ON THE RECEPTIVE PROSODIC LOSS IN PARKINSON'S DISEASE

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ABSTRACT

To comprehensively explore how the processing of linguistic and affective prosodic cues is affected by idiopathic Parkinson's disease (PD), a battery of receptive tests was presented to eleven PD patients without intellectual or language impairment and eleven control subjects (NC) matched for age, gender, and educational attainment. Receptive abilities for both low-level (discrimination) and higher-level (identification) prosodic processing were explored; moreover, the identification of prosodic features was tested at both the lexical level (phonemic stress perception) and over the sentential domain (prosodic pattern identification). The results obtained demonstrated a general reduction in the ability of the PD patients to identify the linguistic- and affective-prosodic meaning of utterances relative to NC subjects, without a concurrent loss in the ability to perceive phonemic stress contrasts or discriminate prosodic patterns. However, the qualitative pattern of the PD and NC groups' performance across the various identification conditions tested was remarkably uniform, indicating that only quantitative differences in comprehension abilities may have characterized the two groups. It is hypothesized that the basal ganglia form part of a functional network dedicated to prosodic processing (Blonder et al., 1989) and that the processes required to map prosodic features onto their communicative representations at the sentence level are rendered less efficient by the degenerative course of PD.

INTRODUCTION

Parkinson's disease (PD) is a degenerative disorder of the basal ganglia recognized primarily by its deleterious effects on the *motor* capacity of those afflicted. In verbal behaviour, the motor symptom disturbances associated with PD (tremor, rigidity, bradykinesia) are reflected in an apparent dysarthric condition characterized by marked abnormalities in speech prosody (Critchley, 1981; Kent and Rosenbek, 1982; Monrad-Krohn, 1947).

Prosody, or changes in the fundamental frequency, duration, and amplitude of the voice, is an integral component of the speech signal. Prosodic cues communicate to the listener, amongst others, the linguistic modality of an utterance (e.g., whether a statement or question is intended) and the affective disposition of the speaker (e.g., whether the speaker is angry or happy). Acoustic descriptions of parkinsonian speech have been relatively consistent in noting such prosodic irregularities as monopitch, reduced vocal intensity, and rate abnormalities when compared to the speech of healthy control (NC) subjects (e.g., Canter, 1963; Darley, Aronson and Brown, 1969; Kent and Rosenbek, 1982; Le Dorze, Dionne, Ryalls et al., 1992). These alterations in the speaking voice of parkinsonian patients may emerge due to reduced physiological support

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for speech or "prosodic insufficiency" in this clinical population (Canter, 1965; Darley, Aronson and Brown, 1969).

More recently, Parkinson's disease has been further associated with a *receptive* disturbance for the linguistic or affective features of speech prosody (Blonder, Gur and Gur, 1989; Borod, Welkowitz, Alpert et al., 1990; Scott, Caird and Williams, 1984). For example, Scott, Caird, and Williams (1984) presented several short tasks to examine both the reception and production of prosody in 28 adults with PD (without intellectual impairment) and 28 healthy control subjects. In the receptive mode, the authors assessed the ability to discriminate prosodic features (i.e., make a same/different judgement about sentence pairs differing only in prosodic content) and to identify the grammatical or affective significance of prosodic patterns. Scott et al.'s (1984) results demonstrated that, although the two diagnostic groups could discriminate differences in prosodic patterns at a comparable level, the ability to *identify* the emotional and grammatical intent of prosodic contours was disturbed in the PD patients relative to the control subjects (expressive qualities of the PD subject's prosody were also perceived as abnormal). Based on their findings, the authors postulated a specific impairment in Parkinson's disease for both the production *and* comprehension of speech prosody, speculating that a "specific failure to react to patterns of intonation" may constitute one of the early signs of the disease process (Scott et al., 1984).

However, the extremely small number of trials presented on many of Scott et al.'s (1984) tasks (e.g., a single exemplar contributed to the significance of one of their tests) invites caution in interpreting their results. Indeed, in an attempt to replicate Scott et al.'s (1984) findings using a larger number of stimuli, Caekebeke, Jennekens-Schinkel, van der Linden et al. (1991) were unsuccessful in demonstrating differences between PD and NC subjects in the comprehension of prosodic meanings. Interestingly, the *production* of prosodic features was again deemed impaired in the PD sample reported by these authors, consistent with Scott et al.'s (1984) findings (Caekebeke et al., 1991).

