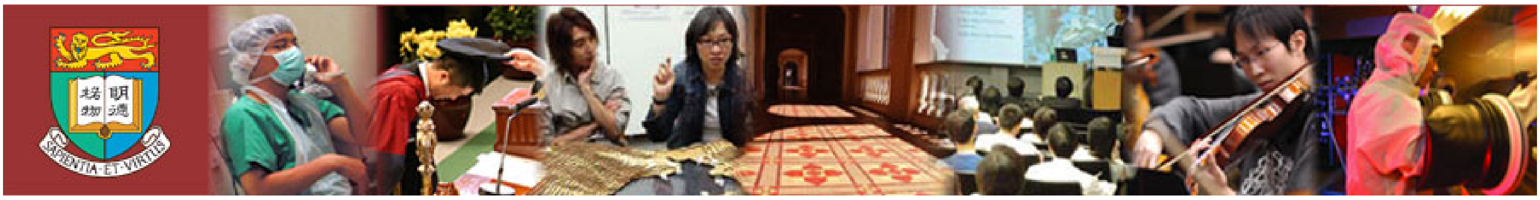

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Dysprosody in Cantonese Parkinson's Disease: Stimuli Effects

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Abstract

The aims of this study were to develop a perceptual prosody 'profile' for Chinese patients with hypokinetic dysarthria, and to compare dysprosody across three stimuli: sentence reading, passage reading, and connected speech. The subjects were 10 Cantonese speakers with Parkinson's disease. Perceptual ratings on 10 prosodic parameters were made by 12 speech-language pathology undergraduates for each of the three speech samples. The prosodic parameters were developed from a model proposed by Pfitzinger (2006). The four most severely affected prosodic parameters were monopitch, harsh voice, monoloudness and breathy voice. This was similar to profiles for Cantonese and English speakers in previous studies. Group statistics did not reveal significant differences in prosody across stimuli. However, differences were noted for seven of the ten speakers. The implications of these findings for evaluation and intervention planning are discussed.

Dysprosody in Cantonese Parkinson's Disease: Stimuli Effects

The purposes of the current study were to develop a perceptual prosody 'profile' for Chinese patients with Parkinson's disease (PD) and hypokinetic dysarthria, and to compare dysprosody across three different stimuli: sentence reading, passage reading, and connected speech. Parkinson's disease is one of the most common neurodegenerative diseases affecting approximately two in one thousand Chinese aged 55 or above (Woo, Lau, Ziea, & Chan, 2004). A large proportion of PD patients develop hypokinetic dysarthria in the course of illness (Ramig, Fox, & Sapir, 2004). According to Darley, Aronson and Brown (1969a, 1969b, 1975), prosodic disturbances were one of the most prominent features of hypokinetic dysarthria. Nine of the ten most deviant speech dimensions for this type of dysarthria were closely related to prosody. The dimensions were monopitch, reduced stress, monoloudness, inappropriate silences, short rushes of speech, harsh voice quality, breathy voice (continuous), inappropriate pitch level, and variable rate of speech.

Prosody refers to all speech properties that cannot be derived from segmental aspects of phonemes (Hargrove & McGarr, 1994; Nooteboom, 1997; Pfitzinger, 2006). These speech properties may have communicative functions to convey paralinguistic meanings. An example in Cantonese is the use of rising intonation to signal rhetorical questions for the expression of surprise. For example, the sentence「小明去咗街。」with a falling intonation, is a statement declaring that the boy had gone out. However, the sentence「小明去咗街？」

with a rising intonation, is a rhetorical question expressing surprise that the boy was not at home. The speaker of this rhetorical question did not expect the boy to have gone out.

Traditionally, studies of prosody have focused mainly on intensity, intonation and timing of speech. However, a recent study suggested that voice quality, ranging from pressed to breathy voice, varies systematically and independently from fundamental frequency to communicate social and paralinguistic information (Campbell & Mokhtari, 2003). Therefore, any condition that constrains people from varying voice qualities may hamper their use of this prosodic dimension to convey paralinguistic information. In this study, we adopt this broader meaning of prosody. We based this investigation of dysprosody for PD patients with hypokinetic dysarthria on a model recently proposed by Pfitzinger (2006) as his model covered five dimensions of prosody: intensity, intonation, timing, voice quality, and degree of reduction. According to Pfitzinger, the degree of reduction relates to articulation. For example, unstressed syllables are usually produced in a "strongly reduced way" (Pfitzinger, 2006, p. 7). This description appears similar to the articulatory undershooting commonly found in PD patients (Logemann & Fisher, 1981). To our best knowledge, this is the first study to adopt Pfitzinger's model in studying dysprosody in disordered speech. The study attempts to evaluate and characterize systematically the prosodic impairments of dysarthric patients. In addition to contributing to our understanding of the nature of dysprosody, the study may have clinical implications for assessing prosody.

