

## Depression and Coping as Predictors of Change After Deep Brain Stimulation in Parkinson's Disease

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### Key words

- Anxiety
- Coping
- Deep brain stimulation
- Depression
- Parkinson disease
- Quality of life

### Abbreviations and Acronyms

**BDI-II:** Beck Depression Inventory version II

**M0:** Baseline

**M6:** 6 months after the operation

**M12:** 12 months after the operation

**MDRS:** Mattis Dementia Rating Scale

**MCS:** Mental Component Summary

**PCS:** Physical Component Summary

**PD:** Parkinson disease

**PDQ-39:** Parkinson Disease Questionnaire 39 Items

**QoL:** Quality of life

**SF-36:** Medical Outcomes Study 36-Item Short-Form Health Survey

**STAI-Y:** State-Trait Anxiety Inventory

**STN-DBS:** Subthalamic nuclei deep-brain stimulation

**UPDRS:** Unified Parkinson Disease Rating Scale

**WCC-R:** Ways of Coping Checklist—Revised



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### INTRODUCTION

Parkinson disease (PD) is a neurodegenerative disease with symptoms that are primarily treated by dopatherapy, an approach that gradually results in a number of adverse secondary effects. Since 1993, the high-frequency subthalamic nuclei deep-brain stimulation (STN-DBS) has been shown to improve motor symptoms of advanced PD. In carefully selected patients, this technique provides better medical improvement than the best medical management (10). Such interventions can dramatically change pa-

■ **BACKGROUND:** This study examined changes in motor function and quality of life (QoL) after subthalamic nuclei deep brain stimulation (STN-DBS) in patients with Parkinson disease (PD) and the role of psychosocial predictors on individual changes.

■ **METHODS:** Forty-one patients with advanced PD (29 men and 12 women; mean age: 62.0 ± 8.0; disease duration: 14.5 ± 5.7) completed self-report questionnaires before surgery and at 6 and 12 months after surgery. Psychosocial measures assessed coping strategies (Ways of Coping Checklist—Revised), symptoms of depression (Beck Depression Inventory version II), anxiety (State-Trait Anxiety Inventory), and QoL (Parkinson Disease Questionnaire 39 Items, Medical Outcomes Study 36-Item Short-Form Health Survey).

■ **RESULTS:** After surgery, motor function (Unified Parkinson Disease Rating Scale III and IV), global QoL (Parkinson Disease Questionnaire 39 Items) and Physical Component Summary of the Medical Outcome Study Short Form 36-items Health Survey improved, whereas the Mental Component Summary tended to deteriorate. Depression and anxiety were stable. Improvements in motor function and QoL were associated with younger age, shorter duration of illness, higher baseline distress (depression and anxiety), and changes in problem-focused coping. Improvements in mental QoL were associated with a less frequent use of coping focused on seeking social support.

■ **CONCLUSIONS:** STN-DBS is associated with major positive changes in PD affecting motor function and QoL. These changes are related to psychological variables, including emotional distress and coping. A better focus on these individual characteristics is necessary to improve care of patients with PD who undertake STN-DBS.

tients' lives by improving both their motor performance and their quality of life (QoL) (25, 51). However, few studies have examined the psychological changes induced by this intervention (23-49). The aim of the present research was to reveal the psychological changes before and after stimulation and to identify possible psychological predictors of positive developments.

At present, the effects of neurostimulation on emotional distress do not seem to be clear. Some results indicate that mood (depression and anxiety) tends to improve after the intervention (4), whereas others point to a high level of transient depressive disorders—of as much as 25%—and a higher-than-expected frequency of suicides among

patients who have been subject to this intervention (44, 53). STN-DBS gives rise to anxious anticipations and varied, intense reactions (7). A number of clinical observations have shown that the postsurgical depressive and anxious symptoms may be attributable to many different factors, such as direct iatrogenic effects of the intervention that disrupt social relations, marital difficulties, fear of stimulator failure, consequences of the discontinuation of dopamine treatment, and other psychosocial factors (16, 34).

The variety of the effects observed in association with STN-DBS emphasizes the importance of examining individual differences in the evolution of patients as well as

the individual factors that might explain the individual changes in motor functioning and QoL. Two psychological factors may help determine individual developments: the initial emotional distress and the patient's coping style.

