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Recognition of facial and musical emotions in Parkinson's disease

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music, Parkinson's
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Background and purpose: Patients with amygdala lesions were found to be impaired in recognizing the fear emotion both from face and from music. In patients with Parkinson's disease (PD), impairment in recognition of emotions from facial expressions was reported for disgust, fear, sadness and anger, but no studies had yet investigated this population for the recognition of emotions from both face and music.

Methods: The ability to recognize basic universal emotions (fear, happiness and sadness) from both face and music was investigated in 24 medicated patients with PD and 24 healthy controls. The patient group was tested for language (verbal fluency tasks), memory (digit and spatial span), executive functions (Similarities and Picture Completion subtests of the WAIS III, Brixton and Stroop tests), visual attention (Bells test), and fulfilled self-assessment tests for anxiety and depression.

Results: Results showed that the PD group was significantly impaired for recognition of both fear and sadness emotions from facial expressions, whereas their performance in recognition of emotions from musical excerpts was not different from that of the control group. The scores of fear and sadness recognition from faces were neither correlated to scores in tests for executive and cognitive functions, nor to scores in self-assessment scales.

Conclusion: We attributed the observed dissociation to the modality (visual vs. auditory) of presentation and to the ecological value of the musical stimuli that we used. We discuss the relevance of our findings for the care of patients with PD.

Introduction

Emotion recognition is important for aesthetic pleasure, non-verbal communication and social relationships. For nearly two decades, the involvement of the basal ganglia in the recognition of basic facial emotions has been widely studied in patients with Parkinson's disease (PD) (see refs [1,2] for review). Most of the studies reported that the recognition of disgust and fear emotions were the most frequently impaired, followed by sadness and anger, whereas the recognition of happiness and surprise emotions seemed spared [3–16]. Patients with lesions to the amygdala showed impairment in emotional recognition from both face and music [17,18]. Results from both pathophysiological and neuroimaging studies suggested that a dysfunction of the amygdala could be responsible

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for impairment in emotion recognition in patients with PD. Extranigral Lewy bodies were found in the amygdala in non-demented patients with PD [19–21]. Testing the same population, a deactivation of amygdala was shown during facial expression recognition [22,23]. Finally, a reduction in the volume of this limbic structure was reported in PD [16,24,25].

To our knowledge, only one study has assessed emotional recognition from music in patients with PD [26]. Stimuli were 32 musical excerpts from a classical repertoire selected for a specific

emotional value (anger, fear, happiness or sadness). In comparison with the control group, patients with PD showed a marked impairment in recognition of fear, and to a lesser extent to anger, but no deficit in recognition of sadness and happiness. Van Tricht *et al.* [26] reported a positive correlation between the scores in recognition of fear from music and the scores in tests for the assessment of executive functions, which included the Mattis DRS, the Trail Making and the COWAT verbal fluency tests. In contrast, in most of the studies

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conducted with patients with PD, the performance in emotional recognition from face was neither correlated with cognitive impairments nor with levels of anxiety [8,11] or depression (see refs [1,2] for a review) measured with self-assessment scales.

Hypotheses

Patients with PD and controls were administered an emotional recognition task from both face and music for three primary emotions: fear, happiness and sadness. We selected these three emotions because they have been reported to be the most consistently and universally recognized [27,28]. For the emotional recognition from face, we predicted an impairment in emotional recognition of sadness and a more severe impairment for fear. For emotional recognition from music, based on the results of the study conducted with patients with a lesioned amygdala, we hypothesized a selective impairment for the recognition of fear. We predicted the performance in emotional recognition from music, but not that from face, would correlate with the performance in tests for the assessment of executive functions.

Methods

This study was carried out with ethical approval (Reims CPPRB) and funded by a hospital grant: PHRC 2005-11081. Informed consent was obtained by all participants.