Cantonese dysarthric speakers with Parkinson's disease were targeted in the current study as this is a population that relatively few studies have addressed (Wong & Diehl, 1999; Wong, Diehl, Ho, Li, & Tsang, 2001; Whitehill, Ma & Lee, 2003). The study by Whitehill and colleagues provided a perceptual speech profile for Cantonese speakers with hypokinetic dysarthria. Speakers were asked to read a standard Chinese passage and the speech samples were perceptually judged by qualified speech therapists. Ratings were made on 21 speech dimensions adapted from Darley et al. (1969a) using seven-point interval scales. The results showed that six of the ten most severely affected dimensions were related to prosody, including rough voice, strain-strangled voice, monoloudness, monopitch, breathy voice and imprecise consonants. Whitehill et al.'s study investigated a large number of speech dimensions covering different categories. The current study focused only on prosody and aimed to develop a set of parameters for the evaluation of prosody that was theoretically-driven. The use of interval scaling for rating various dimensions of disordered speech has been criticized, and other rating methods such as direct magnitude estimation (DME) and visual analogue scaling (VAS) have been recommended instead (e.g., Zraick & Liss, 2000; Whitehill, Lee, & Chun, 2002). Visual analogue scaling was used for the perceptual ratings in the current study. The results of the current study could be compared to those of Whitehill et al. (2003) in order to validate the previous study as well as to investigate whether different scaling methods could arrive at similar results.

Much of our understanding on dysprosody in hypokinetic dysarthria comes from acoustic studies (e.g., Leuschel & Docherty, 1996; Penner, Miller, Hertrich, Ackermann, & Schumm, 2001; Rosen, Kent, Delancy, & Duffy, 2006). However, acoustic analysis of speech has been criticized for having lower face validity than perceptual judgments (Wertz & Rosenbek, 1992). Moreover, Hargrove and McGarr (1994) cautioned against having direct relationship between perceptual evaluation and one or two acoustic measurements due to the multifaceted nature of prosody. Since dysarthria is by definition a motor speech disorder based on the perception of disordered speech (Rosenbek, Till, Gerratt, & Wertz, 1991), perceptual evaluation of dysarthria remains the gold standard on which other instrumental measurements should be based (Wertz & Rosenbek, 1992; Kent, 1996). Therefore, a perceptual prosody profile for PD patients with hypokinetic dysarthria has important implications for clinical practice and future studies.

There has long been evidence that normal speakers vary in speech performance with different sampling tasks (Barik, 1977; Levin, Schaffer, & Snow, 1982). Such differences have also been noted for dysarthric speakers. Studies comparing the speech performance across sampling tasks (passage reading and spontaneous speech) for normal and dysarthric speakers have shown that both groups vary their performance in significant ways across stimuli types (Brown & Docherty, 1995; Lowit-Leuschel & Docherty, 2001). These results warrant further investigation on how stimuli type can affect speech performance for the dysarthric population.

Although many currently available assessment protocols for evaluating prosody in dysarthric speech elicit speech samples from different stimuli types (e.g., Darley et al., 1975; Drummond, 1993), there has been no systematic way to analyze speech performance in different tasks. Moreover, few studies have explored the differences in prosodic performance of dysarthric speakers across stimuli types. There has been no agreement on the parameters that dysarthric speakers vary in prosodic performance across sampling tasks. In their study using acoustic measurements, Brown and Docherty (1995) observed that dysarthric speakers had different unstressed vowel duration and pause placement in reading and picture description. However, the acoustic studies by Leuschel and Docherty (1996, 2001) found no significant difference in any prosodic parameter between passage reading and spontaneous speech samples. Nevertheless, the researchers noted that individual dysarthric speakers did vary their performance across different stimuli, but in a more variable fashion than normal speakers. Hence, no discernible pattern of variation across sampling tasks could be identified from the dysarthric group. The researchers also cautioned about using statistical analyses to investigate stimuli effects as there was great variability among dysarthric speakers. Since studies that explore stimuli effects on prosodic performance mainly used acoustic measurements, the current study aimed at using perceptual evaluation to examine stimuli effects.

The specific research questions are: (1) How is prosody disrupted in PD patients with hypokinetic dysarthria? More specifically, which are the most severely affected prosodic parameters for PD patients? (2) Are there any significant differences in prosody across different stimuli types using perceptual judgments?

Method

Participants

The ten speakers participated were dysarthric as a result of Parkinson’s disease. The eight males and two females ranged in age from 50 to 73 years with a mean of 61.0 years. The speakers were recruited from a local self-help organization formed by a group of PD patients in the community. Nine of the speakers were unequivocally diagnosed by a neurologist as having idiopathic Parkinson’s disease. The additional speaker had Parkinsonism after a cerebrovascular accident. All speakers were judged to demonstrate some degree of hypokinetic dysarthria by two qualified speech therapists (both with experiences working with individuals with dysarthria), based on a reading passage sample. The two therapists agreed closely on the degree of severity for each speaker. Five speakers were judged to have mild dysarthria and the other five moderate.