As far as emotional distress is concerned, depression has been associated with a deterioration of the state of health in numerous diseases, such as cancer (19). In patients with implantable cardioverter-defibrillators, presurgical anxio-depressive symptoms have been associated with postsurgical complications and a reduced QoL after 14 months (41). In the case of multiple sclerosis, stress seems to be related to the development of new lesions (31). This link with negative outcomes is probably due to complex mechanisms that are both biological and, with reference to self-care behaviors, behavioral in nature (5, 36).

In the case of coping, a large number of studies, including some conducted in the neurological field, have revealed the positive impact of active strategies, either problem-oriented or targeting the active control of one's emotions, on patients' physical and mental health (31, 29). The coping effect may be direct, for example by favoring self-care, or indirect via the moderating effect of the negative impact of stress and emotional distress on the disease (3, 33, 48).

No research has so far been devoted to the prospective assessment of psychological characteristics before and after STN-DBS to identify the effects of this stimulation and establish a link between the subjects' initial characteristics and their subsequent development. Certain studies have attempted to determine the psychological predictors of QoL or of the development of patients with PD by means of prospective follow-up (14-15, 39). In patients with advanced PD, QoL has been shown to be stable on average, and the favorable evolution observed after 1 year was associated with the use of active initial strategies (39) as well as reduced use of avoidance strategies and higher flexibility in making adaptive choices (14,15), but these results were observed in mixed samples and not just in patients receiving STN-DBS. One study considers coping in association with QoL of patients who have received STN-DBS. The results of this cross-sectional research indicated that there is no link between the coping strategies used and the QoL associated with PD in stimulated patients. The re-

search also concluded that there is an association between emotion-oriented strategies and reduced QoL among individuals receiving conventional best medical treatment (32). There is a need for prospective studies following up patients receiving STN-DBS and investigating predictors of change in new samples.

The aim of the present study was to evaluate the positive impact of STN-DBS on motor symptoms and to quantify the changes in QoL, anxiety, and depression after surgery. We also wanted to identify the individual characteristics associated with favorable developments. Alongside clinical and sociodemographic characteristics, we studied the role of both anxiety/depression and coping strategies in explaining the motor and QoL changes observed in patients. Research conducted in the field of chronic illness suggests that initial anxiety and depression have a detrimental impact on subsequent developments and that active strategies, rather than avoidance, have a positive effect on them.

## METHODS

### Participants and Design

A total of 41 consecutive patients participated in this study. They had all been operated on in the Neurosurgical Department of Henri Mondor Hospital (Créteil, France). They all satisfied the criteria of the United Kingdom Parkinson Disease Brain Bank for the diagnosis of PD, as well as those of the Core Assessment Program for Surgical Interventional Therapies in Parkinson Disease (8, 17). During the first 6 months after the operation (M6), one person decided to cease participating in the research, two others had their stimulation electrodes removed due to an infection, and a fourth committed suicide. During the subsequent 6-month period (M12), one person died and another showed atypical psychiatric disorders that made assessment impossible. The analyses are therefore based on a set of 41 (baseline [Mo]), 37 (M6), and 35 patients (M12). At the time of inclusion, men accounted for 71% of the sample, and people living with a partner 71%. The sample is described in **Table 1**.

The study was conducted from March 2004 through April 2007. All the patients were visited at their homes at all three assessment times. The five questionnaires

were completed with the help of a clinical psychologist (T.S.) during the first 3 weeks of the month preceding the intervention ( $20 \pm 5$  days), and then 6 months ( $190 \pm 17$  days) and 1 year ( $367 \pm 17$  days) after the intervention. All of the assessments of motor symptomatology were performed by the same neurologist (J.M.G.). Before being included in the study, each patient received all of the required information and signed an informed consent form. The study protocol received full internal review board approval.

### Measures

Evolution after the STN-DBS was assessed using two criteria: motor symptomatology and QoL. The factors predicting this evolution were depression, anxiety, and coping. In all cases, the validated French versions of the instruments were used. Reliability indexes were computed when appropriate and are reported in **Table 1**.