Participants

We recruited 24 medicated patients with PD (12 females; 12 males) in the Neurology Department from Reims Hospital and 24 healthy controls (HC; 11 females; 13 males). The patients with PD were selected

using the following criteria: (i) they were ambulatory; (ii) the duration of the disease from first signs was at least 4 years; (iii) the severity of the disease was mild to moderate (Hoehn and Yahr stage < 4). All patients were medicated during the testing, taking either anticholinergics (9%) or dopaminergic agonists (65%) anti-parkinsonian medication ('on-state'). Nine patients were receiving an antidepressant. Exclusion criteria for the two groups were the presence of any relevant comorbidity (ongoing psychiatric episode, history of substance abuse or any other associated severe medical condition) and any sensory deficit (visual or auditory) that could interfere with testing. All participants were administered a gender identification

tal State Examination (MMSE) [29] and the Mattis Dementia Rating Scale (DRS) [30] were administered to the HC group to discard all suspicion of neurodegenerative disease. HC and PD groups were matched for age, years of education and gender. Sociodemographic data for the PD and HC groups, and neurological, cognitive and psychiatric characteristics for the patients with PD are reported in Table 1.

Materials and procedure

Cognitive tasks

To investigate the relationship between recognition of emotions and cognitive function, a series of tests were administered to the PD group: MMSE [29], Mattis DRS [30], Brixton test [31], digit and spatial span tests [32], verbal fluency tests (from letter and from semantic category) [33], Similarities and Picture Completion subtests of the WAIS III [34], Bells [35] and Stroop tests [36]. In order to investigate the relationship between recognition of emotions and anxiety, depression or apathy, the PD group fulfilled the Hospital Anxiety and Depression scale (HAD) [37] and the Lille Apathy Rating Scale (LARS) [38] (Table 2).

Emotional recognition tasks

The stimuli for recognition of emotions from facial expressions were adapted from the Pictures of Facial Affects [39]. A preliminary testing of an independent group of 155 control participants and 46 patients with multiple sclerosis revealed that the scores using the original stimuli in Ekman & Friesen's study were too low, particularly for the fear emotion [40]. To make

Table 1 Sociodemographic and clinical characteristics of patients with PD and HC participants

task	HC group
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PD patients
consisting of 10 face stimuli to control for
prosopagn-osis and impairment in visual acuity. The
Mini-Men-

(years)	
UPDRSIII	18.62 (11.13)
(on medication)	
Hoehn & Yahr	2 (0.37)

F/M, female/male; HC, healthy controls; PD, Parkinson's disease;SD,
standard deviations.

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Table 2 Percentages of patients with PD who obtained a score below 1.65 SD of the mean reported in norms, mean and SD in the PD group in the 12 neuropsychological tests

Neuropsychological tests	Percentage of patients with scores below	
	1.65 SD	Mean (SD)
Forward digit span	0	6.08 (1.02)
Backward digit span	62.5	4.25 (1.11)
Forward spatial span	16.67	5.65 (0.98)
Backward spatial span	33.33	4.65 (0.88)
Brixton spatial anticipation test (/55)	33.33	36.61 (7.96)
Phonemic fluency (R)	4.17	18.46 (7.91)
Category fluency (fruits)	4.17	19.5 (4.79)
Ruff Figural Fluency Test	20.83	54.13 (19.35)
Bells test (/35)	25	32.83 (2.74)
Pictures completion (WAIS-III, standard score/19)	25	8.29 (2.58)
Similarities (WAIS-III, standard score/19)	0	10.67 (1.9)
Stroop interference errors	8.3	2.71 (3.37)

the task easier, we produced hybrid faces all derived from one female face. For each emotion (fear, happiness and sadness), hybrid faces were created by using a morphing software (Morph 1.0) allowing variation of the level of emotional intensity, from full-blown expression (100% intensity) to neutral expression (0% intensity). For each emotion, we generated a continuum comprising 10 stimuli by increasing the level of intensity by 10%. The final stimuli set was composed of 30 black and white photographs. The 4.93 inches photographs were presented in a pseudo-random order (no more than two successive trials were of the same emotion type) on a 17 inches computer screen. Each trial consisted of a 5-s presentation of a face stimulus followed by the presentation on the screen of three labels. The participants were asked to produce orally the label that best described the facial expression shown on the screen. The testing session was preceded by a training phase including three trials. The participants were allowed to take as much time as they needed to make their decision and they received no feedback. The 155 HC and the 46 patients with multiple sclerosis, who were tested with both versions of test, obtained significantly higher scores in our version of the test than in the Ekman's test. In the present study, both the PD and the control group were tested using our adapted version only.