All speakers were native Cantonese speakers with normal oral-peripheral structures. In addition, all speakers passed a hearing screening at 40 dBHL at 500, 1000, 2000 and 4000 Hz with their better ear and a screening test for apraxia and aphasia. The screening test was adapted from the Cantonese Aphasia Battery (Yiu, 1992).

Twelve speech-language pathology undergraduates served as listeners. All had no previous clinical exposure to patients with hypokinetic dysarthria. They were all native Cantonese speakers and they were reported to have normal hearing.

Stimuli

Three types of stimuli were used: a set of 15 sentences, a standard Chinese reading passage and a monologue. Each speaker was asked to read a set of 15 Chinese sentences and a reading passage. The set contained sentences in three sentence types of statement, imperative and question. Each sentence type consisted of five sentences ranged in length of 7, 9, 11, 13 or 15 syllables. The reading passage was 'North Wind and the Sun' (Yiu & Chan, 2003). Speakers were also asked to produce a two-minute monologue after watching a four-minute episode from a popular Cantonese TV drama, pretending to summarize the episode for their spouse. Probing questions were provided for elicitation of the monologue (See Appendix A). The order of task presentation was counterbalanced across speakers. All tasks were sampled in the same session during the period that speakers felt their medication was at optimal effect, to prevent any influences from off-periods.

All recordings were made in a quiet room with low level background noise of less than 42.6dB, except for one speaker, where the ambient noise was at 50.5 dB. Speech samples were recorded using an Aardvark Direct Mix USB 3 Soundcard and Audacity 1.2.6.

An AKG C 525 S or Shure SM48 low-noise unidirectional microphone was held at a mouth-to-microphone distance of 10 cm.

An approximately 30-second sample was extracted for each stimuli type edited from each speaker using Praat (version 5.0.15; Boersma & Weenink, 2008). Speech samples of sentence reading comprised sentences of different syllable lengths and sentence types. Each sentence was separated by a one-second pause. The number of sentences in the samples differed across speakers due to differences in speech rate. For passage reading, the 30-second sample was extracted starting from the second sentence of the passage. For monologue, a 30-second sample was extracted starting from the beginning of the monologue. The speech samples were loaded into a HyperCard program running on a Machintosh PowerBookG4 for the listening tasks. The samples were blocked by stimuli type. Within each block, the order of presentation of the samples was randomized automatically by the program. Speech samples from one speaker were repeated in each block to calculate intra-rater reliability.

Listening procedures

Listeners were asked to perceptually judge ten prosodic parameters, covering five dimensions of prosody: intensity, intonation, timing, voice quality and degree of reduction. These five dimensions of prosody were based on Pfitzinger (2006).

All perceptual ratings were made using a 10cm visual analogue scale. For most of the parameters, a rating on the leftmost end (0 cm) represented a normal production and the rightmost end (10cm) represented the most abnormal production. However, for the parameter of rate, the midpoint of the 10cm scale (taken as 0cm) represented normal speech rate, while the leftmost end (-5cm) represented abnormally slow rate and the rightmost end (+5cm) abnormally rapid. Listeners indicated their judgment by putting a cross at any point of the 10cm scale, including the endpoints, after listening to the whole sample.

Listeners were instructed to focus on one prosodic parameter at a time and rated that parameter for all samples from the ten speakers. After rating that prosodic parameter for all speakers, the speech samples were played again and listeners focused on the next parameter. These procedures were repeated for the ten prosodic parameters. Listeners could listen to each sample a maximum of two times in rating each parameter. In order to familiarize listeners with the description of the prosodic parameters, simple definitions for each parameter were indicated on the top of the recording sheets (See Appendix B). All descriptions were from Darley et al. (1969a) except that for breathy voice (See Appendix C). The description of breathy voice was modified from Darley and colleagues' definition due to anticipated difficulty differentiating breathy voice (transient) and breathy voice (continuous) for a group of inexperienced listeners. All listening tasks were conducted individually in a soundproof booth using a HyperCard program running on a Machintosh PowerBook G4 and Sennheiser HD 212Pro headphones. Listeners rated the three types of speech samples in three separate sessions. All three sessions were conducted within two weeks with at least three days separating each session. The order of presentation for the three types of speech samples was counterbalanced across listeners.

Data analysis

Perceptual ratings for all speech samples by each listener were measured manually by the investigator using a ruler that enabled measurements up to 0.05cm. All ratings were entered into a spreadsheet for further analyses.

