Characteristics of Stuttering-like Disfluencies in Portuguese School Age Children

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1. Introduction

Speech is the most complex motor activity that humans engage in, requiring coordination of processes related to respiration, phonation and articulation. Syllabic production, in particular, involves rapid and precisely controlled transition between open and closed configurations of the vocal tract. Speech requires fine control of physiological processes, extending from the lungs to the lips (Brown, Ingham, Ingham, Laird, and Fox, 2005).

Fluent speech is difficult to define, but the concept of normally fluent speech usually incorporates: a natural flow of speech, with relatively little effort in most situations, a normal rate of speech, a natural sound quality, considering also the existence of a small amount of hesitation phenomena (Guitar, 2006; Ingham, Warner, Byrd, and Cotton, 2006). Like any complex motor activity, speech may be subject to disruption at various levels (Brown et al., 2005). Thus, the presence of hesitation phenomena in the speech of a child or an adult may not indicate the existence of a fluency disorder, such as stuttering. Particularly in preschool age, speech hesitations may occur since the children try to master the constant changes that come with language development. There are a number of factors that increase the likelihood of a hesitation phenomenon being regarded as a symptom of a fluency disorder by speech and language therapists (SLTs). These factors are related to the types, the frequency, the duration, the existence of concomitant symptoms and feelings associated with the hesitation phenomena.

There are some types of disfluencies that are typically associated with stuttering. Ambrose and Yairi (1999) described sound/syllable repetition, monosyllabic whole-word repetitions, prolongations, blocks and broken words, as disfluencies that are associated with stuttering (stuttering-like disfluencies (SLD)). Sound/syllable repetition and monosyllabic whole-word repetition are the type of disfluencies that are commonly observed in the speech of children who stutter and consist of repeated productions of words or segments of words (Guitar, 2006). Prolongations of voiced or voiceless sounds occur when there is a continuous flow of air, but movement of the articulators is stopped (Guitar, 2006). Prolongations appear later than repetitions (Riper, 1982). Blocks are typically the last type of disfluency to appear, consisting of an inappropriate interruption of air flow and articulatory movement (Guitar, 2006). Broken-words consist of abnormal pauses between syllables (Silverman, 2004).

Ambrose and Yairi (1999) described other types of disfluencies: interjections, revisions or multisyllable/phrase repetition. Results based on the observation of 90 children who stutter and 54 normally fluent children, revealed that sound/syllable repetition, monosyllabic whole-word repetition, prolongation, blocks, and broken words were the types of disfluencies that happened most frequently and for longer in the group of children who stutter. The frequency of "other disfluencies" was quite similar. The proportion of SLD in the total disfluency was higher in the group of children who stutter than in the group of normally fluent children. On the other hand, the proportion of "other disfluencies" was lower in the group of children who stutter and higher in the group of normally fluent children. It has been shown (Yairi, 1997) that normally fluent preschool age children have

a smaller proportion of SLD, which differs from the children who stutter. Zebrowski (1991) also argues that preschool age children who stutter and matched normally fluent children produce the same type of disfluencies, but the relative proportion differentiates the groups.

The frequency at which a given hesitation phenomena occurs is a reliable measure that distinguishes significantly normal disfluency from stuttering (Boey, Wuyts, Heyning, Bodt, and Heylen, 2007; Guitar, 2006). Thus, the more frequently a hesitation phenomenon occurs, the more likely it is to be considered pathological (Silverman, 2004). Different studies (Boey et al., 2007; Johnson, 1959, 1961; Silverman, 1974) with preschool children, school age children and adults, revealed that the frequency of SLD is higher in people who stutter than in people considered fluent, which shows that the high frequency of disfluencies is one of the defining characteristic of this disorder (Silverman, 2004).

