

## Case reports

# Favorable stimulus words for the treatment of phonological disorders involving the production of simple onset sounds

## *Palavras-estímulo favorecedoras para o tratamento do desvio fonológico em onset simples*

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### ABSTRACT

**Purpose:** to develop and analyze a list of target words providing a favorable environment for the acquisition of target sounds in simple onset position, using a programming algorithm to assign a favorability score for each of these words.

**Methods:** an algorithm was programmed to calculate a favorability score for target words by adding up the weights assigned to the following variables, with regards to the target sound: position within the word, stress pattern, number of syllables, preceding and following context. The algorithm was programmed using Java. The lists of target words for each target sound contained a total of 748 words. A score was calculated for each item, and used to classify the word as favorable, neutral, or unfavorable.

**Results:** target words with the highest scores on the aforementioned variables were considered favorable, as they provided a facilitating context for the production of the target sound. However, target words did not need to meet all aforementioned linguistic criteria to be considered favorable.

**Conclusion:** the algorithm was efficient in calculating favorability scores for the target words. However, although words classified as favorable, or those with high scores on linguistic measures, should be preferred during the selection of target stimuli, these may not necessarily apply to all types of phonological disorder.

**Keywords:** Speech; Speech Disorders; Child; Rehabilitation of Speech and Language Disorders; Speech Therapy

### RESUMO

**Objetivos:** propor e analisar listas com palavras-estímulo em contextos linguísticos favorecedores para segmentos-alvo na posição de *onset* simples, utilizando um padrão de programação para pontuar o nível de favorecimento dessas palavras.

**Métodos:** foi desenvolvido um padrão de programação, em linguagem Java, para determinar a pontuação das palavras-estímulo, que considerou o somatório dos pesos atribuídos às variáveis linguísticas: posição na palavra, tonicidade, número de sílabas, contexto precedente e contexto seguinte, para cada segmento-alvo. Foram utilizadas 748 palavras para elaboração de listas de palavras-estímulo para cada segmento-alvo. Todas as palavras-estímulo tiveram sua pontuação de favorecimento calculada a partir do padrão de programação e classificadas quanto ao nível de favorecimento.

**Resultados:** verificou-se que as palavras-estímulo classificadas como favorecedoras (PEF) foram as que alcançaram maior pontuação, uma vez que contemplaram os contextos mais favorecedores para produção do segmento-alvo. Contudo não foi necessário que todos os contextos favorecedores fossem privilegiados para as palavras serem classificadas como PEF.

**Conclusão:** o padrão de programação desenvolvido foi eficiente para pontuar o nível de favorecimento das palavras-estímulo. Além disso, deve haver uma preferência por palavras-estímulo favorecedoras, ou que alcançam maior pontuação, porém nem sempre essas palavras são as mais adequadas para o tratamento de qualquer sistema fonológico desviante.

**Descritores:** Fala; Distúrbios da Fala; Criança; Reabilitação dos Transtornos da Fala e da Linguagem; Fonoaterapia

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## INTRODUCTION

Phonological disorders are characterized by the substitution, omission or distortion of speech sounds in the absence of organic conditions<sup>1</sup>. These impairments may influence the intelligibility of speech to varying degrees, and are highly incident in childhood<sup>2</sup>. Several phonological treatments have been developed for these disorders based on the production of target words. The cycles approach<sup>3</sup>, for instance, involves the careful selection of target words to be used in production practice, whose aim is to help the child form new auditory and kinesthetic images, while facilitating accurate production and self-correction.

As a result, one of the most important aspects of treatment planning is the selection of target words, since the first stages of treatment will inevitably focus on word-level interventions<sup>4-11</sup>. Therefore, regardless of the treatment used, target words must be carefully selected based on several criteria, including the provision of a facilitating environment for the accurate production of the target sound<sup>4-12</sup>.

Each phoneme is associated with a unique acquisition process, which may be facilitated by several features of its linguistic and extralinguistic environments. The presentation of target sounds in a favorable environment may be an important aspect of effective speech therapy<sup>3-8</sup>. The extent to which a linguistic environment can be considered favorable for the correct production of a target sound is determined by the following linguistic variables: word and syllable position; syllable stress; and the preceding and following context of the target sound<sup>6-8,12-17</sup>.

Additional variables which may also influence the production of the target sound include familiarity with the target word<sup>6,9,18,19</sup>, its role in the child's communication system and presence in their phonetic inventory<sup>6,9</sup>, its frequency<sup>8,9</sup> and the "number of problem sounds"<sup>9,10,16,18,19</sup> in the word.