**Motor Function.** The Unified Parkinson Disease Rating Scale (UPDRS) (12) made it possible to perform a multidimensional analytical evaluation of the parkinsonian syndrome. The motor effect of the stimulation was evaluated by using the motor score of the UPDRS III after antiparkinsonian medication had been stopped for 12 hours. Medical treatment-related complications (including fluctuations and dyskinesias) were assessed using the UPDRS IV. The assessment of these complications was based on the patients' own evaluations of their difficulties during the week preceding the interview. Higher scores on the UPDRS measures reflect a greater prevalence of symptoms. An improvement of 30% was considered to be clinically significant (26).

**Cognitive Status.** Cognitive impairment was assessed by the Mattis Dementia Rating Scale (MDRS), a widely used screening test for rating patients with dementia that sensitively measures the degree of frontal-subcortical defects (30).

**QoL.** We used two QoL instruments, one of which was specific to PD and the other generic. QoL associated with PD was assessed using the Parkinson Disease Questionnaire 39 Items (PDQ-39) (24). The PDQ-39 is sensitive to changes induced by drug-based and surgical treatment. It provides a global index of QoL (**Table 1**). A score between 1

**Table 1.** Sample Description at Baseline and Follow-Up

Variables	Baseline (n = 41)		6 Months (n = 37)		12 Months (n = 35)		Alpha Range Minimum–Maximum	Evolution		
	M	SD	M	SD	M	SD		F	t M0/m6	t M0/M12
Patients characteristics							Baseline: minimum–maximum			
Age at surgery (yrs)	62.02	7.96	62.00	7.76	62.74	6.97	40–75 yrs			
Disease duration (yrs)	14.49	5.71	15.03	5.71	15.43	5.61	7–40 yrs			
Daily levodopa equivalent dose (mg)	1,504	667.32	569	351.02	554	336.24	258–3,700 mg/d	63.04*	8.90*	8.01*
Coping WCC-R										
Problem	30.63	6.12	30.43	5.54	29.31	6.22	0.75–0.78	0.59	0.19	0.89
Emotion	23.49	5.88	23.00	5.05	22.91	4.83	0.60–0.69	0.31	0.67	0.52
Social support	22.14	5.90	23.03	5.56	22.11	5.30	0.71–0.76	0.33	–0.58	0.03
Anxiety and Depression										
STAI-Y										
Trait anxiety	44.44	10.47	44.46	12.36	46.31	12.50	0.88–0.93	0.61	0.28	–0.75
≥46	46% (n = 19)		41% (n = 15)		57% (n = 20)					
State anxiety	43.22	14.93	43.38	15.88	43.57	14.76	0.93–0.95	0.11	–0.23	–0.40
≥46	44% (n = 18)		38% (n = 14)		37% (n = 13)					
BDI-II	16.34	10.48	17.81	12.03	16.80	9.95	0.89–0.92	0.51	–0.88	–0.75
≥19	42% (n = 17)		43% (n = 16)		37% (n = 13)					
Quality of life										
PDD-39 Summary Index	49.89	11.06	41.68	13.67	39.12	16.09	0.87–0.93	7.88†	3.13†	3.29†
SF-36 PCS	34.49	6.66	41.20	8.15	40.68	8.70	‡	9.35*	–3.63†	–3.08†
SF-36 MCS	39.94	9.69	34.36	9.45	37.33	7.67	‡	4.80§	2.81†	1.70
Neurological evaluations										
UPDRS III Off medication	49.24	16.57	20.55	10.12	21.62	10.60	‡	87.84*	10.59*	10.02*
UPDRS IV	9.76	2.72	2.69	1.92	2.74	2.31	‡	119.3*	12.34*	12.79*

WCC-R, Way of Coping Checklist–Revised; STAI-Y, State-Trait Anxiety Inventory; BDI-II, Beck Depression Inventory, Second Edition; PDD-39, Parkinson Disease Questionnaire 39 items; PCS, Physical Component Score; MCS, Mental Component Score; UPDRS, Unified Parkinson Disease Rating Scale.

