CONTRIBUTIONS TO THE ELABORATION OF A PHONETICALLY BALANCED TEXT FOR THE EUROPEAN-PORTUGUESE

Contributos para a construção de um texto foneticamente equilibrado para o português-europeu

Ana Paula Mendes [1], **Alexandra Nunes da Costa** [2], **Alexandra Delgado Martins** [3], **André Filipe Oliveira Fernandes** [4], **Sara Margarida Dias do Rosário Vicente** [5], **Tânia Carina Samouco Freitas** [6]

ABSTRACT

Purpose: the aim of this study is to elaborate a Phonetically Balanced Text for the European-Portuguese (EP) called "O Sol" (*The Sun*). **Method:** four subjects (two females and two males) with [21-49] year-old read aloud the text. Recordings were obtained with Olympus (VN-240PC and VN-2100PC) and were used to account the produced phonemes. The procedures were: 1) the comparison between the relative frequency of the phonemes of "O Sol" and the relative frequency described in PF_fone through the correlation coefficient of Pearson and the Mann-Whitney, 2) the comparison between the large and short transcriptions in order to analyze the co-articulation phenomenon 3) the analysis of the syllabic formats. **Results:** statistical analysis showed that relative frequency occurrence of phonemes of the text "O Sol" have a strong correlation with those of PF_fone (r = 0,924). The median values of the relative frequency occurrence of phonemes of "O Sol" were significantly equal to the PF_fone (p<.05). **Conclusion:** the text "O Sol (*The Sun*)" is close to an ideal phonetically balanced text, since it achieved the predefined assumptions. Phonologically, it shows the most common formats syllable in the EP. We verified a decrease in relative frequency of phonemes in the close transcription, due to co-articulation phenomenon. Future work will focus on increasing said sample.

KEYWORDS: Voice; Voice Quality; Speech; Reading

(1) Professor of Health School of Polytechnic Institute of Setúbal, ESS-IPS, Setúbal, Portugal; PhD in Speech Sciences from University of Florida.

(2) Speech-Language Pathologist of Sertã School, Portugal; B.A. in Speech Therapy from Health School of Polytechnic Institute of Setúbal.

(3) Speech-Language Pathologist of Portuguese Red Cross, Lisbon, Portugal; B.A. in Speech Therapy from Health School of Polytechnic Institute of Setúbal.

(4) Speech-Language Pathologist of Health Clinic Esfera Saúde of Guimarães, Portugal; B.A. in Speech Therapy from Health School of Polytechnic Institute of Setúbal.

(5) Speech-Language Pathologist of LAB FALA, LDA, Póvoa de Santa Iria, Portugal; B.A. in Speech Therapy from Health School of Polytechnic Institute of Setúbal.

(6) Speech-Language Pathologist of City Council of Sertã, Portugal; B.A. in Speech Therapy from Health School of Polytechnic Institute of Setúbal.

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INTRODUCTION

Reading aloud is a phonatory task often used by the Speech-Language Pathologists (SLP) in formal and informal assessment of speech production (e.g., articulation, voice, resonance, fluency, speech rate and intelligibility, usage of phonological processes). This phonatory task has physiological demands and consequently acoustic and audio-perceptual patterns similar to spontaneous speech [1,2].

Traditionally, for this phonatory task, SLPs use a text from a daily newspaper or a Phonetically Balanced Text (PBT). For a valid and reliable assessment and analysis, it should use a PBT, because it is a representative text of the standard language. That is, a PBT has all the phonemes and syllabic formats which compose a language,

and thus distinguish and highlight those that occur with higher and lower frequency in commonly speech [3]. Currently, there are PBTs in several languages, however, there is no standardized material for the European-Portuguese (EP)[4-9].(see Table 1).

Table 1 – Phonetically balanced texts used in different countries

	Phonetically balanced texts	Countries where they are used
1	Arthur the rat[5]	Australia, Canada, England, India and the USA
2	The rainbow passage[6]	England and USA
3	The north wind and the sun [7]	England and USA
4	Comma gets a cure[8]	USA
5	I teach Ferdinand…[9]	England and USA
6	Bother, father caught…[9]	Australia, Canada, England, Ireland, New Zealand and USA

To design of a PBT, it was necessary to establish the following assumptions:

1. Contain all the phonemes of a language, in this case the EP;
2. Have all phonemes with the same relative frequency of occurrence of spontaneous speech;
3. Contain all syllabic formats;
4. Have contextual cohesion;
5. Have an appealing theme, without childish or scientific characteristics;
6. Be written in plain language to facilitate its understanding, and reading aloud skills;
7. Be succinct in order to avoid fatigue [10].

