



Impaired emotion recognition in music in Parkinson's disease

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ABSTRACT

Music has the potential to evoke strong emotions and plays a significant role in the lives of many people. Music might therefore be an ideal medium to assess emotion recognition. We investigated emotion recognition in music in 20 patients with idiopathic Parkinson's disease (PD) and 20 matched healthy volunteers. The role of cognitive dysfunction and other disease characteristics in emotion recognition was also evaluated.

We used 32 musical excerpts that expressed happiness, sadness, fear or anger. PD patients were impaired in recognizing fear and anger in music. Fear recognition was associated with executive functions in PD patients and in healthy controls, but the emotion recognition impairments of PD patients persisted after adjusting for executive functioning. We found no differences in the recognition of happy or sad music. Emotion recognition was not related to depressive symptoms, disease duration or severity of motor symptoms.

We conclude that PD patients are impaired in recognizing complex emotions in music. Although this impairment is related to executive dysfunction, our findings most likely reflect an additional primary deficit in emotional processing.

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1. Introduction

Patients with Parkinson's disease (PD) show impairments in emotion recognition. These impairments occur in the recognition of emotions from facial expressions (Lawrence, Goerendt, & Brooks, 2007; Sprengelmeyer et al., 2003; Suzuki, Hoshino, Shigemasa, & Kawamura, 2006; Yoshimura, Kawamura, Masaoka, & Homma, 2005) and emotional prosody (Blonder, Gur, & Gur, 1989; Dara, Monetta, & Pell, 2008; Drago, Foster, Skidmore, Trifiletti, & Heilman, 2008; Yip, Ho, Tsang, Li, & Ho, 2003). Still there is some controversy about which specific emotions are recognized abnormally in PD. Some researchers report specific impairments in the recognition of fear and sadness (Ariatti, Benuzzi, & Nichelli, 2008; Troisi et al., 2002), whereas others have reported deficits in recognizing anger or disgust (Clark, Neargarder, & Cronin-Golomb, 2008; Lawrence et al., 2007; Sprengelmeyer et al., 2003; Suzuki et al., 2006), while still others failed to replicate emotion recognition deficits (Adolphs, Schul, & Tranel, 1998; Mitchell & Boucas, 2009).

The recognition of emotions is a complex process. It consists of both the perceptual processing of the stimulus and the recognition of its emotional meaning (Adolphs, 2003). Therefore cognitive functions, in particular executive functions such as attention and decision making, play an important role in emotion recognition

(Breitenstein, Van Lancker, Daum, & Waters, 2001; Dujardin et al., 2004; Gray & Tickle-Degnen, 2010; Ibarretxe-Bilbao et al., 2009; Mathersul et al., 2008). PD patients show cognitive impairments, executive dysfunctions being most frequent, which in a considerable proportion of patients develop early in the course of the disease (Dubois & Pillon, 1997; Muslimovic, Post, Speelman, & Schmand, 2005; Zgaljardic, Borod, Foldi, & Mattis, 2003). Yet, the role of cognitive abilities in emotion recognition in PD patients has not been studied sufficiently. Studies that did take cognitive functions into account have led to conflicting results (Assogna, Pontieri, Caltagirone, & Spalletta, 2008). While some authors report associations between cognitive functions and emotion recognition (Breitenstein et al., 2001; Dujardin et al., 2004), others have not (Ariatti et al., 2008; Troisi et al., 2002). This discrepancy may be due to differences in the cognitive tasks that were administered or to selection bias in the PD samples.

PD is characterized by a loss of dopaminergic innervation of the basal ganglia, including the ventral striatum and the subthalamic nucleus. These structures are richly interconnected with, for instance, the amygdala and the orbitofrontal cortex, brain regions associated with emotion recognition in faces and prosodic stimuli (Ariatti et al., 2008; Bertrand et al., 2004; Braak et al., 2003; Breitenstein, Daum, & Ackerman, 1998; Harding, Stimson, Henderson, & Halliday, 2002; Ibarretxe-Bilbao et al., 2009; Junqué et al., 2005). Largely the same brain regions are active during the recognition of emotions in music (Gosselin, Peretz, Johnsen, & Adolphs, 2007; Gosselin et al., 2005; Khalifa et al., 2008). Therefore, deficits in recognizing emotions in music can also be expected in PD. Until

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now, most studies on emotion recognition in PD have used facial or prosodic stimuli. Emotion recognition in other relevant modalities such as music or other art forms has received no or scarce attention. Music is a powerful instrument in evoking emotional responses (Baumgartner, Esslen, & Jäncke, 2006; Juslin & Sloboda, 2001; Koelsch, 2005; Menon & Levitin, 2005; Peretz, Gagnon, & Bouchard, 1998). In comparison to non-musical stimuli, such as pictures, music can elicit stronger emotions (Goldstein, 1980). Music might therefore be a better means to investigate emotion recognition in PD than faces or prosodic stimuli.

The primary aim of this study was to investigate the recognition of emotions in music in a group of PD patients and a group of healthy volunteers. We aimed at gaining insight in the extent of emotional deficits in PD patients: if PD patients are indeed less able to recognize emotions in music than controls, this would entail even broader deficits in emotion recognition in PD, spanning across modalities other than faces and prosody. Moreover, given the fact that music may provoke stronger emotions than other stimuli, our study might allow a clearer sight at the determinants of emotional deficits in PD patients.