\* $P < 0.001$ . † $P < 0.01$ . ‡Internal consistency indices are not appropriate for these scores. Higher UPDRS scores reflect more symptoms. Higher PDD-39 SI scores reflect poorer QoL, higher SF-36 scores reflect better QoL. § $P < 0.05$ .

and too is obtained by performing a linear transformation of the questionnaire's components. Unlike the SF-36, a higher score on this instrument indicates a poorer QoL. The health-related QoL was assessed using the Medical Outcome Study Short Form 36-items Health Survey (SF-36) (55). The SF-36 is sensitive to state changes induced by treatment and is currently used in the PD

field. Here, we use the Physical Component Summary (PCS) and Mental Component Summary (MCS) scores. The higher the scores, the better the QoL is. As advocated in the manual, when assessing QoL, we considered changes  $\geq 0.8$  standard deviations from the original value to represent a major change and changes  $\geq 0.4$  standard deviations to be medium (27).

**Depression.** Depressive symptoms were assessed using the Beck Depression Inventory version II (BDI-II) (2, 50). This 21-item questionnaire assesses the intensity of the various depressive symptoms experienced over the preceding 2 weeks in accordance with the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition depression criteria.

**Table 2.** Clinical Evolutions of Motor Function and Quality of Life in Parkinson Disease Patients After Neurostimulation

Evolution in motor function	6 Months Postsurgery (n = 37)			1 Year Postsurgery (n = 35)		
	Improvement ≥30% n (%)	No Clinical Evolution n (%)	Deterioration ≥30% n (%)	Improvement ≥30% n (%)	No Clinical Evolution n (%)	Deterioration ≥30% n (%)
UPDRS III	32 (86)	4 (11)	1 (3)	30 (86)	5 (14)	0 (0)
UPDRS IV	37 (97)	0 (0)	0 (0)	34 (94)	1 (3)	0 (0)

  

Evolution in QoL	Improvement		Deterioration		Improvement		Deterioration	
	Large	Medium	Medium	Large	Large	Medium	Medium	Large
PDQ-39 SI	15 (41)	4 (11)	2 (5)	4 (11)	16 (46)	6 (17)	2 (6)	5 (15)
SF-36 PCS	20 (54)	2 (5)	4 (11)	5 (14)	15 (44)	3 (9)	4 (12)	5 (15)
SF-36 MCS	4 (11)	6 (16)	2 (5)	16 (43)	3 (9)	6 (17)	4 (12)	12 (35)

Large evolutions in quality of life equal or larger than sample average  $M \pm 0.8$  SD. Medium evolutions are between  $M \pm 0.4$  SD and  $M \pm 0.8$  SD. UPDRS, Unified Parkinson Disease Rating Scale; PDQ-39, Parkinson Disease Questionnaire 39 Items; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey.

**Anxiety.** We used the State-Trait Anxiety Inventory (STAI-Y) (46). This  $2 \times 20$ -item questionnaire provides two measures of anxiety: trait anxiety and state anxiety.

**Coping.** We used the revised 27-item Ways of Coping Checklist—Revised (WCC-R) (13, 52). This scale assesses three types of coping strategies: problem-focused coping, emotion-focused coping, and seeking social support. These were assessed by asking the participants to indicate on a scale of 1 to 4 the extent to which they use each of the presented strategies to cope with stressful events associated with the disease.

**Statistical Analyses.** We examined mean-level evolutions using repeated-measures ANOVAs. We examined the associations of individual variables and psychological variables with individual changes using hierarchical regressions analyses with UPDRS and QoL scores as dependent variables, and personal and clinical variables, coping, and anxiety and depression scores as predictors. We predicted M12 outcomes while controlling for Mo outcomes (Block 1) as well as sex, age, disease duration, and MDRS scores (Block 2). Alternate Block 3s were then considered, with each of the psychological predictors introduced in turn. Significant associations in Block 3 reflected associations between psychological characteristics at baseline with changes in the outcome, whereas other variables were controlled for. We also ran t-tests,  $\chi^2$  tests, and nonparametric Mann-Whitney U tests to

compare groups that were determined as a function of clinical change on each outcome. Finally, we tentatively explored the links between the different psychological evolutions (QoL, depression, and coping) and age using Bravais-Pearson correlations. The alpha level was set at a two-tailed 0.05 for all analyses. Analyses were performed with SPSS 14.0 (Statistical Package for the Social Sciences, Chicago, IL, USA).