A more rigorous examination of receptive prosody in PD was conducted by Blonder, Gur and Gur (1989). These researchers compared the ability of 21 hemiparkinsonian patients and 17 NC subjects to discriminate, identify, and express linguistic and emotional attributes of sentence prosody. Further, they assessed each group's capacity to disambiguate *lexically*-assigned phonemic stress contrasts (e.g., "*réd*coat" versus "red *cóat*"). Results obtained for this study illustrated that of the various receptive tasks presented, only the ability to perceive phonemic stress led to a divergence in the performance of the two diagnostic groups, the PD patients committing significantly more errors than the control subjects on this task (again, PD patients were significantly impaired on production tasks relative to NC subjects). However, despite the relative paucity of differences between the PD and NC subjects on individual prosody tasks, subsequent analyses undertaken by the authors revealed that the PD patients performed at an inferior level in the receptive mode *overall* (i.e., across linguistic and affective tasks) when compared to the NC subjects. Based on this overall pattern, the authors hypothesized that both the comprehension and expression of prosody is defective in parkinsonian patients (Blonder et al., 1989).

However, specific difficulties in processing phonemic stress cues, and not sentence prosody, may have contributed disproportionately to the authors' conclusion that impaired comprehension of speech prosody is a feature of PD (Blonder et al., 1989). Unfortunately, the effects of PD on the perception of lexical stress also remain unclear at this time, as *spared* comprehension of phonemic stress cues has been reported elsewhere in the literature using a similar paradigm (Darkins, Fromkin and Benson, 1988). Clearly, the nature of a receptive prosodic disturbance in parkinsonian patients (if any) remains controversial.

To re-examine how the processing of prosodic cues is affected by idiopathic Parkinson's disease, the current investigation presented a battery of receptive tests to parkinsonian subjects without intellectual or language impairment and to matched control subjects. To more thoroughly assess whether patients with PD comprehend the linguistic and emotional significance of intonation contours, the identification of each prosodic "function" was tested at two distinct task levels that varied the processing demands imposed by the stimuli (i.e., both semantically well-formed and nonsensical utterances were presented). To explore the integrity of low-level auditory processing of prosodic features, two additional tasks evaluated the subjects' ability to utilize prosodic cues to *discriminate* differences among utterances devoid of phonetic or semantic content (i.e., from utterances that had been "speech-filtered"). Finally, one task assessed the perception of phonemic stress in PD and NC subjects through the presentation of bisyllabic word pairs differing only in the location of lexically-assigned stress. Clarifying the influence of these various factors (i.e., the mode of processing required, or the "domain" over which prosodic features are perceived) on the receptive control of prosody within a well-defined group of PD patients may help illuminate the underlying mechanisms involved in receptive prosody functions, and lead to a less fragmentary understanding of the communicative sequelae of Parkinson's disease.

Materials and Method

Subjects

Eleven (11) subjects diagnosed with idiopathic Parkinson's disease and eleven (11) control subjects matched for age, sex, and educational attainment were recruited for the study. Patient volunteers were approached through their participation at a movement disorders clinic at the Jewish General Hospital in Montréal, Canada. With the exception of one subject (P9) who was left-handed, all subjects were right-handed native English speakers living in the greater Montréal region. Except for the diagnosis of PD (for the clinical subjects), none of the participants were known to have prior history of neurologic or psychiatric disorder as determined from their medical records. Basic clinical and demographic characteristics of the experimental subjects are summarized in Table I.

As may be seen, the patients reported in this study exhibited mild to moderate, predominantly bilateral motor symptoms (three patients in stage 1, five in stage 2, and three in stage 3 of the Hoehn and Yahr, 1967, PD scale). The mean duration of PD for this group was 8 years (range = 3-17 years). All patients were receiving antiparkinsonian medications at the time of testing; these included Artane, Cogentin, Sinemet, Eldepryl, and Deprenyl. The absence of intellectual impairment was determined by means of the Mini-Mental State Examination (group mean = 27.4/30, range = 24-30) and through clinical observation. None