Based on the above considerations, we hypothesized that PD patients are impaired in the recognition of emotions in music. We also expected to find a relationship between emotion recognition and executive functions. We examined if possible group differences in emotion recognition would persist after controlling for executive functioning. If so, then it would imply an independent, non-cognitive effect of PD on emotion recognition. In view of the high prevalence of psychiatric disturbances in PD, in particular depression (Schrage, 2004), we also controlled for depressive symptoms. Furthermore, we explored the relationship between emotion recognition and disease variables, e.g. disease duration, medication dosage and motor symptoms.

2. Method

2.1. Participants

Twenty patients with idiopathic PD and 20 healthy controls participated (Table 1). Patients were selected from the control group of an ongoing study on the neuropsychological effects of deep brain stimulation in PD (as described in Smeding, Speelman, Huizenga, Schuurman, & Schmand, 2009; Smeding et al., 2006). All patients had idiopathic PD for more than 5 years. They were recruited from the outpatient clinic of the AMC and two other hospitals in the region: the Kennemerghasthuis in Haarlem and the Vrije

Universiteit Medical Center. Exclusion criteria for both groups were a history of psychiatric disorder, dementia (as defined by a Mattis' Dementia Rating Scale (Mattis, 1996) score of less than 123 (Llebaria et al., 2008), other severe neurological or somatic diseases, and moderate or severe hearing loss. The healthy volunteers were matched to the patients in terms of age, gender, education and musical training.

The study design was approved by the Medical Ethical Committee of the Academic Medical Center. Written informed consent of all the participants was obtained after the nature of the procedures had been fully explained.

2.2. Materials

2.2.1. Emotion recognition task

The emotion recognition task consisted of 32 musical excerpts (see Appendix A). The musical excerpts were selected from previous studies on emotion recognition in music (Baumgartner et al., 2006; Kallinen, 2005; Koelsch, 2005; Menon & Levitin, 2005; Peretz et al., 1998; Terwogt & Van Grinsven, 1991). Only excerpts which had been shown reliable in expressing happiness, sadness, fear or anger were selected. For happiness and sadness, only excerpts were selected that were correctly identified by at least 95% of healthy controls. For anger and fear the percentage correct in healthy controls was at least 90%. For each of the four emotions, eight fragments were chosen. The excerpts followed the rules of the Western tonal system. Only instrumental music was used to ensure the emotional evaluation would not be influenced by the lyrics. The excerpts were selected from different periods of the musical history, including baroque, classical and romantic periods. Furthermore, different instrumentations, such as solo, chamber and orchestral music were used. The stimuli lasted on average 17 s (range 9–35 s). The excerpts expressing happiness (13 s) and anger (16 s) were shorter in duration than the sad and fearful excerpts (20 s and 21 s respectively). However, since no association between excerpt duration and emotion recognition has been found (Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005), it is unlikely that differences in stimulus length influence emotion recognition. The experimental task was preceded by four examples, one of each emotion. The examples were selected from movie soundtracks. All excerpts were presented on a CD-player with two loudspeakers. The excerpts were presented in random order. No feedback was given, with exception of the examples. Following each excerpt, the participants had to judge which of the four emotions (happiness, sadness, anger or fear) was expressed in

Table 1
Demographic and disease characteristics of Parkinson disease (PD) patients and controls.

	PD patients (n = 20)	Controls (n = 20)	Statistics (p value)
Male/female	14/6	10/10	.20 ^a
Education level (Unesco ISCED; range 1–7 ^c)	5.4 (1.4)	5.2 (1.4)	.62 ^b
Age	66.0 (8.6)	67.0 (10.6)	.75 ^c
Level of musical training (range 1–5)	1.6 (.8)	2.1 (1.0)	.19 ^b
Length of musical training (years)	2.3 (4.3)	3.7 (4.8)	.36 ^c
Frequency of listening to classical music (range 1–5)	3.0 (.8)	2.7 (.7)	.33 ^b
Familiarity with the classical music repertoire (range 1–5)	2.5 (.8)	2.4 (.8)	.82 ^b
Disease duration (years)	11.9 (4.6) (range: 7–22)	–	–
Levodopa equivalent units (LEU)	747.6 (425.9) (range: 210–1846)	–	–
Unified Parkinson's Disease Rating Scale (UPDRS); part 3	25.7 (14.8) (range: 7–64)	–	–

Values are mean (SD). *p* = level of significance.

^a Chi-square test.

^b Mann Whitney *U* test.

^c *t*-test.

^c United Nations Educational Scientific and Cultural Organization. International Standard Classification of Education. ISCED (1997, 2006). LEU was calculated according to the following conversion formula: regular levodopa dose × 1 + slow release levodopa × 0.75 + bromocriptine × 10 + apomorphine × 10 + ropinirole × 20 + pergolide × 100 + pramipexole × 100 + [regular levodopa dose + (slow release levodopa × 0.75)] × 0.2 if taking entacapone (Esselink et al., 2004).

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