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7
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Michele Poletti
Orbitofrontal cortex-related executive functions in children and adolescents: their assessment and its ecological validity 7

Rajakumari P. Reddy - Rajan Jamuna - Lata Hemchand
Integrated cognitive retraining in agenesis of corpus callosum: a single case study 29

Sherin P. Antony - Rajan Jamuna - Satish M. Kini Murali Chakravarthy
Neuropsychological deficits in patients with myocardial infarction 37

Giovanni Albania - Riccardo Pignatti - Alessandro Mauro Carlo Semenza
Presence of freezing and naming abilities in Parkinson's disease 51

Presence of freezing and naming abilities in Parkinson's disease

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Abstract

We found that mildly cognitive impaired patients with PD and freezing are less impaired than comparable patients with PD and no freezing in action naming rather than in object naming. This effect may be attributable to the compensatory activation of Broca's area. More, the presence of freezing can induce patients to create behavioural strategies, by offering major care on carrying out executive tasks, including verb naming.

Keywords: Parkinson's Disease; Freezing; Language; Naming; Broca's Area

1. Introduction

Gait disorder is one of the most relevant symptoms for progression of disability (Gray & Hildebrand, 2000; Aarsland et al., 2000) in patients with Parkinson's disease (PD), particularly for those experiencing the phenomenon of freezing (F), where patients can meet with sudden unwanted arrests in their walking.

PD patients with F are involved into ipokinetic-rigid forms much more than into the tremorigen ones, and are more likely to develop cognitive

impairments (Giladi et al., 2000). Yet, few neurofunctional studies have been proposed to better understand the pathogenesis of F: in one SPECT study (Fabre et al., 1998), it was not found any deficit of cortical perfusion, while another study did demonstrate hypoperfusion in the orbital frontal cortex of patients with F (Matsui et al., 2005). A PET study (Albani et al., 2001) showed how, in PD patients without F (NF), moving a joystick to a given rhythm with the right hand enhances activation of the contralateral supplementary motor cortex, while in patients with F a major activation in Broca's area and in the contralateral sensory-motor area was observed. In order to account for this difference, and, in particular, for the specific activation of Broca's area, it has been proposed that PD patients with F tend to compensate their problems by generating internal verbal cues that would help them in controlling their movements.

One attribute of Broca's area is its specific function in retrieving verb names (naming of actions), while nouns names (naming of objects) is, by contrast, supported by more posterior perisylvian areas (Perani et al., 1999). Investigations on cognitive deficits in PD showed that, indeed, an action verb fluency difficulty is one of the distinctive features of transition into dementia associated with PD (Piatt et al., 1999; Peran et al., 2003). Damage to the fronto-striatal system in PD has been considered as responsible for these findings.

On the basis of the above reported evidence we predicted that, insofar Broca's area is more activated in PD patients with F, respect to PD NF, action naming should be relatively less disturbed in the former than in the latter group.

2. Participants and methods

Sixty-four PD (32 Males, 32 Females; mean age: 67.31 y.o., range: 47-88); mean education: 8.02 years, range 3-18) admitted at the Neurorehabilitation Unit of the Istituto Auxologico Italiano were submitted to a full neuropsychological investigation. In particular, these evaluations excluded the presence of main linguistic defects through the Aachener Aphasie Test (Huber et al., 1983) spontaneous speech evaluation, and the phonemic and semantic fluency. Patients with invalidating hypovision, hypacusia or dysarthria were also discarded. On the basis of their score at Mini-Mental State Examination (MMSE), they were classified in either a Mild Deteriorated (MD, with $17 < MMSE < 27$) or a Non Deteriorated group (ND, $MMSE \geq 27$). The restrictive cut-off score of 27 was applied because it could emphasize the sensitivity

