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Effects of non-native spelling in the production accuracy of Portuguese medicine brand names

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Abstract

Medicine brand names should be correctly read, because confusions with these names may lead to serious medication errors. Objectives: to evaluate if aspects of the spelling of medicine names negatively influence the way they are read aloud. Methods: a pronunciation task was conducted where participants had to read aloud medicine brand names. The names were classified in three groups: names comprising letters that are not used in Portuguese native vocabulary, names deviating from the Portuguese orthographic rules, and names following Portuguese spelling. The effect of name length was also investigated. Two groups of participants were tested: thirty non-biomedical university students (younger and more educated), and thirty-seven pharmacy customers (older and less educated). Results: names with non-native letters (both groups of participants) and names with non-native patterns (students group only) yielded significantly more errors than the names with native shapes. Longer names showed more pronunciation errors than shorter names. Less educated, older subjects made significantly more errors than more educated, younger participants. Conclusion: some medicine brand names may need to be adapted or modified before commercialization in order to prevent potential errors in the use of medicines.

Keywords: Medicine brand names; Pronunciation; Non-native spelling; Word length; Level of education; Health security

1. Introduction

Medicine brand names are defined as invented (fantasy) names, and are preferentially formed by just one word. It is important that these names are not prone to confusion with the name of marketing authorization holders, health authorities, and crucially with other medicinal products (e.g. names of medical devices) [1-3]. Incorrect reading or

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writing of medicine names by health professionals, providers or patients, may lead to an increased risk of medication errors during the prescription, dispensing or administration of medicines [4-5]. According to the regulations, medicine names should be readable and pronounceable, and not allow for ambiguity [2,3]. However, the number of studies specifically addressing pronunciation accuracy and the structure and characteristics of brand names in a given language, and in particular in Portuguese, is very limited [6-8].

The format of words may have great impact on different kinds of tasks. The size of words may affect the accuracy of spelling, thus being a relevant factor when designing and developing new names [9]. Word size and phonotactic probability (i.e. the frequency of sounds in a given sequence) also play a role in memory-related tasks, such as word recognition ([10-13]). Speakers characteristics may influence word production as well, in particular education and age, but at least for age there is some variability depending on the task [14-17].

In this study, we investigate the effect of particular formal properties of medicine brand names in use in the Portuguese market. In Portugal, like in other countries, medicine users are most often elderly, because, unlike younger people, the geriatric population tends to have chronic diseases and be polymedicated [18]. Older population also tends to have lower education-level, since the compulsory education in Portugal was low until a few decades ago (comprising six, nine, and 12 years, after 1984, 1986, and 2009, respectively) [19-22].

We are thus also interested in determining if typical pharmacy customers may be more vulnerable to issues related to the form of medicine names than younger and more educated groups of subjects. The study goal was therefore to evaluate the extent to which the pronunciation of a sample of Portuguese medicinal brand names are affected by: 1) non-native grapho- and/or phonotactic structure (i.e. a spelling that deviates from the Portuguese orthographic and/or phonological system); 2) word length; and 3) age/level of education of the participants.

2. Methods

This experiment is part of a larger study [23]. The pronunciation task reported here is the last of three successive tasks run with the same participants, in a single session, with a 10 minutes break between experiments.

2.1. Tested brand names of medicines

The sampled medicine names were conveniently selected from the names of the Portuguese prescribing guide [6, 24]. Repeated names, names consisting of more than one word, and names containing abbreviations or symbols were excluded in order to standardize the procedure. The names of generic medicines were not included, since they have a specific format, containing a common scientific name followed by the name of the marketing authorization holder [1,3]. The tested names were divided in three groups: Group 1 – words comprising at least one occurrence of <y>, <k>, and <w>, which are not used in Portuguese native vocabulary (e.g. Ribomunyl®); Group 2 – non-canonical words, including at least one letter combination that is not allowed in the language orthography (e.g. “th”, as in Bepanthene®); and Group 3 – canonical words, displaying the native patterns of the language (e.g. Claritine®). 36 names were randomized and tested in a pronunciation task. The names were distributed by three blocks (Appendix A). A similar proportion of canonical and non-canonical names were maintained across blocks.

2.2. Participants

Two groups of participants were conveniently enrolled: a group of university students, including younger and more educated subjects, and a group of pharmacy customers, formed of older and less educated participants. The sample size and the characteristics of the samples of subjects were established on the basis of previous studies [25, 26]. The first group was composed of 30 students, from non-biomedical studies, in order to minimize possible previous knowledge of medicine names. Students were in the 1st to 3rd year of humanities studies, 70% were female, had 14 ± 1 years of schooling on average, and were 25.9 ± 9.3 years-old on average. The second group was composed of 37 participants, conveniently selected in Portuguese Community Pharmacies from the Lisbon region, with 7.5 ± 3.2 years of schooling on average, had 58.7 ± 12.8 years-old on average, and 67.6% were females.

The inclusion criteria consisted in consent to participate in the study, be over 18 (the legal age of majority in Portugal), and have European Portuguese as native language. All data were anonymous and confidential.