Duration is another factor that distinguishes hesitation phenomena from symptoms of a fluency disorder. In general, children who stutter have longer repetitions and prolongations than normally fluent children (Boey et al., 2007). Specifically, a duration of three or more repetition units (produced faster and with a shorter silent interval between repetition units) (Throneburg and Yairi, 1994) seems to be more characteristic of children who stutter than normally fluent children (Ambrose and Yairi, 1995). However, studies by Zebrowski (1991) and Kelly and Conture (1992) that compared the mean duration of disfluencies of children who stutter and normally fluent children, have also concluded that the duration factor did not distinguish significantly the two groups.

The presence of secondary behaviours, which consist of reactions used by people who stutter in an attempt to end or prevent the moments of stuttering, can also differentiate the hesitation phenomena from the stuttering events (Silverman, 2004). Secondary behaviours, that often happen simultaneously with the stuttering events (Guitar, 2006; Riley, 2009; Silverman, 2004), can be classified as (Guitar, 2006): escape behaviours and avoidance behaviours. The escape behaviour occurs when the speaker intends to terminate a stuttering event and finish the word (Guitar, 2006). These behaviours may include muscle movements of the speech articulators, head and neck or extremities, which may have an excessive degree of physical tension, or may result in sounds, words or phrases that are not part of the message (Guitar, 2006; Silverman, 2004). The avoidance behaviours are learned when the speaker anticipates the moment of stuttering and remembers a negative experience when stuttering occurs. To avoid stuttering, people who stutter emulate behaviours used previously or introduce a novel behaviour, such as changing the word that they intended to produce (Guitar, 2006). These behaviours provide an emotional relief to the person who stutters (Guitar, 2006).

Anxiety, worry, frustration or embarrassment resulting from hesitations in speech, are considered important predictors of the likelihood of a stuttering disorder (Silverman, 2004). A person may develop speaking fear, shame or negative attitudes and beliefs about themselves as communicators, based on their experiences and stereotypical reactions from listeners (Guitar, 2006). It has been shown (Yaruss and Quesal, 2004, 2006) that stuttering is something more than a visible disorder. The analogy of the iceberg supported by Sheehan (1970), argues that the speaker's experience of his own stuttering occurs “under the surface” (Yaruss and Quesal, 2006, p. 91), and the impact of stuttering on their lives involves more than the observable disfluencies in his speech (Yaruss and Quesal, 2004, 2006), emphasizing the existence of feelings of shame and guilt (Murphy, 1999). Guntupalli, Kalinowski and Saltuklaroglu (2006) proposed various levels of stuttering behaviours. In the first compensatory level events such as avoidance behaviours (defined by Guitar (2006) as secondary behaviours) and negative reactions were not visible, which

lead to a second level (subperceptual stuttering) and thus to a third level, where the behaviours are perceptive.

In conclusion, stuttering events, defined as the moments when stuttering occurs, can be characterised by the frequency and duration of disfluencies as well as the existence of concomitant symptoms (secondary behaviours) and associated feelings.

The goal of the assessment process consists in obtaining a set of information to conclude if a person has a fluency disorder, in order to select an intervention program with specific therapeutic targets and to establish a prognosis (Guitar, 2006; Silverman, 2004). SLTs initially gather critical information from the individual and/or parents, caregivers or teachers (Guitar, 2006; Haynes and Pindzola, 1998). Determining stuttering severity is also part of the assessment process. Riley (2009) proposed that the determination of stuttering severity should be based on the assessment of the frequency and duration of moments of stuttering, and the presence of physical concomitants (distracting sounds, facial grimaces, head movements and movements of the extremities). Guitar (2006) also highlights the importance of assessing the types of disfluencies that occur in each moment of stuttering. These factors may be evaluated on a sample of spontaneous speech or read speech (Riley, 2009).

The present work aims to compare the characteristics of SLD in a group of school age children who stutter (Group_S) with a group of normally fluent school age children (Group_F), during reading. An assessment tool (Jesus and Valente, 2010) has been developed incorporating the evaluation of the factors that characterise SLD: frequency and types of SLD, duration and physical tension of concomitant symptoms (Guitar, 2006; Riley, 2009). The determination of the characteristics of SLD in Group_S and Group_F aims to define a minimal set of parameters that could help SLTs to diagnose stuttering.

