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PROJECT REGISTRATION

BUILDING A CORPUS TO ANALYZE **STUTTERING** ACCORDING TO A DYNAMIC MODEL OF **SPEECH RHYTHM** PRODUCTION

EDITORS
- Leônidas Silva Jr. (UEPB)
- Plinio Barbosa (UNICAMP)
- Sandra Madureira (PUC-SP)
- Renata Passetti (UFSCar)

REVIEWERS
- Larissa Berti (UNESP)
- Juliana Andreassa (PUC-SP)

ABOUT THE AUTHORS
- Sandra Merlo
  Conceptualization; Methodology; Investigation; Resources; Data Curation; Project Administration; Writing – Original Draft; Writing – Review & Editing.
- Luciana Lucente
  Conceptualization; Methodology; Formal Analysis; Investigation; Data Curation; Supervision; Project Administration; Visualization; Writing – Original Draft; Writing – Review & Editing.

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Sandra MERLO
Board of Directors - Brazilian Fluency Institute (IBF)
São Paulo, SP, Brazil

Luciana LUCENTE
Faculty of Letters - Federal University of Minas Gerais (UFMG)
Belo Horizonte, MG, Brazil

ABSTRACT

This article presents the design and theoretical motivation for the construction of a corpus of stuttered Brazilian Portuguese (BP) speech, to be analyzed within the framework of a model of speech rhythm. Stuttering is a fluency disorder characterized by recurrent disruptions in the temporal organization of speech, such as part-word repetitions, sound prolongations, and blocks. Despite the relevance of temporal aspects for the characterization of stuttering, there is currently no corpus in BP specifically designed to support rhythmic and prosodic analyses of stuttered speech. The proposed corpus aims to fill this gap through the systematic collection, acoustic analysis, and annotation of data from children, adolescents, and adults who stutter, encompassing a wide range of stuttering profiles. These profiles include different stuttering types and degrees of severity, co-occurrence with cluttering, covert stuttering, acquired stuttering, and speech produced before and after behavioral treatment. Within this phonetic model, stuttering is analyzed as part of a continuous rhythmic process rather than as a set of isolated disfluent events, allowing stuttered and non-stuttered intervals to be examined in terms of vowel-to-vowel (V–V) unit duration, rhythmic variability, and the organization of stress groups within a

coupled-oscillator framework. The corpus design integrates clinical and acoustic variables, enabling a detailed investigation of how stuttering affects speech rhythm in BP.

RESUMO

Este artigo apresenta o desenho e a motivação teórica para a construção de um corpus de fala gaguejada do português brasileiro (PB), a ser analisado no âmbito de um modelo de ritmo de fala. A gagueira é um distúrbio da fluência caracterizado por rupturas recorrentes na organização temporal da fala, tais como repetições de partes de palavras, prolongamentos e bloqueios de sons. Apesar da relevância dos aspectos temporais para a caracterização da gagueira, não existe atualmente um corpus em PB especificamente concebido para análises rítmicas e prosódicas da fala gaguejada. O corpus proposto busca preencher essa lacuna por meio da coleta, análise acústica e anotação sistemáticas de dados de crianças, adolescentes e adultos que gaguejam, contemplando uma ampla variedade de perfis de gagueira. Esses perfis incluem diferentes tipos e graus de severidade da gagueira, a coocorrência com taquifemia, a gagueira encoberta, a gagueira adquirida e a fala produzida antes e após tratamento fonoaudiológico. No âmbito deste modelo fonético, a gagueira é analisada como parte de um processo rítmico contínuo, e não como um conjunto de eventos disfluentes isolados, permitindo que intervalos gaguejados e não gaguejados sejam examinados em termos da duração das unidades vogal-a-vogal (V–V), da variabilidade rítmica, da organização dos grupos acentuais em um modelo de osciladores acoplados. O desenho do corpus integra variáveis clínicas e acústicas, possibilitando a investigação detalhada de como a gagueira afeta o ritmo da fala no PB.

KEYWORDS

Fluency; Cluttering; Phonetics; Acoustic Analysis.

PALAVRAS-CHAVE

Fluência; Taquifemia; Fonética; Análise Acústica.

INTRODUCTION

This article presents the objectives, hypotheses, and the process involved in constructing a corpus of stuttered speech to be analyzed within the framework of the Dynamic Model of Speech Rhythm proposed by Barbosa (2006).

The linguistic literature discusses theoretical assumptions and methodological aspects related to the compilation of linguistic corpora – both written and spoken – which guide the corpus linguistics field (Tognini-Bonelli, 2001; Meyer, 2004; Baker, 2010; McEnery; Hardie, 2012). Language corpora are compiled for purposes such as teaching, typology, diachronic analysis, and the study of language use and variation, among others (O'Keeffe; McCarthy, 2010). In the present study, the corpus under development is intended to investigate a communication disorder observable in speech rather than a specific language per se. Nevertheless, the data that compose the corpus are drawn from Brazilian Portuguese (hereafter BP), as is the Dynamic Model of Speech Rhythm itself, which was originally proposed based on BP data.

Several studies (Raso; Rocha, 2017; Barbosa; Raso, 2018; Teixeira; Barbosa; Raso, 2018; Teixeira; Raso; Barbosa, 2020) that analyze BP data within the framework of Barbosa's (2006) rhythm model rely on the C-ORAL-BRAZIL corpus (Raso; Mello, 2012; Mello *et al.*, 2021). C-ORAL-BRAZIL is a reference corpus of informal and spontaneous BP speech and constitutes an important resource for corpus linguistics research in Brazil.

In addition to C-ORAL-BRAZIL, another central reference corpus for BP is the NURC Digital corpus (Oliveira Jr., 2019), a digitized and phonetically transcribed version of the original NURC project (Castilho, 2021). This corpus was employed in the study conducted by Terto and Oliveira Jr. (2021), which also draws on assumptions of Barbosa's rhythm model in the segmentation of utterances. Specifically, the authors adopt vowel-to-vowel (V–V) units in their analysis to describe prosodic characteristics of metadiscursive utterances in contrast with adjacent non-metadiscursive utterances.

