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Primary vision and facial emotion recognition in early Parkinson's disease ☆

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ABSTRACT

Background: In early stages of idiopathic Parkinson's disease (IPD), lower order vision (LOV) deficits including reduced colour and contrast discrimination have been consistently reported. Data are less conclusive concerning higher order vision (HOV) deficits, especially for facial emotion recognition (FER). However, a link between both visual levels has been hypothesized.
Objective: To screen for both levels of visual impairment in early IPD.
Methods: We prospectively recruited 28 IPD patients with disease duration of 1.4 +/− 0.8 years and 25 healthy controls. LOV was evaluated by Farnsworth-Munsell 100 Hue Test, Vis-Tech and Pelli-Robson test. HOV was examined by the Ekman 60 Faces Test and part A of the Visual Object and Space recognition test.
Results: IPD patients performed worse than controls on almost all LOV tests. The most prominent difference was seen for contrast perception at the lowest spatial frequency ($p = 0.0002$). Concerning FER IPD patients showed reduced recognition of "sadness" ($p = 0.01$). "Fear" perception was correlated with perception of low contrast sensitivity in IPD patients within the lowest performance quartile. Controls showed a much stronger link between "fear" perception" and low contrast detection.
Conclusion: At the early IPD stage there are marked deficits of LOV performances, while HOV performances are still intact, with the exception of reduced recognition of "sadness". At this stage, IPD patients seem still to compensate the deficient input of low contrast sensitivity, known to be pivotal for appreciation of negative facial emotions and confirmed as such for healthy controls in this study.

1. Introduction

Processing visual information occurs at two levels. The lower order vision (LOV) is involved in colour identification, contrast sensitivity and processing of line orientation. Higher order vision (HOV) is responsible for further processing visual input, leading to object recognition, space and motion perception, face identification, and facial emotion recognition (FER). During the early motor stage of idiopathic Parkinson's disease (IPD), patients regularly show LOV deficits. Standardized clinical tests supported by computer-driven evaluation, optical coherence tomography and neuroimaging techniques have convincingly shown that colour discrimination and contrast sensitivity are impaired [1–3]. In terms of HOV, studies yield less conclusive results. IPD patients show impairment for space perception and object recognition [4]. However, most of the studies have been performed at an advanced stage of the disease. Controversy has also arisen concerning the recognition of facial expressions. While it is generally accepted that IPD patients may be most susceptible to misperception of negative emotions [5–7], the causes of these deficits remain controversial. Potential contributing factors have been proposed such as male gender, predominant right-hemisphere pathology, executive dysfunction, apathy, dopaminergic therapy or its withdrawal and deep brain stimulation of the nucleus subthalamicus [7–9]. At an early disease stage – the focus of interest of the present study – some authors have reported marked impairment [5], others only mild restrictions [10], or no deficit at all [11]. Evidently, other visuo-spatial deficits may play a substantial role as well, but have not been analysed as such. A potential important link is suggested by findings physiologically linking intact perception of low contrast to rapid recognition of negative emotional face expressions [12].

Based on these findings we designed the present study and hypothesized that, at an early motor stage of IPD, patients may show impaired LOV, but would produce only mild deficits of HOV, especially in the domain of FER. So far no study has systematically investigated such potential links between LOV and FER at an early IPD stage.

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2. Methods and materials

2.1. Subjects

Within an ongoing study on the evolution of non motor signs in early IPD [13], we recruited 28 patients at a very early stage of the disease. Thus all patients had to satisfy to the strict inclusion criterion of equal or less than three years of disease duration. The diagnosis was established according to the UK Parkinson's Disease Society Brain Bank clinical diagnostic criteria [14]. Twenty-five healthy control subjects were recruited, mainly as spouses of IPD patients or by the mass media. Visual acuity was tested in all subjects, while wearing their best glasses and at a five meter distance from the board. All had normal visual acuity as assessed by a Snellen fraction >0.6. In a standardized way all subjects were proactively and systematically asked about visual hallucinations and illusions. IPD patients were tested on their usual dopaminergic medication. All subjects gave informed written consent before entering the study. The study was approved by the National Ethical Research Committee of Luxembourg (CNER).

2.2. Methods

2.2.1. LOV evaluation

Contrast sensitivity was tested by two wall-mounted charts: Vistech test and Pelli Robson test. Colour discrimination was assessed by the Farnsworth-Munsell 100 Hue test.