According to a previous study<sup>7</sup>, the extent to which a given word facilitates the production of a target sound can be calculated based on its linguistic features. The "degree of favorability" associated with each word can be calculated using a formula involving the weight assigned to the following variables: syllable stress, preceding context, following context, number of syllables and position of the target sound within the word.

In another study<sup>20</sup>, these variables were analyzed for all Brazilian Portuguese phonemes in both simple and complex onset positions, as well as /r/ and /s/ in

coda position. Its results revealed that some contexts may facilitate the acquisition of the target sounds, while others may hinder it.

The use of target words which provide a favorable environment for the production of target sounds can make a positive contribution to treatment. This hypothesis is supported by studies of phonological change following treatment involving target words which provide a favorable environment for target sounds<sup>3,4,7,11,12,14,21,22</sup>.

In light of these observations, the aim of this study was to develop and analyze a list of target words providing a favorable environment for the acquisition of target sounds in simple onset position, using a programming algorithm to assign a favorability score for each of these words.

## METHODS

This was an exploratory quantitative study, approved by a university research ethics committee. All ethical and methodological procedures followed the guidelines established in Resolution 466/2012 of the National Health Council. The present study is registered under protocol number CAEE 28053914.1.0000.5346.

As a first step, word lists were created for each target sound in simple onset position. The lists were developed using 748 target words with corresponding pictures, available in the Speech Intervention Software (Software de Intervenção para Fala; SIFALA)<sup>20</sup>. Words were selected from several semantic categories, including toys, animals, fruits and vegetables, clothing and accessories, furniture and home appliances, school and office supplies, shapes and colors and, numbers, letters, colors, musical instruments, tools, etc. All words except for "hamburger" derive from Brazilian Portuguese.

The linguistic context provided by each target word to the target sounds selected was then analyzed, by calculating a "degree of favorability" based on the sum of weights corresponding to syllable stress, preceding context, following context, number of syllables and position within the word<sup>7</sup>.

An algorithm was developed in Java to facilitate the calculation of favorability scores. The weight of each variable relative to the target sounds was first included in a form. This was achieved by creating a new JFrame in the view package. A home screen displaying all phonemes analyzed by the algorithm was then created.

Lastly, the final algorithm for the assessment of each target word, presented in phonetic transcription, was

developed. The algorithm used syntactic analysis to analyze each sequence of characters and construct a structure tree. In this way, the phonetic representation of

each word was divided into blocks, composed of structural units. The screens in the software programmed for this study are shown in Figure 1.