Additionally, the C-ORAL-ESQ corpus (Rocha, 2019; Rocha *et al.*, 2022) is a spoken corpus designed to document the spontaneous speech of Brazilian individuals with schizophrenia. This corpus follows the same principles and methodological procedures as C-ORAL-BRAZIL and focuses on speech produced during psychiatric interviews between patients and their psychiatrists as part of regular treatment. Its primary goal is the informational annotation of texts and words produced by patients, in order to investigate how individuals with schizophrenia manage the relationship between prosody and information structure.

Vital *et al.* (2025) note that C-ORAL-BRAZIL and C-ORAL-ROM (Cresti; Moneglia, 2005) annotate disfluencies in their transcriptions. However, the classification criteria adopted in each corpus take into account elements of different natures. With regard to BP, the proposed classification of disfluencies are: (i) repair - when the speaker reformulates part of an informational

unit, typically to enhance semantic content, (ii) repetition - when the speaker repeats linguistic units within the same informational unit; (iii) change of planning - when the speaker replaces an informational unit's content; (iv) scanning unit - a prosodic break that splits a single informational unit into multiple intonational units; (v) filled pause - vocalized segments filling an intonational unit or its part, signaling turnholding; and (vi) abandonment - when the speaker definitively rejects the whole linguistic sequence.

Currently, there is no corpus in BP exclusively dedicated to stuttered speech. The corpus proposed here aims not only to enable the analysis of stuttering within the framework of the Dynamic Model of Speech Rhythm, but also to support broader research on stuttered speech. However, its design and underlying assumptions, as discussed below, are primarily oriented toward phenomena related to speech prosody.

The following sections present a definition of stuttering and a review of relevant studies, an overview of the Dynamic Model of Speech Rhythm, the hypotheses motivating the corpus construction, and a detailed description of the corpus design.

1. STUTTERING

Stuttering is a communication disorder that affects speech fluency (Andrade, 2006; Theys *et al.*, 2008). From the speaker's point of view, stuttering is characterized by a temporary loss of speech control and feeling stuck (Tichenor; Yaruss, 2019). From the listener's point of view, it is usually characterized by the presence of specific hesitations or disfluencies (Andrade, 2006, 2023; Riley, 2009), such as part-word repetitions, sound prolongations and blocks at the beginning of words, broken words, and extraneous sounds in speech production.

Stuttering hesitations may be accompanied by physical effort (i.e., physical concomitants), which adds qualitative features to speech production (Andrade, 2023; Riley, 2009). For example, if the effort occurs at the glottis, several vocal qualities may occur, such as a creaky or strangled voice. If the effort occurs at the supraglottic region, an increase in sound intensity may be observed during the stuttering moment. Stuttering may also involve physical effort in other parts of the body, such as the eyes, head, and hands.

Cluttering is also a speech fluency disorder and frequently co-occurs with stuttering (Van Zaalen-Op't Hof *et al.*, 2009). It has three main characteristics. First, a fast or irregular speech rate according to the speaker's age and dialect. Second, the presence of acoustic deletions of sounds or syllables, or imprecise articulation due to the fast or irregular speech rate. Third, an increased frequency of typical hesitations, such as fillers, whole-word repetitions, and false starts (Van Zaalen-Op't Hof *et al.*, 2009).

There are two main types of stuttering, considering its etiology. The most frequent one is neurodevelopmental stuttering, which begins in childhood – typically between 3 and 4 years of age for girls and between 4 and 7 years of age for boys (Briley *et al.*, 2021). It is often described as idiopathic, with no clear cause but strongly associated with genetic predisposition (Frigerio-Domingues; Drayna, 2017). The second type of stuttering is acquired, which is far less frequent. It is caused by brain injury, such as a stroke or a neurodegenerative disease (Theys *et al.*, 2008).

Stuttering can be clinically assessed with quantitative and qualitative methods. In BP, there are reference parameters for the percentage of disfluencies, their type (i.e., if typical or stuttered), and speech rate for both biological sexes and different age groups (Andrade, 2006, 2023). Speakers who deviate from these parameters may present with stuttering. The analyses presented by Andrade (2006, 2023) are not specific to the clinical diagnosis of stuttering in BP, but they do present quantitative parameters of what is expected for speech fluency according to sex and age. On the other hand, the Stuttering Severity Instrument (SSI-4; Riley, 2009), for example, is a specific protocol for the clinical diagnosis of stuttering for speakers of American English. Using SSI-4, it is possible to analyze the percentage and duration of stuttered syllables, physical concomitants, and the naturalness of speech. The result indicates stuttering severity, which can range from very mild to very severe. In addition to quantitative assessment, stuttering can also be evaluated qualitatively. The Overall Assessment of the Speaker's Experience of Stuttering (OASES; Yaruss; Quesal, 2016) was originally proposed for speakers of American English, but it has already been translated and validated for other languages, including BP for the adult age group (Bragatto *et al.*, 2012). This instrument assesses the speaker's perception of stuttering, reactions to stuttering, communication difficulties in daily life situations, and the impact of stuttering on quality of life (Yaruss; Quesal, 2016). Therefore, the clinical assessment of stuttering includes both quantitative aspects of speech production and qualitative aspects of being a person who stutters.

Speech therapy is considered the primary treatment for stuttering. It can be indirect, involving support for parents and significant others, or direct, when performed with the person who stutters (Baxter *et al.*, 2015). Speech therapy techniques are usually classified into two main groups – stuttering modification or fluency shaping (Baxter *et al.*, 2015). The goal in stuttering modification is changing the speaker's behavior during stuttering moments – practicing the interruption of a stuttering moment and a smoother restart, for example. The goal in fluency shaping is changing speech production to inhibit stuttering – reducing speech rate in the whole utterance, for example. Some treatments involve the use of devices to modify auditory feedback and others to increase the overall well-being of the person who stutters (Baxter *et al.*, 2015).

