faces showed the same EFE or whether any displayed a different one. Each EFE appeared six times, two in target-absent trials and four in target trials (two as target and two as nontarget). For the nonemotional faces set (nonemotional faces crowd), 30 pictures of men (15) and women (15) displaying neutral expression were selected from the FACES Database (Ebner et al., 2010). With these pictures we composed 20 items consisting in a matrix with $6 \times 4$ nonemotional faces (10 target-absent and 10 target trials) (Example B in Fig. 2). Participants had to decide whether the 24 nonemotional faces corresponded to the same person or to a different person.
Procedure

All experimental tasks were created with E-prime 1.2 (Schneider, Eschman, & Zuccolotto, 2002) which controlled stimuli presentation and trial randomization. Participants were individually tested in a quiet room by means of a high-resolution computer monitor at a visual distance of 60 cm. The PD group was assessed at a time of day when their motor symptoms were less severe (“on-state”).

The tasks were completed in a fixed order in two different sessions of 1 hr duration each, and with an interval of 2 weeks between them (Inhibition task in the first session and Visual Search task in the second) to avoid participants’ fatigue. Emotional face and other trials were blocked within a session. Two PD patients and two individuals from the HC group did not attend the second session, so they did not complete the second task. In both tasks, participants were instructed to respond as soon as possible by pressing the corresponding number to the selected answer on the computer keypad. Once the response had been made (or 10,000 ms elapsed), a fixation point appeared again and a new trial started. The order of the trials in each task was randomized among participants.

Each task started with a verbal explanation and included several practice trials which can be repeated until the task was fully understood. The experiments began showing a centrally located white cross in the middle of the screen for 500 ms, to fixate the participant’s attention. After this, the first trial was shown and remained until a response was made (or 10,000 ms elapsed). For the Inhibition task, the five response options appeared in the right of the screen (see Fig. 1) whereas for Visual Search task, the two response options were shown in the bottom of the screen (see Fig. 2).

Results

Inhibition Task

Accuracy. For the Inhibition task, accuracy mean scores (see Table 2) were analyzed by a two-way mixed ANOVA, with Group (PD patients vs. HC) as the between-subjects factor and Stimuli (EFE-word and Color-word) as the within-subjects factor. The analysis revealed a significant main effect of Stimuli ($F_{1,100} = 255.26, p < .001, \eta^2 = .72$), showing that all participants were more accurate in Color-word than in EFE-word; and Group ($F_{1,100} = 6.84, p < .05, \eta^2 = .06$), with PD patients being less accurate than HC in all sets. The analysis also showed that there was a significant interaction between Group and Stimuli ($F_{1,100} = 5.84, p < .05, \eta^2 = .06$). Analysis for simple effects showed a statistically significant difference when comparing PD and HC scores for EFE-word ($F_{1,100} = 7.36, p < .01, \eta^2 = .07$), but not for Color-word ($F_{1,100} = 0.25, p = .62, \eta^2 = .002$). These results indicated that PD patients were less accurate in their responses than the HC group in EFE-word (see Table 2).

Given the differences we found between PD and HC in depressive mood (measured by the GDS-R scale), we performed an additional covariance analysis in an attempt to discern whether this could explain the differences in accuracy to EFEs. Analysis revealed that GDS-R (included as a covariate) was not significant ($F_{1,99} = 0.21, p = .65, \eta^2 = .002$) and that the significant interaction Group × Stimuli was maintained with respect to the previous one ($F_{1,99} = 5.92, p < .05, \eta^2 = .06$), indicating that differences between PD and HC in response to EFE-word were not influenced by their differences in depression scores.

Finally, in order to analyze possible different effects in the accuracy scores for any of the EFE (see Table 3) we performed a mixed ANOVA with Group (PD patients vs. HC) as the between-subjects factor and emotion (happiness, sadness, anger, disgust, and fear) as the within-subjects factor. The analysis revealed that interaction was not statistically significant ($F_{4,400} = 3.82$, Table 2. Mean and standard deviations for accuracy scores, reaction times, and omitted responses in the inhibition task, both for EFE-word and color-word sets, by HC and PD patients