Statistical analyses were performed using Statistica 8.0 (StatSoft, Inc., USA). For descriptive statistical analyses, mean scale values (MSV) (after Darley et al., 1969a) and standard deviations (SD) were calculated for each prosodic parameter using the mean ratings by the twelve listeners across the three stimuli types to construct the perceptual prosody profile. A two-way repeated measures analysis of variance (ANOVA) was conducted to determine the effects of prosodic parameter and stimuli type. A significance level of 5% was used to indicate a significant difference. Post-hoc tests were performed for specific comparisons among stimuli and parameters.

Intra-rater reliability and inter-rater reliability

Intra-rater reliability was calculated using the listeners’ two ratings for the speaker whose speech samples were repeated. Intra-rater reliability (Pearsons’ r) was 0.82 ($p < 0.05$). Inter-rater reliability for each stimuli type was calculated using intraclass correlation coefficient (ICC 2,k). Reliability ranged from 0.69 to 0.78 across stimuli with a mean reliability of 0.74. The stimuli type with the poorest reliability was sentence reading while passage reading had the highest inter-rater reliability.

Results

Perceptual ratings for the group

The mean scale values (MSV) were computed by calculating the mean ratings of the twelve listeners for each prosodic parameter in the three stimuli types. Passage reading was selected as the initial measure to develop the perceptual prosody profile as it has been used most frequently in previous studies (e.g. Darley et al., 1969a, 1969b; Whitehill et al., 2003). Table 1 shows the MSVs, standard deviations (SD) and rank order for each prosodic parameter for passage reading. The four most severely affected parameters are highlighted. As shown in Table 1, the four most severely affected parameters were monopitch, harsh voice, monoloudness and breathy voice. The parameter of ‘rate’ was not included in the table as the rating scale for rate differed from the other prosodic parameters, in which normal was ‘0cm’ on the scale, abnormally slow rate ‘-5cm’ and abnormally rapid ‘+5cm’ .The results for rate will be discussed separately below.

Table 1

Mean scale values (MSVs), standard deviations (SDs, in parentheses) and rank order of ten prosodic parameters in passage reading for the group of Cantonese speakers with hypokinetic dysarthria.

Speech parameters	MSV	(SD)	Rank order
Monopitch	4.13	(1.50)	**1**
Harsh voice	3.67	(1.83)	**2**
Monoloudness	3.43	(1.78)	**3**
Breathy voice	3.39	(2.05)	**4**
Prolonged intervals	3.05	(2.15)	5
Loudness decay	2.93	(1.86)	6
Imprecise consonants	2.66	(1.32)	7
Excess loudness variation	2.59	(1.48)	8
Distorted vowels	2.15	(1.11)	9

Note. 1 indicates the most severely affected parameter, 9 the least affected. The highest four ranks have been marked in bold.

The results were then analyzed separately for speakers with different severities of dysarthria (mild and moderate, based on the earlier classification). Table 2 shows the MSVs, SDs and rank values for speakers with different severities of dysarthria in each prosodic parameter. As shown, the rank orders for the mild and moderate dysarthric groups were largely consistent with that for the overall pattern of dysarthric speakers as indicated in Table 1. The four most severely affected parameters for the mild dysarthric group were monopitch, harsh voice, monoloudness and imprecise consonants. However, it should be noted that the MSVs for imprecise consonants, prolonged intervals and breathy voice were similar to each other. For the moderate dysarthric group, monopitch, breathy voice, harsh voice and monoloudness were rated the four most severely affected parameters.

Table 2

Mean scale values (MSVs), standard deviations (SDs, in parentheses) and rank orders of ten prosodic parameters in passage reading for groups of Cantonese speakers with mild and moderate hypokinetic dysarthria.

Speech parameters	Mild dysarthric group			Moderate dysarthric group		
	MSV	(SD)	Rank order	MSV	(SD)	Rank order
Monopitch	3.26	(0.92)	**1**	5.00	(1.70)	**1**
Harsh voice	2.68	(1.36)	**2**	4.66	(2.03)	**3**
Monoloudness	2.37	(0.90)	**3**	4.49	(2.08)	**4**
Imprecise consonants	1.99	(1.17)	**4**	3.33	(1.36)	8
Prolonged intervals	1.98	(2.10)	5	4.11	(2.08)	5
Breathy voice	1.92	(0.56)	6	4.87	(2.18)	**2**
Loudness decay	1.81	(1.24)	7	4.05	(2.00)	6
Excess loudness variation	1.66	(1.15)	8	3.53	(1.40)	7
Distorted vowels	1.45	(0.72)	9	2.86	(1.16)	9

Note. 1 indicates the most severely affected parameter, 9 the least affected. The highest four ranks have been marked in bold.