the Western tonal system and used different musical styles proposed by the programme (rock, bluegrass, swing, pop). The average duration of the excerpts was

23.3 s (SD = 6.4 s). The happy excerpts were played at an average tempo (metronome marking) of 124 (range = 107–149), the sad excerpts at an average tempo of 114 (range = 89–152) and the fear excerpts at an average tempo of 106 (range = 89–120). Examples of stimuli for each emotion can be heard at <http://nca.recherche.univ-lille3.fr/index.php?page=auditory-examples>. The sound files were presented from a computer over two loudspeakers. The testing was preceded by two practice trials followed by the presentation of the 18 trials. In each trial, the sound file was immediately followed by the presentation of three labels (fear, happiness and sadness). The participant responded orally and the experimenter pressed the spacebar to go to the next stimulus.

The stimuli for emotional recognition from music were selected from a corpus composed by Eric Jahyer (see ref. [41] for details). Six musical excerpts were selected for each emotion (fear, happiness and sadness). The 18 musical excerpts followed the rules of

Results

Analyses of the distributions of the data were not normal, henceforth we used two non-parametric tests: the Mann–Whitney and the Wilcoxon tests for simple comparisons; and the Spearman tests for correlations.

HC and PD groups were comparable for age (mean = 61.42 ± 6.7 years and 63.83 ± 7.1 years, respectively; $U = 217.5$, NS) and years of education (11.17 ± 2.5 and 9.96 ± 2.6; $U = 214.5$, $P = NS$). The PD group had lower scores (mean = 26.75 ± 2.4) than the HC group (mean = 29.38 ± 0.7) on the MMSE, and the difference was significant ($U = 94.5$, $P < 0.0001$). The scores in the DRS were also lower for the PD (mean = 135.21 ± 5.3) than for the HC group (mean = 141.79 ± 2.4), and the difference was also significant ($U = 69.5$, $P < 0.0001$).

Scores in the emotional recognition tasks

As illustrated in Fig 1, the scores of the PD group for emotional recognition from face were significantly lower than those obtained by the control group. A significant difference was obtained between HC and patients with PD for both fear (8.13 ± 1.8 and 5.83 ± 2.6, respectively; $U = 142$, $P = 0.003$) and sadness (8.13 ± 2.4 and 6.63 ± 2.6; $U = 180$, $P = 0.03$), whereas the difference between the HC (9.96 ± 0.2) and the patient group (9.83 ± 0.4) did not reach the significance level ($U = 252$, $P = 0.46$). There was no significant difference between low and high levels of emotional intensity in PD ($Z = -1.4$, $P = 0.15$). For both HC and patients with PD, a significant difference was shown between happiness and the two negative emotions (happiness vs. fear HC: $Z = -3.62$,

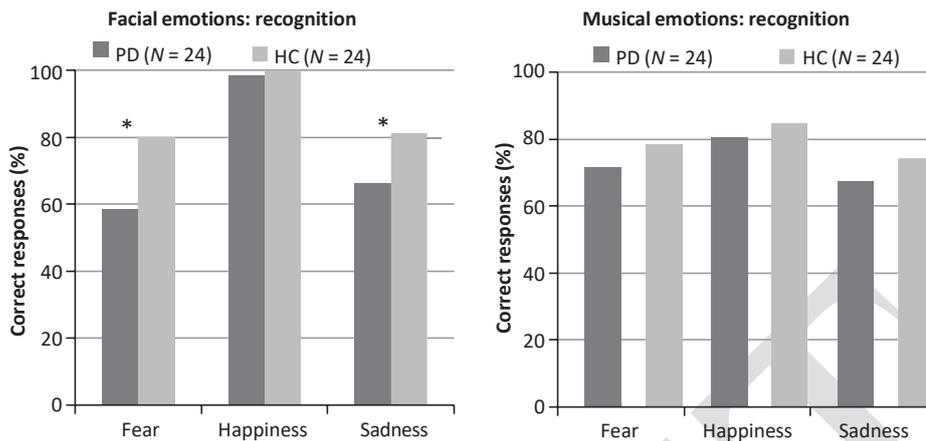


Figure 1 Percentage of correct responses in emotional recognition of fear, happiness and sadness from face and music in the Parkinson's disease (PD) and healthy controls (HC) groups.