For the standard EP there is a language Corpus called PF_Fone, which contains the phoneme relative frequency of occurrence (RF). It was built from the Corpus of Fundamental Portuguese (FP) Frequency, which contains the needed EP vocabulary for effective communication capabilities of everyday life situations. This corpus was developed in order to select vocabulary and grammar based on scientific data for educational purposes [11].

The pertinence of a PBT is to provide the SLPs with material that can help to identify possible problems of articulation, voice, resonance, speech rate and intelligibility, as well as phonological processes usage, using a single phonatory task instead of several that can cause fatigue on the patient.

A standardized PBT can be used in audio-perceptual, acoustic and/or physiological evaluation. Moreover, it can contribute to valid and reliable comparisons within and between subjects. It can also be used in clinical trials (e.g. diagnosed patients) or in normative studies (e.g. in populations free of communication, language and speech disorders).

The aim of this study was to create a PBT for EP called "O Sol" ("The Sun") [12] (Figure 1). This text aims to contribute for a reading aloud task which SLPs can use to evaluate in a fast, efficient and standardized manner, areas of speech, voice and fluency.

The Sun

The Sun is an old star that warms and brightens our planet every day but with an unevenly manner. It has a third of hydrogen, helium and other gases, but none is different from Earth. The Sun is a star of average size and yellow color, which is on half of its lifetime. It is the only star throughout the solar system and the closest to Earth. It is very important for the existence of life on Earth. Without the Sun shine, Earth would be cold, without plants, poorer and less beautiful. The Sun has a grainy appearance and the heat emerges from its grains. The gravitational solar field is stronger on its dark areas or spots.

Figure 1 – Text "O Sol" (2009 version) [12] translated to English

METHOD

Subjects

Four subjects participated in this pilot study, two males and two females from the Setúbal district, with a mean age of 35 years, a standard deviation of 14, and range [21-49] years. The literacy rate ranged from the fourth grade to college level. The characterization of the sample is described in Table 2.

Table 2 – Characteristics of the subjects

Subjects	Age	Sex	Literacy rate
JG	25	M	University attendance
HM	49	M	4th grade
SP	21	F	University attendance
NF	46	F	High school

Inclusion criteria was: 1) EP domain, 2) robust physical health, 3) no medication taken, 4) absence of smoking and alcohol habits, 5) absence of speech, language and communication problems, and 6) without colds or respiratory problems on recording day. The selected subjects filled out a consent form, as well as, a physical and health voice questionnaire.

Procedures

Subjects read aloud the text "O Sol" (2009 version)[12] in a standing position with a comfortable voice. Audio recordings were performed with Olympus (VN-240PC and VN-2100PC) with built-in microphones. Speech samples were recorded in wav format.

This study consisted of two distinct phases. The procedures outlined for the first phase consisted on: 1) analysis of the text "O Sol" (2007 version)[13], 2) adjustments of the text "O Sol" (2007 version)[13], 3) broad phonetic transcription of the text " O Sol" (2009 version)[12] and respective analysis, 4) comparison of phoneme relative frequencies of the text " O Sol" (2009 version) with the PF_Fone, and 5) analysis of syllabic formats "O Sol "(2009 version)[12].

The second phase of the project obey the following steps: 1) recording of the reading aloud of the text "O Sol " (2009 version)[12] of four subjects, 2) narrow phonetic transcription of the reading aloud (phonetic counting, calculation of the phoneme relative frequencies of the text "O Sol" (2009 version) [12] , the text "O Sol" (2007 version) [13] and the values of PF_Fone), 3) comparison of the average of the relative frequencies of broad with the narrow transcripts to check coarticulation phenomena, 4) counting and analysis the words of the text "O Sol" (2009 version)[12] which were included in the PF and compare them with results of the text "O Sol" (2007 version)[13,] and 5) calculate speech rate and intelligibility of the reading aloud of "O Sol" (2009 version)[12].

Statistical analysis was performed with Pearson's correlation and Mann-Whitney test. α level for significance was .05 and a confidence interval 95%.