2. Method

Sixteen male monolingual school age children, native speakers of European Portuguese (EP), were recruited for the study. Only monolingual participants were selected as there is evidence that bilingual children are more likely to stutter than monolingual children (Silverman, 2004). Eight participants were school-age children who stutter (Group_S), diagnosed by a Speech and Language Therapist (SLT) who also developed a therapeutic intervention plan. The mean age of Group_S was 10 years (SD=2.06). Children of Group_S were from Braga (1), Castelo Branco (1) and Aveiro (6). The other 8 male children, also with a mean age of 10 years (SD=1.69), were normally fluent school age children from Aveiro (Group_F). Children in both groups did not have a clinical history of neurological, speech or language (except for the stuttering in Group_S), hearing or cognitive disorders.

Group_S and Group_F were matched by age (± 6 months for most children), gender (participants from both groups were male) and school grade (two participants from the 2º, 3º and 6º grade and one participant from 4º and 5º grade, in each group).

Participants from Group_S were selected based on the following criteria: presence of concern about the child's speech, expressed by parents or other caregivers (e.g., grandparents); a diagnosis of stuttering made by a SLT (with which participants performs intervention in public school, private clinic or at home); produced three or more SLD per 100 words. These are the inclusion criteria used in several studies of children who stutter (Ambrose and Yairi, 1999; Blood and Hood, 1978; Boey et al., 2007; Zebrowski, 1994).

It is important to note that information about the therapeutic approach used with Group_S as well as the frequency of treatment and involvement of parents or caregivers in the therapeutic intervention was not considered in this study (Zebrowski, 1994).

Other studies that compare a group of children who stutter with a control group of normally fluent children (Ambrose and Yairi, 1999; Blood and Hood, 1978; Yairi and Ambrose, 1992) used instruments to assess stuttering severity and determine an inclusion criterion. In Portugal, there are no standardised tests to assess stuttering severity, so it was not possible to quantify the severity of stuttering and convert it into a qualitative scale (mild, moderate or severe), and use that as an inclusion criterion to balance the sample.

Participants from Group_F were selected based in the following criteria: current and past absence of stuttering (reported by parents or other relatives); confirmation of the absence of speech-language pathology by the child's paediatrician and production of less than three SLD per 100 words.

2.1 Stuttering Severity Assessment

A new stuttering severity assessment tool (Jesus and Valente, 2010) was developed (freely available at the Universidade de Aveiro, as part of the Advanced Communication and Swallowing Assessment (ACSA) tools). An adequate (to each grade level) set of texts was selected, due to the fact that textual complexity influences positively the amount of disfluencies in the reading sample (Blood and Hood, 1978). The reading material consisted of 100 words selected from books recommended by the Plano Nacional de Leitura (PNL, 2006)[1] (2º, 3º, 4º, 5º and 6º grade levels).

Specific *Excel 2003* spread sheets were created to register the type and the duration of disfluency and the classification of physical tension associated with SLD occurring in each word of the selected texts.

Speech samples from the reading activity were obtained in an individual session with each participant. An explanation of the objectives of the study was given to parents or caregivers, after which they signed the informed consent. Video and/or audio recordings were collected, depending on the choice of parents or caregivers. Video recordings were carried out using a Sony Digital Handycam DCR-TRV33E (direct recording on a memory card in an mpeg format) and audio recording using a MP4 Player Ingo (mpeg format). Audio from the video files were converted to audio files in a mp3 format, using the *Free Video to MP3 Converter version 3.2.1* (FreeVideo, 2009).

The first author and the participants sat at a table, face-to-face, starting to interact with a short talk to explain the purpose of the work. Each child read one of the texts that is part of the stuttering severity assessment tool (Jesus and Valente, 2010).