1.1. LINGUISTIC ASPECTS ASSOCIATED WITH THE OCCURRENCE OF STUTTERING AND USUAL INTERPRETATIONS

There are several linguistic aspects associated with stuttering. These aspects can be reported and anticipated by people who stutter (Mersov; De Nil, 2021), which suggests they are very robust. We present here some of these aspects, documented in a wide variety of languages for children and adults with neurodevelopmental stuttering (Al-Tamimi *et al.*, 2013, for Arabic; Aryal; Maruthy, 2023, for Nepali; Bohnen, 2009, for BP; Dworzynski; Howell, 2004, for German; Howell; Au-Yeung, 2007, for Spanish; Uysal *et al.*, 2021, for Turkish; Warner *et al.*, 2023, for English), as well as for adults with acquired stuttering after brain damage (Max *et al.*, 2019): (i) stuttering occurs almost only in the **first syllable of the word or utterance**; (ii) **word position in the utterance** influences stuttering probability, being greater at the beginning; (iii) some **classes of segments** are more likely to be stuttered (such as plosives and oral vowels); (iv) the **structure of the word first syllable** may increase the likelihood of stuttering, particularly syllables with complex onset (consonant-consonant-vowel) or only rhyme (vowel); (v) **word length** influences the likelihood of stuttering, being greater with longer ones; (vi) **open-class words** may increase the likelihood of stuttering compared to closed-class words.

These aspects are usually understood from a psycholinguistic perspective, i.e., from conceptual preparation to speech articulation (Ratner, 1997; Warner *et al.*, 2023). For example, "word position in the utterance" is attributed to the grammatical selection stage, "word length" is attributed to phonological encoding, and "classes of segments" to phonetic encoding (Ratner, 1997; Warner *et al.*, 2023). However, a different perspective will be adopted here, with the authors assuming that there are no significant phonological, lexical, grammatical, or semantic processing difficulties related to stuttering. The hypothesis here is that the processing difficulties that acoustically occur as stuttering are related only to the phonetic encoding stage and, particularly, to speech rhythm. This does not mean that stuttered speech is being understood as a speech motor disorder. As will become clear in the next section, speech rhythm is controlled by linguistic rules and receives input from higher language levels.

Arguments in favor of the hypothesis that stuttering does not involve deficits at higher language levels include the rejection of the Covert Repair Hypothesis (Kolk; Postma, 1997) and evidence that children who stutter, as a group, do not exhibit inferior language skills (Nippold, 2012, 2019). The Covert Repair Hypothesis postulated that stuttered hesitations/disfluencies would be phonetic consequences of underlying phonological repairs. The phonological repair would not be transparent - as when one corrects an overtly incorrect segment, for example - because it would be done by internal speech, which precedes articulation. The repairs would be phonological in nature because stuttering always involves sublexical segments (phones or syllables), with no indication that the difficulty lies in lexical selection, morphological selection, or syntactic structuring. However, after a large amount of experimental research, the Covert Repair Hypothesis was rejected because its

premises were not confirmed (Gregg; Yairi, 2012; Nippold, 2009; Wolk *et al.*, 2000, among others). For example, if stuttering implied underlying phonological repairs, (i) children who stutter should present higher rates of phonological disorder during language acquisition (Nippold, 2009), (ii) stuttering should occur less frequently in syllables with overtly phonological errors as an evidence of non-repairing of these errors, and occur more frequently in syllables without overtly phonological errors as an evidence of error correction (Wolk *et al.*, 2000), or (iii) as the phonological disorder is more severe, stuttering should be milder and vice versa (Gregg and Yairi, 2012). However, these assumptions have not been confirmed (Gregg; Yairi, 2012; Nippold, 2009; Wolk *et al.*, 2000).

There is evidence that children who stutter do not exhibit inferior language skills when compared to their peers who do not stutter (Nippold, 2012, 2019). Although some studies suggest that children who stutter perform inferiorly on language assessments, there are significant methodological flaws in these studies, such as the lack of control for variables that influence language acquisition (such as parental education or socioeconomic level), the exclusion of children with language disorders from the non-stuttering group, or the selection of tasks that place children who stutter at a clear disadvantage (for example, in a rapid naming task) (Nippold, 2012, 2019). Additionally, there is no evidence that deficits in language acquisition influence the onset, recovery, or persistence of stuttering (Nippold, 2012, 2019).

Still, according to an innatist perspective, there is also the hypothesis proposed by the Integrated Theory of Fluency (Correia, 2020), which conceives fluency as a linguistic skill. Correia *et al.* (2023) hypothesize that verbal fluency depends on the identification of formal and categorical features of words, with stuttering being related to the difficulty in representing formal features in the mental lexicon or in accessing them during speech production. This is the only study from this perspective with data from BP that we are aware of, and it is quite different from the stuttering perspective analysis of this work.

1.2. STUTTERING AND ACOUSTIC PHONETICS; SPEECH-LANGUAGE PATHOLOGY AND LINGUISTICS

Few studies analyze stuttering from the perspective of acoustic phonetics. In December 2025, 44 and 95 studies were found by combining the words "stuttering AND phonetic" and "stuttering AND acoustic", respectively, in the "Title and/or Abstract" fields of the PubMed database (National Library of Medicine, 2025). On the other hand, 368 studies were found by combining the words "stuttering AND brain" in the same database on the same date. These findings suggest that stuttering is studied much more in its neurological aspects than in its phonetic aspects, for example.

However, given that stuttering occurs in speech production, acoustic phonetic analyses are highly desirable. Possible reasons for the reduced number of studies analyzing stuttering from an acoustic phonetics perspective include training of speech-language pathologists and linguists, and

the specificities of data acquisition, analysis, and interpretation. Speech-language pathologists are responsible for stuttering assessment and treatment (Brasil, 1981), but do not usually have in-depth knowledge of phonetics, although this discipline is part of their undergraduate curriculum (Brasil, 2002a). On the other hand, linguists have advanced knowledge of phonetics but may have no familiarity with stuttering or other communication disorders (Brasil, 2002b). In addition, there are specificities in the acquisition, analysis, and interpretation of acoustic phonetic data that are not trivial. Professional-quality equipment is necessary to record speech signals, as well as a room with acoustic treatment and low-intensity noise (Cunto, 2009). Data analysis requires specific software, such as Praat (Boersma; Weenink, 2025). Finally, data interpretation requires acoustic phonetics models (such as Source-Filter Theory; Stevens, 2000), in addition to prosodic models (such as speech rhythm; Barbosa, 2006). The combination of all these elements likely reduces stuttering studies from an acoustic phonetics perspective.

