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A cross-linguistic perspective to the study of dysarthria in Parkinson's disease

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ABSTRACT

Cross-linguistic studies aim at determining the similarities and differences in speech production by uncovering linguistic adaptations to specific constraints and environments. In the field of motor speech disorders, such a cross-language approach could be of great interest to understand not only the deficits of speech production that are induced by the pathology, but also the difficulties that are induced by the linguistic constraints specific to the patients' language. From a more clinical point of view, cross-linguistic studies should specifically focus on the relationship between speech disorders and speech intelligibility. The aim of this opinion article is to identify the currently scarce theoretical and clinical avenues for cross-linguistic studies of dysarthria in Parkinson's disease, and to establish guidelines that would lead future research in this direction. In turn, the practical and behavioral management of dysarthria in Parkinson's disease has so far only focused on the 'universal' dimensions of speech production and feedback (*e.g.*, treatment of loudness and dysprosody). Such approaches could benefit immensely from proper recommendations that would be more 'language-driven' and individually adapted to the patients' language environment. An additional factor to consider for a better understanding and treatment of dysarthria in PD is the role of adjustment and cultural identity.

1. Introduction

1.1. The rationale for studies on dysarthria

Speech motor control is an important part of successful communication. The breakdown of such motor control can result in speech impairment, such as ***dysarthria***, a speech disorder present in most movement disorders. '*Dysarthria is a collective name for a group of speech disorders resulting from disturbances in muscular control over the speech mechanism due to damage of the central or peripheral nervous system. It designates problems in oral communication due to paralysis, weakness, or incoordination of the speech musculature.*' (Darley, Aronson, & Brown, 1969b, p. 246). The description and classification of dysarthrias, provided by Darley, Aronson and Brown in their pioneering work on motor speech disorders in neurological movement disorders (Darley, Aronson, & Brown, 1969a; Darley et al., 1969b), still represents a consensual, easy-to-understand and practical way to describe speech impairment in movement disorders. Dependent on the location of the nervous system disruption (central or peripheral) that affects muscular control, dysarthria can be further classified into several subtypes (Darley et al., 1969a, 1969b; Duffy, 2005, 2013): flaccid (bulbar lesion and/or dysfunction), spastic (pseudo-bulbar), ataxic (cerebellar), hypokinetic (basal ganglia), hyperkinetic (basal ganglia) and mixed (diffuse).

Among other possibilities, there are two principal ways of examining dysarthria in movement disorders: On the one hand, one can adopt what could be called a *neurological disease-based approach*, which implies that pathophysiological processes are at the origin of the motor signs that contribute, maybe exclusively, to speech disorders; On the other

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hand, a *(neuro)linguistic-based approach* considers that motor speech disorders are the result of alterations dependent on modifications of linguistic processes that have emerged along the progression of the disease. From the former point of view (*i.e.*, disease-based), dysarthria needs to be ***assessed***, in order to be ***managed***; eventually, it can help the clinician and/or the researcher to understand more precisely the pathophysiology of the speech symptom and/or the disease itself as an example of variation-from-normal. From the latter perspective (*i.e.*, (neuro)linguistic-based), dysarthria can be ***studied*** and this pathological model would help to define and refine (neuro)linguistic models of speech production, especially in the case of neurodegenerative diseases that represent, *per se*, a dynamical model of progressive speech variation-from-normal across time. Biasing towards one of the two approaches would narrow the impact of the findings, and it is reasonable to argue that both approaches are complementary and much needed to provide the most thorough description and analysis of dysarthria.