$P = 0.0003$; PD: $Z = -4.06$, $P < 0.0001$; happiness vs. sadness HC: $Z = -3.62$, $P = 0.0003$; PD: $Z = -3.91$, $P < 0.0001$. No statistical difference appeared between the two negative emotions (HC: $Z = -0.59$, $P = 0.55$; PD: $Z = -1.4$, $P = 0.16$).

No significant group differences were found in the recognition of emotions from music stimuli ($U = 252$, NS for fear; $U = 264.5$, NS for happiness; $U = 240.5$, NS for sadness). Mean scores and SDs were 4.71 ± 0.8 in the HC group vs. 4.29 ± 1.4 in the PD group for fear emotion; 5.08 ± 0.83 in HC and 4.83 ± 1.1 in the PD group for happiness; and finally, 4.46 ± 1.1 in the HC group and 4.04 ± 1.3 in the PD group for sadness. For both HC and patients with PD, a significant difference was shown between happiness and sadness (HC: $Z = -2.2$, $P = 0.03$; PD: $Z = -2.44$, $P = 0.01$). No statistical difference appeared with fear (happiness vs. fear HC: $Z = -1.4$, $P = 0.16$; PD: $Z = -1.39$, $P = 0.16$; sadness vs. fear: HC: $Z = -1.16$, $P = 0.25$; PD: $Z = -5.69$, $P = 0.0001$).

Correlations analyses

Only significant correlations ($P < 0.05$) explaining at least 20% of the total variance were considered, and Bonferroni corrections for multiple comparisons were applied. For both groups, no significant correlations were found between the variables gender, age, years of education, and the performance in the recognition tasks, neither from face nor music stimuli. The correlations between the scores in the recognition tasks and the scores to the MMSE and the DRS were not significant in either group. For the PD group, the correlations between the scores in the emotional recognition tasks and the scores in motor symptom severity

(UPDRSIII), disease duration, HAD, LARS, and tests assessing executive function were not significant. As for cognitive tests, only the correlation between the scores to the Brixton test and the scores in the emotion recognition task from face was significant ($R = 0.598$; $P = 0.005$), but this only when the scores for the three emotions were averaged. Spearman coefficients and P -values are reported in Table 3.

Discussion

The showing of a deficit in the recognition of fear and sadness emotions from face confirmed previous reports in medicated patients with PD [1,2]. The poor performance of the patients with PD for these two emotions was neither correlated with cognitive or executive functions, nor with depressive or anxious symptoms. The fact that both groups had better scores in the recognition of the happiness emotion from face stimuli is indicative of a difference in the levels of complexity across stimuli. The problem of matching the levels of complexity across facial emotions remains unresolved, and better performance for recognition of positive emotions from face stimuli is classically documented [1,2].

For the emotion recognition task from music, the results in the present study were not totally congruent with those reported in Van Trich *et al.*'s study [26], which reported impairment in the recognition of fear in patients with PD. In contrast, our findings revealed that patients with PD were unimpaired for all three emotions that were tested. This discrepancy in the findings could be explained by differences in the stimuli sets. Our musical stimuli were original scores, characterized by polyphony and 'middle-of-the-road

Table 3 Spearman coefficient values for correlations between the scores in the facial and musical emotion recognition tests and age, scores to the clinical tests, disease duration, scores in each of the 12 neuropsychological tests, and scores in the anxiety and depression self-assessment tests in patients with PD