2.3. Pronunciation through a reading task

Before the onset of the experiments, the information about the socio-demographic indicators of the participants was collected (sex, age, and years of schooling). Participants were instructed to remain focused throughout the experiments and read as fast as possible. First, training blocks were presented before the test trials using car brand names. At the end of each experiment participants were asked if they knew any of the names of medicinal products previously seen or heard. The group of students reported knowing 5.7% of the medicine names they were presented, while the group of pharmacy customers declared to know 6% of the tested names. Given that the names reported to be known by the participants did not change the profile of the results, we have included all data in our final analysis. A pilot of this experiment was conducted with 5 undergraduates, and no problem was identified.

Following work by Lambert and colleagues, participants were asked to read aloud names of medicine brands [25, 26]. The names were sequentially presented in the center of the screen. Participants were instructed to read the name aloud immediately after their presentation on the screen.

For the group of students, the three blocks were run (one block = a sequence of 12 brand names of medicines), i.e. each student was required to read aloud three groups of 12 brand names of medicines (Appendix A). This procedure allowed collecting more data per participant and improving the accuracy of the study and was in line with the methodology in other studies [25, 26]. Because of participants' time constraints, the group of pharmacy customers did only one block i.e. each pharmacy customer was required to read aloud 12 names, only.

2.3.1 Data analysis

Names were coded '0' when the production prevented the identification of the target form due to a null response or errors other than hesitations or lengthening, and '1' when they were produced with a hesitation or lengthening. When names were correctly produced, they were coded '2'. The errors found fall in the following five categories: 1) substitutions – a new segment replaces one in the target form; 2) insertion – a segment is added that was not present in the target form; 3) metathesis – segments interchange positions; 4) deletion – a segment present in the target form is deleted; 5) vowel reduction – unreduced vowels appear in post-tonic position. The statistical analysis was performed using SPSS for Windows (version 25.0, IBM-SPSS, Chicago, IL).

3. Results

Each subject of the student group pronounced 36 names divided in 3 blocks (12 names per block) (Appendix A), and a total of 1068 words were phonetically transcribed (12 names x 3 blocks x 29 subjects – recording problems prevented the phonetic transcription of the data from one of our subjects). As shown in Table 1, the students group show very high rates of correct responses in both block conditions. All blocks taken together yielded more correct responses and less incorrect productions than block 1 alone, showing a possible training effect. The rate of correct results in block 1 vs. block 2 and 3 was significantly different ($X^2 = 21.7$, $p<0.001$).

Table 1. Performance in the pronunciation task (%) – Students and pharmacy customers

	Students: Block 1 (%)	**Students: Block 1, 2, 3 (%)**	**Pharmacy customers (%)**
Correct	76.7	84.2	60.9
Pauses and hesitations	8.9	5.1	8
Incorrect	14.4	10.7	31

The results show that the group of pharmacy customers performed globally poorer than the group of students in the pronunciation task. This difference is statistically significant considering the three blocks from the group of students ($X^2 = 92.875$, $p<0.001$), as well as block 1 alone ($X^2 = 90.594$, $p<0.001$).

Significant differences were also found in the results of the pronunciation task by the group of students across the three groups of names ($X^2= 30.3$, $p<0.001$ – all blocks; $X^2= 15.539$, $p = 0.004$ – block 1). As shown in Figure 1, the error rate and the number of pauses and hesitations were higher in the names of Groups 1 and 2, and the names in

Group 3 had a higher rate of fully correct pronunciations. Thus, students performed significantly better at pronouncing medicine names with native spelling than names with non-native spelling. Significant differences were also found in the results of the pronunciation task by pharmacy customers across the three groups of names (X^2 = 23.04, p<0.001). The error rate in Group 1 was higher than in Groups 2 and 3: 49.1% vs. 22.4% and 26.4%, respectively. Surprisingly, Group 2 showed lower error rates than Group 3 and the highest rate of fully correct productions (68.5%). These results indicate that less educated/older participants were better at pronouncing names with native spelling than names with non-native letters, but non-native grapho- and/or phonotactics did not seem to promote error rate. There were no significant differences between Groups 2 and 3 for pauses or hesitations and incorrect answers (X^2 = 0.019, p=0.891). The difference in the rate of correct pronunciation between Groups 2 and 3 is small but significant (X^2 = 16, p<0.001), with better results for Group 2 (68.5%) than Group 3 (64. 6%).

Comparing the proportions of names correctly written with 5-6 letters vs. 7-11 letters the following results were obtained: 91.4% vs. 73.1% (students: Block 1); 94.7% vs. 81.4% (students: Block 1, 2, 3) and 84.2% vs 55.8% (pharmacy customers). Both groups of subjects produced shorter names (⩽6 letters) more accurately than longer names (> 6 letters): X^2 = 22.306; p<0.001 (group of students, all blocks); X^2 = 11.118; p=0.004 (group of students, block 1); and X^2 = 23.934; p<0.001 (group of pharmacy customers). In general, these findings indicate that both groups of subjects have increased difficulty in pronouncing longer names.