of MMSE in symptomatic patients (Kukull et al., 1994). This subdivision classified 32 PD (15 males and 17 females; mean age: 70.09 y.o., ranging from 48 to 88; mean education: 7.13 years, ranging from 3 to 18) into the MD group and they entered the study (Table 1). After that, patients were further divided into two balanced groups, on the basis of the presence or not of freezing of gait. As far as the F group was selected according to the established clinical criteria (Factor et al., 2002); moreover, a Pull-text and Standing up from a chair were rated according to the UPDRS (Fahn et al., 1987). The NF group included patients who showed isolated tremor at rest and/or segmental hypokinesia especially of upper limbs in absence of clinical signs of gait or posture impairment. Again, this subdivision classified 18 patients into the F group and 14 into the NF group. Participants in the two groups were comparable for age, education and MMSE score (Table 1). Twenty-eight age- and education-matched people with no evidence of neurological or psychiatric disease constituted the control group (Table 1). Participants' naming abilities were tested with the object and action naming test from the Miceli, Burani and Laudanna's battery (1990), a widely used instrument for the assessment of aphasia in Italian. They were asked to name, one at a time, each of the 52 pictures of objects and the 50 pictures of actions included in the battery. Participants received a score of 2 if they could correctly name the picture within 10 seconds, a score of 1 if they could provide the correct answer within a minute and a score of 0 for a wrong answer. Raw scores were transformed in percentage to permit comparisons between unequal numbers of pictures of objects and pictures of actions. A ratio index "object/action" was also calculated for each subject in order to enlighten the disproportionate difficulty encountered with nouns or verbs. The dependent variables were constituted by scores obtained on object naming, action naming and object/action rate.

3. Data analysis

A series of ANOVA were carried out on three independent groups (GD, NGD and Controls), all compared on three dependent variables: object naming, action naming and object/action rate. Post-hoc analyses were conducted via Fisher's PLSD.

4. Results

A one-way ANOVA revealed that the groups differed in naming objects ($F(2,57) = 15.543$ $p < 0.0001$, Adjusted $R^2 = 0.330$,), actions ($F(2,57) = 27,115$, $p < 0.0001$, Adjusted $R^2 = 0.470$,) and in objects/actions rate ($F(2,57) = 15,240$, $p < 0.0001$, Adjusted $R^2 = 0.326$). Post-hoc analyses evidenced both GD and NGD worse performances in naming objects respect to controls ($p < 0.0001$ in both cases), with no difference between GD and NGD; whilst both GD and NGD performed again worse than controls in naming actions ($p < 0.0001$ in both cases) but also NGD performed worse than GD ($p = 0.049$). The confrontation of objects/actions rate evidenced harder difficulties with naming actions for both GD ($p = 0.012$) and NGD patients ($p < 0.0001$) with respect to controls, but a relative spare of naming actions for GD respect to NGD ($p = 0.006$). Details are provided in Table 1.

5. Discussion

A dissociation in object-actions naming, with disproportionate action deficit in PD patients has been found even in relatively early stages of PD, with mild or no mental deterioration, in absence of a similar effect in a repetition task (Bertella et al., 2002). By contrast, a previous investigation on data from spontaneous speech indicated a poorer verb vocabulary in early AD, relative to PD (Pignatti et al., 2006). All these observations led to state that the action deficit in PD should be attributed to a lexical level rather than to a phonological-articulatory output (repetition is not impaired) or to a semantic level.

This work confirms that naming of actions appears to be a very demanding task, showing action-naming ability already impaired in PD with mild levels of cognitive impairment, respect to controls.

After which, our study has focused on the potential clinical and functional correlation between two different, linguistic and motor, disorders, underlying a similar circuit: lexical involvement and freezing of gait in PD.

The action naming defect in PD seem to belong to clinical picture of dysexecutive syndrome, where verbal recall memory and verbal fluency are affected. More specifically, fluency tasks involve different cognitive processes, including immediate attention in order to initiate the generation of words, an available knowledge base from which to select relevant items, an ability to retrieve items, an ability to retrieve from declarative memory and executive abilities to coordinate these processes, including working memory to monitor performance and avoiding breaking rules (Ruff et al., 1997).