In the Vis-tech test [15] chart photographs of sinusoidal gratings are presented and thresholds for different spatial frequencies are determined by the subject recognising the correct orientation of the stripes of the gratings varying in contrast. Subjects are placed at three meters from the chart. The test is performed in normal daylight conditions. For each of the five different spatial frequencies (1.5 cycles per degree (cpd), 3 cpd, 6 cpd, 12 cpd, 18 cpd), nine figures with decreasing contrasts are presented. Subjects have to determine the line orientation (to the left, right, up, down). The scores for each spatial frequency are the sum of correctly identified items (1–9). In the Pelli-Robson test [16] standard sized letters of uniform spatial frequency are presented with decreasing contrast on a chart, as the subjects read along a line, allowing threshold detection. There are two triplets of letters per line, the contrast being decreased for each triplet. This chart is placed at one meter from the subjects and performed in normal daylight conditions. In the Farnsworth-Munsell 100 Hue test [17], subjects have to place caps of different shades of colours in the right order. The test is performed under daylight conditions by using a special daylight lamp (Richmont Flat Tray True-Daylight Illuminator). The caps are arranged in four boxes, each containing a fixed anchor cap at each end. There are 4 colour axes: yellow, blue, green and red. For each colour axis an error score is calculated, following the manufacturer's recommendations and as similarly applied in other studies [13].

2.3. FER evaluation

FER was evaluated with the Ekman 60 Faces Test (E60FT). This test explores six emotions: anger, fear, disgust, happiness, sadness, and surprise [18]. Subjects are placed in front of a computer screen where they are shown ,one by one, 60 greyscale photographs of faces expressing one of the six emotions. Subjects have to indicate which one of the six possible emotions is expressed. For each emotion, there are ten portraits expressing this emotion, so the possible score for each emotion ranges between 0 and 10.

2.4. Visual object perception (VOP)

Visual object perception was evaluated by part A of the Visual Object and Space Perception (VOSP) battery [19]. There are four subtests. In the subtest "incomplete letters" twenty letters that are partially degraded have to be identified. In the subtest "silhouettes" the participant has to identify 15 animal silhouettes and 15 inanimate object silhouettes, all presented in an unusual perspective. In the subtest "object decision" four objects are presented in a rotated manner; three are not real objects; the subject has to identify the one real object out of the four. Finally, in the subtest "progressive silhouettes", the subject has to identify a gun and a trumpet; both objects are presented as ten silhouettes that are initially abstract and progressively revealing more details.

2.5. Executive functions and sequencing of the tests

Executive functions were evaluated by the Frontal Assessment Battery (FAB) and motor sequencing by the Trail Making Test A (TMT A). The tests were administered by two experienced neuropsychologists (GH and VP) on two different days. FER and VOP were tested during the first session, FAB, TMTA and LOV during the second session. Importantly, in order to avoid reduction of the attention span, pauses were regularly inserted in the testing program.

2.6. Data analysis

The means between the two groups were compared by using ANOVA on raw values and by using the Mann–Whitney test. The interdependency between the test results within groups was analysed with Pearson correlation coefficients. We defined the values derived from the tests Farnworth-Munsell, Vis-tech and Pelli-Robson as primary outcome variables. For multiple comparisons we used the Hochberg comparison (1988) to correct the individual p values (proc multitest in SAS version 9.3).

3. Results

3.1. Descriptive demographics

Gender distribution was similar in both groups. IPD group: 15 women and 13 men; control group: 15 women and 10 men (NS). Age was similar in both groups: 62.49 +/− 11.9 years in the IPD group versus 59.57 +/− 7.4 years in the control group ($p = 0.09$). In IPD patients disease duration was 1.36 +/− 0.8 years and the score on the motor part of the Unified Parkinson Disease Rating Scale (UPDRS), while being "on" medication, was 8.39 +/− 3.52 [range: 0–25]. The mean daily levodopa dosage in the IPD patients was 198.4 ± 248.3 mg.

3.2. Cognitive performances

No subject had a pathological score on the MMSE and the mean values were: 28.8 ± 1.4 [range: 25–30] for the IPD patients and 29.4 ± 0.7 [range: 28–30] for the controls ($p = 0.03$). No subject scored >0 at the Clinical Dementia Rating Scale (CDRS). No participant reported visual hallucinations. IPD patients had lower performances than controls on the FAB (15.46 +/− 1.57 vs. 17.08 +/− 0.95, $p < 0.00001$). They also performed more slowly on the TMT A test than the controls (42.8 ± 13.9 vs. 36.0 ± 10.8, $p = 0.04$).

3.3. LOV performances

3.3.1. Colour discrimination and contrast sensitivity (Table 1)

The IPD patients performed worse than control subjects on all the LOV tests. Concerning colour discrimination, there was a significant difference for one of the four colour axes (red: $p = 0.03$). The total error score was higher in IPD patients than in control subjects, but not significantly, due to high variability. Concerning contrast sensitivity evaluated by Vistech, the highest difference concerned the lowest spatial frequency (1.5 cycles/degree: $p = 0.0002$). The IPD patients performed worse than control subjects on the Pelli-Robson test for binocular ($p = 0.0002$) vision only. All results are listed in Table 1 which, of