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Communication change in Parkinson's

The nature, assessment and management of communication changes in Parkinson's:

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Abstract

This review looks at the nature and impact of communication changes in Parkinson's, approaches to assessment, and directions for intervention, especially given that medical and surgical interventions beneficial for limb movement are largely ineffective, or even detrimental, for speech. Most people with Parkinson's notice changes to their communication. Voice alters early on – even in the prodromal stage. Later, articulation may impair intelligibility further. These changes impact on mood and social participation. However, a full characterisation of communication changes in Parkinson's must acknowledge that changes are far more pervasive and varied than a quiet voice. Communication is affected by marked dysprosody, cognitive-linguistic impairment, alterations to social interaction and pragmatics. Changes entail not just expressive elements but also receptive. A comprehensive evaluation of potential communication challenges faced by people with Parkinson's must cover all these aspects. Similarly, intervention that ignores the breadth and depth of changes will always remain incomplete.

Key words: Parkinson's, speech, language, assessment, management

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INTRODUCTION

Standard neurological textbooks typically summarize that Parkinson's leads to a quieter voice (hypophonia), possible imprecise articulation (hypokinetic dysarthria), and speech rate may alter. This is true enough, but it represents only a partial picture. Disruption to communication in Parkinson's extends much further, not just in terms of speech changes, but in respect of many other factors impinging on communication. Importantly, difficulties involve not just spoken output but receptive aspects of understanding and processing too. Changes in cognitive-language function (semantics and syntax/grammar) and social interaction have far-reaching effects, even in the absence of dementia. Crucially, communication impairment can be present even when speech sounds otherwise intelligible.

This article looks at the ways in which communication alters and how this affects daily living. It introduces strategies for assessment and mentions directions in management – including why medical therapy and deep brain stimulation appear to have little influence on speaking, and may even be detrimental. The focus is on spoken communication, rather than reading and writing.

Why consider communication?

Around 90% of PwP (people with Parkinson's) report changes to their communication,[1]. Changes impact on daily living and represent a major influence not just on ability to communicate effectively and participate fully in work and social activities (though few studies on work access actually give any direct consideration to communication), they also directly affect mood and feelings about oneself,[2]. There are two-way interactions between communication changes and cognitive, affective and social variables,[3]. Changes can contribute to carer burden. Attention to communication is therefore central to achieving and maintaining an optimum psychosocial quality of life. Monitoring speech changes is also important since rapidly deteriorating speech can be indicative of atypical parkinsonism or other intercurrent disorder.

WHAT CHANGES?

Voice (phonation)

Hypophonia is a prominent symptom. It may even prompt the initial suspicion in family and friends that something is amiss. Indeed, phonation has proved a promising variable to monitor in attempts to detect prodromal changes, diagnosis of Parkinson's and charting change from the earliest stages,[4].

Hypophonia is usually attributed to rigidity of thoracic, laryngeal and pharyngeal musculature, arguing this leads to reduced breath support, poorer vocal cord approximation and less effective voice resonance. That provides only a partial explanation. The underlying peripheral voice mechanism is not impaired – contrary to some aetiologies of neurological dysphonia, where changes to muscle tone and power affect voice quality. PwP can produce a louder voice, certainly early on.

The crucial disruption to voice intensity arises more centrally, from underscaling of vocal parameters and inability to adequately monitor voice intensity,[5, 6]. Thus, despite underlying ability to produce greater volume in response to environmental cues (the Lombard effect) or listener requests, full intensity is not attained or even if reached not held. This is exacerbated by the impaired self-monitoring and reduced awareness of voice intensity, with PwP typically not appreciating they have a quieter voice.

There are further disruptions to voice. PwP experience problems initiating phonation, similar to limb motor initiation difficulties. At first this manifests itself in occasional blocks or hesitant, repetitive sounding speech. Later, pauses become abnormally long (>200ms; see figure 1), making speech dysfluent, with possible freezing of voice-speech analogous to freezing of gait,[7].

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Voice tremor may be present (reportedly in between 15-55% of PwP), [8, 9]. Notably, this may emanate not from intrinsic laryngeal musculature tremor (thyroarytenoids; cricoarytenoids) but more likely from tremor in respiratory muscles, pharyngeal walls, soft palate or tongue. Tremulous voice may be distressing for some, but is not a common cause of significant reduced intelligibility.