<table>
<thead>
<tr>
<th>Set</th>
<th>HC ($N = 51$)</th>
<th>PD ($N = 51$)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Accuracy (740)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFE-word</td>
<td>32.69</td>
<td>3.61</td>
<td>30.29</td>
</tr>
<tr>
<td>Color-word</td>
<td>38.90</td>
<td>1.50</td>
<td>38.73</td>
</tr>
<tr>
<td>Average</td>
<td>35.79</td>
<td></td>
<td>34.51</td>
</tr>
<tr>
<td>Reaction times (710,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFE-word</td>
<td>5,761.66</td>
<td>626.46</td>
<td>5,776.39</td>
</tr>
<tr>
<td>Color-word</td>
<td>5,807.82</td>
<td>663.84</td>
<td>5,831.00</td>
</tr>
<tr>
<td>Average</td>
<td>5,784.74</td>
<td></td>
<td>5,803.70</td>
</tr>
<tr>
<td>Omitted responses (740)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFE-word</td>
<td>1.04</td>
<td>1.13</td>
<td>1.71</td>
</tr>
<tr>
<td>Color-word</td>
<td>0.24</td>
<td>0.55</td>
<td>0.19</td>
</tr>
<tr>
<td>Average</td>
<td>0.64</td>
<td></td>
<td>0.95</td>
</tr>
</tbody>
</table>
indicating that differences between PD and HC were not attributable to specific deficits with any of the emotions we observed.

**Reaction times.** We also computed the reaction times (see Table 2) in order to analyze the possible influence of response slowing in PD performance. A mixed ANOVA 2 (Group: PD patients vs. HC) × 2 (Stimuli: EFE-word and Color-word) was carried out with reaction time as the dependent measure. Neither a significant Group × Stimuli interaction (\(F(1,100) = 0.02, p = .89, \eta^2 = .001\)), nor a significant main effect of Group (\(F(1,100) = 3.34, p = .07, \eta^2 = .03\)) were observed. However, there was a significant main effect of Stimuli (\(F(1,100) = 436.31, p < .001, \eta^2 = .81\)), showing that all participants were slower in EFE-word than in Color-word.

We also performed an additional analysis of the number of omitted responses due to not choosing an answer within the 10,000 ms period (see Table 2). The analysis revealed a significant main effect of Stimuli (\(F(1,100) = 49.68, p < .001, \eta^2 = .32\)), with all participants having more omission in EFE-word than in Color-word; and a nonsignificant main effect of Group (\(F(1,100) = 3.05, p = .08, \eta^2 = .03\)). The analysis also showed a significant interaction between Group and Stimuli (\(F(1,100) = 4.62, p < .05, \eta^2 = .04\)). Analysis for simple effects showed a statistically significant difference when comparing PD and HC scores for EFE-word (\(F(1,100) = 4.13, p < .001, \eta^2 = .04\)), but not for Color-word (\(F(1,100) = 0.14, p = .08, \eta^2 = .003\)). Thus, PD patients had more omission than HC in EFE-word.

**Visual Search Task**

**Accuracy.** Similar analyses to those carried out for the Inhibition task were obtained for the Visual Search task. Firstly, a two-way mixed ANOVA was performed with Group between-subjects factor (PD patients vs. HC) and the repeated factor Stimuli (EFE crowd and Nonemotional face crowd) with accuracy scores as the dependent variable (see Table 4). The results showed a significant main effect of Stimuli (\(F(1,96) = 45.67, p < .001, \eta^2 = .32\)), with all participants being more accurate in EFE crowd than in Nonemotional face crowd; and a significant main effect of Group (\(F(1,96) = 7.66, p < .05, \eta^2 = .07\)), with less accuracy shown by PD patients than HC in all sets. We also observed a significant interaction between Group and Stimuli (\(F(1,96) = 4.56, p < .05, \eta^2 = .05\)). The analysis for simple effects (Fig. 2) showed a significant difference when comparing PD and HC scores for EFE crowd (\(F(1,96) = 14.80, p < .001, \eta^2 = .13\)) but not for Nonemotional crowd (\(F(1,96) = 1.21, p = .27, \eta^2 = .01\)). In EFE crowd, PD patients’ mean accuracy score was below that of the HC group.
We also repeated the first analysis including GDS-R score as a covariate in order to analyze the possible influence of depression on PD performance. Results revealed that GDS-R was significant \( F(1,95) = 4.39, p < .05, \eta^2 = .05 \). However, we also found that the significant interaction obtained in the previous analysis was maintained \( F(1,95) = 4.49, p < .05, \eta^2 = .05 \), and that differences between PD and HC groups in EFE crowd were still significant \( F(1,95) = 10.35, p < .01, \eta^2 = .09 \).