2.2 Observation and Frequency of SLD Characteristics

Disfluency types analysed (SLD) were monosyllabic word repetitions, repetitions of sounds or syllables, prolongations of sounds, blocks, and broken words (Ambrose and Yairi, 1999; Boey et al., 2007). A total of 1600 words were extracted from the reading task. Audio or video recordings were analysed ("off-line" judgment) (Cordes and Ingham, 1994) and the stuttering severity assessment tool (Jesus and Valente, 2010) record sheets

[1] Plano Nacional de Leitura (PNL) is a national education program designed to raise the level of literacy of the Portuguese population. PNL develops principles, objectives and strategies to promote literacy among pre-school and school age children. One of the initiatives was a list of books which were appropriated to the development level of students in Portuguese language classes.

were used to register all measurements. For each participant in Group_S and Group_F the total frequency of SLD and the frequency of each type of SLD, per 100 words, were calculated (automatically) using specifically created spread sheet formulas.

2.3 Duration of SLD

The duration of sounds/syllable repetitions and monosyllabic whole-word repetitions of reading samples was expressed as the number of repeated units. One repeated unit is defined as an extra production of a segment (Ambrose and Yairi, 1995; Boey et al., 2007; Throneburg and Yairi, 1994; Yairi and Lewis, 1984). Previous studies (Yairi and Lewis, 1984; Zebrowski, 1991, 1994) showed that the duration of repeated units is a reliable measure.

Measuring the duration of the repetitions of sounds or syllables, prolongations, blocks and broken words produced by participants was based on acoustic analysis (Zebrowski, 1991) using *Audacity version 1.2.6* (SourceForge, 2000). Acoustic analysis provides a precise and accurate measurement of the duration of SLD, because this type of analysis is not affected by human reaction time (as measured with a stopwatch). Previous studies (Zebrowski, 1991, 1994) have shown that this method can be used with a high degree of intra- and inter-rater reliability, which allows replication and subsequent comparison with other studies.

Duration of sound/syllable repetition was measured from the onset of the acoustic energy associated with the disfluent initial sound in the word to the cessation of acoustic energy for the final iteration of the repeated sound or syllable (Zebrowski, 1994). Duration of prolongation was measured from the onset of acoustic energy associated with the disfluent initial sound in the word, to the cessation of acoustic energy for the audibly prolonged sound (Zebrowski, 1994). In the case of blocks, duration was measured from the offset of acoustic energy associated with the final sound in the preceding word to the onset of the perceptually fluent portion of the first sound in the disfluent word (Zebrowski, 1994).

The observation of the onset and offset of each SLD was accomplished using the audio recording and the waveform display in *Audacity version 1.2.6* (SourceForge, 2000). Waveform analysis was especially important in the assessment of the block duration, since these moments of stuttering start with a “hard attack”, easily observed in the acoustic signal as a high amplitude “burst”.

2.4 Physical tension associated with SLD

Evaluation of physical tension associated with SLD was performed using a scale from 0 to 3 (Boey et al., 2007; Jesus and Valente, 2010): a score of “0” means that no physical tension was observed; a score of “1” means that the physical tension was mild and subtle to observe; a score of “2” was given for moderate physical tension, which means that signs of physical tension were distracting; a score of “3” means that physical tension was severe.

Each SLD was given a score using this scale, in order to classify the visible signs of physical tension (such as raising the upper lip, lip pressure, eye blinks, lateral eye movement or tremor) and/or audio signals (such as loudness increase). Physical tension was observed in video recordings and during the assessment of the participants (on-line assessment) (Cordes and Ingham, 1994).

2.5 Data Analysis

Data were imported into *Excel 2003* and the *Statistical Package for Social Sciences 17.0* (SPSS) for statistical analysis. The mean and standard deviation for the overall frequency of disfluencies and types of disfluencies, number of repeated units, duration of repetitions, prolongations, blocks and broken words, as well as for the classification of physical tension, were calculated. In order to analyse the differences between Group_S and Group_F a Mann-Whitney U test was performed.