Table 1. Clinical characteristics and experimental task results in Parkinson's disease (PD) with freezing (F) and without freezing (NF)

	MMSE Score (range)	Age Years (range)	Education Years (range)	Object naming %	Action naming %	Object/Action rate
Controls (n = 28)		66.46 ± 10.60 (59-90)	8.21 ± 3.86 (3-16)	92.76 ± 9.08	85.50 ± 12.24	1.10 ± 0.12
PD NF (n = 14)	23.85 ± 2.91 (17-26)	70.14 ± 10.93 (48-88)	6.14 ± 2.38 (4-13)	78.92 ± 10.97	55.36 ± 14.35	1.49 ± 0.32
PD with F (n = 18)	23.67 ± 2.91 (17-26)	70.01 ± 8.05 (51-80)	7.89 ± 4.71 (3-18)	79.43 ± 8.53	65.00 ± 14.64	1.27 ± 0.24
Fischer's PLSD Significance Level				NF vs. Controls*** F vs. Controls***	NF vs. Controls*** F vs. Controls*** NF vs. F*	NF vs. Controls*** F vs. Controls** NF vs. F**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.0001$.

Recent neurofunctional studies (Laisney et al., 2009) confirmed that impaired performances in phonemic fluency are attributable mainly to the hypometabolism of left frontal lobe, whilst a loss in semantic fluency should be correlated with gray matter of temporal, frontal and cerebellar areas (Pereira et al., 2009). Naming of objects had similar neural underpinnings as semantic fluency: both of them are indeed more impaired when a deterioration of temporal lobes (e.g. in Alzheimer-type dementia) is occurring and, by contrast, preserved when frontal areas are mainly reduced, as in PD (Melrose et al., 2009).

PD with F, at least when a mild cognitive deterioration is found, are relatively less impaired than PD NF, in action naming with respect to object naming: this result emerged especially when considering the objects/actions rate, which allowed us to obtain an index based on each subject's performance. Since the degree of deterioration in F and NF groups was comparable, this effect may indeed be due to the selective, compensatory, activation of Broca's area that would thus stimulate action retrieval with respect to object retrieval. In patients with F, inside the motor reorganization, it is well known the involvement of other regions, such as the sensory one, not strictly involved in the control of locomotion, in order to supply the hypoactivation of supplementary motor area and compensate the working memory deficit by means of an attentional reinforce. Thus, presence of freezing can induce to a compensatory behavioural strategy, by offering major care on execution of verbal tasks, in order to reduce the dysexecutive defect. Further investigations are needed to clarify the interaction of pre-motor and motor areas with verb retrieval (Silveri & Ciccarelli, 2007) as those areas appear to be strongly involved in the motor verb production.

References

Aarsland, D., Larsen, P., Tandberg, E., & Laake, K. (2000). Predictors of nursing home placement in Parkinson's disease: a population-based, prospective study. *Journal of the American Geriatric Society*, 48, 938-942.

Albani, G., Kunig, G., Martin-Soelch, C., Mauro, A., Priano, L., Martignoni, E., & Leenders, K.L. (2001). The role of language areas in motor control dysfunction in Parkinson's disease. *Neurological Sciences*, 22, 43-44.

Bertella, L., Albani, G., Greco, E., Priano, L., Mauro, A., Marchi, S., et. al. (2002). Noun verb dissociation in Parkinson's disease. *Brain & Cognition*, 48, 277-280.

Fabre, N., Brefel, C., Sabatini, U., Celsis, P., Montastruc, J.L., Chollet, F., et al. (1998). Normal frontal perfusion in patients with frozen gait. *Movement Disorders*, 13, 677-683.

Factor, S.A., Jennings, D.L., Molho, E.S., & Marek, K.L. (2002). The natural history of the syndrome of primary progressive freezing of gait. *Archives of Neurology*, 59, 1778-1783.

Fahn, S., Elton, R.L, & Members of the UPRDS Development Committee (1987). Unified Parkinson's Disease Rating Scale. In: Fahn, S., et al. (eds.). *Recent Developments in Parkinson's Disease II.* New York: MacMillan Health Care Information, pp. 153-163.