Currently, some contributions of acoustic phonetics regarding the duration parameter can be exemplified as follows:

- *Vowel duration in syllable repetitions* tends to be shorter compared to the same syllable produced fluently (Howell; Vause, 1986; Howell; Williams, 1992). These findings were observed both in the spontaneous speech of children and adolescents (Howell; Williams, 1992) and in adults with stuttering who speak English (Howell; Vause, 1986).
- *Segmental duration in syllables with simple onset* can be different in the fluent speech of people who stutter (Falk *et al.*, 2016). Falk *et al.* (2016) analyzed consonant-vowel (CV) stressed syllables formed by the voiceless stops [p, t, k] and the vowels [a, i, u] in fluent spoken and sung sentences in German. In speech, the duration of the occlusion and release phases of consonants was more variable in adolescents who stutter compared to those who do not. In addition, the release phase in singing was less variable compared to speech in adolescents who stutter, while the opposite occurred in adolescents who do not stutter. Vowel duration was shorter in the stuttering group compared to the control group, both in speech and singing.
- *Segmental duration in syllables with complex onset* can also be different in fluent speech of people who stutter (Franke *et al.*, 2023). Franke *et al.* (2023) analyzed vowel and consonant compression in syllables with complex onset in one-syllable words in German. Syllables with complex onset (consonant-consonant-vowel, CCV, such as [kla]) showed shorter segment durations compared to corresponding syllables with simple onset (CV, such as [ka] and [la]) (Katz, 2012). While children and adolescents who stutter produced a vowel compression pattern similar to the group who do not stutter, the same did not occur with consonant compression, with the target consonants in the CCV syllables being significantly more compressed in the group with stuttering (Franke *et al.*, 2023).
- *Voice onset time* (VOT) can show different durations in people who stutter (Al-Tamimi; Howell, 2021; Falk *et al.*, 2016). Al-Tamimi and Howell (2021), analyzing the fluent production of one-syllable words in Arabic, found a shorter VOT in emphatic and non-emphatic [t] produced by

adolescents who stutter compared to their peers without stuttering. In addition, adolescents who stutter produced a longer VOT in the emphatic [d] and a shorter one in the non-emphatic [d], while the opposite was found with their peers without stuttering.

- The *adaptation effect* produces changes in syllable duration in people who stutter (Neel *et al.*, 2023). This effect refers to a decrease in stuttering moments due to successive readings of the same text. Neel *et al.* (2023), analyzing data from adults who stutter who read the same text five times, observed a reduction in the frequency and duration of stuttering moments, as well as an increase in the duration of fluent syllables that preceded the stuttered syllables.
- *Speech rate in fluent speech* tends to be lower in those with more severe stuttering compared to those with milder stuttering (Arcuri *et al.*, 2009). Arcuri *et al.* (2009), analyzing the repetition of carrier phrases with target words in BP, found that adults with more severe stuttering had a lower speech rate compared to their peers with milder stuttering.
- *Duration variability* may change after speech behavioral treatment for stuttering (Onslow *et al.*, 1992). Onslow *et al.* (1992) analyzed spontaneous fluent speech in a group of English-speaking school-aged children after a fluency shaping treatment. There was a reduction in the variability of vowel duration and articulation rate after treatment.
- *Speech rate in fluent speech* may be lower after speech behavioral treatment for stuttering (Tasko *et al.*, 2007). Tasko *et al.* (2007) analyzed physiological and acoustic variables in adult English speakers who stutter, before and after an intensive fluency shaping treatment. All participants showed a quantitative reduction in stuttering moments after treatment. In addition, there was a reduction from 4.5 to 3.8 syllables/s in the speech rate of the target phrase before and after treatment. Thus, the production of longer segments was related to stuttering improvement.

Therefore, differences in duration occur both in fluent and stuttered speech of people who stutter compared to their peers without stuttering. It is noteworthy that many studies analyze only fluent speech of people who stutter (Al-Tamimi; Howell, 2021; Arcuri *et al.*, 2009; Falk *et al.*, 2016; Franke *et al.*, 2023; Neel *et al.*, 2023; Onslow *et al.*, 1992; Tasko *et al.*, 2007), with few studies also analyzing stuttering moments (Howell; Vause, 1986; Howell; Williams, 1992; Neel *et al.*, 2023). Until now, there have been few studies that provided phonetic descriptions of stuttering moments, describing the behavior of the acoustic parameters of duration and frequency in these moments.

No study has analyzed the long-term evolution of speech rhythm in subjects who stutter – only specific aspects of segmental duration were analyzed (Al-Tamimi; Howell, 2021; Arcuri *et al.*, 2009; Falk *et al.*, 2016; Franke *et al.*, 2023; Neel *et al.*, 2023; Onslow *et al.*, 1992; Tasko *et al.*, 2007). Smith and Weber (2017) observed that, in clinical practice, excessive emphasis is placed on stuttering moments, as if stuttering is a phenomenon that occurs in a separate moment, with no relation to fluent speech. The authors speculate that a stuttering moment may be the result of a continuous process and not a process restricted to a single syllable (Smith; Weber, 2017). The fact that there

are significant differences in segmental duration in fluent speech of people who stutter (Al-Tamimi; Howell, 2021; Falk *et al.*, 2016; Franke *et al.*, 2023; Neel *et al.*, 2023) suggests that fluency difficulties are not restricted to stuttering moments, supporting the hypothesis of Smith and Weber (2017). Considering this, a speech rhythm model can add to the understanding of how syllable duration evolves in the speech production of people who stutter, also analyzing syllables that precede stuttered ones, without the need to separate "fluent speech" from "stuttered speech".

2. DYNAMIC MODEL OF SPEECH RHYTHM

The speech rhythm model that will be used as the theoretical basis for the analysis of the corpus is the Dynamic Model of Speech Rhythm (DMR) (Barbosa, 2006). This model proposes that variations in the duration of syllable-sized units throughout the utterance are a consequence of two rhythmic properties – stress and syllabicity. Thus, speech rhythm results from the coupling between the stress and the syllable oscillators. In this model, the stress oscillator is mathematically coupled to the syllable oscillator, so that the influence of the former on the latter increases the duration of the syllable oscillator. The model works with syllable-sized units, specifically vowel-to-vowel (V-V) units, which correspond to the segments between the onset of one vowel and the onset of the next vowel. The reason for this is that, in BP, the duration of V-V units is more stable than syllable duration (Barbosa, 2006).