For the parameter of rate, a slow speech rate was observed in passage reading, in which the MSV was -0.23. Similar results were found in sentence reading and monologue (MSV = -0.71 and -0.84, respectively), indicating a slow speech rate in general. However, when analyzing results according to severity, the speech rate for the mild dysarthric group was close to normal (MSV = 0.17, 0.21, -0.07 for sentence reading, passage reading and monologue respectively), while the moderate dysarthric group had slow speech rate across stimuli (MSV = -1.58, -0.69, -1.62, respectively). Furthermore, when examining individual speakers, five had a slow speech rate for all stimuli types and two had rapid rate. The remaining three speakers had both rapid and slow speech rates across stimuli.

Stimuli effects

As shown in Figure 1, the ten speakers performed fairly consistently across stimuli types. There was less than 1cm difference on the 10cm scale between stimuli for all parameters. This observation was supported by the statistical analysis. Repeated measure ANOVA testing revealed no significant main effect for stimuli type [$F(1, 2) = 1.55$, $p = 0.22$] and no interaction effect for the parameter versus stimuli comparison [$F(1, 18) = 0.78$, $p = 0.72$]. Post-hoc analysis of Tukey HSD revealed no significant difference for any prosodic parameter in sentence versus passage, sentence versus monologue and passage versus monologue comparisons ($p > 0.05$).

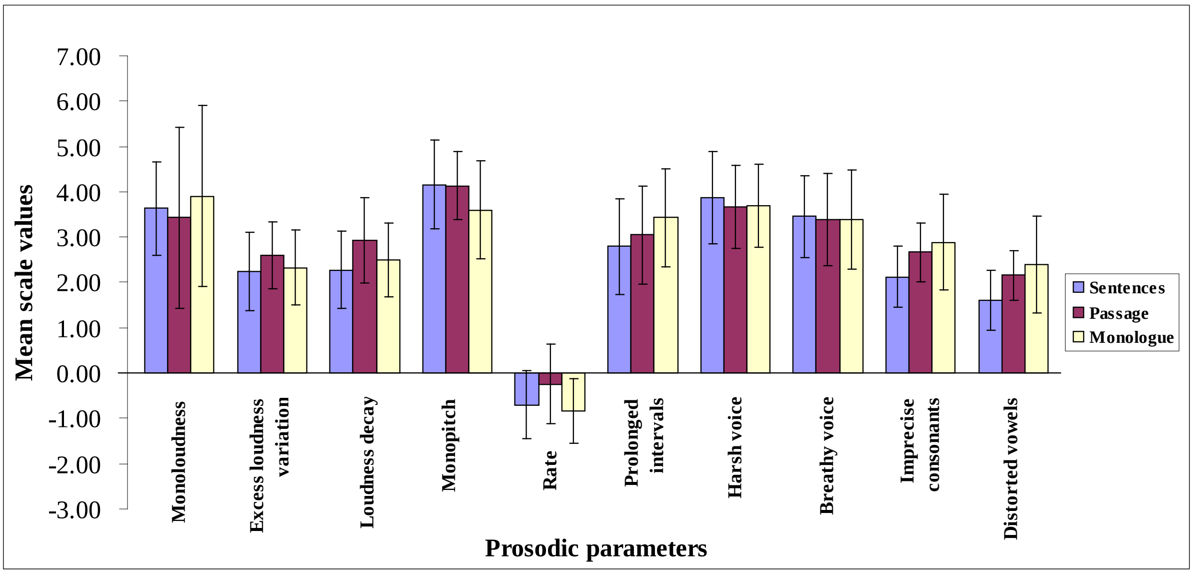

Figure 1. Mean scale values (MSVs) and standard deviations (SDs) of ten prosodic parameters across three stimuli types for the group of Cantonese speakers with hypokinetic dysarthria.

Although group analysis of data did not reveal significant differences across stimuli types, examination of ratings for individual speakers showed stimuli-specific performance. According to post-hoc analyses, seven of the ten speakers showed stimuli effects in one or more prosodic parameters. Table 3 lists the stimuli-specific performance from the seven speakers. A *p*-level of less than 0.05 was used to indicate a significant difference. For example, PD22 showed stimuli-specific performance in two prosodic parameters of monopitch and rate. He had significant differences in performance in passage reading and monologue for both parameters.

No discernible pattern could be identified for the parameters or stimuli types that showed stimuli-specific performance among speakers. However, speakers with moderate dysarthria generally showed a greater stimuli effect than the mild dysarthric group, in terms of the number of prosodic parameters and number of stimuli types that were affected.

Table 3

Speakers with significant stimuli-specific performance on particular prosodic parameters.