The Ethics Committee for Research (ECR) of the Health School of Polytechnic Institute of Setúbal was created on 4/12/2011, which was a later date to the study. However, all subjects filled out and signed the consent form. Moreover, the principal investigator of the PBT is a member of ECR.

RESULTS

The text "O Sol" (2009 version) [12] presented all EP phonemes and had an average of phonetic relative frequency of occurrence similar to the spontaneous speech (PF_Fone), as shown in Table 3. According to Figure 2, the means of phoneme relative frequency (RF), obtained from the narrow transcription, was similar to the spontaneous speech. The Pearson correlation coefficient, r = 0.924, revealed a strong correlation between the phoneme relative frequencies of PF_Fone and the text "O Sol" (2009 version)[12]. Mann-Whitney statistical test revealed a *p-value* = .763, meaning that the medians of the phoneme RF of PF_Fone and the text "O Sol" (2009 version)[12] were not significantly different (i.e., $p > .05$).

Table 3 – Descriptive statistics of phoneme relative frequency of the text "O Sol" (2009 version) and PF_Fone

	N	RF (M±SD)	Variance	Maximum	Minimum
Text "O Sol"	38	2,63 ± 2,48	6,16	11,21	0,43
PF_Fone	38	2,63 ± 2,40	5,76	10,20	0,20

N=Number of EP phonemes, RF=Relative frequency, M=Mean, SD=Standard Deviation

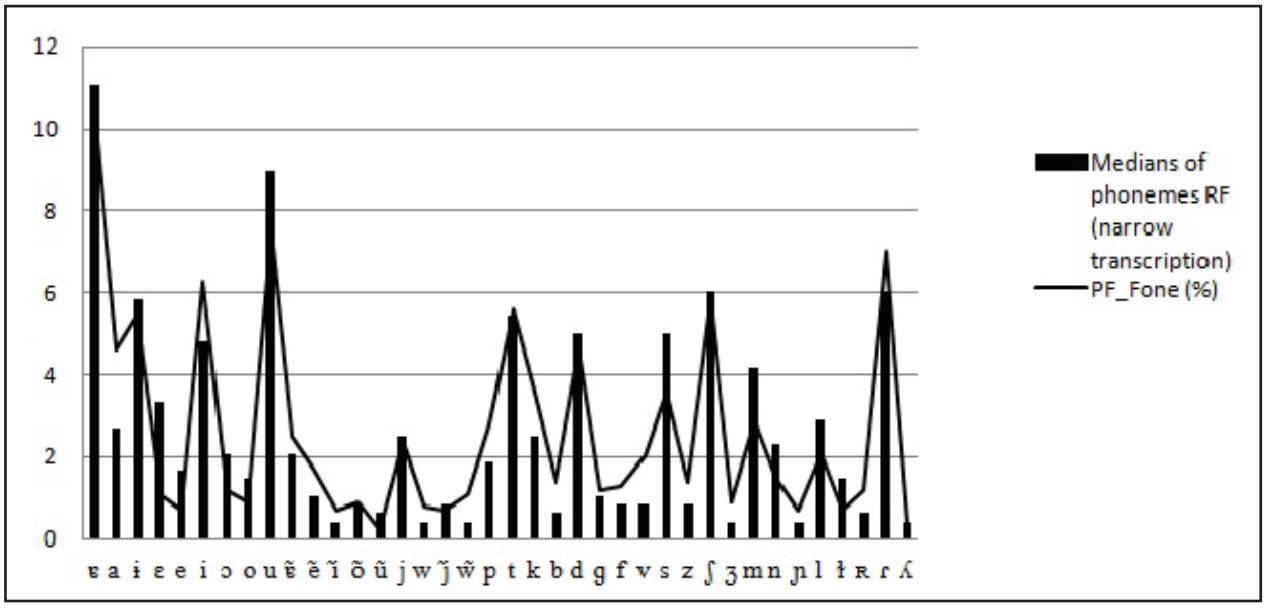

Figure 2 – Comparison between the average phonemes RF of the text of "O Sol" (2009 version) with the values of PF_Fone

Concerning coarticulation phenomena, it was verified that 10.52% of the phonemes were altered. They were /ɨ/, /p/, /ʃ/, /ɾ/.

The analysis of syllabic structure was performed based on the comparison between the existing syllabic formats from the text "O Sol" (2009 version)[12] and the *Corpus* FreP [14]. The text contained all the syllabic formats of the EP, and the most common CV (consonant+vowel) format. See Table 4.