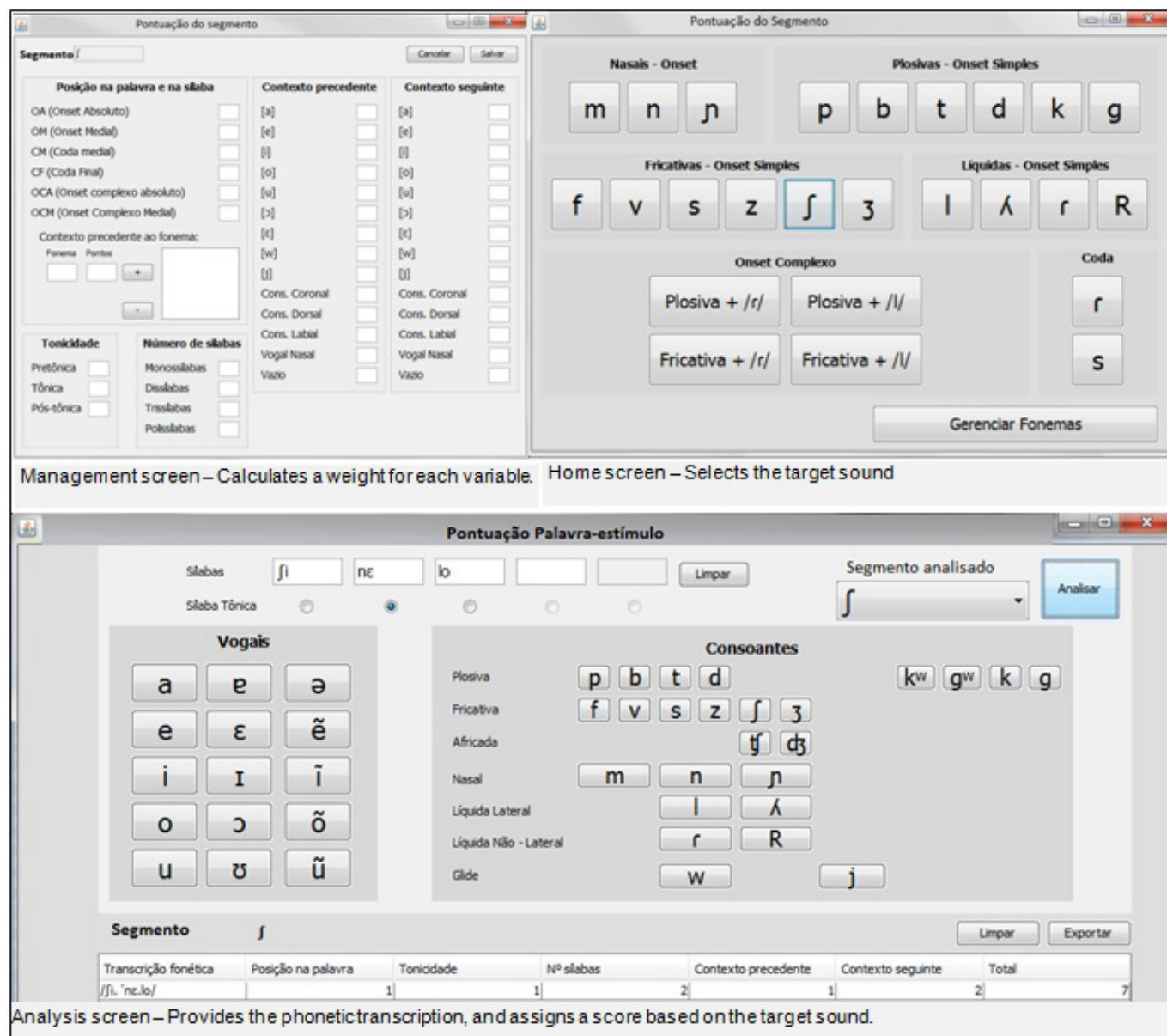


Figure 1. Screen in the software programmed for this study

The algorithm analyzed each individual structure in order to determine the score of the target word in terms of its favorability for the production of the target sound. The weights assigned to each linguistic variable were obtained from a previous study<sup>20</sup> which identified favorable environments for the correct production of all nasal, plosive, fricative and liquid sounds.

Scores on the “word position” variable were calculated based on the word position of the target sound (i.e. initial or medial onset). The variable “syllable stress” was measured by determining whether the target sound was in a pre-stressed, stressed, or post-stressed syllable. The number of syllables was examined by classifying words as monosyllabic, disyllabic, trisyllabic and polysyllabic. Lastly, the presence of the following features was investigated in the preceding and following context of the target sounds: oral vowels, semivowels, nasal vowels, coronal consonants, dorsal consonants, labial consonants, or empty context<sup>20</sup>.

The sample<sup>20</sup> consisted of a corpus of speech samples obtained from the first phonological assessment of 58 individuals with phonological disorders. A total of 21,619 words were analyzed using the VARBRUL 2S statistical package. Relative weights were then assigned to the features of the context provided by each target word based on the probability of correct production of the target sound.

Values equal to or lower than 0.5 were considered unfavorable, and assigned a weight of “1.” Values ranging from 0.50 to 0.59 were classified as neutral, and assigned a weight of “2.” Lastly, values equal to or greater than 0.60 were considered favorable, and given a weight of “3”. In addition to these parameters, others were also used in a few special cases. A weight of “0” was assigned to cases in which the percentage of correct production was 0% or when the structure in question did not exist in Brazilian Portuguese. A weight of “1” was assigned to features which exist in Brazilian Portuguese, but were not observed in the sample.

Lastly, a weight of “3” was given to features associated with correct production in 100% of cases. As a result, linguistic variables were analyzed as ordinal qualitative variables.

The target words in each list were then given a “favorability score” by the algorithm, based on the target sound of interest. Each word list was then ranked from lowest to highest in terms of the favorability score of each word relative to the target sound of interest. These values were then analyzed using the Biostat software, which calculated the first (Q1) and third (Q3) quartile values. These results were then used to classify target words into the following categories: Favorable (FTW) - scores in Q1; Neutral (NTW) - scores in the interquartile range, including the values of Q1 and Q3; Unfavorable (UFTW) - scores in Q3. The highest-scoring target words, corresponding to the top 25% of each list, were therefore classified as Favorable Target Words (FTW) for each target sound.