Speaker	**Severity of dysarthria**	**Prosodic parameter(s)**	**Specific comparison**	***p*-level**
PD4	Mild	Monoloudness	P v. M	$p < 0.001$
PD9	Mild	Breathy voice	S v. P	$p < 0.01$
PD22	Mild	Monopitch	P v. M	$p < 0.0001$
		Rate	P v. M	$p < 0.001$
PD31	Moderate	Monoloudness	S v. M	$p < 0.05$
		Monopitch	S v. M	$p < 0.001$
		Rate	S v. M	$p < 0.001$
		Prolonged intervals	S v. M	$p < 0.005$
			P v. M	$p < 0.005$
PD32	Moderate	Excess loudness variation	S v. M	$p < 0.005$
		Prolonged intervals	S v. M	$p < 0.0001$
			P v. M	$p < 0.0001$
		Imprecise consonants	S v. M	$p < 0.0001$
			P v. M	$p < 0.0001$
		Distorted vowels	S v. M	$p < 0.0001$
			P v. M	$p < 0.0001$
PD36	Mild	Loudness decay	S v. P	$p < 0.05$
		Prolonged intervals	S v. P	$p < 0.001$
PD37	Moderate	Rate	P v. M	$p < 0.0001$
		Prolonged intervals	P v. M	$p < 0.01$

Note. S = Sentence reading, P = Passage reading, M = Monologue

In summary, the four most severely affected prosodic parameters for the PD patients were monopitch, harsh voice, monoloudness and breathy voice. Rate varied across individual speakers, with some showing rapid rate and some slow rate. No significant stimuli effect was shown for the group of dysarthric speakers. However, analysis of individual speakers showed significant stimuli effects for some parameters in seven of the ten speakers. The stimuli effect appeared greater for the more severe dysarthric speakers.

Discussion

The study explored the performance of dysarthric speakers on different prosodic parameters across three stimuli types. As shown from the perceptual prosody profile (Table 1), the four most severely affected prosodic parameters were related to reduced pitch and loudness variation and to voice. This is consistent with a previous study on speech characteristics of Cantonese speakers with hypokinetic dysarthria in which rough voice, strained-strangled voice, monoloudness, monopitch and breathy voice were ranked in the ten most deviant speech dimensions (Whitehill et al., 2003). Although comparison between the current study and the study by Whitehill and colleagues revealed similar results, the visual analogue scale used in the current study might be a more valid method for rating. Equal-appearing interval scaling has been criticized for its validity in rating various dimensions of disordered speech (e.g., Zraick and Liss, 2000; Whitehill et al., 2002).

The current profile also revealed similar patterns to those found for English dysarthric speakers (Darley et al., 1975), even though the previous study investigated a large number of speech dimensions, not only focusing on prosody. However, caution must be taken for direct comparison between studies because the studies might have different definitions of prosody and different classification of speech parameters. For example, the model that the current study used (Pfitzinger, 2006) included the dimensions of voice quality and degree of reduction within prosody. However, Darley and colleagues did not classify vocal quality and articulation within prosody. It seems that the definition for prosody is changing, and hence, it is difficult to compare between studies due to differences in definition of prosody.

Though early reports suggested rapid speech rate as a common characteristic in hypokinetic dysarthria, more recent studies found that a relatively small proportion of speakers with hypokinetic dysarthria had rapid speech rate (Ludlow & Bassich, 1984; Adams, 1997). Darley and colleagues (1975) also characterized variable rate as one of the most distinctive prosodic changes in hypokinetic dysarthria. The results of the current study are consistent with those reports as five speakers had a slow speech rate for all stimuli types and three others showed both rapid and slow speech rates across stimuli.

The current data found that voice impairment was observed to be a prominent impairment in dysarthric speakers. Considering that different voice qualities can be used to signal paralinguistic information, such as "interlocutor relations", "speaker intention", and " speaking-style" (Campbell & Makhtari, 2003, p.2417), voice impairments may restrain speakers from varying their voice qualities and hence hinder their abilities to communicate such information. Moreover, one of the main functions of prosody is to express affects, and voice qualities have been found to be an important cue for affect (Chasaide & Gobl, 2004). Losing the ability to vary voice qualities may have an impact on speakers' social communication. Therefore, the prosodic dimension of voice quality should be granted more emphasis in the study of prosody, especially for studies that aim at investigating disordered speech.

In the current study, pitch and loudness variation, and voice qualities were the most severely affected prosodic parameters for both mild and moderate dysarthric groups. This was consistent with the findings of Ho, Iansek, Marigliani, Bradshaw and Gates (1998), who conducted a large scale study on speech impairment in groups of patients with Parkinson’s disease. In their study, Ho and colleagues found patients with mild dysarthria had voice dysfunction (which included deviant voice quality, monotonous voice and decreased loudness variation) as the most frequently and severely affected dimension, while fluency (which included rate, speech initiation and termination) and articulation were close to normal. Although the mild dysarthric group in the current study showed impairments in articulation, these were relatively mild when compared with other prosodic dimensions. In addition, rate in the mild dysarthric group was close to normal.