Table 4 – Analysis of the syllabic formats of the text "O Sol" (2009 version) using the *Corpus* FreP

Syllabic format	Text "O Sol" (2009 version)	*Corpus* FreP [14]
V	20,09%	15,83%
VC	3,49%	3,03%
CV	47,60%	46,36%
VG	0,87%	1,51%
CVC	13,54%	11,01%
CVG	3,06%	2,66%
CCV	5,68%	2,18%
CGV	2,18%	0,25%
CVGC	1,75%	1,21%
CCVC	0,87%	0,38%
CGVC	0,44%	0,12%
CCVGC	0,44%	< 0,10%
Total	100%	

The word percentage belonging to the FP of the text "O Sol" (2009 version) [12] was 82.5% and the 2007 version [13], was showed 78.52%. 17/18 words introduced in the 2009 version (94.4%) were part of FP. See Figure 3.

Speech intelligibility was 100% and speech rate was 114.54 to 168 words/ minute. See Table 5.

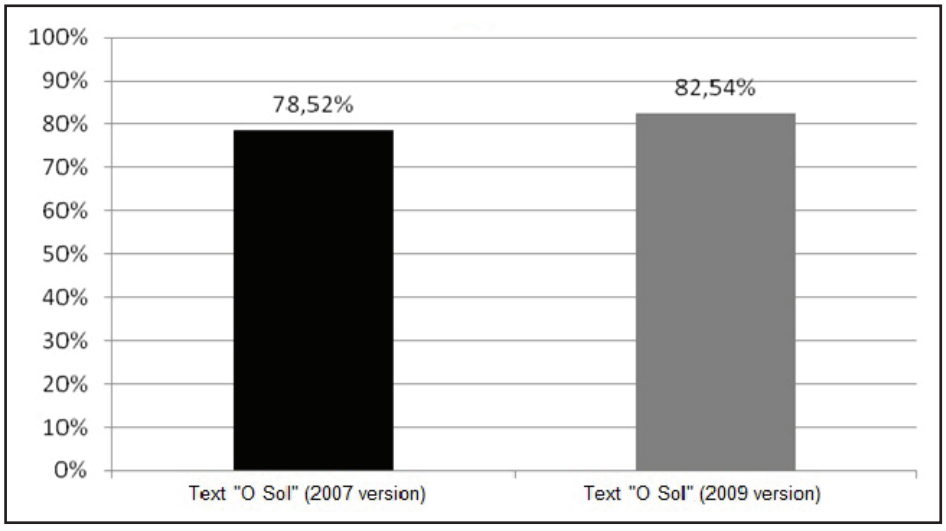

Figure 3 – Comparison between PF words of the Text "O Sol" (2007 version) and the text "O Sol" (2009 version).

Table 5 – Values of speech rate and intelligibility of each subject from the reading aloud the text "O Sol" (2009 version)

Subjects	Speech intelligibility (%)	Speech rate (words/ minute)	Normative data (Adults)[16]
JG	100%	168	270 (reading aloud) 160 – 180 (conversation) 220 – 410 (speech)
HM	100%	114,54	
SP	100%	164,35	
NF	100%	168	

DISCUSSION

The Pearson correlation coefficient *(r* = 0.924) indicated a strong correlation between the results of spontaneous speech and the text "O Sol" (2009 version) [12]. The value obtained with the Mann-Whitney test *(p* = 0.763), showed that the medians of phonemes' RF of the text "O Sol" (2009 version) [12] and spontaneous speech were not significantly different.

The results obtained by descriptive and inferential analysis, showed that the text "O Sol" (2009 version) [12] presented all phonemes existing in the EP and the phoneme RF of the text was similar to those of spontaneous speech, as noted in comparison with the *Corpus* of PF_Fone.

The coarticulation phenomena observed when reading aloud the text "O Sol" (2009 version) [12] were similar to those of spontaneous speech. As noted in the reading-aloud the text, the phonemes /ʃ/ and /ɨ/ suffered a coarticulation phenomena, which usually happens in spontaneous speech [15]. The phoneme /ɨ/ was omitted and the phoneme /ʃ/ assimilated. Differences were also observed in the phonemes /p/ e /ɾ/ due to some hesitation during the reading aloud.

