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BRIEF COMMUNICATION

Emotional valence may influence memory performance for visual artworks in Parkinson's disease

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Abstract

Background Non-motor symptoms in Parkinson's disease (PD) include reduced reactivity to emotional stimuli. Visual artworks can evoke emotional responses. Motor, sensorial and cognitive networks implicated in the aesthetic experience and in the emotional-reward domain show a significant overlap with the pathological nigrostriatal, mesocortical and mesolimbic circuitry that characterises PD.

Methods Memory enhancement by emotional stimuli such as visual artwork-stimuli was explored in 12 right-sided and 12 left-sided non-demented-PD patients, 12 Alzheimer's disease patients (AD) and 13 healthy controls (HC). Ten emotional and 10 non-emotional stimuli were previously identified based on the ratings of the emotional impact provided by 45 non-PD subjects on 82 pictures of paintings. Only figurative artworks were included. Patients and HC were requested to rate on a 7-point scale the emotional impact of 20 pictures; they were then requested to recognise the 20 pictures amongst 20 distractors (incidental memory task).

Results and Conclusion Recognition of emotional stimuli was more accurate compared to non-emotional stimuli in AD, left-sided PD and HC; right-sided PD did not show sensitivity to the emotional valence of the stimuli suggesting the involvement of the nigrostriatal, mesocortical and mesolimbic circuitry of the left hemisphere in the emotional-reward system related to the aesthetic experience.

Keywords Parkinson's disease · Aesthetic experience · Left-sided PD · Right-sided PD · Incidental memory · Symptom asymmetry

Introduction

Among the environmental stimuli, visual works of art can evoke emotional responses [1]. The aesthetic experience is a complex process integrating cognitive components, perception and motor responses and in which the emotional valence of the stimuli, associated with reward mechanisms, plays a major role [2].

Notably, motor, sensorial and cognitive networks involved in the aesthetic experience and emotional-reward system show a significant overlap with the nigrostriatal, mesocortical and mesolimbic circuitry that is impaired in Parkinson's disease (PD). Accordingly, non-motor symptoms include reduced reactivity to emotional stimuli, and potential flattening of the emotional response while beholding a visual artwork may be expected in PD [3]. Several factors may contribute to the inability of PD patients to take full advantage of the aesthetic experience. First, the movement disorder might prevent the embodied simulation of emotions, thus minimizing the emotional response evoked by visual artworks. Moreover, reward mechanisms may be altered due to the impaired circuitry between the orbitofrontal and ventromedial prefrontal cortex and the striatum. Finally, visual dysfunction might hamper the early stages of the elaboration of the visual emotional stimuli making them unsuitable for further processing [4].

Here, we explored the sensitivity of PD patients to the emotional valence of visual artworks by using an incidental memory

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task. In particular, we assessed whether the accuracy in the recognition of visual artworks might be enhanced by the emotional valence of stimuli that were previously rated as for their emotional impact. Since cognitive disorders in PD may be influenced by the side of symptoms, both right-sided and left-sided PD patients were included in the study [5, 6]. Amnesic patients (mild Alzheimer's disease patients) (AD) and healthy controls (HC) also took part in the study as control groups.

Subjects and methods

Twelve right-sided and 12 left-sided non-demented-PD patients, 12 AD patients and 13 (HC) matched for age, sex and education (see Table 1 for the demographic data) were asked to rate the emotional impact of 20 pictures by using a 7-point rating scale. PD subgroups were also matched for disease duration (years from clinical onset: $p = 0.683$), motor disorder severity (Unified Parkinson's Disease Rating Scale—UPDRS (part III): $p = 0.387$), antiparkinsonian drugs (levodopa equivalent daily dose-LEDD: $p = 0.508$) and cognitive status (MMSE: $p = 0.978$).

Ten emotional and ten non-emotional stimuli were previously identified based on the ratings of the emotional impact provided by 45 normal subjects on 82 pictures of paintings by nineteenth- and twentieth-century artists, randomly downloaded from the web. Only figurative artworks were included.

Patients and HC were requested to rate on a 7-point scale, the emotional impact of the 20 stimuli. No mention was made to the participants that they would be asked to recognise later the 20 stimuli.

In the recognition task, participants were asked to recognise the 20 stimuli randomly presented among 40 distractors chosen among the 62 remaining pictures of paintings. All participants rated again the emotional impact of the 20 stimuli after the recognition task.

PD and AD participants also received a neuropsychological assessment of attention, executive functions, memory and language (see Table 1 for subjects' performance on the neuropsychological test battery).