The stages involved in the planning of the algorithm were carried out by an IT company, with the researchers providing assistance and theoretical insight. This interface was linked to the Speech Intervention Software (Software de Intervenção para Fala– SIFALA)<sup>20</sup>. Research costs were covered by a 2012 FAPERGS/PRONEX grant, number 11/2060-5.

## RESULTS

Figure 2 shows the FTWs for the production of nasal and plosive sounds in simple onset position. The /m/, /p/, /t/ and /k/ sounds were associated with the highest number of FTWs.

Figure 3 shows the FTWs for the production of fricatives and laterals in simple onset position. At least eight FTWs were identified for all target sounds save for /r/. A significant number of target words containing /r/ received a modal score of 11, which was the cutoff for Q1. As a result, the first quartile contained less than 25% of words in the list, yielding fewer FTWs.



| Target Sound |   | Target words (score)  |
|--------------|---|---|
| Nasals       | /m/   | remo[paddle](14); algema[handcuffs](13); gêmeos[twins](13); gema[yolk](13); “M”(13); perfume[perfume](13); pijama[pajamas](13); diploma[diploma]; dálmata[dalmatian](13); grama[grass](13); pluma[feather](13); creme[cream](1); rímel[mascara](13); cama[bed](13); arame[wire](13); salame[salami](13); fliperama[arcade](13); lesma[snail](13); fantasma[ghost](13); remédio[medicine] and termômetro[thermometer](13)  |
|              | /n/   | violino[violin](14); bailarina[ballerina](14); espinafre[spinach](13); binóculos[binoculars](13); alfinete[pin](13); dezenove[nineteen](13); sino[bell](12); sinaleira[traffic light](12); cisne[swan](12); azeitona[olive](12); carne[meat](12); telefone[telephone](12); cortina[curtain](12); lanterna[lantern](12); dinossauro[dinosaur](12); caderno[notebook](12); pepino[cucumber](12); pernas[legs](12); microfone[microphone](12); nó[knot](12)  |
|              | /ɲ/   | passarinho[bird](13); ursinho[teddy bear](12); pintinho[chick](12); carrinho[toy car](12); joaninha[ladybug](12); trenzinho[toy train](12); golfinho[dolphin](12)   |
| Plosives     | /p/   | zíper[zipper](13); xarope[syrup](13); chope[draft beer](13); jipe[jeep](13); pipoca[popcorn](12); roupas[clothes](12); pipa[kite](12); lâmpada[lightbulb](12); copo[glass](12); envelope[envelope](12); sopa[soup](12); grampo[staple](12); espelho[mirror](12); champanhe[champagne](12); esponja[sponge](12); repolho[cabbage](11); fliperama[arcade](11); hipopótamo[hippopotamus](11); grampeador[stapler](11); guarda-roupa[wardrobe](11); espada[sword](11); despertador[alarm clock](11); clips[paperclip](11); espingarda[shotgun](11); P(11); pão[bread](11)   |
|              | /b/   | ônibus[bus](12); globo[globe](11); lobo[wolf](11); alfinete[pin](11); proibido[forbidden](11); nabo[turnip](10); hambúrguer[hamburger](10); pomba[dove](10); beterraba[beet](10); rabo[tail](10); robô[robot](10); cachimbo[pipe](9); carambola[starfruit](9); quebra-cabeça[puzzle](9); frigobar[mini fridge](9); gambá[skunk](9); tambor[drum](9); goiaba[guava](9); cabide[clothes hanger](9); bule[teapot](9); burro[donkey](9); bench[bank](9)   |
|              | /t/   | fantochê[puppet](11); pimentão[bell pepper](11); batom[lipstick](11); quatorze[fourteen](11); biblioteca[library](11); chuteira[cleats](11); patins*[skates](11); chocolate[chocolate](10); charuto[cigar](10); cotonete[cotton swab](10); cartola[top hat](10); prateleira[shelf](10); lanterna[flashlight](10); ratoeira[mousetrap](10); cafeteira[coffee maker](10); sapato[shoe](10); oitenta[eighty](10); abacate[avocado](10); sapatilha*[ballet shoes](10); bateria[battery](10); extintor*[fire extinguisher](10); trator[tractor](10); alicate[pliers](10); antena[antenna](10); tomate[tomato](10); tatu[armadillo](10); esmalte[nail polish](10); batata[potato](10); peteca[shuttlecock](10); gafanhoto[grasshopper](10); batedeira[mixer](10)  |
|              | /d/   | dólar[dollar](11); dedo[finger](10); doze[twelve](10); pudim*[pudding](10); dor[pain](9); dinossauro*[dinosaur](9); diamante*[diamond](9); dezessete[seventeen](9); dois[two](9); dez[ten](9); dezenove[nineteen](9); despertador[alarm clock](9); dentadura[dentures](9); dedal[thimble](9); dado[die](9); detergente[detergent](9); D(9); frigideira[frying pan](9); crocodilo*[crocodile](9)   |
|              | /k/   | suco[juice](11); círculo[circle](11); tucano[toucan](11); banco[bank](11); peruca[wig](11); tronco[trunk](11); escuro[dark](11); buquê[bouquet](11); cinco[five](11); branco[white](11); brinco[earring](11); cinquenta[fifty](10); cocô[poop](10); coqueiro[palm tree](10); parque[park](10); óculos[glasses](10); mosquito[mosquito](10); faca[knife](10); esquilo[squirrel](10); máscara[mask](10); fraco[weak](10); isqueiro[lighter](10); jaca[jackfruit](10); jaqueta[jacket](10); macaco[monkey](10); escova[brush](10); placa[sign](10); chocalho[rattle](10); taco[bat](10); vaca[cow](10); arco[arch](10); barco[boat](10); barraca[tent](10); macaco[monkey](10); boca[mouth](10); saco[bag](10); caqui[persimmon](10); macacão[overalls](10); caracol[snail](10); porco[pig](10); casaco[coat](10); casca[peel](10); cerca[fence](10) |
| /g/          | Agulha[needle](11); hambúrguer[hamburger](11); bigode[moustache](11); água[water](10); frango[chicken](10); mangueira[hose](10); flamingo[flamingo](10); figo[fig](10); morango[strawberry](10); morcego[bat](10); trigo[wheat](10); dragão[dragon](10); carga[charge](10); prego[nail](10); água[water](10); gangorra[see-saw](10) |   |