Up to now, dysarthria has been assessed and studied either in clinical settings or through acoustic and other experimental analyses. Similar to the aforementioned distinction between disease- and (neuro)linguistic-based accounts, the ways to assess dysarthria differ depending on the research question: In a clinical setting, the physiological functions of articulatory muscles are principally evaluated through means of qualitative judgments by a speech and language pathologist (*e.g.*, using the Frenchay Dysarthria Assessment; Enderby, 1980; Enderby & Palmer, 2008). This assessment will establish the impact of the disease and define the pathophysiological state of the speaker to better manage speech impairments. An alternative assessment is the acoustic analysis of speech from dysarthric patients to extract quantitative measures of how the patients' speech differs from healthy speakers and to understand how neurological dysfunction impacts speech production. Importantly, though, it is still unclear in these kinds of assessments how speech breakdown in dysarthria may interact with the typological characteristics of the target language spoken by the patient. In such a context, it seems important to identify a further potential source of variation to dysarthria. Independent of how this phenomenon is assessed, managed, or studied, one needs to know which processes underlying speech production can be applied universally, and which ones are prone to cross-linguistic differences.

For instance, the conceptual level, where thoughts and messages to be expressed are constructed, is generally considered as being largely language-independent (*cf.* Levelt, 1989; but see Slobin, 1996). To date, most studies on cross-linguistic speech production have focused on lexical access, sentence construction, and phonological encoding, since these levels of processing likely show differences across languages. Probably, one reason why the role of speech motor control across languages has been largely neglected is due to the fact that motor abilities are universally shared, and thus motor execution has long been considered as modular and separate from speech planning stages. However, the shared motor and neural basis of speech production contrasts with the remarkable diversity of human languages in which speakers are actively engaging and 'training' on a daily basis. On top of that, recent studies in speech production have shed considerable doubt on the traditional dissociation between the planning and execution levels of speech processing (*e.g.*, Bell, Brenier, Gregory, Girand, & Jurafsky, 2009; Spencer & Rogers, 2005). Thus, one question that derives from this change of perspective is how motor speech breakdown, such as in dysarthria, would interact with these cross-linguistic variations, and specifically, to what extent dysarthria is affected by the language a person speaks.

1.2. The rationale for cross-linguistic studies on dysarthria

In this opinion article, we will consider the possibility that, although speech motor control is a universally shared human ability, the evolution and impact of speech disorders may depend on the linguistic and cultural environment of the patients. Alternatively, it could also be argued that there are compensation strategies that evolve together with the processes that accompany speech motor breakdown, suggesting a universal tendency for adjustments to speech disorders in patients. The rationale of carrying out cross-language studies on motor speech disorders such as dysarthria is to reveal the universal and language-specific dimensions of a patient's speech. Despite the universality of speech motor abilities, communication needs to be studied within specific cultural and linguistic environments, since long-term language-specific influences are likely to interact with its universal foundation. Research in speech production has mainly focused on unraveling the universal processes that govern the development, use, and breakdown of language processes. Only recently have researchers turned to ask how these universal principles may be modulated by and extended to the specificities of other languages (*e.g.*, Costa, Alario, & Sebastián-Gallés, 2007; Norcliffe, Harris, & Jaeger, 2015; O'Seaghdha and Chen, 2009; Sadat, Martin, Costa, & Alario, 2014). Most research in the field of the language sciences has been conducted in English, and thus one may ask whether current findings refer to language universal mechanisms or English-specific facts. An example of how articulation and speech control mechanisms differ across languages can be found when assessing voice onset times (VOTs), the interval between the release of a stop consonant occlusion and the onset of the vocal-fold vibration, across different languages. For example [p] in French has a VOT similar to a [b] in English which reveals language-specific quantitative VOT values in different languages (*e.g.*, Keating, 1984; Sancier & Fowler, 1997). Moreover, speech sounds never occur in isolation and thus additional levels such as prosody that are susceptible to language-specific differences can also influence the articulation of speech.

Overall, it remains unclear how motor speech breakdown will vary with environmental contexts, and in particular, to what extent motor speech breakdown is dependent on the properties of the specific language one speaks. Previous cross-linguistic work in the context of language pathologies has mainly focused on higher levels of language processing (*e.g.*, aphasia, dyslexia) and explored how they influence speech errors and disfluencies (for a detailed statement of the rationale for cross-language studies on motor speech disorders, *cf.* Miller, Lowit, & Kuschmann, 2014). This body of research supports the idea that predominant properties of a