TABLE I
Clinical and Demographic Characteristics of the PD and NC Subjects

Subject	Sex	Age	Education	Duration of PD	H&Y Score
P1	M	63	12	12	1
P2	F	73	14	4	2
P3	F	52	16	17	2
P4	M	71	16	7	1
P5	F	58	10	3	1
P6	M	62	19	9	3
P7	M	72	11	7	2
P8	F	69	19	9	3
P9	F	62	12	9	2
P10	M	68	11	3	3
P11	M	64	16	8	2
Mean		64.9	14.2	8.0	
N1	M	63	12		
N2	F	72	14		
N3	F	52	16		
N4	M	72	16		
N5	F	57	10		
N6	M	62	22		
N7	M	73	13		
N8	F	69	18		
N9	F	62	13		
N10	M	68	12		
N11	M	64	16		
Mean		64.9	14.7		

Age, education, and duration of PD are expressed in years; H&Y = Hoehn and Yahr (1967) PD Scale.

of the patients exhibited speech or language deficits as evaluated using the Boston Naming Test (Kaplan, Goodglass and Weintraub, 1983) and an aphasia screening protocol.

Due to the auditory demands of the experiment, the adequacy of each subject's hearing was ascertained by means of a puretone air conduction screening of both ears at .5, 1 and 2 kHz. This evaluation was conducted prior to the testing session using a Maico (MA-19) portable audiometer. Acceptable hearing levels for inclusion in the study were set at 30 dB HL at each frequency, for the better ear. No prospective subject was excluded based on these criteria.

Experimental Tasks/Stimuli

1) Phonemic Stress Perception

To assess the perception of lexical (phonemic) stress in PD patients, a subset of the items used by Blumstein and Goodglass (1972) and Baum, Daniloff, Daniloff et al. (1982) were employed (the use of these stimuli accords with previous investigations of stress comprehension in PD patients, Blonder et al., 1989; Darkins et al., 1988). Nine word pairs differentiated solely on the basis of primary stress location, one item constituting a noun compound and the other a noun phrase (e.g., *hótdog* vs *hot dóg*, respectively), served as stimuli. To provide subjects a somewhat more natural context from which to make a judgement, each item was presented at the end of the "carrier" phrase, "*Look at the...*" (e.g., *Look at the hótdog*). These utterances were recorded onto cassette tape in a soundproof booth by a female speaker using a high-quality Sony cassette recorder and a Sony ECM-909 directional microphone, placed approximately 20 centimeters from the speaker's mouth. The stimulus tapes were then digitized using the BLISS speech analysis system (Mertus, 1989), sampled at a rate of 20 kHz using a 9 kHz low-pass filter and 12-bit quantization.

Stimuli were randomized and presented to subjects in one of two orders, "ascending" or "descending" (i.e., the random order played forward or backward). Before presentation of each trial, subjects were provided a multiple-choice array consisting of three pictures: the target response (i.e., *hótdog*), the response predicted by alternate placement of phonemic stress (i.e., *hot dóg*), and an unrelated foil (e.g., *bluejay*). Subjects were asked to identify the picture corresponding to each auditory stimulus by means of a pointing response, recorded manually by the experimenter (total score = 18).

2) Prosodic Pattern Identification

To evaluate receptive prosody in PD at the *sentence* level, 180 utterances employed in a previous investigation of prosodic comprehension abilities in patients with focal left- and right-hemisphere cortical damage (Pell and Baum, 1996a) were utilized. When naturally produced and intoned by a female speaker, half of the stimuli served to distinguish the linguistic modality of the utterance (declarative, interrogative, imperative) and half served to convey the affective tone of the speaker (angry, sad, happy). The adequacy of the stimuli in conveying the intended linguistic or affective target meaning was established by means of a group of listeners; these and other details describing the manner in which stimuli were constructed and rated are provided elsewhere (Pell and Baum, 1996a).

For each prosodic context (linguistic and affective), three distinct sets of stimuli varying the extent to which the segmental content of the utterances were linguistically structured were further identifiable. An initial set consisted of 60 semantically "well-formed" sentences, in which both prosodic and semantic structure cued the linguistic or affective intonational meaning (e.g., *The doctor examined the patient - DECLARATIVE*; *You're late again for our meeting - ANGRY*). A second stimulus set was comprised of 60 "nonsense" sentences, in which phonetically-plausible but meaningless utterances were intoned by the speaker (modelled after the well-formed utterances) to convey the prosodic target (e.g., *Suh feckter egzullin tuh boshent*). Finally, 60 "speech-filtered" utterances were constructed, for which the well-formed stimuli were low-pass filtered at 500 Hz to obscure segmental information while retaining the prosodic cues. Each stimulus "type" (semantic, nonsense, filtered) was presumed to vary the processing demands placed on the subject *vis-à-vis* an analysis of the underlying (linguistic or affective) prosodic features.