Briefly, the model proposes that the stress oscillator receives information from higher linguistic levels (i.e., syntax, semantics, and pragmatics). This allows the occurrence of phrasal accents due to syntactic, semantic, and pragmatic focus. The higher linguistic levels also provide information to the gestural lexicon, which determines the position of lexical stress. This ensures that the pulses of the stress oscillator occur only at lexically stressed syllables. The sequence of pulses specifies the locations where phrasal stress isomorphically occurs. Thus, the influence of the stress oscillator on the duration of the syllable oscillator period can be understood as an accent mechanism throughout the cycles of the syllabic oscillator, which generates the duration patterns of segment units throughout the utterance and determines phrasal stress (Barbosa, 2006). The phrasal stress, which can be defined by a local increase in V-V unit duration, signals a prominence in speech production, based only on intrinsic segment duration. The interaction between this prominence and the gestural pattern determines the gestural duration. The DMR diagram can be seen in Figure 1.

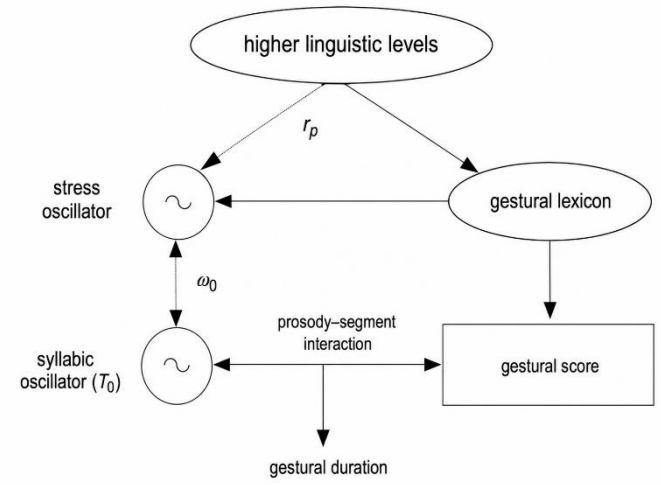

Figure 1. Diagram of the Dynamic Model of Speech Rhythm (Barbosa, 2006). The arrows indicate that one level influences another. ALT: Schematic model of prosodic organization with stress and syllabic oscillators coupled via ω_0 and influenced by higher linguistic levels (r_p). The gestural lexicon interacts with coupled oscillators, determining gestural duration.

The stress oscillator also presents with induction and decay mechanisms, responsible for fine adjustments of V-V unit duration (Barbosa, 2006). The induction rate exponentially increases the duration of V-V units up to the phrasal stress, while the decay rate decreases the duration of V-V units after the end of a stress group. These mechanisms enhance the effect of prosodic boundaries (Barbosa, 2006).

By assuming these two oscillators in speech rhythm production, the DMR deals with the dichotomy between stress-timed and syllable-timed languages (Barbosa, 2000). According to the model, this distinction depends on the degree of coupling between the two oscillators. The degree of coupling (ω_0 in the model diagram) is a continuous variable, as is the distinction between stress- and syllable-timed rhythms. When this degree of coupling approaches 0, the language tends towards a syllable-timed rhythm, and when it approaches 1, the tendency is towards a syllable-timed rhythm.

There is also the possibility of a glottal mechanism in speech rhythm production. Barbosa (2006) highlights that the intonational emphasis caused by the fundamental frequency (f0) movement leads to an increase in the duration of vowel segments. This is perceptually more salient than just an increase in duration and also enhances the effect of prosodic boundaries. This alignment between f0 and duration provides clues about how phrasal stress can influence the intonational structure of utterances.

As the original formulation of the DMR considers the possible existence of a glottal oscillator interacting with the other two oscillators, Lucente (2012) proposes the inclusion of the glottal oscillator in the DMR based on the analysis of intonational patterns of spontaneous utterances in BP. These patterns are related to the utterance discourse structure and the stress groups – the latter corresponding to the time period between two phrasal accents (Lucente, 2012).

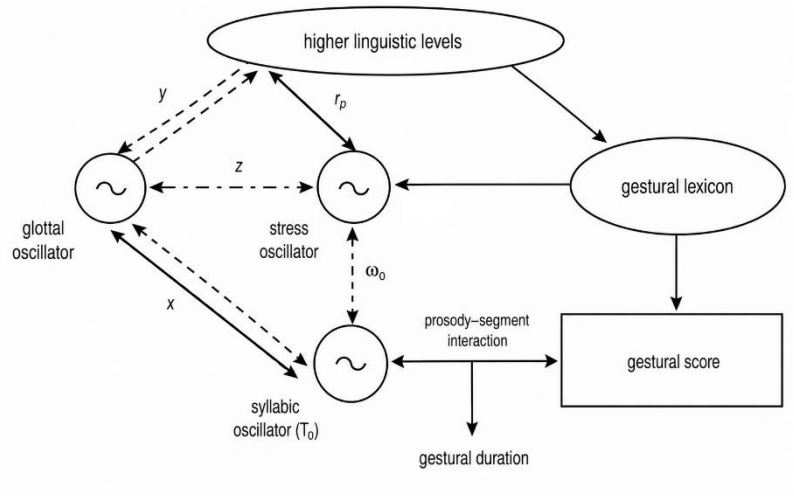

Figure 2. Addition to the original model proposed by Barbosa (2006), with the inclusion of the glottal oscillator. The continuous arrows indicate that one level influences another. The interrupted arrows indicate the hypothesis of the glottal oscillator influence (Lucente, 2012). ALT: Extended model including glottal, stress, and syllabic oscillators with bidirectional coupling (x, y, z, r_p). Higher linguistic levels and the gestural lexicon interact with coupled oscillators, determining gestural duration.

Using the DMR and the relationship between stress and syllable oscillators in determining the duration of V-V units, the boundaries of stress groups were seen as cyclic attractors. This has led to the assumption of the existence of a glottal oscillator combined with the other two originally proposed in the DMR. The glottal oscillator would be coupled to the syllable oscillator by a force *x*, while keeping a coupling interaction *z* to the stress oscillator. This can be seen in the reformulation of the DMR in Figure 2 proposed by Lucente (2012). This inclusion means that the coupling between the glottal and syllable oscillators would influence the interaction between discourse information of intonational patterns and stress groups, which would be specified by the relationship *y* (Lucente, 2012).