Note: \* Affricate production, allophones.

**Figure 2.** Favorable target words (FTWs) for nasals and plosives in simple onset.

| Target sound |     | Target words (score)  |
|--------------|-----|---|
| Fricatives   | /f/ | feijão[bean](11); ferro[iron](11); faca[knife](10); fada[fairy](10); foto[photo](10); forte[strong](10); farol[lighthouse](10); favo[honeycomb](10); fechadura[lock](10); foca[seal](10); troféu[trophy](10); café[coffee](10)  |
|              | /v/ | “V”(11); vô[grandpa](10); vô[grandma](10); vinte[twenty](10); véu[veil](10); vaso[vase](10); verde[green](10); vagem[string bean](10); vaca[cow](10); vela[candle](9); vinho[wine](9); varal[clothesline](9); noiva[bride](9); pavão[peacock](9)  |
|              | /s/ | “S”(11); peças[pieces](11); alface[lettuce](10); fumaça[smoke](10); abraço[hug](9); S(9); taça[goblet](9); quebra-cabeça[puzzle](9); pulseira[bracelet](9); polícia[police](9); passarinho[bird](9); palhaço[clown](9); dinossauro[dinosaur](9); crianças[children](9); classe[class](9); massa[pasta](9); aliança[ring](9); calça[pants](9); balança[scale](9); bolsa[bag](9); capacete[helmet](9) |
|              | /z/ | trenzinho[train](11); trezentos[three hundred](10); duzentos[two hundred](10); quatorze[fourteen](10); presunto[ham](10); presente[present](10); lasanha[lasagna](10); televisão[television](10); blusão[sweater](10); explosão[explosion](10)  |
|              | /ʃ/ | roxo[purple](11); sanduíche[sandwich](10); boliche[bowling](10); mochila[backpack](10); lagartixa[gecko](10); flecha[arrow](10); fichas[tokens](10); salsicha[sausage](10); coxinha[drumstick](10)  |
|              | /ʒ/ | Frigideira[frying pan](11); zoológico[zoo](10); bandeja[tray](10) cerveja[beer](10); cereja[cherry](10); beija-flor[hummingbird](9); relógio[clock](9); caranguejo[crab](9); carruagem[carriage](9); coruja[owl](9); esponja[sponge](9); laranja[orange](9); injeção[injection](9); tijolo[brick](9); pijama[pajamas](9)  |
| Liquids      | /l/ | lua[moon](11); luva[glove](11); lupa[magnifying glass](11); lustre[chandelier](11); luta[fight](11); lápis[pencil](10); lobo[wolf](10); lata[can](10); livro[book](10); linha[line](10); cola[glue](10); dólar[dollar](10); mola[spring](10); bola[ball](10)  |
|              | /ʎ/ | ervilha[pea](11); filhote[cub](11); lentilha[lentil](11); chocalho[rattle](11); medalha[medal](11); baralho[deck](11); toalha[towel](11); agulha[needle](11)  |
|              | /R/ | régua[ruler](11); rímel[mascara](11); rosa[rose](10); rolo[roll](10); rolha[cork](10); rodo[mop](10); roupas[clothes](10); rato[rat](10); roxo[purple](10); rabo[tail](10); ralo[drain](10); rádio[radio](10); ferro[iron](10); burro[donkey](10); terra[earth](10)   |
|              | /r/ | pirulito[lollipop](12); aquário[fish tank](12); girassol[sunflower](12)   |