## RESULTS

### Evolution of the Patients After Stimulation

The STN-DBS was associated with a clear improvement in parkinsonian symptomatology as indicated by the UPDRS III and IV scores (Table 1). The UPDRS III scores improved very significantly from Mo to M6 and from Mo to M12, the observed decline being judged highly significant in accordance with the clinical criterion of  $-30\%$  that is conventionally used in this field (mean change Mo to M6 =  $-58\%$ ; Mo to M12 =  $-56\%$ ) (26). The greatest improvement was observed during the 6 months that followed the intervention. The decrease in the UPDRS IV scores was highly significant during the first 6 months after the intervention and over the full year, with the improvement remaining stable over the second 6 months (mean  $-72\%$  improvement). These results are confirmed by the number of patients who experienced a clinically sig-

nificant improvement in their symptoms. Of the 41 initially included in the study, 30 patients (73%) experienced an improvement of more than 30% in their UPDRS III scores (Table 2).

Contrasting clinical changes were observed for QoL (Table 2, lower part). We observed a positive evolution in the PDQ-39 global score directly after the intervention. With regard to the SF-36, the PCS score developed positively, unlike the MCS score, which tended to deteriorate during the poststimulation year. Nearly two-thirds of the sample experienced an improvement in their overall QoL specific to PD (PDQ-39), and half of the sample experienced a physical QoL improvement (PCS-SF-36). Only a quarter of the sample experienced an improved mental QoL, whereas half of the participants reported deterioration. The results were very similar for the follow-up between M6 and M12. With reference to the other psychological characteristics (distress and coping), we observed no significant change over the period considered here. The variations observed in the changes in QoL emphasize the need to examine the individual characteristics associated with change.

### Individual Characteristics Associated with Change

Table 3 examines the associations between changes after a period of 1 year and the participants' initial characteristics (the observations are very similar when we examine

**Table 3.** Summary of Hierarchical Regression Analyses with M12 Scores as the Dependent Variables and Characteristics of the Sample, Emotional Distress and Coping as Predictors

	Motor Function, 12 Months				Quality of Life, 12 Months					
	UPDRS III		UPDRS IV		PDQ-39 SI		SF-36 PCS		SF-36 MCS	
	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$
Block 1		0.077		0.068		0.074		0.000		0.046
Baseline outcome	0.082		0.363		0.197		0.007		0.126	
Block 2		0.241		0.108		0.367*		0.379*		0.299†
Sex	0.140		0.201		-0.087		-0.043		0.155	
Age at surgery	0.115		-0.084		0.640†		-0.635*		-0.313	
Disease duration	0.422†		0.235		0.077		-0.078		0.047	
MDRS score	-0.170		-0.004		0.244		-0.265		0.064	
Block 3										
WCC-R										
Problem-focused	-0.039	0.001	0.126	0.012	0.238	0.047	-0.169	0.021	-0.106	0.010
Emotion-focused	0.046	0.001	0.159	0.014	-0.201	0.021	0.062	0.002	-0.116	0.007
Social support	0.278	0.066	-0.097	0.008	0.234	0.048	-0.120	0.013	-0.326†	0.095†
STAI (trait)	-0.321‡	0.089‡	0.199	0.034	0.230	0.029	-0.092	0.007	0.153	0.016
BDI-II	-0.380	0.133†	-0.072	0.005	-0.179	0.020	-0.097	0.009	0.319‡	0.072‡

Higher UPDRS scores reflect more symptoms. Higher PDQ-39 SI scores reflect poorer quality of life. Higher SF-36 scores reflect better quality of life.

\* $P < 0.01$ . † $P < 0.05$ . ‡ $P < 0.10$ .

BDI-II, Beck Depression Inventory version II; M12, 1 year postsurgery; MDRS, Mattis Dementia Rating Scale; SI, Single-Index PDQ-39; PCS, Physical Component Score SF-36; MCS, Mental Component Score SF-36; PDQ-39, Parkinson Disease Questionnaire 39 Items; SF-36, Medical Outcomes Study 36-Item Short-Form Health Survey; STAI, State-Trait Anxiety Inventory; UPDRS, Unified Parkinson Disease Rating Scale; WCC-R, Ways of Coping Checklist—Revised.

the changes reported after 6 months and thus are not reported in further analyses). A positive change in motricity (UPDRS III) was associated with shorter disease duration. It was also associated with higher initial depression, and tententially, larger trait anxiety scores ( $P = 0.06$ ).