For the moderate dysarthric group, impairments in articulation and rate increased in degree of severity, as in Ho and colleagues’ (1998) study. Both studies showed more variable performances in the moderate dysarthric group as compared to the mild group. The more variable performances were shown in terms of greater standard deviations in the current data and speakers performed at different levels of impairment in each speech dimension in Ho and colleagues’ study. Variable performance among more severe dysarthric speakers was also found in the study of Holmes, Oates, Phyland and Hughes (2000).

The second purpose of the study was to investigate stimuli effects. The statistical analysis indicated no significant differences between sentence reading, passage reading and monologue for all prosodic parameters for the whole group. However, analysis of individual performance revealed different results. Post-hoc analyses showed that only three of the ten speakers had no significant stimuli effect. The remaining seven speakers showed stimuli-specific performance on at least one prosodic parameter. Such findings confirmed the results of a prior study that evaluated prosodic variations for dysarthric speakers using acoustic measurements (Lowit-Leuschel & Dorcherty, 2001). Both perceptual judgments and acoustic measurements revealed no significant group difference across stimuli types. However, differences did exist in individual speakers. The current study supported Lowit-Leuschel and Dorcherty's caution that group statistical analyses may not be a valid measure to indicate stimuli effects, especially for dysarthric speakers due to the heterogeneous nature of performance. Therefore, greater emphasis should be given to the between-subject variability (Metter & Hanson, 1986) and to the within-subject variability across stimuli types (Lowit-Leuschel & Dorcherty, 2001).

Although statistical analyses revealed no significant difference in performance across stimuli for three of the ten speakers, stimuli-specific performance might occur in these individuals. From the post hoc analyses, significant differences were shown only with a difference greater than 2cm across stimuli. For instance, the parameter of breathy voice was found to have significant difference between sentence and passage reading for PD9. The difference in MSVs was 2.03 (MSV = 4.28 and 2.25 for sentence reading and passage reading respectively). Given that a 2cm difference on a 10cm scale is a great difference, we question about whether speakers should have a difference of greater than 2cm to be claimed to have stimuli-specific performance. Moreover, we also question on how great the magnitude of the scale values on a 10cm scale will reveal the actual impact of impairment on an individual’s communication ability. As visual analogue scale is increasingly being used as the rating scale for disordered speech, future studies should aim at investigating the relationship between the scale values and the impacts on communication ability.

As the majority of speakers in the study exhibited stimuli-specific performances, it warrants the importance of different sampling tasks in the evaluation of prosody. No single task is entirely representative of a patient’s performance under all circumstances. Furthermore, it is recognized that patients with Parkinson’s disease have difficulties varying speech behaviors like speaking rate as instructed (Ludlow & Bassich, 1984). It is clinicians’ emphasis to investigate patients’ ability to adapt and modify speech behaviors according to different situations. Therefore, both structured tasks (such as sentence reading and passage reading) and naturalistic tasks (such as conversation and monologue) should be sampled from dysarthric speakers for comparison. By making comparisons between speech samples, patients’ ability to vary their speech behaviors can be determined and the extent of difficulty in specific task(s) should be highlighted for intervention planning.

Many assessment protocols available for evaluating prosody (e.g., Darley et al., 1975;

Drummond, 1993) have included elicitation of reading and connected speech samples already. Such practice should continue and analyses should be performed on both samples for comparison and identification of individual stimuli effects.

In summary, this study provided a perceptual prosody profile for a group of Cantonese patients with Parkinson's disease and hypokinetic dysarthria. This profile was theoretically driven by a model recently proposed by Pfitzinger (2006). It attempted to systematically characterize the prosodic impairments for dysarthric patients. The profile closely resembled similar profiles in previous studies of Cantonese and English dysarthric speakers. The most severely affected prosodic parameters were monopitch, harsh voice, monoloudness and breathy voice.

Although group statistics did not reveal significant differences in prosody across sentence reading, passage reading and monologue, differences were noted for individual speakers (7/10). This has implications for evaluation protocols. Moreover, variability across stimuli types should be considered in the process of intervention planning.

Possible limitations in the current study included the relatively small subject size. The small group size may have had implications on the statistical results. Furthermore, as speakers in the study all had mild or moderate dysarthria, the results may not be representative for the entire hypokinetic dysarthric group. Therefore, it is recommended that future investigations may focus on a larger sample of patients with Parkinson's disease, ideally encompassing a full scale of severity, from mild to severe hypokinetic dysarthria.