Finally, we analyzed accuracy scores for the different EFEs (see Table 5) performing a mixed ANOVA with Group (PD patients vs. HC) as the between-subjects factor and emotion (happiness, sadness, anger, disgust, and fear) as the within-subjects factor. There was not a statistically significant interaction effect \( F(4,396) = 1.04, p = .39, \eta^2 = .01 \), showing that differences between PD and HC did not seem attributable to any specific emotion.

**Discussion**

The aim of this research is to study the relationship between selective attention and EFE recognition abilities in PD compared with healthy individuals. For this purpose, we have designed two tasks to assess different components of selective attention: Inhibition and Visual Search abilities. We have also compared both groups’ responses to EFE and other nonemotional stimuli (colors and faces). This design permits us to establish whether selective attention is globally impaired in PD or, conversely, whether there is specific damage which is shown only to emotional faces. Results show that PD patients perform less well than HC, both in Inhibition and Visual Search tasks with EFE. In contrast, performance with a nonemotional stimulus is similar to HC in both tasks.

This PD performance does not seem to be related to motor slowing as we do not observe differences between the reaction times of patients and healthy individuals. Furthermore, the mean of omitted responses is greater in PD than in HC when they see EFE, but not in the nonemotional tasks (both in Inhibition and Visual Search tasks). So, while no differences between the reaction times of both groups indicates no influence of motor slowing, in our PD results the greater number of omissions to EFE imply a particular difficulty with these kind of stimuli.

Regarding a possible influence on the results of depressive symptoms of PD individuals in spite of their higher mean scores on the depression scale administered, they do not reach the clinical criterion for depression. Moreover, we have introduced depression as a covariate in the statistical analysis to assess accuracy and the significant interaction between group and stimuli (indicating lower EFE recognition of the PD group) is maintained. Thus, differences between PD and HC, both in EFE Inhibition task and in EFE Visual Search task, are not likely to be explained by the subclinical depressive mood of PD patients. This is also in accordance with the conclusion of the meta-analysis carried out by Gray and Tickle-Degnen (2010) which point to depression as a non-relevant factor to explain EFE recognition difficulties in PD. Some other studies have also indicated that mild to moderate depressive signs of patients do not have a relevant influence on cognitive performance (Costa, Peppe, Carlesimo, Pasqualetti, & Caltagirone, 2006; Klepac, Trkulja, & Relja, 2008).

### Table 5. Mean and standard deviation for accuracy scores for each emotion in EFE crowd set, by HC and PD patients

<table>
<thead>
<tr>
<th>Emotion</th>
<th>HC M (SD)</th>
<th>HC SD (M)</th>
<th>PD M (SD)</th>
<th>PD SD (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happiness</td>
<td>3.35 (0.72)</td>
<td>3.04 (0.86)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sadness</td>
<td>2.94 (0.97)</td>
<td>2.43 (1.09)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disgust</td>
<td>3.28 (0.87)</td>
<td>2.94 (1.01)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fear</td>
<td>2.45 (0.58)</td>
<td>2.20 (0.74)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>3.08 (0.76)</td>
<td>2.94 (1.01)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is also noteworthy that the patients’ poorer performance with EFEs cannot be attributed to a greater complexity of these kinds of stimuli in comparison to the others used. In this sense, the worse performance in the EFE tasks of PDs’ is observed, both in the Inhibition task, when this task is more difficult than the other (color) task for all participants, and also in the Visual Search task, when the EFE task seems to be easier than the Nonemotional task. Thus, we could infer that task difficulty itself is not a suitable explanation for the worse performance of PD patients respect to HC.

Hence, our current results seem to indicate that selective attention abilities are not globally damaged in PD, and cannot alone explain the deficit observed in EFE tasks. Instead, results seem to report the presence of a specific deficit in EFE recognition among PD. These results are globally congruent to previous literature, indicating that PD patients show EFE recognition impairments for all emotions studied (Beatty et al., 1989; Breitenstein, Daum, & Ackermann, 1998; Dujardin et al., 2004; Herrera et al., 2011; Yip et al., 2003). However, other researchers have only found it in some of them (Assogna et al., 2010; Kan et al., 2002; Lachenal-Chevallet et al., 2006; Suzuki et al., 2006) and, on the whole, PD individuals tend to be more impaired at recognizing negative emotions (anger, disgust, fear, and sadness) than positive ones (Gray & Tickle-Degnen, 2010). In any case, we must emphasize that we have used a relatively reduced number of trials for each emotion, so future studies could include a greater number of trials in order to analyze the specificity versus generality of the EFE recognition impairments among PD patients.