Prosody changes

A core disruption to spoken output is marked dysprosody – i.e. alterations to the stress and intonation patterns of speech. Utterances are characterised by a tendency towards flattened intonation (speech all on one note, monopitch), and loss of contrast between stressed and unstressed syllables (monoloudness; see figure 1). This represents one reason for the misperception that PwP are depressed, disinterested, or tired, when they are not, and the negative evaluation of PwP by listeners – a perception reinforced by hypomimia and reduced arm movements that accompany speech.

As with the voice changes, dysprosody in Parkinson's does not rest solely on impairment of the mechanics of speech from rigidity and bradykinesia. Underscaling of movements contributes too. A key component in dysprosody in Parkinson's is a more generalised higher-level impairment in understanding and producing appropriate prosody. PwP have difficulty clearly differentiating between e.g. happy-sad, angry-disappointed, joking-serious tone of voice in their own speech, but also demonstrate a parallel problem in appreciating the contrasting prosodic tones in others, [10, 11]. This represents a likely component in carers' reports that the PwP has lost their sense of humour (e.g. they fail to convey humour in their voice or misinterpret another's joking remark as serious); habitually gets the wrong end of the stick (e.g. interprets an ironic remark as literal – *what time do you call this!*); and they never really know how the PwP is feeling. It appears likely that the problems with (mis)perception of affect extend to visual aspects of processing, e.g. detecting sad vs happy

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faces or picking up on implications of body posture in communication. This topic is pursued under pragmatic disorders below.

Speech (pronunciation, articulation) changes

Hypokinetic movements and difficulties with rapid alternation of movements of the tongue and lips lead to weaker articulatory contacts and in turn to imprecise sounds and indistinct words,[6, 12]. Once more, the issue concerns underscaled movements rather than simply neuromuscular restrictions on the ability to reach target articulatory positions or velocities. Attempting to maintain normal rate of speech in the face of an underfunctioning system may also contribute to imprecise articulation. Sounds requiring firm contacts between articulators become especially vulnerable – *bee, riding, watching, corn* sound like *V, rising, washing, horn*. Vowels produced high or far forwards or back in the mouth tend to be pronounced more centrally: together with the consonant imprecision *heat, boot, queen* sound like *hiss, foot, win*.

To listeners speech rate may sound accelerated. This is an auditory illusion. Imprecise articulatory contacts, monoloudness and monopitch and lack of perceptible boundaries between words found in Parkinson's speech also characterise fast speech in people unaffected by Parkinson's (count as rapidly as you can to 20 to illustrate this, or listen to the horse race commentator when it's neck and neck in the final furlong). Objectively measured rate is the same or even slower than matched unaffected speakers,[6]. PwP may show a greater tendency to accelerate speech over an utterance/passage compared to unaffected speakers. Some PwP show short rushes of accelerated speech. These have been linked to attempts to produce longer utterances on one (reduced) breath, realignment to the natural rhythm of speech after difficulty initiating phonation and/or speech festination akin to that found in gait,[13].

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Altered speech movements are detectable from early on, but typically do not seriously affect intelligibility until later,[1]. However, despite impressions on the part of the listener that speech is unaffected because intelligibility remains viable, should not imply the PwP is not already negatively impacted by the changes,[2, 14]. They may maintain intelligibility only at considerable cost in terms of attention to effort and monitoring of speech. Intelligibility may be fine one to one in a quiet clinic room, but ineffective in noisy environments, over the phone, or when the speaker is involved in activities that distract their attention from optimising speech output,[15].

LANGUAGE CHANGES

PwP frequently report difficulty finding words or expressing their thoughts clearly. What underlies this impression has not received so much attention as voice-speech deterioration and is certainly not as recognised in clinical assessment and management. Nevertheless, ample evidence exists that even in PwP without dementia there are changes to language processing from early on,[16-18]. PwP produce less complex grammar than unaffected individuals. They show slower language processing speed, are more susceptible to misunderstanding metaphor and inferred meaning (*he's a real fighter, are you still putting your shoes on!*) and experience difficulty in resolving lexical and contextual ambiguities (*he picked up the spade – is this about gardening or playing cards?*). A particular difficulty centres on retrieving action verbs/ semantics,[19], which in turn can dissociate from impairment of syntax and object semantics.