3. HYPOTHESES ABOUT THE INFLUENCE OF STUTTERING ON SPEECH RHYTHM

The most important aspect of analyzing stuttering according to a dynamic model of speech rhythm concerns the non-separation between "fluent speech" and "stuttered speech". The duration of V-V units will be analyzed over time, regardless of whether a given unit is perceived as fluent or stuttered. Thus, moments of stuttering will be integrated into the evolution of speech rhythm.

The initial hypotheses are as follows:

1. The occurrence of a part-word or one-syllable word repetition tends to decrease segmental and syllable-sized unit durations (Howell; Vause, 1986; Howell; Williams, 1992). The hypothesis is that there is an initial decrease and progressive increase in segment or V-V unit duration in order to reach the acoustic target. Thus, part-word or one-syllable word repetitions would not be actual repetitions but successive attempts to reach an acoustic target.
2. The occurrence of a prolongation, block, or broken word would tend to increase segmental and syllable-sized unit durations. The hypothesis is that this may result in a prosodically unexpected prominence (i.e., phrasal stress).
3. Greater variability in segmental (Falk et al., 2016), V-V unit, and phrasal stress are expected in the speech of people who stutter, suggesting greater rhythmic instability.
4. Less interaction (i.e., coupling) is expected between the glottal, syllabic, and stress oscillators (i) in the speech of people with more severe stuttering compared to those with milder stuttering and (ii) in speech before behavioral treatment compared to speech after treatment. The decreased coupling between the oscillators would be one of the factors responsible for the emergence of stuttering moments.
5. A lower induction rate is expected (i) in the speech of people with more severe stuttering compared to those with milder stuttering and (b) in speech before behavioral treatment compared to speech after it. The reduced induction rate would account for a hypothesized difficulty in the exponential increase of duration of V-V units up to the phrasal stress. This factor could explain the almost exclusive occurrence of stuttering moments in the first syllable of words (particularly in longer words) and at the beginning of the utterance.
6. Greater variability in segmental, V-V units, and phrasal stress duration is expected before stuttering behavioral treatment compared to after it, suggesting that the process helped to stabilize speech rhythm.
7. Greater variability in the speech rhythm of people who stutter and clutter is expected compared to people who only stutter, given that cluttering is characterized by an irregular speech rate.
8. A shorter period at rest of the syllabic oscillator is expected in people who stutter and clutter compared to those who only stutter, given that speech rate is higher in those with cluttering.
9. A higher decay rate of the stress oscillator is expected in people who stutter and clutter compared to those who only stutter, given the difficulty for those with cluttering to finely adjust the duration of V-V units after the end of a stress group.
10. Weaker syllable-timed rhythm in the speech of people who stutter or stutter and clutter before stuttering behavioral treatment compared to after it, suggesting that the process helped to become closer to the expected syllable-timed rhythm in BP. If this hypothesis is supported, it will mean that people who stutter do not fully acquire their language's speech rhythm, suggesting an incomplete process of language acquisition specifically related to speech rhythm.

4. A STUTTERED SPEECH CORPUS

There are several purposes for building a corpus of stuttered speech in BP. First, to register the many forms of stuttering in children, adolescents, and adults. The corpus will include different types of stuttering moments, different vocal qualities associated with them, covert stuttering, and cluttering co-occurrence. Second, it will be possible to acoustically describe segmental and rhythmic aspects of stuttered speech before and after speech behavioral treatment. Third, it will be possible to produce reference material regarding the relationship between stuttering and speech prosody, approaching the areas of fluency disorders and phonetics.

4.1. DEMOGRAPHIC VARIABLES

Both demographic and speech-language pathology variables will be taken into consideration to build the corpus. For demographic variables, binary biological sex (female or male) and the different age ranges (childhood, adolescence, and adulthood) will be variables of interest. The purpose is to collect speech samples for both sexes in the following age ranges: early childhood (2-6 years of age), middle childhood (7-12 years of age), adolescence (13-17 years of age), young adulthood (18-39 years of age), and middle adulthood (40-64 years of age). Therefore, ten participants are expected for each speech-language pathology variables related to stuttering (Table 2). It is expected that some cells will not be fulfilled in relation to the age range (see item 4.2 for clarification).

Additionally, demographic variables regarding the native dialect of BP, stuttering description, presence of co-occurring spoken language disorders, and co-occurring health conditions usually associated with stuttering will be noted for each participant (Table 1).

4.2. SPEECH-LANGUAGE PATHOLOGY DESCRIPTION OF STUTTERING

Considering that the corpus aims at registering the many forms of stuttered speech (Table 2), the categories presented here were developed based on the clinical experience of one of the authors in assessing and treating people with stuttering. The purpose is to analyze how each category affects speech rhythm.

The category "Stuttering type" refers to the different kinds of stuttering moments – part-word or one-syllable word repetitions, sound prolongations at the beginning of words, sound blocks at the beginning of words, and extraneous segments (Andrade, 2006, 2023; Marcuschi, 2006).

The category "Stuttering associated with voice phenomena" will include different voice occurrences, such as the use of brief voicing for releasing speech, as well as the occurrence of a creaky or tense-strangled voice during moments of stuttering.