At this point it is also necessary to explain why we do not observe deficits in nonemotional inhibition and visual search, as several studies have previously found (Djamshidian et al., 2011; Horowitz et al., 2006; Hsieh et al., 2008; Mannan et al., 2008). One plausible possibility may be that the effect of dopaminergic therapy improves global attention performance (as reflected by nonemotional stimuli). As mentioned previously, this has been suggested in some previous studies and could indicate the relevance of frontostral dopaminergic circuits in executive processes and, in particular, in selective attention processes (Djamshidian et al., 2011; Fera et al., 2007; Jahanshahi et al., 2000; Kehagia, Cools, Barker, & Robbins, 2009). Our PD patients were tested just after medication was administered (On state) and the fact that EFE recognition impairment persists could be related to the possible implication of other nondopaminergic circuits in emotional processing. Thus, it is known that mesolimbic cortical and subcortical brain areas play a very relevant role in emotional recognition and have been found to be damaged as the course of the disease progresses (Péron, Dondaine, Lejeune, Grandjean, & Vérin, 2012). Our results could, therefore, provide indirect evidence that damage in nondopaminergic circuits in PD is related to emotional recognition difficulties.

The lack of general cognitive impairments may also be related with the variable performance shown by our PD patients in relation to HC in all the tasks we administered. This result is congruent with the widely heterogeneous and variable pattern of cognitive performance in nondemented PD individuals (Kehagia et al., 2010). Some patients develop widespread cognitive deficits from relatively early stages, while others remain relatively intact in their abilities throughout the course of their disease (Schrag & Schott, 2006). Hence, while some authors have reported significant alterations in attention deficit in nondemented PD patients, others have found that these are only a characteristic feature in those diagnosed with dementia (Ballard et al., 2002). Moreover, among nondemented PD patients, it has been suggested that it is possible to differentiate several PD subtypes as a function of their cognitive performance (Williams-Gray, Foltynty, Brayne, Robbins, & Barker, 2007). In this same line, Foltynty, Brayne, Robbins and Barker (2004) have observed a notable variability in cognitive impairments in the disease, estimating that executive function deficit (including attention) may affect 12%, memory deficits 8%, and global deficits 15% of patients. This heterogeneity may also be related to the variable set of, mainly dopaminergic, but also cholinergic, noradrenergic, and serotonergic deficits that characterize PD (Kehagia et al., 2010).

Nevertheless, it should be taken into account that we have employed two newly developed experimental tasks which may be not wholly comparable with the traditional Stroop and Face-in-the-Crowd paradigms, and this may limit the explanation we suggest. In any case, even considering possible differences in stimuli, our present results show a specific deficit in EFE recognition which is not dependent on attention abilities. This impairment may have clinical relevance because the recognition of other people’s faces plays a central role in social communication, and is one of the most complex perceptive abilities in humans (Haxby & Gobbini, 2011). Different information can be extracted from an individual face, including identity, age, gender, the direction of gaze and, of course, the emotional state of others through EFE. They are especially relevant to guide social activities and, hence, recognition problems may be a potential source for communicative difficulties and social isolation in PD individuals. For example, Clark and colleagues (2008) have shown that their emotion recognition disabilities are correlated with different subjective complaints, such as frustration in social relations, feelings of social disconnection, and a desire to connect with others. These interpersonal communication difficulties may have a great impact on patients’ quality of life, and some studies have indicated that they can be even more detrimental than their physical symptoms (Schreurs, De Ridder, & Bensing, 2000). So, from a clinical point of view, our results emphasize the need for a specific assessment and rehabilitation of emotional recognition abilities, as a way to prevent possible problems in these communicative skills. As our results indicate, these problems may be subtle and independent of cognitive performance in PD individuals. Nonetheless, we are aware that our results may be contrasted and confirmed with complementary works, including, for example, an assessment of emotional recognition abilities in more natural settings and, as suggested previously, a more in-depth examination of all the basic emotions.
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