**Figure 3.** Favorable target words (FTWs) for fricatives and liquids in simple onset.

## DISCUSSION

After all linguistic variables were assigned a weight of “0”, “1”, “2” or “3,” each target word could obtain a maximum score of 15<sup>7,20</sup>. However, in addition to these weights, the combination of favorable factors associated with each variable must also be considered when estimating the favorability of each target word<sup>7</sup>. As a result, in some cases, only pseudowords could possibly contain all features considered favorable. Additionally, according to a previous study,<sup>20</sup> some target sounds may not have a target word that achieves the maximum score (3) on all five variables analyzed.

The target sounds occur in medial onset position in the majority of FTWs. However, the production of /d/, /f/, /v/, /l/ /ʎ/ and /R/ appears to be favored when these sounds are in initial onset position. This finding suggests that the most favorable onset position may vary depending on the target sound<sup>7,17,23</sup>.

In most FTWs, the target sound was in a stressed or post-stressed syllable. This finding supports the hypothesis that children who speak Brazilian Portuguese as a native language find it easier to

produce syllables in metrical feet (to the left of two syllables) due to word stress patterns in Brazilian Portuguese (paroxytone)<sup>7,16,24</sup>. These results also corroborate those of another study<sup>25</sup> suggesting that target sounds are more likely to be produced correctly in stressed syllables, as a result of the stress contrast. Stressed syllables also benefit from increased attention by the speaker to ensure their correct production, which may favor target sounds located in such a syllable<sup>26</sup>.

The majority of FTWs was also found to be di- or trisyllabic. However, according to the literature, words with fewer syllables provide an easier context for production and stimulation<sup>9,10,26-28</sup>. As a result, mono- and disyllabic words are likely to be more easily produced. The fact that this finding was not confirmed in the present study may be attributable to the low frequency of monosyllabic words in Brazilian Portuguese.

Lastly, studies suggest that the production of speech sounds may be influenced by adjacent phonemes<sup>10,23</sup>. As a result, the production of a sound may be facilitated when it shares the place of articulation with a preceding or following sound<sup>7,10,23,26</sup>. The target sound was not

adjacent to one with the same place of articulation in all FTWs. However, in most cases, a phoneme with similar features to the target sound was present either in the preceding or following context provided by the target word. This finding supports the hypothesis that correct speech production is favored when there is less articulatory adjustment between sounds<sup>6,9</sup>.

A literature search revealed no studies of the target words used in the treatment of nasals in onset position, probably because their production is rarely affected by phonological disorders, except in very severe cases<sup>29</sup>. Nevertheless, the use of FSWs may still contribute to the treatment of nasals.

FSWs for the target sound /k/ are all disyllabic or trisyllabic, and in all cases except for “tucano” (toucan), “escuro” (dark) and “buquê” (bouquet), present the target sound in a post-stress syllable, as suggested by a previous study<sup>8</sup>. The target words “frango” (chicken), “mangueira” (hose), “flamingo” (flamingo), “morango” (strawberry) and “gangorra” (see-saw), containing the target sound /g/, followed previous recommendations regarding the presence of a nasal vowel in its preceding context<sup>8</sup> and its presentation in a medial onset position<sup>8,15,17</sup>. The presence of coronal consonants, /a/ and /w/ in the preceding context of the /g/ sound were also found to favor its production. This finding corroborates those of previous studies regarding the facilitating role of coronal and dorsal vowels in the production of /k/ and /g/<sup>15</sup>.

The use of target words which provide a favorable environment for the production of target sounds may contribute to treatment gains in speech therapy. However, it may not always predict a better treatment outcome<sup>3,4,12,21,22</sup>, nor should it be used as the only criterion in the selection of target words<sup>9,10,19</sup>.