3. Results

The frequency and types of SLD during reading in Group_S and Group_F were analysed. A total of 75 SLD in Group_S and 8 SLD in Group_F were observed. SLD were more frequent in children who stutter than in normally fluent children (see Table 1). Specifically, mean frequency of monosyllabic whole-word repetitions (1.5%), sounds/syllables repetition (1.4%), prolongations (3.3%), blocks (2.5%) and broken words (0.8%) in participants of Group_S was higher than the mean frequency of monosyllabic whole-word repetitions (0.5%), sounds/syllables repetition (0.5%), prolongations (0.0%), block (0.0%) and broken words (0.0%) in participants of Group_F.

Table 1. Mean (M) and standard deviation (SD) of total frequency of SLD and types of SLD per 100 words during reading in Group_S and Group_F

	Group_S (%) (M±SD)	*Group_F* (%) (M±SD)
SLD total	9.1±7.4	1.0±0.8
Monosyllabic whole-word repetition	1.5±1.6	0.5±0.5
Sound/syllable repetition	1.4±1.4	0.5±0.8
Prolongation	3.3±3.3	0.0±0.0
Blocks	2.5±3.1	0.0±0.0
Broken words	0.8±0.9	0.0±0.0

The group's total disfluencies were statistical significantly different (Mann-Whitney, U=0, p=0.000). However, the Mann-Whitney U test results for monosyllabic whole-word repetition and sounds/syllables repetition (the only two types of SLD observable in the reading samples of both groups) were not (Mann-Whitney, U=15.5, p=0.083 for monosyllabic whole-word repetition and Mann-Whitney, U=19, p=0.195 for sounds/syllables repetition).

3.1 Number of repeated units in reading activity in Group_S and Group_F

The total number of monosyllabic whole-word and sounds/syllables repeated units were: 23 for Group_S (12 were related to monosyllabic whole-word repetition and 11 were

related to sounds/syllable repetition); 8 for Group_F (4 related to monosyllabic whole-word repetition and 4 related to sounds/syllable repetition).

Results showed that the mean number of repeated units for Group_S was higher than for the Group_F (1.6±1.2% for Group_S and 1.0±0.0% for Group_F), similar to studies by Ambrose and Yairi (1999) and Boey et al. (2007), for preschool age children. However, results from a Mann-Whitney U test were not statistical significantly (Mann-Whitney, U=60, p=0.257) different between Group_S and Group_F for the number of repeated units of monosyllabic whole-word and sounds/syllable repetitions.

These findings were consistent with the study of Yari and Lewis (1984), where it was argued that normally fluent children rarely repeat a speech segment more than once. In fact, the mean number of repeated units for Group_F was precisely 1.0%, since all sounds/syllables repetition in the reading task of Group_F presented one repeated unit.

Fourteen (66.7%) SLD from Group_S had one repeated unit. For children of Group_F, all the repetitions observed had one repeated unit. Thus, for both groups, most SLD had one repeated unit.

3.2 Duration of SLD in the reading activity in Group_S and Group_F

Sixty three (63) SLD from Group_S (11 sound/syllable repetitions; 26 prolongations; 20 blocks; 6 broken-words) and four (all sounds/syllable repetitions) SLD for Group_F were analysed.

Data presented in Table 2, shows that the mean duration of the different types of SLD was higher in Group_S than in Group_F (it is only possible to compare the mean duration of sounds/syllable repetitions in both groups, because the other SLD were not observed in Group_F).

Table 2. Mean (M) and standard deviation (SD) of duration (in seconds) of the types of SLD during reading in Group_S and Group_F.