Four distinct tasks of 30 trials each required subjects to identify the communicative import of prosodic cues; two tasks employed nonsense utterances and two tasks employed semantically well-formed utterances as base stimuli (filtered utterances served as the basis for *Prosodic Pattern Discrimination*, described below). The elimination of syntactic/semantic cues in the nonsense condition constituted a direct test of the subjects' ability to interpret *only* prosodic cues in judging intonational meanings; the inclusion of such cues in the semantic condition served to compare each group's comprehension of the stimuli when segmental content additionally biased the prosodic target meaning. A separate task tested the subjects' comprehension of linguistic (declarative, interrogative, imperative) and emotional (angry, sad, happy) meanings of prosody for both the nonsense and semantic stimuli.

For each of the four identification tasks, subjects listened to the stimuli and then judged their meaning by pushing one of three horizontally-arranged buttons on a response board. Each button was identified by both a written label (e.g., *STATEMENT, HAPPY*) and a corresponding graphic representation (punctuation mark (.?!) or facial expression). Prior to the nonsense tasks, subjects were informed that the sentences they would be hearing would not sound like ordinary speech; for all tasks, subjects were urged to attend to the speaker's tone of voice in making their judgements (total score = 30/task).

3) Prosodic Pattern Discrimination

To ensure that subjects were capable of perceiving global differences in the temporal/spectral composition of utterances, stimuli low-pass filtered of their segmental content at 500 Hz (described above) were presented for discrimination in a linguistic and an emotional task; for each task, the stimuli employed represented filtered exemplars of the corresponding (linguistic or affective) semantically well-formed sentences. Utterances within each stimulus set were randomly paired, with the restriction that an equal number of trials constitute "same" and "different" pairings for each task. The paired stimuli (separated by a 500 msec interval) were then presented to subjects who made a same/different judgement about their suprasegmental content using a push-button response (total score = 30/task).

Procedure

Subjects were tested individually in a quiet room (often in the subject's home) during a single one-hour session; this always commenced with the screening procedures and terminated with the presentation of the seven experimental tasks. All auditory stimuli were presented in random order (except where noted) by a computer, binaurally over headphones at a comfortable listening level. Each experimental task was preceded by a practice session, allowing subjects to become accustomed to the demands of the procedure and the orientation of the response buttons (where appropriate). The ordering of lexical- and utterance-level prosody tasks, as well as linguistic and affective tasks, were counterbalanced for presentation within each subject group.

RESULTS

The mean accuracy scores and standard deviations of the PD and NC groups on tasks of phonemic stress perception (1 task), prosodic pattern discrimination (2 tasks), and prosodic pattern identification (4 tasks) are furnished in Table II.

Phonemic Stress Perception

To examine whether the two diagnostic groups (PD, NC) differed in the ability to disambiguate phonemic stress constrasts, a t-test on independent means was performed on the data derived from the phonemic stress perception task. As displayed in Table II, accuracy on this test was generally low, and did not differ significantly between the two groups ($t = -0.838$, d.f. $= 20$, $p > .05$).

Prosodic Pattern Identification

A $2 \times 2 \times 2$ mixed design ANOVA, with a between-groups factor of GROUP (PD, NC) and within-groups factors of TASK (nonsense, semantic) and

TABLE II

Mean Accuracy Scores (and Standard Deviations) for the PD and NC Groups on Tasks of Phonemic Stress Perception, Prosodic Pattern Discrimination, and Prosodic Patterns Identification

Task	PD	NC
1. Phonemic Stress Perception (max = 18)	12.1 (3.7)	13.4 (3.4)
2. Prosodic Pattern Discrimination (max = 30)		
Linguistic	28.5 (1.6)	28.6 (2.2)
Affective	28.2 (2.1)	28.4 (1.8)
3. Prosodic Pattern Identification (max = 30)		
Nonsense Stimuli		
Linguistic	20.0 (3.6)	22.7 (3.8)
Affective	23.1 (3.2)	25.6 (2.8)
Semantic Stimuli		
Linguistic	27.9 (2.3)	29.2 (1.5)
Affective	29.6 (0.5)	29.9 (0.3)