Results

HC tended to perform at ceiling. Overall (Kruskal-Wallis test: $\chi^2 = 12.018$, gl = 3, $p = 0.007$), no difference emerged between the two PD groups. Left-sided PD were more accurate than AD ($z = 14.000$, $p = 0.010$) but right-sided PD did not differ from AD. AD patients performed worse than HC ($z = -17.359$, $p = 0.001$).

Within groups differences

Left-sided PD recognised more accurately emotional than non-emotional stimuli (Wilcoxon test: $z = -2.000$; $p = 0.046$), while no difference emerged in right-sided PD. AD were more accurate in recognising emotional than non-emotional stimuli (Wilcoxon test: $z = -2.205$; $p = 0.027$); the results were confirmed when the number of false recognitions in the recognition task were considered (% accuracy evaluated by the signal detection theory) (Wilcoxon test: $z = -2.142$; $p = 0.032$). False recognitions were negligible in all the other groups (see Fig. 1a).

Between-group differences

On emotional stimuli (Kruskal-Wallis test: $\chi^2 = 10.828$, gl = 3, $p = 0.013$, see Fig. 1b), although right-sided and left-sided PD did not differ significantly, left-sided PD was more accurate than AD ($z = 9.417$, $p = 0.043$), whereas right-sided PD did not differ from AD. Notably, right-sided PD were less accurate than HC ($z = -9.833$, $p = 0.031$), while left-sided PD did not differ from HC. As expected, AD was less accurate than HC ($z = -14.083$, $p = 0.002$).

On non-emotional stimuli (Kruskal-Wallis test: $\chi^2 = 8.872$, gl = 3, $p = 0.031$, see Fig. 1b), the comparison between right-sided and left-sided PD did not reach statistical significance. Left-sided PD was more accurate than AD ($z = 11.833$, $p = 0.026$); a tendency in the same direction was also observed between right-sided PD and AD ($z = 8.792$, $p = 0.097$). AD was less accurate than HC ($z = -14.728$, $p = 0.005$).

Finally, all groups were consistent in rating the emotional impact of the stimuli before and after the recognition task (Pearson's r: all correlations $p \leq 0.001$).

Discussion

The emotional valence of the stimuli improved the memory performance of left-sided PD and AD. This is in line with the previous results by Cupchik et al. [7] showing that the presentation of highly emotional stimuli can generate an automatic activation of the reward processes that may facilitate their recognition.

The reduced sensitivity of right-sided PD (with prevalent left hemisphere damage) to the emotional valence of the stimuli supports the hypothesis that the reward system might be less efficient in PD, but mostly in subjects with prevalent left hemisphere damage, as in right-sided PD, suggesting a specific role of the left hemisphere in the emotional response.

We might also hypothesise that the left hemisphere damage could reduce the linguistic support to the memorisation process. Indeed, processing of visual perceptual items such as paintings, presumably engages the right hemisphere; however, figurative artworks could also elicit verbalisation processes, and lack of memory enhancement in subjects with prevalent left hemisphere damage could be brought back to a disadvantage in using language-based strategies that might contribute to the perception and experience of emotions [8].

Table 1 Demographical characteristics and adjusted and row scores (when adjusted scores are not available) obtained by left-sided and right-sided PD (Parkinson's disease), AD (Alzheimer's disease) and HC (healthy controls) groups on neuropsychological tests