	Facial emotions				Musical emotions			
	Fear	Happiness	Sadness	Total score	Fear	Happiness	Sadness	Total score
Age (years)	-0.070	-0.178	0.059	-0.255	-0.276	-0.014	-0.389	-0.35
Education (years)	0.335 ^{NS}	-0.025 ^{NS}	0.080 ^{NS}	0.269 ^{NS}	0.213 ^{NS}	0.351 ^{NS}	0.035 ^{NS}	0.204 ^{NS}
Mini-Mental State Examination (/30)	0.181 ^{NS}	0.016 ^{NS}	0.429 ^{NS}	0.385 ^{NS}	0.165 ^{NS}	0.243 ^{NS}	0.233 ^{NS}	0.328 ^{NS}
Dementia Rating Scale (/144)	0.134	-0.105	0.213	0.327	-0.071	0.242	0.000	0.118
Attention	-0.015	0.056	0.074	0.158	0.140	0.038	-0.047	0.130
Initiation	0.114	-0.049	0.152	0.278	-0.042	0.338	-0.161	0.103
Construction	-0.124	0.075	-0.025	0.108	-0.112	0.176	0.259	0.157
Concept	-0.028	-0.133	0.067	0.255	-0.164	0.080	0.214	0.089
Memory	0.165 ^{NS}	0.025 ^{NS}	0.154 ^{NS}	0.185 ^{NS}	-0.161 ^{NS}	0.091 ^{NS}	0.038 ^{NS}	0.020 ^{NS}
Disease duration (years)	-0.166	0.081	-0.024	-0.173	-0.175	-0.393	-0.026	-0.318
UPDRSIII (on medication)	-0.122 ^{NS}	0.122 ^{NS}	0.113 ^{NS}	-0.100 ^{NS}	-0.418 ^{NS}	-0.311 ^{NS}	0.158 ^{NS}	-0.100 ^{NS}
Forward digit span	0.071 ^{NS}	0.269 ^{NS}	0.049 ^{NS}	0.229 ^{NS}	0.278 ^{NS}	0.122 ^{NS}	-0.041 ^{NS}	0.187 ^{NS}
Backward digit span	0.123 ^{NS}	-0.017 ^{NS}	0.287 ^{NS}	0.377 ^{NS}	0.295 ^{NS}	0.043 ^{NS}	-0.063 ^{NS}	0.196 ^{NS}
Forward spatial span	0.079 ^{NS}	0.259 ^{NS}	-0.026 ^{NS}	0.104 ^{NS}	-0.151 ^{NS}	0.198 ^{NS}	-0.220 ^{NS}	-0.021 ^{NS}
Backward spatial span	-0.011	0.394	-0.094	-0.024	-0.311	-0.007	-0.110	-0.218
Brixton spatial anticipation test	0.348 ^{NS}	-0.312 ^{NS}	0.405 ^{NS}	0.598 ^{NS}	0.047 ^{NS}	0.402 ^{NS}	0.182 ^{NS}	0.405 ^{NS}
				<i>P</i> = 0.005				
Phonemic fluency	0.308 ^{NS}	0.024 ^{NS}	0.404 ^{NS}	0.330 ^{NS}	0.208 ^{NS}	0.319 ^{NS}	0.037 ^{NS}	0.248 ^{NS} Category
fluency	0.150 ^{NS}	-0.065 ^{NS}	0.372 ^{NS}	0.334 ^{NS}	0.105 ^{NS}	-0.053 ^{NS}	0.209 ^{NS}	0.188 ^{NS} Ruff
Figural fluency test	0.099 ^{NS}	0.016 ^{NS}	0.111 ^{NS}	0.223 ^{NS}	0.106 ^{NS}	0.332 ^{NS}	0.258 ^{NS}	0.385 ^{NS} Bells
test	-0.344 ^{NS}	0.073 ^{NS}	-0.234 ^{NS}	-0.188 ^{NS}	-0.258 ^{NS}	0.319 ^{NS}	0.201 ^{NS}	0.155 ^{NS}
Pictures completion	0.169 ^{NS}	0.041 ^{NS}	0.355 ^{NS}	0.174 ^{NS}	0.067 ^{NS}	0.373 ^{NS}	-0.041 ^{NS}	0.278 ^{NS}
Similarities	0.303 ^{NS}	-0.074 ^{NS}	0.325 ^{NS}	0.300 ^{NS}	-0.018 ^{NS}	0.230 ^{NS}	-0.114 ^{NS}	0.055 ^{NS} Stroop
interference errors	-0.124 ^{NS}	-0.075 ^{NS}	-0.004 ^{NS}	-0.251 ^{NS}	-0.137 ^{NS}	-0.247 ^{NS}	-0.044 ^{NS}	-0.318 ^{NS} Anxiety
score(HAD)	0.064 ^{NS}	-0.236 ^{NS}	-0.002 ^{NS}	0.019 ^{NS}	-0.029 ^{NS}	0.051 ^{NS}	0.381 ^{NS}	0.311 ^{NS} Depression
score (HAD)	0.072 ^{NS}	-0.147 ^{NS}	0.254 ^{NS}	0.238 ^{NS}	0.298 ^{NS}	0.019 ^{NS}	0.333 ^{NS}	0.318 ^{NS}