CONTEXT (linguistic, affective), was utilized to analyse the data emanating from the four identification tasks. A significant main effect of group emerged ($F=7.73$; d.f. = 1, 20; $p=.01$); this effect could be explained by the inferior performance of the PD patients, overall, in identifying the linguistic- and affective-prosodic significance of utterances relative to the matched control subjects. Significant main effects of task ($F=132.89$; d.f. = 1, 20; $p<.001$) and context ($F=11.63$; d.f. = 1, 20; $p<.01$) were also found, as was a significant task × context interaction ($F=5.08$; d.f. = 1, 20; $p<.05$). The interactive effect is depicted in Figure 1 for each of the subject groups independently.

As represented in Figure 1, both groups demonstrated a marked decrement in their ability to judge prosodic meanings on the nonsense task when compared to the semantic task. In addition, all subjects exhibited greater difficulty identifying linguistic- than affective-prosodic stimuli, although this latter difference appeared to diminish considerably for both groups on the semantic task. *Post hoc* analyses of the task × context interaction using Tukey's method ($p<.05$) confirmed that both PD and NC subjects experienced greater difficulty identifying the linguistic or emotional intent of prosody when *only* suprasegmental cues could be used to interpret the target meaning (i.e., on the nonsense tasks) than when concurrent semantic information further biased the target response. The analyses further revealed that both groups were more

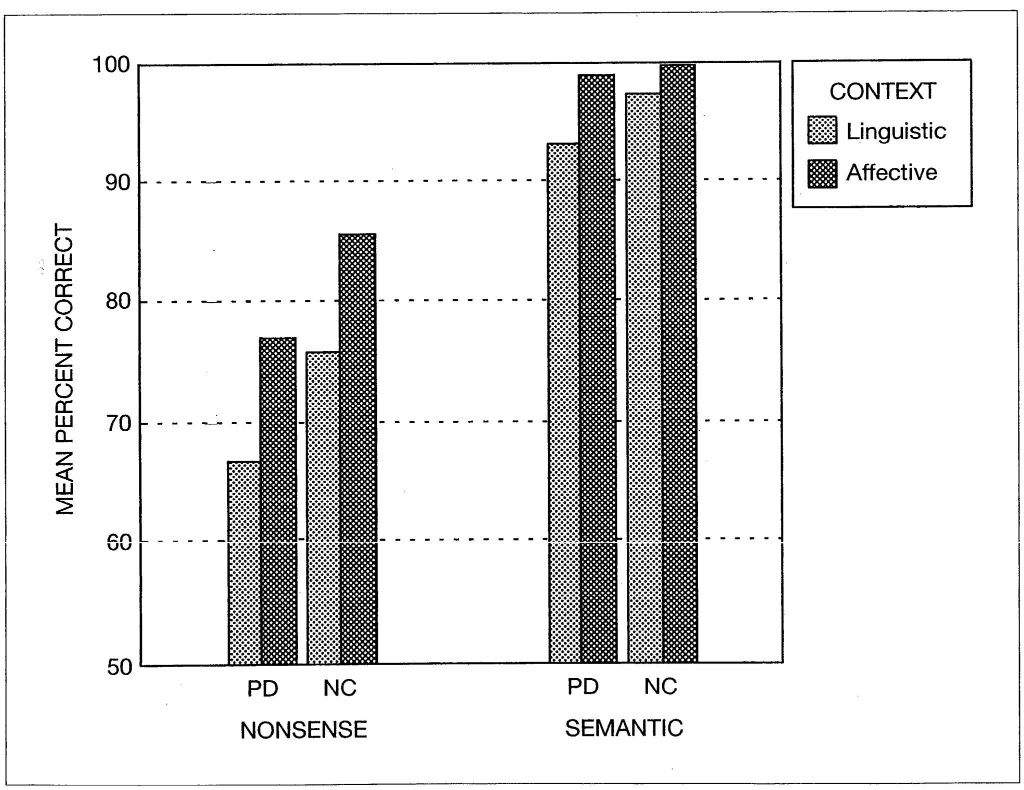

Fig. 1 – *Mean percent correct on nonsense and semantically well-formed tasks for linguistic- and affective-prosodic stimuli (by group).*