	HC [$N = 13$]	AD [$N = 12$]	PD [$N = 24$]		Group comparison [p value]	Pairwise comparisons
			Left-sided PD [$N = 12$]	Right-Sided [$N = 12$]		
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Demographical characteristics						
Age	77.38 ± 8.23	77.33 ± 4.54	75.00 ± 11.88	74.83 ± 7.30	0.792	
Years of education	13.23 ± 3.27	10.67 ± 4.79	13.33 ± 3.55	11.92 ± 3.55	0.280	
Sex (M/F)	8/5	6/6	10/2	6/6	0.290	
Years from clinical onset		4.00 ± 2.28	8.25 ± 5.61	9.67 ± 10.43	0.140	
UPDRS III—motor part			32.83 ± 14.25	27.42 ± 15.80	0.387*	
LEDD			607.92 ± 265.29	516.00 ± 391.26	0.508*	
Neuropsychological test						
MMSE (0–30)	28.77 ± 1.44	22.09 ± 4.85	25.65 ± 4.85	25.70 ± 3.08	*0.002*	*AD < HC*
TMT part A (time)	42.31 ± 18.41	113.92 ± 100.37	120.08 ± 122.34	69.00 ± 57.07	0.076	
TMT part B (time)	83.69 ± 51.15	231.29 ± 50.28	279.55 ± 268.43	195.82 ± 116.54	*0.025*	*Left-sided PD > HC*
TMT part B-A (time)	42.00 ± 39.85	167.14 ± 62.62	163.18 ± 152.34	141.36 ± 99.13	*0.013*	*Left-sided PD > HC; AD > HC*
Stroop test—time interference effect	23.19 ± 15.51	42.38 ± 26.69	46.17 ± 73.01	23.58 ± 25.98	0.401	
Stroop test—error interference effect	0.42 ± 0.98	5.28 ± 8.02	3.67 ± 8.61	1.67 ± 3.53	0.238	
Face memory test	4.92 ± 0.28	4.08 ± 1.08	4.58 ± 0.67	4.67 ± 0.49	*0.032*	*AD < HC*
Verbal span forward (0–9)		5.58 ± 1.06	5.27 ± 0.54	5.59 ± 0.43	0.516	
Verbal span backward (0–9)		3.66 ± 0.78	3.87 ± 0.83	4.02 ± 0.59	0.539	
Immediate recall of 15 words (0–75)		24.83 ± 4.36	36.45 ± 12.82	39.45 ± 6.41	*0.002*	*AD < Left-sided PD; AD < Right-sided PD*
Delayed recall of 15 words (0–15)		1.59 ± 2.14	6.69 ± 4.29	7.79 ± 3.08	*< 0.001*	*AD < Left-sided PD; AD < Right-sided PD*
Raven coloured matrices (0–36)		24.56 ± 4.33	26.97 ± 6.62	27.14 ± 5.92	0.558	
MFTC accuracy (0–1)		0.82 ± 0.19	0.86 ± 0.14	0.95 ± 0.05	0.096	
MFTC false alarms		2.11 ± 3.13	1.78 ± 5.07	2.43 ± 5.16	0.948	
MFTC time		65.81 ± 59.86	73.55 ± 49.13	84.32 ± 59.73	0.773	

Significant p values ($p < 0.05$) are in italics. Tukey's multiple comparisons adjustment was applied to pairwise tests

SD, standard deviation; *LEDD*, levodopa equivalent daily dose; *MMSE*, Mini Mental State Examination; *TMT*, Trail Making Test; *MFTC*, Multiple Features Target Cancellation

* Statistical comparisons are limited to PD groups

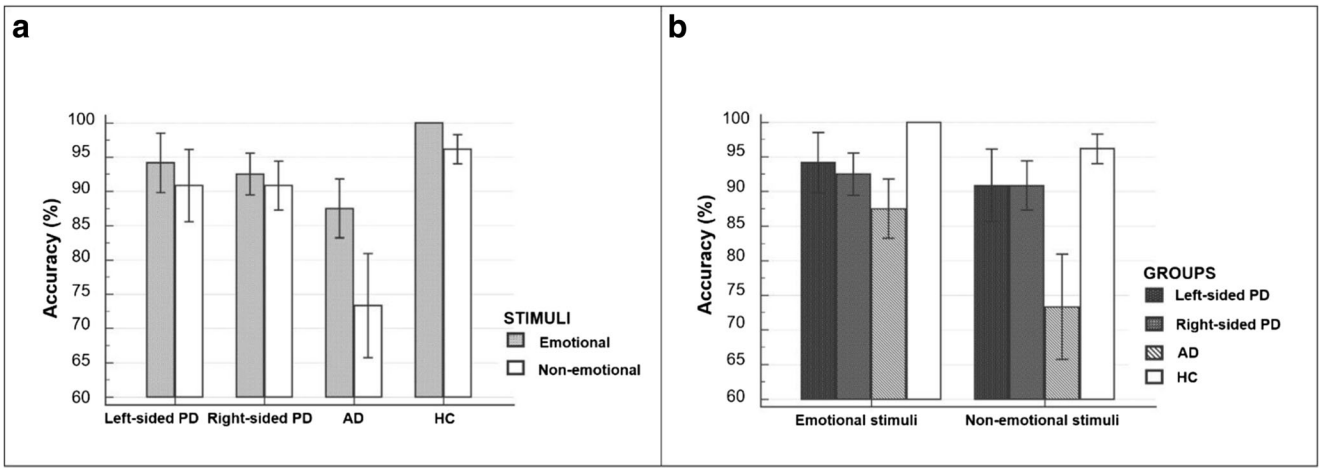

Fig. 1 Recognitions (means and standard errors) of emotional and non-emotional stimuli in left-sided and right-sided PD (Parkinson's disease), AD (Alzheimer's disease) and HC (healthy controls) groups. In panel a, within group differences; in panel b, between groups differences

Furthermore, the consistency between the ratings provided before and after the recognition task observed in all groups confirmed that the aesthetic preference is preserved in brain-damaged patients and independent of memory capacity [9].