Studies<sup>12,21,22</sup> of the effects of phonological treatment for speech sound disorders on the acquisition of fricatives using target words providing a favorable phonological context, and words providing neutral or unfavorable contexts, selected the words “azedo” (sour), “azeite” (oil), “asa” (wing), “doze” (twelve), and “casinha” (little house) as the most favorable for the acquisition of /z/. The algorithm developed in the present study would assign a score of nine to all of the words except for “asa” (wing) and “doze” (twelve), which would receive a score of eight. As a result, all would be classified as neutral.

Studies analyzing the acquisition of /ʃ/ <sup>12,21,22</sup> selected the words “bicho” (animal), “cachorro” (dog), “peixe” (fish), “caixa” (box), “roxo” (purple)

and “abacaxi” (pineapple) - all of which present the target sound in medial onset position - as the most favorable for treatment. In the present study, the word “roxo” (purple) was considered a FTW, as shown in figure 3. The word “bicho” (animal) would also be classified as favorable. However, the remaining words would be classified as neutral by the algorithm.

The acquisition of the target sound /ʒ/ has been found to be favored by the words “beijo” (kiss), “queijo” (cheese), “anjo” (angel), “canja” (broth), “loja” (store), “laranja” (orange), “pijama” (pajamas)<sup>12,21,22</sup>, “jibóia” (python), “joaninha” (ladybug) and “longe” (far)<sup>9</sup>. All of these present the target sound in medial onset position. In the present study, only “laranja” and “pijama” were classified as favorable, as shown in Figure 3. According to the algorithm, the remaining words would be classified as neutral.

The influence of favorable environments on the production of fricatives has also been analyzed in a previous study<sup>7</sup>. However, the investigation in question involved pre-existing data, whose collection did not consider the need for a standardized number of favorable vs. unfavorable words. Its results revealed no correlation between the use of FTWs and a successful treatment outcome, as measured by the number of words produced, the number of sounds acquired, and the different types of generalization. However, subjects whose treatment involved only one or no FTWs showed the least generalization. The remainder of the sample, whose treatment involved a higher number of FTWs, was able to acquire a larger number of phonemes, in addition to correctly producing the target words.

Another study<sup>13</sup> used normal phonological acquisition data to examine facilitation effects on the production of non-lateral liquids. The authors found that some words may be more linguistically efficient in phonological rehabilitation. The study<sup>13</sup> identified the following FTWs for the acquisition of /R/ ([X]) in initial onset position: “Roger”, “Roque”, “roda” (wheel), “rosa” (rose), “rodo” (mop), “roxo” (purple), “rolha” (cork), “Rose”, “Rute”, “Rubens” and “roupas” (clothes). These words have several features in common, including the number of syllables (two), the location of the target sounds in a stressed syllable, and the presence of particular phonemes following the target (/o/, /ɔ/ or /u/). FTWs for the target sound /R/ in medial onset were “ferro” (iron), “burro” (donkey), “morro” (hill), “gorro” (cap), “serrote” (saw), “verruca” (wart) and “cachorro” (dog). All target words in the list<sup>9</sup> analyzed for the present

study were classified as FTWs, with the exception of “rato”(rat) and “rádio”(radio).

The words identified as FTWs<sup>10</sup> for the acquisition of /r/ in simple onset were: “peruca”(wig), “peru”(turkey), “girafa”(giraffe), “pirata”(pirate), “seringa”(syringe), “pirulito”(lollipop), “labirinto”(maze), “girassol”(sunflower) and “Irineu”. Two of the three words included in the present study (“girassol” and “pirulito”) were classified as favorable by the algorithm. In the aforementioned study<sup>13</sup>, the adult pronunciation of the word “peruca” was used; that is, [pi´ruka]. In this case, the word can also be considered favorable for the acquisition of the target sound.

In the present study, the pronunciation of target words followed the phonological standard as closely as possible. As such, words like “cavalo”(horse), “peixe”(fish), and “peru”(turkey) were transcribed as follows: [ka´valo] /ka´valo/, [´pej]e /´peie/, and [pe´ru] /´pe´ru/. These phonetic transcriptions were then used to calculate the degree of favorability associated with each target word. The use of this form of pronunciation in phonological treatment may be preferable to others due to its potential contribution to writing. However, variations in the production of these words can also occur, as in the case of [ka´valu], [´pe]e, [´pe]i, [´pej]i, [pi´ru], as a result of individual differences in dialect or sociocultural background. This must always be considered by speech therapists, who may need to recalculate the values associated with these target words.