Semantic ('*tell me as many animals as you can think of*') and phonemic/letter fluency tasks ('*tell me as many words as you can starting with F*') are widely employed in assessing language in neurology. When controlled for motor speed PwP can perform similarly to unaffected individuals on semantic fluency tasks. Some reports claim poorer performance on letter fluency, but even in unaffected individuals this can be susceptible to literacy influences, so the issue remains open. The reasons for reduced output may evolve over time.

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Impairment may be dominated by motor slowness in early Parkinson's, but later bradyphrenia and other cognitive changes underlie poorer performance,[20]. PwP struggle especially when they need to alternate between categories (*'tell me the name of an animal then something you can eat; tell me a word beginning with F then with A; keep switching between the two'*),[21].

Debate continues regarding how far such changes relate to language specific processing deficits and how far they are linguistic reflections of dysfunction in other cognitive domains,[16, 18, 20]. The answer is probably both. Particular aspects of language are impaired, but language comprehension and production are not possible without the support of executive functioning, attentional focus and switching, balanced excitation and inhibition in retrieval of words and grammatical structures, and auditory verbal short term, working memory.

Discourse management and pragmatics

Discourse and pragmatics refer here to the practical and social skills necessary to manage conversations. Successful conversations involve knowing how to gain and initiate a turn in a conversation. One must be able to signal one does or does not want another speaker to take the floor. Conversations depend on being able to clearly structure an explanation or request and keep track of themes and changes in topic. One must know how and when to introduce new material, know what knowledge can be taken as given versus when to be more explicit, and so forth. Parkinson's affects these abilities,[11, 18, 22]. It also impacts on the ability to recognise misunderstandings have taken place and the ability to repair them,[14].

Such changes interact too with the other verbal and nonverbal impairments. Alterations to facial, arm and body posture signals that indicate one wants a turn or is not yet finished hamper entry into and staying in a conversation. Delay initiating voice or abnormally long pauses are misperceived by listeners as signals one does not want a turn or is finished.

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Bradyphrenia creates a constant struggle to fully understand and keep up with talk.

Difficulties retrieving words, switching mental sets and distinguishing the implicit (tone of voice; irony; seriousness) content of exchanges because of receptive and productive prosody problems present added challenges.

Part of the problem here may centre on an impaired theory of mind (ToM). ToM enables us to anticipate others' intentions, desires, emotions, (re)actions and beliefs within the social context as well as reconcile their (re)actions with our own. It has been argued to be affected in Parkinson's and posited to contribute to breakdown of the discourse and pragmatic skills outlined above,[11, 18].

Psychosocial impact of communication changes

Communication is central not just to functioning successfully on a day to day basis, it is intimately tied up with feelings about ourselves and how others react to us. It is unsurprising therefore that changes to communication profoundly affect the PwP and those with whom they communicate. Speech and language changes, even when intelligibility remains apparently intact, can cause the speaker to lose confidence in speaking, give a sense of inadequacy and/or frustration and feeling that one is being negatively judged,[2]. Speech that lacks varied stress and intonation patterns, is quiet and imprecise and where the person is hesitant in their formulations or replies invites negative judgements by listeners,[11], adding a further barrier to social participation and positive self-perception.

Assessment

Assessment examines whether, and to what extent, any of the above changes pertain, and their impact on the ability of the PwP to make themselves understood, reliably understand others, and participate effectively in daily living. Since the central aim of intervention is always to improve intelligibility and participation, these constitute the key focus of assessment.

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To ascertain speech intelligibility levels and what variables should form targets in therapy to improve it, one uses diagnostic intelligibility testing,[23]. Intelligibility rating scales differentiate broad levels of severity, but can suffer the drawback of poor intra and interrater reliability and tell one nothing about which targets to tackle to improve the situation. Once more, performance varies markedly between clinic and real life situations. Ideally, therefore, intelligibility is also assessed under dual task conditions and in naturalistic settings,[15, 24].

Questionnaires support evaluation of psychosocial impact. They cover (speaker; carer; clinician) perceptions of what aspects of communication have altered; how this affects participation in social roles and situations; and how these may alter affective self-perceptions and interactions,[2, 14, 25, 26].

Turning to more impairment based outcomes, voice assessment establishes the person's ability to produce a sustained vowel (*'say 'ah' as long as you can*), to say this with increasing intensity (louder) and varying and wider pitch range. Easily usable instrumental methods provide objective acoustic measurements to quantify performance,[27], bearing in mind that which articulatory-acoustic variables are key ones to measure may contrast across languages.

