FACES OF EMOTION IN PARKINSON'S DISEASE:

Micro-expressivity and Bradykinesia during Voluntary Emotions

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ABSTRACT

Previous investigators have has suggested that the "masked facies" of Parkinson's disease involves spontaneous, but not voluntarily expressed emotions. In contrast, we hypothesized that even voluntary expressions are affected due to decreased dopaminergic innervation of frontal motor systems in PD. To test this hypothesis, we used sophisticated computer imaging techniques to quantify dynamic fa cial expressions that were voluntarily produced by PD patients and normal controls. Neither group was demented nor clinically depressed. Relative to controls, Parkinson patients had reduced facial mobility (**micro-expressivity**) and were significantly slowed in reaching a peak expression (**bradykinesia**). These findings add to the literature in two ways: First, the masked facies of PD is not limited to spontaneous facial emotions, but also involves voluntary or posed facial expressions. Second, the use of PD as a model system for the neuroanatomic dissociation between voluntary and spontaneous expressions is unjustified. Both systems appear detrimentally influenced by depleted dopamine innervation of the brain.

BACKGROUND

Facial expressions are complex signals caused by rapid changes in the face muscles. The neural circuitry underlying these signals differs depending on whether the emotions are spontaneously (i.e., limbic, subcortical) or voluntarily initiated (i.e., frontal, pyramidal). Evidence for this dissociation has derived from clinical observations of with cortical lesions. It also derives from patients with Parkinson's disease who normally display "masked " facies " but are able to voluntarily pose appropriate facial expres-sions when told to do so. Thus, patients with PD have been described as showing impaired spontaneous but normal voluntary expressions.

Schematic of innervation of face by frontal cortex For voluntary movments

HYPOTHESIS: We present an ***alternative*** to the traditional view about facial expressivity in PD. We hypothesize that even voluntary facial expressions are abnormal in PD due to depleted dopaminergic innervation of frontal lobe regions that are involved in voluntary movement.

SUBJECTS

8 patients with idiopathic Parkinson's Disease, on medications, tested during "on" period; 6 males, Hohn & Yahr < 3, duration of PD = 5.2 years,

8 age and education matched healthy controls (6 males, 2 females)

	Age	Education	MMSE	Geriatric Depression Scale
Parkinson	69.1	15.2	28.3	7.8
Controls	66.3	15.3	29.2	4.5

PROCEDURES

Overall Design

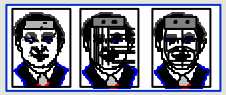
Videotape subjects → **Capture video frames** *digitize* → **Analyze Facial Expressions** *custom software"*
a. Define face landmarks
b Extract regions of interest
c. Quantify local expression

VIDEOTAPING & DIGITIZING FRAMES

Participants were videotaped while making voluntary emotional ex pressions (sad,anger, fear, disgust, surprise, happy). Each trial began with the presentation of a card denoting the target emotion and was followed by an auditory tone. The tone cued the Ss to make the target emotion. For each expression the initial 30 videoframes were captured, digitized, and saved on the hard drive of a computer. Each digitized frame was 30 ms in duration and represented 640 X 480 pixel array at 256 levels of grey scale.

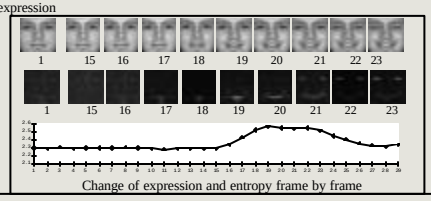
LANDMARKING THE FACE

Sixteen anatomic landmarks were placed on the face using a mouse. This was done on the 1st frame of an expression sequence. Custom soft-ware in PV Wave (CHEES) used these landmarks to automatically compute geographic Boundaries or regions of interest (ROI) that were applied to all images of a particular expression.



COMPUTING MOVEMENT CHANGE (ENTROPY)

For each expression, pixel intensities of adjacent frames were subtracted to obtain difference images over time (See below). On these difference images, we plotted histograms of the region of interest (See below). Custom software, developed by Gokcay , was then used to compute total Entropy, a quantitative index of movement change over the face during the course of the entire expression



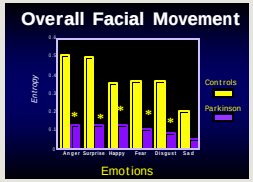
RESULTS

Analyses:

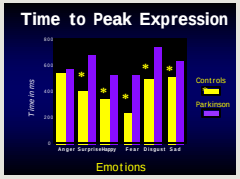
Overall entropy and the time to reach a peak expression were obtained for each expression. These dependent variables were independently analyzed using repeated measures Group (PD,NC) X Affect ANOVAs.

Results

1. ***Micro-Expressivity*: PD patients displayed significantly less facial movement as indexed by Entropy ($p < 0.0001$)**
2. ***Bradykinesia*: PD patients took longer to reach the peak facial expression ($p < 0.01$)**



Relative to the Controls, the PD group was facially less mobile, as indexed by entropy, on all facial expressions except sadness.



Overall, the PD was significantly slower than the controls in reaching a peak expression for all emotions except for anger.

CONCLUSION

We used sophisticated computer imaging techniques to quantify dynamic facial expressions that were voluntarily produced. Relative to controls, Parkinson patients had reduced facial mobility (**micro-expressivity**) and were significantly slowed in reaching a peak expression (**bradykinesia**) relative to controls. These parameters correspond to to what is observed in other aspects of the motor behavior (e.g., hypometria micrographia) associated with PD.

Our findings add to the current literature on facial expressivity in two ways. First, the "masked facies" of Parkinson disease is not limited to spontaneous facial emotions, but also involves voluntary or posed facial expressions. Second, the use of PD as a model system for the neuroanatomic dissociation between voluntary and spontaneous expressions is unjustified. Both systems appear detrimentally affected by depleted dopamine innervation of the brain.