General variables	Specific variables	References
Sociolinguistics	Native dialect of BP	
Stuttering	Reported age of stuttering onset	Briley et al. (2021)
	Possible stuttering etiology (i.e., genetics or brain damage)	Frigerio-Domingues and Drayna (2017); Theys et al. (2008)
	Age at data collection	
	Quantitative data from speech fluency assessment – percentage of syllables stuttered, fluent syllables per minute, physical concomitants, and subjective stuttering severity	Andrade (2006, 2023); O'Brian et al. (2004)
	Qualitative data regarding the subjective stuttering experience	Yaruss and Quesal (2016)
	Stuttering treatment duration	
Co-occurring language disorders	Speech sound disorder	Blood et al. (2003)
	Developmental language disorder	
Co-occurring health conditions usually associated with stuttering	Allergies	Ajdacic-Gross et al. (2020); Briley and Merlo (2020); Merlo and Briley (2024)
	Seizures/epilepsies	Briley and Ellis (2018); Briley et al. (2021)
	Sleep disorders	Briley and Merlo (2020); Couto et al. (2024); Merlo and Briley (2019, 2024)
	Learning disorder	Briley and Ellis (2018)
	Intellectual disorder	Briley and Ellis (2018)
	Attention-deficit hyperactivity disorder	Briley and Ellis (2018)
	Autism spectrum disorder	Briley and Ellis (2018)
	Social anxiety disorder	Engelen et al. (2024)
	Mood disorder	Engelen et al. (2024)

Table 1. Demographic variables for stuttering and other coexisting conditions to describe the corpus's participants. ALT: Table listing the study's general and specific variables, with supporting references. The general variables include sociolinguistics, stuttering, co-occurring language disorders, and co-occurring health conditions usually associated with stuttering. The specific variables include several additional variables.

The category "Stuttering associated with cluttering" refers to the different cluttering characteristics. The presence of a fast speech rate is mandatory for the diagnosis of cluttering. There may also be excessive coarticulation and/or a high number of typical hesitations/disfluencies. This category does not include participants in early childhood, considering that cluttering usually appears after seven years of age.

The category "Covert stuttering" aims to analyze speech rhythm in people with covert stuttering, i.e., people who consider themselves to have a stutter but with scores within the expected range or very close to it in the quantitative analysis of speech fluency. This category will probably not include participants in early and middle childhood, considering that learning strategies to hide stuttering usually occur during adolescence or adulthood.

General stuttering categories	Specific stuttering categories	Additional information
Stuttering type	Stuttering with part-word or one-syllable word repetitions	At least 50% of stuttering moments related to specific hesitation/disfluency.
	Stuttering with sound prolongations at the beginning of words	
	Stuttering with sound blocks at the beginning of words	
	Stuttering with extraneous sounds	
	Stuttering with mixed types	No stuttered hesitations/disfluencies with more than 50% of occurrences.
Stuttering associated with voice phenomena	Stuttering associated with different voice qualities (such as creaky or tense voice)	
Stuttering associated with cluttering	Cluttering characterized by a fast speech rate and excessive coarticulation	Coarticulation will be considered excessive when acoustic deletions that impair speech intelligibility are present. Speech rate and typical hesitations/disfluencies will be analyzed according to Andrade (2006, 2023) for BP.
	Cluttering characterized by a fast speech rate, excessive coarticulation, and excessive typical hesitations/disfluencies	
Covert stuttering	Speech without the classic hesitations/disfluencies associated with stuttering	The participant considers him/herself as a person who stutters, and the quantitative fluency analysis is within or near the expected, according to Andrade (2006, 2023) for BP.
Stuttering and treatment	Before and after behavioral treatment	Speech treatment is considered successful by the client and/or caregivers and the speech-language pathologist.
Stuttering associated with vocal tics	Simple vocal tics, such as sniffing, throat clearing, or tongue clicking	
Acquired stuttering	Chorea	Medical diagnosis is mandatory.
	Parkinson's disease	
	Frontotemporal lobar degeneration	

Table 2. Stuttering variables according to Speech-Language Pathology for building the corpus. ALT: Table listing the study's general and specific stuttering categories. The general category includes stuttering type, stuttering associated with voice phenomena, stuttering associated with cluttering, covert stuttering, stuttering and treatment, stuttering associated with vocal tics, and acquired stuttering. The specific category includes several additional variables.

The category "Stuttering and speech treatment" aims to compare speech rhythm in people who stutter before and after speech behavioral treatment, when it was considered successful by the client and/or caregivers and by the speech-language pathologist.

The category "Stuttering associated with vocal tics" aims to analyze how the presence of simple vocal tics (such as sniffing, throat clearing, or tongue clicking during speech) affects the speech rhythm of people who stutter.

Finally, the category "Acquired stuttering" aims to analyze speech rhythm in rare cases of stuttering associated with medical conditions such as chorea, Parkinson's disease, and frontotemporal lobar degeneration. This category will include participants in the adult age range.

4.3. DATA COLLECTION

Subjects with stuttering who meet the criteria listed in Table 1 will be invited to participate in the corpus. Participants will be clients assisted at a private clinic in the city of São Paulo (SP). Those who agree to participate will complete the informed consent form approved by the Ethics Committee of UFMG. Data for the corpus will come from the assessment done at the beginning and/or end of the stuttering treatment. When necessary, data not included in the standard speech-language pathology assessment will be collected. All data will be collected by the speech-language pathologist author.

Three speech samples are planned for each participant: (i) a conversation between the participant and the speech-language pathologist on different topics, such as favorite games or cartoons (in case of children) or movies, trips, and work (in case of adolescents and adults); (ii) a monologue from visual stimuli with the story of the "Three Little Pigs" (in case of children in early childhood; Toyster Brinquedos, n.d.) or comic strips without written text (for the other age groups; Aragonés, 2002); and (iii) reading aloud texts about different animals (in case of children in later childhood; Ferreira and Prates, 2016), a phonetically balanced text (for other age groups; Taucci; Bianchini, 2007) and a text with a majority of words beginning with vowels (Behlau *et al.*, 2001). In order to have sufficient V-V units for speech rhythm analysis, the monologue and the reading tasks should be at least one minute long, while the conversation should be at least two minutes long.

Data will be collected using a Logitech HD Pro C920 webcam, a Behringer U-Phoria UMC22 external sound card, and a Shure WH20XLR cardioid dynamic headset microphone. Although acoustic analysis only requires audio data, video data is necessary for the quantitative analysis of stuttering due to physical concomitants. If some children do not accept the headset microphone, the Shure SM48 cardioid dynamic handheld microphone will be used. Data will be collected in a room with an acoustic ceiling and low ambient noise.

Currently, fifteen subjects have agreed to participate in the corpus and have signed the informed consent form for the project approved by the Research Ethics Committee of UFMG (CAAE number: 84885324.4.0000.5149).