Prolonged vowels are good for certain aspects of voice evaluation, but measures based on a standard reading passage (to permit comparisons across time and between individuals), set monologue (e.g. *'tell me how you would make a cup of tea/coffee'*) or picture description allow insights closer to real life situation performance. From these one can employ clinical rating scales or objective acoustic analyses (see figures 1 and 2) to gauge appropriateness and consistency of loudness/ intensity level, pitch range and variability, fluency (pauses, repetitions, prolongations) and rate of speech.

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Prosody production can be evaluated based on reading and monologue samples – using acoustic and/or rating scale instruments. Specifically designed sentences that tap control of stress and intonation patterns can deliver a more focussed assessment of prosody production and perception,[11]. For example, the PwP produces the same sentence (e.g. '*the dress is yellow*'; '*the sausage fell into the trifle*') in a neutral vs angry vs jocular tone. Listeners judge which tone they think they have heard. One can ask the PwP to signal the difference between *SHE drinks coffee* and *she drinks COffee*; disambiguate sentences like *they're hunting DOGS* vs *they're HUNting dogs*; produce the same sentence as a statement vs a question, '*You press this button here!*' vs '*You press this button here?*' For receptive prosody testing, the PwP indicates from pictured or written choices which tone of voice or meaning they hear.

Figures 1 and 2 about here

Rate measurement can be taken from performance on standard reading tasks, and/or be based on speech diadochokinetic repetition of single (papapapa...; tatatata....) or alternating (patakapataka....) syllables in different rhythms (papaPAA papaPAA...; PAApapa...PAApapa... etc). These facilitate quantification of rate control, but also sustainability of rhythm and coordination and integrity and maintenance of articulatory contacts (lips for *pa*, tongue tip for *ta*, tongue back for *ka*). Simple instrumental means can supplement naked ear/stop-watch judgements (figures 1 and 2). Given that speech motor control engages functionally different networks to non-speech control of the tongue, lips, and so forth, ideally tasks should be based on real words,[28], rather than for example 'blow out your cheeks', 'wiggle your tongue from side to side'.

PwP without dementia generally fare well on standard aphasia batteries, since they have no aphasia as seen after stroke. They are more challenged by online tasks that look at speed and complexity of processing, tax attention and short term memory and activation and

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inhibition of (in)appropriate words,[16, 17]. Alternating category naming tests bring naming/ word fluency difficulties into focus,[21].

Management

NICE (National Institute for Health and Care Excellence) Guidelines for Parkinson's recommend intervention for communication changes

(<https://www.nice.org.uk/guidance/indevelopment/gid-cgwave0698> accessed 14 February 2017).

Intervention aims to achieve at any one stage of Parkinson's the optimum level of communication to allow the PwP to participate successfully and meaningfully in family and social life. Clinically relevant outcomes can only be gauged by measuring these factors.

Diadochokinetic rate or acoustic measures provide important objective speech information, but there is poor correlation between changes on these measures and satisfaction with and success in daily living – just as grip force or quadriceps strength are not necessarily clear predictors of whether the person can pick up their cup of tea or stand at the sink.

Rehabilitation targets both speaker and listener. Targets may be underlying impairments (e.g. quiet voice, dysprosody), other techniques seek compensatory or alternative strategies to maximise understandability – but always to functional ends: simply being able to produce a louder 'ah' or with greater pitch range does not automatically translate into improved communication. Important ingredients are education of the speaker and their family about communication, how it changes in Parkinson's, how to anticipate and manage change and create an ideal communicative environment. To facilitate a preventive and anticipatory role it is helpful when referral happens as soon as possible after diagnosis.

Key approaches entail interventions that emphasize self-monitoring and attention to effort, focusing on rescaling of vocal intensity,[29-31]. Rate control, especially when combined with articulatory exaggeration may improve listener perceptions. Rhythmic cueing represents a possibility to aid initiation of speech, maintenance of fluency and control of rate,[32, 33].