	Group_S (s) (M±SD)	*Group_F* (s) (M±SD)
Sound/syllable repetition	1.9±2.7	0.9±0.4
Prolongation	0.8±0.6	0.0±0.0
Blocks	3.1±7.1	0.0±0.0
Broken words	2.2±4.2	0.0±0.0

Types of SLD studied have a mean duration greater than 1 second (except for prolongations). This result differs from previous findings by Zebrowski (1994), that children aged between 3 and 11 years produce prolongations and sound/syllable repetitions with a mean duration of less than 1 second. This finding may be explained by the fact that, in the present study, there was a participant whose durations of disfluencies had a substantial departure from the mean. A Mann-Whitney U test revealed that the differences between the duration of the SLD in Group_S and Group_F were not significant (Mann-Whitney, U=116, p=0.808).

3.3 Classification of physical tension in Group_S and Group_F

The physical tension of seventy three (73) SLD in Group_S and eight (8) SLD in Group_F was analysed. Children from Group_F did not have physical tension associated with SLD (see Table 3). These data was consistent with the findings of Boey et al. (2007), but only for prolongations and blocks. In the study of Boey et al. (2007) the group of normally fluent children showed some physical tension associated with repetitions.

Table 3. Mean (M), standard deviation (SD) and median of the classification of physical tension associated with SLD (0- no physical tension was observed; 1- physical tension was mild and subtle to observe; 2- moderate physical tension; 3-severe physical tension) per 100 words during reading in Group_S and Group_F.

	Group_S (M±SD)	*Group_F* (M±SD)
Monossylabic whole-word repetition and sound/syllable repetition	0.7±0.7 (Median=1)	0.0±0.0 (Median=0)
Prolongation	0.6±0.6 (Median=1)	0.0±0.0 (Median=0)
Blocks	1.5±0.7 (Median=2)	0.0±0.0 (Median=0)
Broken words	0.8±0.4 (Median=1)	0.0±0.0 (Median=0)

4. Conclusions

In this study, both groups produced monosyllabic whole-word repetitions and sounds/syllables repetition in their reading samples, but differed in their relative proportion (Zebrowski, 1991). However, prolongations, blocks and broken-words were not present in reading samples of Group_F. According to Alm (2004), stuttering may be related to difficulties with basal ganglia functioning, which negatively influence timing cues needed for speech-language production and could contribute to the production of prolongations in people who stutter. This seems to explain the disparity between the frequency of prolongations and blocks between Group_S and Group_F. The study by Ambrose and Yairi (1999) for preschool age children showed similar results (the mean of prolongations and blocks was 1.8% amongst children who stutter and 0.1% amongst normally fluent children).

Bloodstein (1987) reported that people with moderate stuttering produce at least 5% of disfluent words in spontaneous speech or reading tasks, which has also been observed in the present study, since the mean of total disfluencies was 9.1%. It is also referred by Bloodstein (1987) that the individual variability is high, which is also observed in this study (standard deviation = 7.4%).

The frequency of SLD (total) differentiates children who stutter from normally fluent children. However, monosyllabic whole-word repetition and sound/syllable repetition (the only two types of SLD observable in the reading samples of both groups) did not contribute to the differentiation between children who stutter and normally fluent children.

Participants from Group_S presented physical tension associated with all types of SLD, (the minimum value was "1" and the maximum value was "2"), and the existence of physical tension associated with different types of SLD was a factor that differentiated children who stutter from normally fluent children (Boey et al., 2007; Guitar, 2006; Silverman, 2004).

In sum, it can be inferred from our results that type (specifically for prolongations, blocks and broken-words), frequency and physical tension of SLD are parameters which differentiate children who stutter from matched normally fluent children. Duration and number of repeated units do not differentiate these two groups.

Further research will include the design of a more balanced sample (a larger number of participants of both genders) and the assessment of frequency, duration and physical tension of "other disfluencies" (Ambrose and Yairi, 1999). The stuttering severity assessment tool's (Jesus and Valente, 2010) reliability and validity will be studied.

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