4.4. DATA ANALYSIS

4.4.1. SPEECH-LANGUAGE PATHOLOGY ASSESSMENT OF STUTTERING

Stuttering data analysis referred to in Table 2 will be performed by the speech-language pathologist author. For each participant, there will be a description of the biological sex, age, sociolinguistic variables, speech-language pathology assessment of stuttering, co-occurring communication disorders, co-occurring health conditions, and which general/specific category of the corpus the participant fits in.

4.4.2. ACOUSTIC PHONETICS ANALYSIS

Acoustic phonetics analyses of speech data will be manually performed by the linguist author and her students. Currently, data from one subject are being analyzed. This is a male child with stuttering associated with motor and vocal tics; data were collected during the period in which he was assisted, between the ages of 6 years and 3 months and 7 years and 11 months. Reading, monologue, and dialogue data were analyzed.

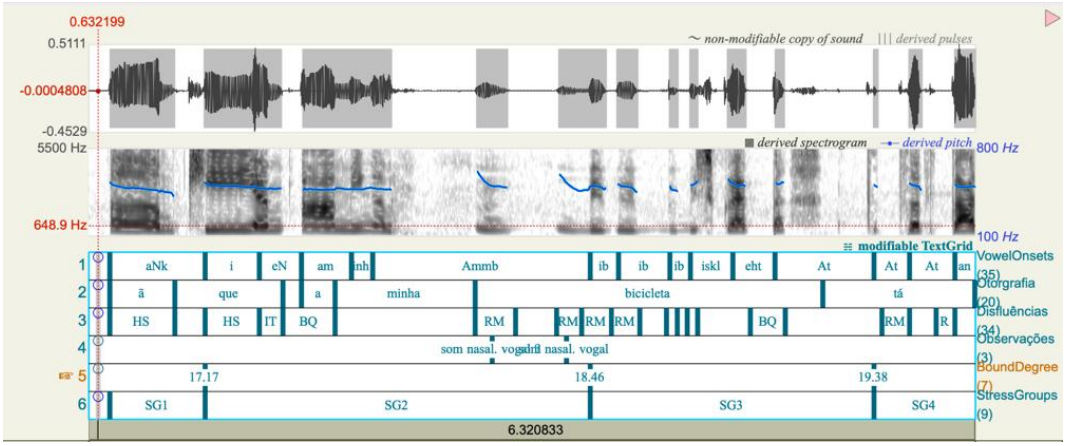

Figure 3. Praat picture from the preliminary acoustic data analysis. The labels in the third layer correspond in BP to: hesitations (HS); extraneous sounds (IT); sound blocks (BQ); repetitions (RM). ALT: Screenshot from Praat displaying waveform, spectrogram, and F0 contour (blue) of a Brazilian Portuguese utterance. Multiple aligned annotation tiers are shown in a TextGrid.

Data was acoustically analyzed in the Praat software (Boersma; Weenink, 2025). Figure 3 shows the preliminary data annotation below the spectrogram, which the layers include: (i) phonetic transcription and segmentation in V-V units; (ii) orthographic-discursive transcription; (iii) place and type of disfluencies; (iv) observations; (v) the bound degree according to the automatic detection of stress groups; and (vi) the stress groups/phrasal accents. Although preliminary, the results indicated the presence of different types of stuttered moments (such as one-syllable word and part-word repetitions, sound prolongations and blocks, and extraneous sounds), sounds related to vocal tics, and a greater occurrence of disfluencies after phrasal stresses, at the beginning of stress groups.

5. FINAL CONSIDERATIONS

The corpus for stuttering case studies that is under construction aims to fill a gap in the literature, analyzing stuttering from the speech rhythm perspective, combining knowledge from Speech-

Language Pathology and Linguistics. The main objective is to develop and test hypotheses about how speech rhythm evolution can explain the emergence of stuttering moments, considering stuttering as the result of a continuous rhythmic process and not a dysfunction that occurs only at specific syllables. The intended corpus aims to record the many forms of stuttered speech, including: (i) different types of stuttering moments, (ii) stuttering associated with voice phenomena, (iii) stuttering associated with cluttering, (iv) covert stuttering, (v) before and after stuttering behavioral treatment, and (vi) acquired stuttering. To date, fifteen subjects have agreed to participate and have signed the informed consent form for the project approved by the Research Ethics Committee of UFMG.

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ADDITIONAL INFORMATION

CONFLICT OF INTEREST

The authors declare no competing interests.

STATEMENT OF DATA AVAILABILITY

This manuscript is a Project Registration. The public materials package for this project (protocol documents, study materials/templates, annotation/codebook templates, variable definitions, README, and the AI prompt log/templates and final ALT texts) is openly available in the folder "Project materials" at: https://doi.org/10.17605/OSF.IO/GB9JT. Data related to the preliminary acoustic analysis are also openly available in the folder "Preliminary analysis" at: https://doi.org/10.17605/OSF.IO/GB9JT. License/terms of reuse for the public package: CC BY-NC-SA 4.0 (Attribution - NonCommercial - ShareAlike 4.0 International).

The planned corpus includes raw audio/video recordings and identifying metadata from human participants, including minors. These files are restricted due to ethical/legal constraints and the informed-consent terms. Under the current consent terms, access to the raw recordings cannot be granted outside the authors' research team.

At this Project Registration stage, evaluation proceeds based on the publicly available protocol/materials package cited above.

AI USE STATEMENT

During the preparation of this work, the authors used ChatGPT (OpenAI, GPT-4.1 model, February 2026 version) and Grammarly (version 6.8.261, 2009-2026 Grammarly Inc.) for creating alternative texts for figures and English revision, respectively, with minimal contribution. All content was reviewed and edited by the authors, who take full responsibility for the manuscript.

The prompts/templates (and the final ALT texts) are deposited in the same DOI package cited in the Data Availability Statement.

ETHICS AND CONSENT

The execution of this project was approved by the Research Ethics Committee of the Federal University of Minas Gerais on December 17, 2024 (CAAE number: 84885324.4.0000.5149). Video and audio files cannot be provided due to ethical and legal restrictions. However, acoustic data analysis can be shared (see Data Availability Statement). Informed consent was obtained from participants and, for minors, from their legal guardians; confidentiality safeguards apply.

REVIEW AND AUTHORS' REPLY

Review: https://doi.org/10.25189/2675-4916.2026.V7.N7.ID973.R
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