TABLE III

Response Matrices for the PD and NC Groups for the Identification of Individual Linguistic- and Affective-prosodic Meanings (collapsed across nonsense and semantic tasks)

Context		PD				NC		
		S	Q	C		S	Q	C
Linguistic	S	182	9	28	S	197	4	19
	Q	11	203	2	Q	8	206	5
	C	64	12	142	C	42	9	168
		A	S	H		A	S	H
Affective	A	189	9	18	A	201	2	16
	S	5	213	5	S	0	216	3
	H	23	18	179	H	16	11	193

Note: Target responses are indicated on the vertical axis and actual responses are indicated on the horizontal axis (S = statement, Q = question, C = command; A = angry, S = sad, H = happy).

accurate in recognizing the emotional than the linguistic intent of prosodic contours only on the nonsense task; differential performance on linguistic and affective tasks was not observed for the two groups when appropriate semantic information directed their judgements.

The absence of an interaction between group and the task and/or context factors is noteworthy, as it indicates the high degree of uniformity observed in the performance of the PD and NC subjects across the various conditions (review Figure 1). Thus, despite the PD subjects' demonstrably inferior comprehension of linguistic and emotional prosody overall (group main effect), no indications in the data pointed to qualitative differences in the pattern of responses observed for the PD and NC groups.

The lack of a distinct response pattern for the PD group is further indicated by an examination of each group's accuracy in identifying the individual linguistic and affective sentence types presented on the nonsense and semantically well-formed tasks (summarized in Table III). As may be seen, a similar distribution of errors emerged for both groups; on the linguistic tasks, both groups made very few errors in identifying interrogatives from the prosody, but experienced some difficulty in distinguishing imperative from declarative utterances (and vice versa). On the affective tasks, both groups were most accurate in recognizing sad stimuli and least accurate in identifying happy stimuli.

Prosodic Pattern Discrimination

As suggested in Table II, the performance of the two subject groups for prosody discrimination was highly comparable, approaching ceiling on both tasks. A 2 × 2 mixed design ANOVA with a between-subjects factor of GROUP (PD, NC) and a within-subjects factor of CONTEXT (linguistic, affective) was performed on the accuracy data; this analysis failed to yield a significant effect for either group ($F = 0.06$; d.f. = 1, 20; NS) or context ($F = 0.68$; d.f. = 1, 20; NS). An interactive effect did not emerge ($F = 0.0001$; d.f. = 1, 20; NS).

Discussion

The present study sought to investigate the effects of PD on various receptive functions for speech prosody, and explore in greater detail a number of the different factors that may be associated with the abnormal reception of prosody by parkinsonian patients (e.g., the domain over which prosodic cues operate, or the processing mode by which prosodic patterns are received). Unique to this study, the identification of linguistic- and affective-prosodic meanings by PD patients was appraised in separate tasks that varied the extent to which the experimental stimuli were semantically structured; this permitted a comparison of the PD subjects' comprehension of intonational meanings with and without the redundancy of congruent segmental and suprasegmental content. These methods may help mitigate previously-reported discrepancies in this literature (Blonder et al., 1989; Borod et al., 1990; Caekebeke et al., 1991; Darkins et al., 1988; Scott et al., 1984).

The ability to perceive the prosodic cues to phonemic stress is imperative in English in order to disambiguate certain noun compound/noun phrase lexical contrasts. In the present experiment, it was shown that the PD patients' performance on the phonemic stress perception task was fully comparable to that of the NC subjects, suggesting that local, linguistically-derived prosodic features are receptively preserved in PD (Darkins et al., 1988; but cf. Blonder et al., 1989). Similarly, the accuracy of the PD group was shown to ressemble that of the NC group on the two tasks of *discriminating* sentence-level prosody; this latter result, although perhaps unsurprising given the concordance of past findings on such tasks (Blonder et al., 1989; Borod et al., 1990; Caekebeke et al., 1991; Scott et al., 1984), is essential in confirming that low-level input or feature detection processes underlying the perception of prosodic stimuli were intact in the present PD sample.