In conclusion, the emotional valence of the stimuli does not facilitate memory processes in right-sided PD, thus suggesting a role for the nigrostriatal, mesocortical and mesolimbic circuitry of the left hemisphere in the emotional-reward system related to the aesthetic experience, possibly mediated by language. Additional studies on larger samples of patients and more sensitive memory tasks are needed to corroborate these findings.

Lastly, from a rehabilitative perspective, the facilitation of the memory processes produced by the emotional value conveyed by the artworks further supports the use of art therapy in neurological pathologies associated with memory disorders [10, 11].

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Compliance with ethical standards

Authors' roles NC, SDT and MCS conceived the study. ES and AC planned the study design. MLM and VDD contributed to patient recruitment and helped with implementation. SDT and AC performed statistical analyses. All authors contributed to writing, review and editing of the manuscript and approved the final content.

Ethical compliance statement Each participant provided informed consent and the study was approved by the Ethics Committee of our Institution.

Conflict of interest The authors declare that they have no conflicts of interest.

References

1. Pelowski M, Markey PS, Forster M, Gerger G, Leder H (2017) Move me, astonish me… delight my eyes and brain: the Vienna integrated model of top-down and bottom-up processes in art perception (VIMAP) and corresponding affective, evaluative, and neurophysiological correlates. Phys Life Rev 21:80–125. https://doi.org/10.1016/j.plrev.2017.02.003
2. Di Dio C, Gallese V (2009) Neuroaesthetics: a review. Curr Opin Neurobiol 19(6):682–687. https://doi.org/10.1016/j.conb.2009.09.001
3. Péron J, Dondaine T, Le Jeune F, Grandjean D, Vérin M (2012) Emotional processing in Parkinson's disease: a systematic review. Mov Disord 27(2):186–199. https://doi.org/10.1002/mds.24025
4. Weil RS, Schrag AE, Warren JD, Crutch SJ, Lees AJ, Morris HR (2016) Visual dysfunction in Parkinson's disease. Brain 139(11): 2827–2843. https://doi.org/10.1093/brain/aww175
5. Di Tella S, Baglio F, Cabinio M, Nemni R, Traficante D, Silveri MC (2018) Selection processing in noun and verb production in left- and right-sided Parkinson's disease patients. Front Psychol 9:1241. https://doi.org/10.3389/fpsyg.2018.01241
6. Verreyt N, Nys GM, Santens P, Vingerhoets G (2011) Cognitive differences between patients with left-sided and right-sided Parkinson's disease. A review. Neuropsychol Rev 21(4):405–424. https://doi.org/10.1007/s11065-011-9182-x
7. Cupchik GC, Vartanian O, Crawley A, Mikulis DJ (2009) Viewing artworks: contributions of cognitive control and perceptual facilitation to aesthetic experience. Brain Cogn 70(1):84–91. https://doi.org/10.1016/j.bandc.2009.01.003
8. Lindquist KA, MacCormack JK, Shablack H (2015) The role of language in emotion: predictions from psychological constructionism. Front Psychol 6:444. https://doi.org/10.3389/fpsyg.2015.00444
9. Silveri MC, Ferrante I, Brita AC, Rossi P, Liperoti R, Mammarella F, Bernabei R, Marini Chiarelli MV, De Luca M (2015) "The memory of beauty" survives Alzheimer's disease (but cannot help memory). J Alzheimers Dis 45(2):483–494. https://doi.org/10.3233/JAD-141434
10. Mirabella G (2015) Is art therapy a reliable tool for rehabilitating people suffering from brain/mental diseases? J Altern Complement Med 21(4):196–199. https://doi.org/10.1089/acm.2014.0374
11. Mirabella G, De Vita P, Fragola M, Rampelli S, Lena F, Dilettuso F, ... Modugno N (2017). Theatre is a valid add-on therapeutic intervention for emotional rehabilitation of Parkinson's disease patients. Parkinson's Disease 2017: 7436725. https://doi.org/10.1155/2017/7436725