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Gains in a calm, unhurried clinic room are relatively easy to attain. The constant challenge is to transfer and maintain gains into the to and fro of fast moving, inherently distractive situations outside. Therapy programmes commonly incorporate systematic methods to achieve this. More recently apps have been piloted to enable better self-management of transfer and maintenance of loudness, rate and intelligibility levels in naturalistic contexts,[24, 34]. Other devices have been trialled that augment or compensate for impaired voice and speech. If spoken output becomes unviable alternative or augmentive means of communication are introduced.

Several studies address the effects on voice of acting or singing in a choir,[35]. Unequivocal lasting benefits for speech-voice parameters directly related to the breathing and voice exercises of these passtimes have still to be established. Outcomes are further generally biased by recruiting self-selecting participants. Studies are unanimous, though, in concluding there are social and psychological advantages and in turn this may translate into less depression, more confidence and through this better speech and social participation.

Other interventions attend to the pragmatic and discourse aspects of communication. They (re)train skills for entering and retaining a place in conversations, recognising breakdowns in understanding and how to successfully repair these. Therapeutic management of language processing issues is under-researched, though studies that have examined effects of cognitive training in PwP may be relevant here.

Repetitive transcranial magnetic stimulation (rTMS) offers a safe non-invasive intervention to treat deficits in Parkinson's, though with variable indications regarding what is ameliorated or not and short and longer term effectiveness. Much still needs to be learned regarding the variables of site of stimulation and its intensity, depth and frequency. Little work exists exploring effects on speech and voice and weaknesses in design and low numbers cloud

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conclusions for most studies,[36]. The reader should also be aware that some specific published TMS data targeting speech in PwP has now been retracted,[37].

L-dopa effects on speech

A longstanding debate concerns whether dopaminergic therapy has similarly positive effects on speech as it does on limb movement. Speech motor decline correlates only weakly with limb motor changes,[1, 27], and is largely unaffected by dopaminergic intervention.

Studies and systematic reviews,[27, 38-40] conclude that whilst individual voice-speech parameters (e.g. velocity, intensity of movement; pitch range) may be positively influenced, benefits do not transfer to improved intelligibility or communication. This likely reflects the fact that speech motor control depends on more than just dopaminergic pathways; the complexity of speech motor control means that there is typically only a weak relationship between the nonverbal oral tasks or isolated acoustic parameters usually employed to test the articulators and actual live speech performance; and speech is intimately tied up with language processing that involves cognitive processes beyond dopaminergic influence and that may even be depressed via L-dopa 'overdosing'.

Deep brain stimulation (DBS) and speech

The heterogeneity of patient groups reported and variety of measures utilized hamper definitive conclusions on the effects of DBS on voice, speech and language. General indications are that sites and settings of stimulation compatible with improvement to limb function are neutral or even detrimental to speech intelligibility and language. Pre-existing significant speech problems serve as a contraindication for DBS in some centres,[41]. Dysarthria and even dysphasia represent adverse effects of DBS, especially bilateral,[42-44].

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Whilst individual acoustic or speech motor parameters may improve, or there is differential impact on underlying processing networks (e.g. reaction time vs set switching in language output), these do not carry through to improved intelligibility or perceived benefit of communication,[43]. DBS may provoke added speech impairments, with greater spasticity and increased dysfluency besides the existing hypokinetic picture,[45]. Speech-language therapy interventions successful with patients without DBS may not succeed or require modification for DBS treated individuals,[46].

Some adverse effects on speech may be device insertion related. Other effects may relate to current diffusion into neighbouring cortico-bulbar, thalamo-cerebellar or periaqueductal tracts. Pulse width and frequency can also influence speech outcomes,[47, 48]. Little et al,[49] found adaptive DBS less detrimental to speech and maybe even capable of benefits.

Conclusion

This overview has emphasized that communication change in Parkinson's is much more than just the quiet voice, and even when voice intensity and intelligibility appear unaffected there are many more barriers to successful communication. Motor, non-motor and cognitive changes permeate all aspects of message formulation and expression. Aspects of communication difficulty link to more far-reaching impairments in auditory perception, attentional control, attentional switching and interpersonal behaviour. Thus, it is more realistic to view communication change in Parkinson's as a receptive/perceptual and cognitive-linguistic disorder, not just an isolated dysarthrophonia. Vitaly, assessment and management must also acknowledge the pragmatic and psychosocial consequences of communication changes. Pharmacological and surgical interventions offer little for speech. This is likely to alter soon with advances in DBS and for those for whom DBS is indicated, but currently behavioural interventions remain the core methods for rehabilitation.