When we consider the changes in QoL, a favorable development in the PDQ-39 and SF-36 PCS scores was associated with a younger age in participants. None of the psychological variables had any linear association with changes to these two criteria. In contrast, the change in the MCS in the SF-36 was negatively associated with seeking social support from the WCC-R: the higher this score was at baseline, the smaller the improvement in mental QoL was on the SF-36. We also noted a tendency for MCS scores to be positively associated with higher initial BDI II scores ( $P = 0.08$ ). This point indicates that the patients who initially suffered from higher levels of distress exhibited a greater tendency than the

others to experience favorable psychological changes after the intervention.

Then, we compared the participants whose clinical evolution was clearly beneficial ( $z$  score for M12-Mo  $< -0.80$ ) with those who experienced a detrimental change ( $z$  score  $> 0.80$ ) in QoL. We observed that an improvement in the PDQ-39 score was associated with a younger age (56 vs. 65 years,  $t(13) = -3.32$ ,  $U = 7.50$ ,  $P < 0.05$ ), a shorter disease duration (12 vs. 17 years,  $t(13) = -3.09$ ,  $U = 8.50$ ,  $P < 0.05$ ), and higher levels of depression (BDI-II: 17 vs. 5,  $t(13) = -2.68$ ,  $U = 7.00$ ,  $P < 0.05$ ). A comparison of groups contrasted on changes in the SF-36 scores did not reveal any significant difference in PCS. On the other hand, MCS improvement was associated with a shorter disease duration (14 vs. 18 years,  $t(10) = -2.50$ ,  $U = 5.00$ ,  $P < 0.05$ ).

Finally, we examined the links between Mo-M12 evolutions in psychological variables (QoL, depression, and coping) and

age. Higher favorable changes in the PDQ-39 global score were linked with age ( $r = 0.46$ ,  $P < 0.01$ ). The evolution of problem-focused coping was also associated with age ( $r = 0.39$ ,  $P < 0.05$ ). Problem-focused coping reduced in the youngest participants and increased in the oldest when median splits were compared (median = 65 years;  $M = -1.4$  vs.  $M = +5.36$ ;  $t(33) = -2.78$ ,  $P < 0.05$ ). Favorable changes in PDQ-39 summary index were associated with reduced use of problem-focused coping ( $r = 0.34$ ,  $P < 0.05$ ). Other associations were not significant.

To summarize, a more favorable evolution on motor symptomatology and QoL appeared to be associated with younger age, more recent disease onset, and a higher level of emotional distress (depression and/or anxiety). Furthermore, the favorable development of mental QoL was associated with a lesser use of seeking social support coping.

## DISCUSSION

This is the first study to examine both clinical changes and the long-term predictive value of initial distress and coping on post-surgical QoL and motor improvements in PD patients after STN-DBS.

The first line of results deals with clinical changes in motor function and QoL. As expected, these were characterized by an improvement in neurological criteria that confirms the value of this method of treatment (22, 51). This is also reflected in the improvement of physical QoL. In contrast, mental QoL was subject to deterioration followed by stabilization 1 year after the intervention (7, 16, 44, 53). This is in line with some results indicating that the variations of both depression and anxiety are independent of improvements to motor symptomatology (20, 35). The patients showed QoL improvements corresponding to the habitually reported values, both in terms of global QoL (PDQ-39) and physical QoL (PCS) (10, 11, 42). These evolutions are very probably due to improvements in motricity.

After 12 months, anxiety, depression, and mental distress are consistent and relatively stable. The absence of benefit of surgery on mental QoL is difficult to explain given improvements in symptoms. One explanation is that stimulated patients with PD tended during a *posteriori* assessments of their presurgical QoL (i.e., after the surgical intervention has been performed) to overestimate their initial QoL. This may bias assessments of their QoL 6 months after the intervention (18). In that sense, one could consider the presurgical assessment as reflecting expectations and the postsurgical assessment as reflecting postsurgical satisfaction. This is a well-known phenomenon in QoL research that has been labelled response shift. It reflects a certain degree of reconceptualization and reprioritization between baseline and follow-up measures of QoL (47).