Giladi, N., Mc Dermott, M.P., Fahn, S. Przedborski, S., Jankovic, J., Stern, M., et al. (2001). Freezing of gait in PD: prospective assessment in the Datatop cohort. *Neurology*, 56, 1712-1721.

Gray, P., & Hildebrand, K. (2000). Fall risk factors in Parkinson's disease. *Journal of Neuroscience Nursing*, 32, 222-228.

Gurd, J.M., Amunts, K., Weiss, P.H., Zafiris, O., Zilles, K., Marshall, J.C., & Fink, G.R. (2002). Posterir parietal cortex in implicated in continuous switching between verbal fluency tasks: an fMRI study with clinical implicants. *Brain*, 125, 1204-1238.

Huber, W., Poeck, K., Weniger, D., & Willmes, K. (1983). *The Aachener Aphasie Test (AAT).* Göttingen: Hogrefe Verlag.

Kukull, W.A., Larson, E.B., Teri, L., Bowen, J., McCormick, W., & Pfanschmidt, M.L. (1994). The Mini-Mental State Examination Score and the clinical diagnosis of dementia. *Journal of Clinical Epidemiology*, 47, 1061-1067.

Laisney, M., Matuszewski, M., Mézenge, F., Belliard, S., de la Sayette, V., Eustache F., & Desgranges, B. (2009). The underlying mechanisms of verbal fluency deficit in frontotemporal dementia and semantic dementia. *Journal of Neurology*, 256, 1083-1094.

Matsui, H., Udaka, F., Miyoshi, T., Hara, N., Tambura, A., Oda, M., et al. (2005). Three-dimensional stereotactic surface projection study of freezing of gait and brain perfusion image in Parkinson's disease. *Movement Disorders*, 20, 1272-1277.

Melrose, R.J., Campa, O.M., Harwood, D.G., Osato, S., Mandelkern, M.A., & Sultzer, D.L. (2009). The neural correlates of naming and fluency deficits in Alzheimer's disease: an FDG-PET study. *International Journal of Geriatric Psychiatry*, 24, 885-893.

Miceli, G., Laudanna, A., & Burani, C. (1990). *Battery for the Assessment of Aphasic Deficits.* Milano: Associazione per lo Sviluppo delle Ricerche Neuropsicologiche.

Peran, P., Rascol, O., Demonet, J.F., Celsis, P., Nespoulous, J.L., Dubois, B., & Cardebat, D. (2003). Deficit of verb generation in nondemented patients with Parkinson's disease. *Movement Disorders*, 18, 150-156.

Perani, D., Cappa, S.F., Schnur, T., Tettamanti, M., Collina, S., Rosa, M.M., & Fazio, F. (1999). The neural correlates of verb and noun processing. A PET study. *Brain*, 122, 2337-2344.

Pereira, J.B., Junqué, C., Martí, M.J., Ramirez-Ruiz, B., Bartrés-Faz, D., & Tolosa, E. (2009). Structural brain correlates of verbal fluency in Parkinson's disease. *NeuroReport*, 20, 741-744.

Piatt, A.L., Fields, J.A., Paolo, A.M., Koller, W.C., & Troster, A.I. (1999). Lexical, semantic, and action verbal fluency in Parkinson's disease with and without dementia. *Journal of Clinical and Experimental Neuropsychology*, 21, 435-443.

Pignatti, R., Ceriani, F., Bertella, L., Mori, I., & Semenza, C. (2006). Naming abilities in spontaneous speech in Parkinson's and Alzheimer's disease. *Brain & Language*, 99, 124-125.

Ruff, R.M., Light, R.H., Parker, S.B., & Levin, H.S. (1997). The psychological construct of world fluency. *Brain & Language*, 57, 394-405.

Silveri, M.C., & Ciccarelli, N. (2007). The deficit for the word-class "verb" in corticobasal degeneration: Linguistic expression of the movement disorder? *Neuropsychologia*, 45, 2570-2579.