Key points

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- 1 Communication changes are pervasive in their occurrence and impact in Parkinson's
- 2 Changes extend well beyond a quiet voice and imprecise speech to encompass language and social interaction variables and receptive as well as expressive challenges
- 3 Absence of obvious changes to the naked ear does not mean the person with Parkinson's and/or their family are not affected by communication changes
- 4 Speech and language changes are largely uninfluenced by medical therapy and deep brain stimulation currently can result in detrimental effects
- 5 Behavioural therapies therefore remain the first choice for rehabilitation of communication changes, especially those that focus on attention to effort, self-monitoring of output and transfer of practice into naturalistic settings

Declaration of interests

The author has no conflicts of interest to declare.

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Captions for figures:

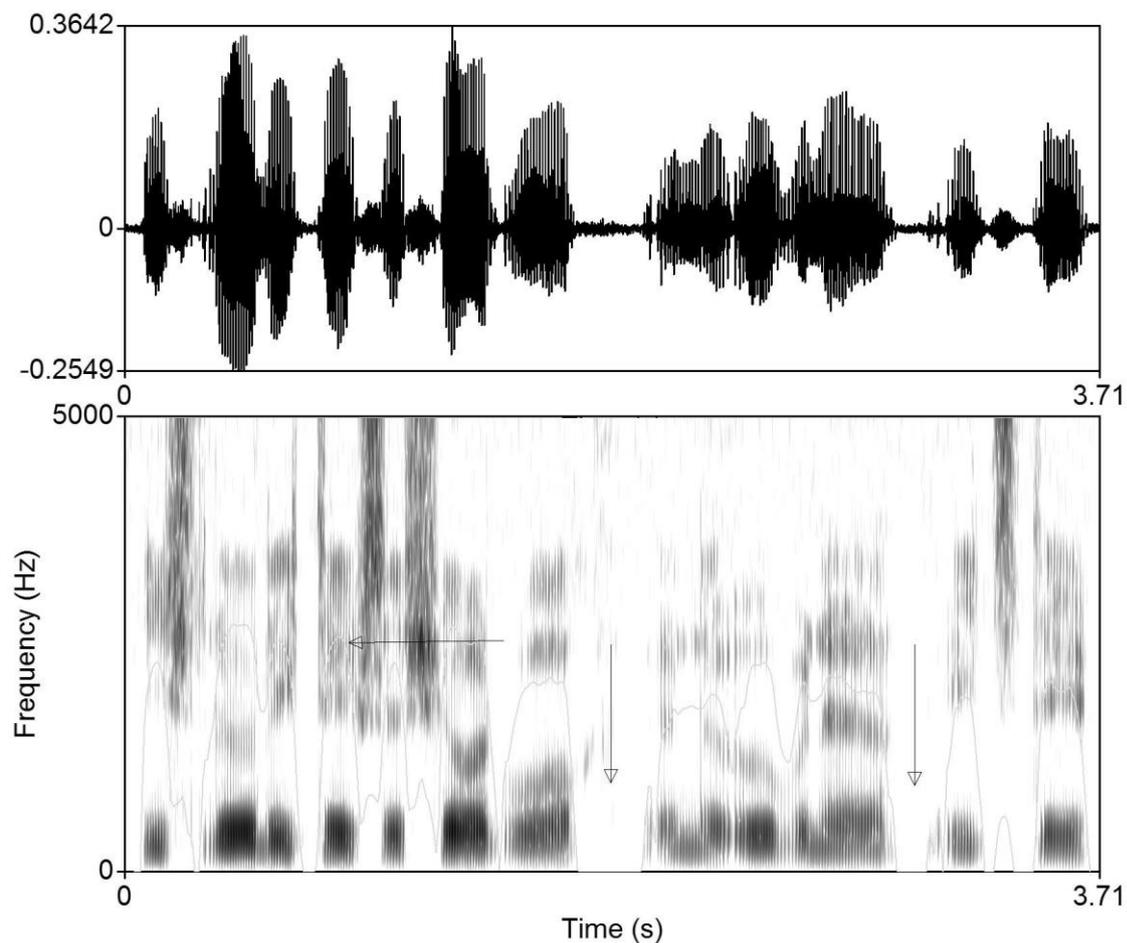


Figure 1: Oscillogram (top) showing intensity variation and accompanying sound spectrogram (bottom). 74 year old male with Parkinson's (UPDRS III Speech rating '2', 'slurred but understandable'). Reading 'He slowly takes a short walk [pause] in the open air [pause] each day'. Of note: tendency to monoloudness illustrated by relatively even oscillogram and level peaks on intensity trace on spectrogram (horizontal arrow left centre); appropriately placed but abnormally long pauses (vertical arrows).