The second important result related to the individual characteristics that were predictive of change. Our results showed that a favorable evolution of motricity and QoL was associated with younger age and a more recent onset of the disease. In our study, longer periods of illness were associated with less favorable clinical evolutions, thus echoing the findings of certain recent studies (37, 56). Furthermore, it was the older patients whose PD-related QoL and physi-

cal QoL improved the least, even though their motor improvements were in line with those observed for the rest of the sample (9, 37, 56).

Contrary to our expectations, we observed that anxiety and depression prior to the intervention were linked to more extensive improvements in motricity and mental QoL. These results were observed even though we controlled for age and disease duration. It is probable that this finding is a consequence of the expectations placed on the intervention by patients who suffer particularly severely from their condition. These expectations should contribute to a commitment to this surgical operation and may promote a greater level of subsequent adjustment. It should also be borne in mind that depression and mental QoL are partially confounded. As a result, mental QoL is all the more likely to improve during the follow-up phase if it was initially poor, as for example due to higher levels of depression (54). This indicates that we should qualify the generalized assumption that depression, and more generally negative affect, are factors favoring increased deterioration or negative outcomes postsurgery.

We also observed that the individuals who searched least for social support tended to exhibit favorable developments at the level of mental QoL. The other strategies, including the most active (problem solving, planning, emotional control), were not associated with the outcomes (32). As for seeking social support, it is probable that the effect of this strategy depends on characteristics of the social network. If the patient's social network is available to listen to and share the emotions, then the effect of these strategies would be positive (1, 48). These coping styles are dependent on the characteristics of the patient's social context, friends, family, and caregivers. If the burden remains unchanged after surgery, relatives may experience negative feelings and the search for social support may thus become maladaptive (34, 40, 45). This finding emphasizes the need for further studies to take account of the patient's social environment in a more sophisticated way, including exploring psychological moderators such as passivity or dependence tendencies.

The negative consequences associated with certain types of coping raise the question of whether the coping strategies ad-

opted by patients are appropriate. In effect, in the face of a chronic, evolutive disease such as PD and the surgery, adaptive changes will be necessary (15). In contrast with this assumption, we found that coping processes were surprisingly stable and consistent with the standards gathered from the general population (6). One hypothesis is that the maladaptive consequences of some coping reactions might reflect the difficulties encountered in flexibly adapting these coping strategies to different situations. This absence of flexibility in coping may be due to cognitive disturbances in executive functions and to increased impulsiveness observed in connection with PD and STN-DBS (28, 38, 43). It should also be investigated in further research.

It has previously been shown that using active strategies and higher flexibility in making adaptive strategies is advantageous in terms of QoL (15). In our study, we observed that an increasing use of problem-focused coping was linked to a reducing global QoL over time, thus reflecting that patients with lower QoL need to cope because they experience additional stress.

In practice, results observed here advocate for considering depression more a positive than a negative indicator for surgery because patients with higher depression scores improved best. In contrast, calling for social support, a strategy that is probably a reflection of passivity or dependence, would be a negative indicator for surgery.

The present study has certain limitations. Firstly, the sample of 35 individuals 1 year after intervention is limited. Yet it still represents a considerable number of participants to be recruited in the specific field of STN-DBS in patients with PD. Secondly, certain measures such as those used to assess QoL have been criticized because they induce biases due to floor and ceiling effects (range restriction) and therefore limit the possibility of detecting correlations (21). However, these instruments are those in the most widespread use at present. Finally, we could not include a control group to compare the effect of an alternative treatment and therefore could only study the association of baseline characteristics with differential change postsurgery.

In conclusion, this study enabled us to confirm previously observed results concerning the evolution of patients treated using STN-DBS: very clear motor improve-

ments, major improvement in physical QoL for a significant proportion of the participants, but unexpectedly, no improvement in mental QoL. The results emphasize that the psychological evolution after surgery in PD is underpinned by psychological characteristics that include the level of depression and coping reactions. They might also point a way toward specific treatment indications intended to optimize psychological care as a function of personal data.

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