A case study<sup>4</sup> of the influence of favorable environments on the treatment of an individual with a phonological disorder found that the words used for the acquisition of /r/ in simple onset did not provide a favorable environment<sup>13</sup> in terms of their stress patterns, number of syllables, and preceding and following context. The words used in treatment were “barata”(cockroach), “coração”(heart), “cenoura”(carrot), “coruja”(owl), “morango”(strawberry), and “tesoura”(scissors). The results revealed that the target sound was more likely to be produced correctly when placed in a stressed syllable. None of the words provided a favorable environment in terms of the context of the target sound. However, the presence of the vowels /o/ in the preceding context, and /a/ in the following context, appeared to favor the acquisition of the target sound: the words associated with the highest production accuracy were “coruja,” “morango,” and “barata”.

Another case study<sup>5</sup> of the acquisition of /r/ in simple onset in two subjects with phonological disorders using a word hierarchy<sup>13</sup> and generalization during treatment revealed that the subject treated with target words providing a favorable environment had a better treatment outcome. This was confirmed by his accuracy in the production of target sounds and higher frequency of generalization. This finding supports the idea that words which provide a favorable environment for the target sound may reduce the duration of treatment, as suggested by previous studies<sup>7,11</sup>. It also corroborates the hypothesis of increased generalization with the use of FTWs<sup>7,10,22</sup>.

However, a comparative study<sup>14</sup> of favorable and neutral environments, classified based on data drawn from typically-developing children, found that target words providing a neutral context (/r/ in a stressed syllable, preceded by /o/ and followed by /ε/) produced larger changes in the phonological system of six children treated for phonological disorders than favorable target words (target sound preceded by the vowel /i/ and followed by /u/; target sound preceded by /a/ and followed by /e/). These findings suggest that favorable contexts determined based on data from typically-developing children may not apply to children with phonological disorders. Therefore, in the present study, the weights assigned to variables in the calculation of favorability were obtained from data collected in children with phonological disorders<sup>20</sup>.

According to the literature, other variables must also be considered in the selection of target words in addition to the scores obtained by their linguistic variables and/or their favorability classification. These variables include the “number of problem sounds” and familiarity to the child. With regards to the former, the literature suggests that target words should be selected so that the target sound is the only one the child has difficulty producing<sup>9,10,17</sup>. That is, the presence of additional sounds which the child can accurately produce, and are not the focus of treatment, may favor the production of the target sound<sup>16</sup>.

Therefore, words in which the target sound is present more than once, such as “macacão”(overalls) and “casaco”(coat) for the production of /k/, should be avoided, even if they are considered favorable. It is also crucial for the therapist to be familiar with the child’s phonetic inventory and phonological system to avoid the selection of target words involving more than one sound that the child is unable to produce<sup>9,10,19</sup>.



Lastly, target words should always be part of the child's vocabulary, since, according to the literature, the higher the familiarity of the word, the more easily will it be included in the child's vocabulary<sup>9,10,18,19</sup>. As a result, words such as "rímel" (mascara) - though they may be considered favorable - should be avoided when the child is unable to name or recognize its corresponding image after being given the name, meaning and function of the target word.

A recent case study<sup>30</sup> of phonological treatment using FTWs selected using the algorithm described in the present study and the variables recommended by the literature<sup>9,10,16-19</sup> identified significant advances in terms of the establishment of new sounds in the patient's phonetic inventory and their acquisition in the phonological system. Although additional studies involving larger samples are still required to confirm the present findings, the use of the target words included in these lists and classified as favorable may contribute to the acquisition of target sounds. However, the advantages offered by these stimuli over other target words in the context of treatment can only be measured and confirmed by clinical application.

## CONCLUSION

The algorithm developed in the present study was efficient in providing favorability scores for the target words provided, facilitating and simplifying the procedures involved. The degree of favorability associated with word position, stress pattern, number of syllables, preceding context, and following context may change depending on the target sound.

Target words with the highest scores on the aforementioned variables were considered favorable, as they provided a facilitating context for the production of the target sound. However, target words did not need to meet all aforementioned linguistic criteria to be considered favorable.

The selection of target words for treatment should not focus exclusively on these scores or the favorability classification, but should also consider the "number of problem sounds" and word familiarity, both of which can influence the production of target sounds. Therefore, although words classified as favorable, or those with high scores on linguistic measures, should be preferred during the selection of target stimuli, these may not necessarily apply to all types of phonological disorder. The therapist must have the knowledge required to select the best target words, but, most

importantly, should attend closely to the results of treatment and monitor its efficacy.

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