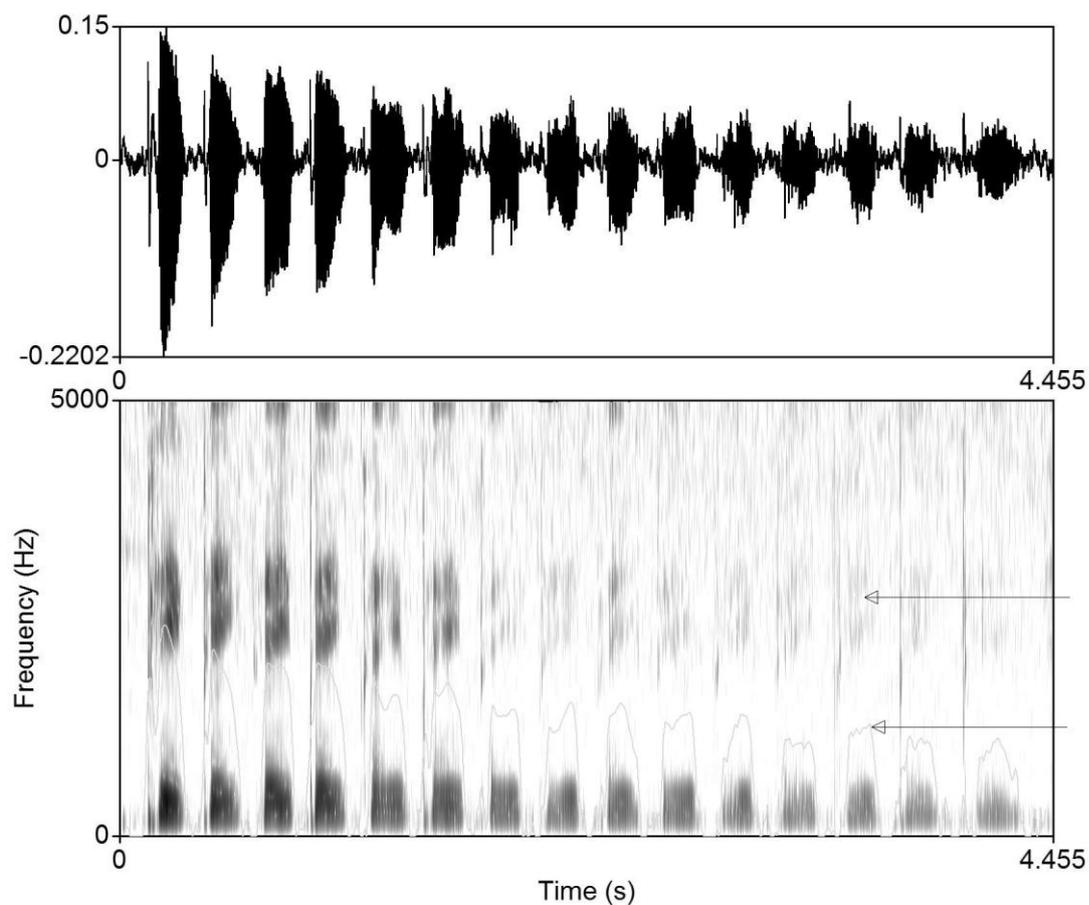


Figure 2: Oscillogram (top) and accompanying sound spectrogram. 70 year old female with Parkinson's (UPDRS III Speech rating '1', 'slight speech changes'). 15 repetitions of 'pea'. Of note: loss of intensity (around 75dB to 55dB) across 4.45 seconds, shown on decreasing oscillogram excursions and spectrogram intensity wave (arrow lower right); loss of sound distinction in mid-high frequencies (arrow centre right), associated with loss of energy/intensity of sound signal and weaker lip contacts. Net perceived effect: change from easily to poorly audible voice, heard at start as 'pea', in mid-repetitions more as 'fee', at end going to 'he'.