NS, non significant.

popular' aspect, contrasting with 'classical' music excerpts that were used in Van Tricht's study [26]. Even if these authors found no significant link between the musical background of patients with PD and the emotional results [26], classical music may require more attentional resources than popular music.

The most striking result in the present study was that the patients with PD, even those with severe cognitive impairments, were impaired in the recognition of fear and sadness emotions from face, but not from music stimuli. This dissociation contrasted with the performance of patients with amygdala lesions, who were impaired for emotional recognition both from face and music stimuli. Our findings were, however, consistent with the results of two previous studies [5,13] showing that patients with PD tested for emotional recognition from both face and speech prosody showed a selective impairment in emotion recognition from face. The selective impairment for emotion recognition from face in patients with PD suggests that this impairment more likely results from lesions to the basal ganglia, and/or from lesions to its connections

with the amygdala, rather than from lesions to the amygdala *per se*.

Because one face was used for the emotion recognition from face, whereas six music stimuli were used in the emotion recognition from music, one could argue that this difference may account for the better performance of patients with PD with music stimuli. Previous studies conducted by our team (unpublished data) in which we tested controls, as well as patients with multiple sclerosis, revealed that both controls and patients obtained better scores when tested with our version of the emotion recognition from face, using only one face, than when tested with the Ekman's test including multiple faces. It thus appears that the test used in the present study is easier than the Ekman's test. However, because the population of patients with PD had not been tested with both versions of the test, we cannot rule out the possibility that this specific population could be sensitive to the number of different stimuli used in the emotion recognition from face and from music. Finally, because both groups showed better scores in the recognition of happiness from face than from music stimuli, at

least, in the case of this emotion, the number of stimuli cannot account for the difference in performance.

The contrast in the performance for emotional recognition from face and music could also be accounted by the difference in the modality of presentation, which was visual for the face stimuli, and auditory for the music stimuli. As reported by Circelli *et al.* [42], recognition of facial emotion involves visual scanning patterns that are specific to faces. In the auditory modality, no studies have yet tested the specificity of emotion recognition from music in comparison to emotion recognition from speech prosody. Results in Kan *et al.* [5], Clark *et al.* [13], and findings of the present study all indicated a better performance for emotion recognition from auditory than visual stimuli. Another explanation could be that photographs are static whereas music stimuli are dynamic, in the sense that they vary over time. In HC, it has been previously reported that dynamic facial expression of emotion could enhance emotional feeling as compared with static stimuli, such as photographs [43]. Vicente *et al.* [44] reported that patients with PD, independently of the stage of the disease or the dopaminergic medication, were unimpaired in emotion recognition from emotional films. However, because the film stimuli were presented with a soundtrack, it is not possible to decide whether patients with PD were better with films because the stimuli were dynamic, or because the stimuli were bimodal.

In conclusion, our findings revealed impairment in emotional recognition from face in patients with PD that contrasted with unimpaired recognition for the same emotions from music stimuli.

Stimulation based on auditory rhythmic cues had been successfully utilized by clinicians to improve walking speed, movement and speech motor control in patients with PD [45–47]. The increase in walking speed of patients with PD following auditory stimulation was not observed when the clinicians used visual stimulation [45]. Music conveys intense emotions and was shown to have positive effects on dopaminergic activity (see ref. [48] for review). Findings of the present study suggest that musicotherapy may be used in patients with PD as a non-pharmacological approach to depressive and anxious symptoms.

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Disclosure of conflict of interest

The authors declare no financial or other conflict of interests.

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