In the reading aloud, all the words produced by subjects were intelligible, revealing a speech intelligibility of 100%. The speech rate was 114.54 to 168 words/minute. There are no normative data for the EP. Comparing them with those published in the literature for American-English revealed discrepancies (e.g., 270 words/minute reading aloud), but this comparison has its limitations because they are related to different languages[16].

The text "O Sol" (2009 version) [12] presented all EP syllabic formats. It also presented those that are most frequent and common in spontaneous speech, specifically the CV format.

The text "O Sol" (2009 version)[12] had more words belonging to the PF then the previous version (i.e., version 2007). 82.5% were words of the EP spontaneous speech, as they were part of the PF.

Clinical Implications

The PBT allows an evaluation of several areas such as articulation, voice and fluency. And it is easy to implement without inducing patient's fatigue. The demands of this task are reduced during the evaluation. The PBT also allows a homogenized usage by SLPs. Last but not the least, the PBT can be used to evaluate the effectiveness and efficiency of intervention and therapeutic advances.

Limitation of the study

This study has some limitations such as: 1) a small sample considering just a preliminary study of N = 4, consequently does not allow inferences or extrapolations, 2) study was conducted in the Setúbal district not considering the other two EP dialects (i.e., northern and islands), 3) the information source for speech rate was from American-English scientific studies, rather than EP normative data, and 4) reduced bibliographic databases, since it is an innovative and pioneering study.

Future investigations

In the future, the PBT should be applied to a large sample and in various regions of Portugal (i.e., mainland and islands), to cover the three dialects of EP (northern, central and islands). The literacy level should also be included in the study. Normative data of speech rate is also a target. Other measures that should be included are speech intelligibility, number of words/respiratory group and number of pauses. The descriptive statistics for the PF_Fone for each phoneme in isolation should also be investigated.

CONCLUSION

The text "O Sol" (2009 version)[12] had all EP phonemes and the phoneme RF was similar to the spontaneous speech of PF_Fone. It had the most EP frequent syllabic formats, the most frequent CV syllabic format and the closest to the reference values of the *Corpus* FreP. Therefore, it contributes to an accurate approximation of a PBT. The text

"O Sol" (version 2009)[12] had contextual cohesion. That is, it presented a logical sequence that allowed its meaning, easily. It is a short text which has a reduced physiological demand on the subject. It has no childish vocabulary. Despite being a text with some scientific terminology, it presented a broad percentage of words that belong to the *Corpus* of the PF (82.54%), contributing to an easy reading and good comprehension. It is concluded that the text "O Sol" (2009 version) [12] is a PBT for EP.

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RESUMO

Objectivo: o objectivo deste estudo consiste na criação de um Texto Foneticamente Equilibrado para o Português-Europeu (PE) designado "O Sol". **Método:** quatro sujeitos da região de Setúbal, entre [21-49] anos (dois do sexo feminino e dois do masculino) leram em voz alta o texto "O Sol". As gravações realizadas com Olympus (VN- 240PC e VN- 2100PC com microfones integrados) serviram para a contabilização dos fonemas produzidos. Os procedimentos foram: 1) a comparação entre as frequências relativas dos fonemas do "O Sol" e as frequências relativas descritas no PF_fone, através do coeficiente de correlação de Pearson e do teste de Mann-Whitney; 2) a comparação entre a transcrição larga e a estreita, verificando-se os fenómenos de coarticulação; e 3) a análise dos formatos silábicos. **Resultados:** a análise estatística demonstrou que as frequências relativas de ocorrência dos fonemas do texto "O Sol" têm uma correlação forte com as do PF_fone (r = 0,924). As medianas das frequências relativas de ocorrência dos fonemas do texto foram significativamente iguais das do PF_fone (p<.05). **Conclusão:** o texto "O Sol" está próximo de um texto foneticamente equilibrado ideal, uma vez que se verificaram os pressupostos pré-definidos. Fonologicamente, apresenta os formatos silábicos mais frequentes no PE, verificou-se ainda uma diminuição na frequência relativa de fonemas na transcrição estreita, devido a fenómenos de coarticulação. Futuros trabalhos incidirão no aumento da amostra.

DESCRITORES: Voz; Qualidade da Voz; Fala; Leitura

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Mailing Address:
Alexandra Nunes da Costa
Av. General Humberto Delgado nº 141 – 1º esq
2840-254
Seixal – Portugal
E-mail: tf.alexandracosta@gmail.com