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Appendix A

Stimuli

Sentences

Table 4

Stimuli for sentences

Number of syllables	Statement	Imperative	Question
7	我交咗份申請表。	即刻同媽媽道歉!	你想飲水定係茶?
9	下星期要去醫院覆診。	你再唔還錢我就報警!	你趕得切做份報告嗎?
11	我地聽日會去迪士尼樂園。	我警告你唔好再打電話嚟!	去香港仔要搭幾多號巴士?
13	妹妹約咗朋友去紅館聽演唱會。	食完晚飯好快啲去做功課啦吓!	你個細仔而家喺邊度讀大學呀?
15	大佬去咗超級市場度買豉油同廁紙。	唔准再用咁嘅語氣叫公公幫你做嘢!	有冇人可以話俾我聽呢度發生咩事?

Passage

北風和太陽

有一天，北風和太陽爭論說，到底誰的本領高。當他們爭論的時候，有一個人經過，

他正穿著一件厚厚的黑色外衣。

因此他們便說，看看誰能脫去那人身上厚厚的外衣。

北風首先狠狠的吹。可是他越吹得狠，那個人就越把外衣拉緊。所以，北風就放棄了。

一會兒後，太陽出來了。那個人很快便將外衣脫下來。北風只好承認太陽較他厲害。

Note: The passage was from 'North Wind and the Sun' of Yiu and Chan (2003).

Monologue

Probing questions:

1. 請你話俾我聽正話段片講乜嘢？

   Can you tell me about the episode that you have just watched?

2. 如果你係唐仁佳(大鮑)，你會點樣同黃秀琴(細契)講你唔要離婚嘅決定？

   If you were Mr. Tong, how would you discuss with Ms. Wong about your wish for not having a divorce?

3. 如果你係黃秀琴，聽到唐仁佳因為唔想分家產俾你而撤銷離婚令，你會有乜嘢反應？

   If you were Ms. Wong, what would be your reaction after knowing that Mr. Tong refused to have a divorce as he did not want to share the family possessions with you?

4. 如果你係唐仁佳嘅仔女，見到父母鬧離婚，你會有乜嘢感想？

   If you were the child of Mr. Tong, what would be your feelings about your parents' divorce?

Appendix B

Sample recording Sheets

Name: ___________________ Date: _________________ Session: 1 / 2 / 3

Please listen to the speech samples and give judgments of the following parameter for each speech sample, by putting a cross on the scale. You can mark at any point of the 10cm scale, including the two end points. There will be 11 speech samples in total.

Monoloudness:	**Voice shows monotony of loudness. It lacks normal variations in loudness.**

Speech sample 1:

Normal **Monoloudness**

Speech sample 2:

Normal **Monoloudness**

Speech sample 3:

Normal **Monoloudness**

Speech sample 4:

Normal **Monoloudness**

Speech sample 5:

Normal **Monoloudness**

Speech sample 6:

Normal **Monoloudness**

Speech sample 7:

Normal **Monoloudness**

Speech sample 8:

Normal **Monoloudness**

Speech sample 9:

Normal **Monoloudness**

Speech sample 10:

Normal **Monoloudness**

Speech sample 11:

Normal **Monoloudness**

Name: ___________________ Date: _________________ Session: 1 / 2 / 3

Please listen to the speech samples and give judgments of the following parameter for each speech sample, by putting a cross on the scale. You can mark at any point of the 10cm scale, including the two end points. There will be 11 speech samples in total.

Rate: Rate of actual speech is abnormally slow or rapid.

Speech sample 1:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 2:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 3:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 4:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 5:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 6:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 7:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 8:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 9:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 10:

Abnormally slow **Normal** **Abnormally rapid**

Speech sample 11:

Abnormally slow **Normal** **Abnormally rapid**

Appendix C

Description of the ten prosodic parameters used in the perceptual judgment tasks

<u>Intensity:</u>

Monoloudness: Voice shows monotony of loudness. It lacks normal variations in loudness.

Excess loudness variation: Voice shows sudden, uncontrolled alterations in loudness, sometimes becoming too loud, sometimes too weak.

Loudness decay: There is progressive diminution or decay of loudness.

<u>Intonation:</u>

Monopitch: Voice is characterized by a monopitch or monotone. Voice lacks normal pitch and inflectional changes. It tends to stay at one pitch level.

<u>Timing:</u>

Rate: Rate of actual speech is abnormally slow or rapid.

Prolonged intervals: There is prolongation of interword or intersyllable intervals.

<u>Voice quality:</u>

Harsh voice: Voice is harsh, rough, and raspy.

Breathy voice: Voice is breathy, weak, and thin.

<u>Degree of reduction:</u>

Imprecise consonants: Consonant sounds lack precision. They show slurring, inadequate sharpness, distortions, and lack of crispness. There is clumsiness in going from one consonant sound to another.

Distorted vowels: Vowel sounds are distorted throughout their total duration.

Note: All descriptions were taken from Darley et al. (1969a), except for breathy voice, which was modified from Darley and colleagues' definition.

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