To test higher-level processing of the communicative *intent* of prosodic stimuli, four tasks of prosodic pattern identification were administered in the current study. Overall, the accuracy of each group averaged across the four identification tasks demonstrated that the PD group, although performing well ($X = 84\%$), was significantly inferior to that of the matched group of control subjects ($X = 90\%$). Thus, generally, the present findings may be viewed as supporting prior claims that the receptive processing of speech prosody is disturbed in PD (Blonder et al., 1989; Borod et al., 1990; Scott et al., 1984).

However, more remarkable about the identification data reported herein was the uniformity of the performance of the two groups across the factors of both prosodic context (linguistic, affective) and task level (nonsense, semantic). Specifically, the accuracy of both groups was (not surprisingly) facilitated by appropriate semantic content in labelling prosodic meanings, and both groups recognized emotional meanings more often than linguistic meanings only on the "pure prosody" (i.e., nonsense) task. This latter finding may reflect greater overlap in the perceptual characteristics of the linguistic stimuli (particularly those that define declarative and imperative intonation contours), leading to more frequent misidentification of the linguistic stimuli when semantic cues are unavailable (see Pell and Baum, 1996b, for a more detailed explanation). More importantly, the absence of a group interaction for this or any other comparison in the data provides strong evidence that the comprehension deficits in the PD subjects reported presently were strictly quantitative in nature. A *generalized* deterioration in the comprehension of intonational meanings by PD patients is therefore indicated by the current data.

If the early pathological course of PD is associated with (mildly) impaired comprehension of sentence prosody, it may be possible to determine the stage of processing at which this breakdown occurs. Prosody comprehension tasks such as those administered here and elsewhere (Blonder et al., 1989; Borod et al., 1990; Scott et al., 1984) tap skills such as input and integration processes, but are also believed to test the integrity of an individual's communicative store for prosodic "representations" (Bowers, Bauer and Heilman, 1993). Indeed, Scott et al. (1984) alluded to a possible disorder at the level of nonverbal communicative representations to account for the prosodic comprehension disturbance observed in their PD patients. However, the PD patients reported presently identified the linguistic and emotional significance of prosodic patterns at a level far exceding chance *without* the aid of appropriate segmental content, and displayed a qualitatively normal distribution of judgement errors for individual linguistic and emotional sentence types (review Table III). Thus, the current data suggest that PD subjects largely *retain* an appreciation of the linguistic and emotional contrasts inherent in prosodic stimuli (see also Caekebeke et al., 1991), contrary to the notion that PD results in a specific loss of this knowledge (Scott et al., 1984).

Rather, the receptive prosodic difficulties observed in the present PD sample may represent a general degradation in the processes required to activate or integrate suprasegmental features and their meanings over the sentential domain. For example, one could speculate that the early course of PD leads to a decline in the ability to map prosodic features analysed over the course of an utterance onto corresponding (linguistic or affective) communicative representations. Such a deficit – which did not co-occur with intellectual or language impairment in the PD subjects tested – is consistent with the pattern of results reported herein (i.e., impaired recognition of intonational meanings with spared ability to perceive lexical stress and discriminate prosodic patterns) and would not appear incongruent with previously reported data in this literature (Borod et al., 1990; Scott et al., 1984).

A relationship between damage to the basal ganglia and disorders of prosody has been recognized by a number of researchers for several neurogenic populations (Brådvik, Dravins, Holtås et al., 1991; Cancelliere and Kertesz, 1990; Cohen, Riccio and Flannery, 1994; Ross and Mesulam, 1979; Speedie, Brake, Folstein et al., 1990; Starkstein, Federoff, Price et al., 1994; Van Lancker and Pachana, 1995). Given the neuropathological consequences of PD (i.e., primarily dopaminergic cell loss in the substantia nigra), it is possible that a functional system subserving prosody is rendered less efficient, leading to the gradual, global decay in comprehension performance observed in the present PD group. Thus, the present data once again highlight a potentially important role for the basal ganglia in a neural system dedicated to the modulation of sentence prosody (Blonder et al., 1989). Within such a framework, future research in this area may prove successful in determining associations between prosodic deficits ascribed to subcortical dysfunction (such as those reported herein) and more select impairments of linguistic and/or emotional prosody hypothesized to occur at the *cortical* level (Blonder, Bowers and Heilman, 1991; Heilman, Bowers, Speedie et al., 1984; Pell and Baum, 1996a; Ross, 1981, Van Lanker and Sidtis, 1992).

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