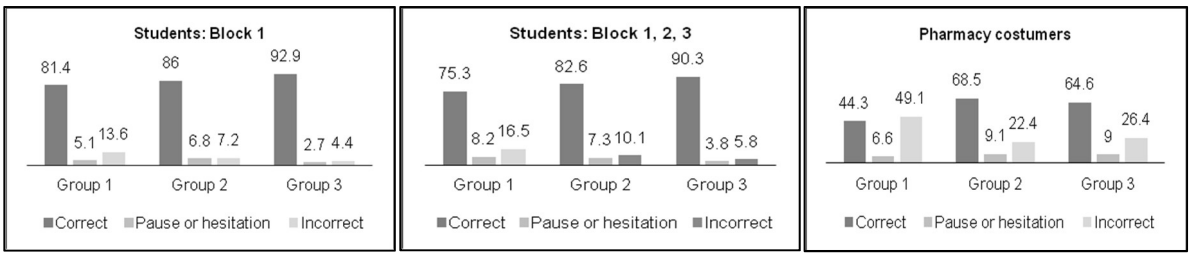

Fig. 1. Performance (%) per category in the pronunciation task (Group 1 – non-native letters; Group 2 – non-native grapho- and/or phonotactics; Group 3 – native grapho- and phonotactics) – Students and pharmacy customers

4. Discussion

Although studies have demosntrated the negative impact of confounding brand names of medicines due to phonological or orthographic similarities (e.g. names that sound and look similarly) [26], investigation specifically reporting a causal association between patients' incorrect oral production of brand names of medicines, and medication errors have not been identified. Additionally, studies on the pronounceability of brand names of medicines are very limited [23], despite current concern of public organizations regarding the pronunciation of medicines names and its effects on clinical practice [2]. Medicine names with non-native graphemes, and, for students only, names with non-native grapho- and/or phonotactics, had a negative effect in pronunciation. The results also show that word size has impact on pronunciation accuracy irrespective of level of education/age considerations, since medicine names longer than 6 letters yielded more pronunciation errors than shorter names in both groups of participants. Level of education/age revealed a clear global effect in subjects' performance, as the group of students, i.e. the group of more educated and younger subjects, had significantly more accurate responses than the group of pharmacy customers, which includes less educated and older participants.

A high accuracy rate was found in the pronunciation of medicine brand names, particularly in the group of students. Both groups of participants showed more errors in the group of names comprising the letters "y", "k", and "w". However, contrary to the group of more educated/younger participants, less educated/older participants performed slightly but significantly better with non-canonical names than with canonical names. We believe that this result may be explained if we take into consideration some fundamental differences between more educated and less educated subjects. Low literate people have less contact with the written form of the language than high literate subjects. In that sense, it seems likely that the effect of familiarity of the native pattern of written words, which explains a higher error rate in non-native patterns than in native patterns in more educated subjects, might not be present in less educated

subjects [30]. In addition, less educated subjects are expected not to fully master the rules of Portuguese orthography. The difference in the results of the pronunciation task between the more educated and the less educated group may thus be explained by differences in the level of linguistic knowledge that is represented in writing in these two groups of participants: for more educated subjects, there may be a stronger connection between the orthographic and the phonological system, whereas for the less educated subjects, orthography may represent more closely the phonetic, superficial level [32, 33].

Overall these results suggest that it might be useful to adapt medicine brand names spelling to assure their pronounceability. It seems advisable that medicine and health authorities investigate the correlation between patients' incorrect oral productions of brand names and medication errors. Despite the relevant results, and given the limited number of participants and names enrolled in the present study, more investigation on the present topic is necessary, including studies on the impact of oral production accuracy of brand names of medicines on subjects' memorization, and influence of other factors on subjects' oral production, such as orthographic/phonological similarities with the disease's name/component, and brand's market share, package color, or pharmaceutical presentation of the medicine.

5. Conclusion

The results from the pronunciation task show that, despite the high rates of correct productions, non-native word shapes seem to impair reading aloud accuracy. Medicine names with non-native graphemes and, in the students group only, with non-native grapho- and phonotactics, as well as longer names, yielded more pronunciation errors. As expected, more educated/younger participants performed better in this task than less educated/older subjects. Our results indicate that adapting medicine brand names to the language of the target users before commercialization may be a necessary step in order to prevent potential errors in the use of medicines.

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Appendix A. An example appendix

	Block 1[a]
1	Ascal - Group 3; 5 letters
2	Resochina - Group 3; 9 letters
3	Lisolac - Group 2; 7 letters
4	Estracyt - Group 1; 8 letters
5	Pegasys - Group 1; 7 letters
6	Fluad - Group 2; 5 letters
7	Dinaxil - Group 3; 7 letters
8	Azarga - Group 3; 6 letters
9	Valium - Group 3; 6 letters
10	Zoloft - Group 2; 6 letters
11	Periogard - Group 2; 9 letters
12	Alorexyl - Group 1; 8 letters

	Block 2[a]
1	Claritine - Group 3; 9 letters
2	Tegretol - Group 3; 8 letters
3	Predonium - Group 3; 9 letters
4	Propycil - Group 1; 8 letters
5	Influvac - Group 2; 8 letters
6	Relmus - Group 3; 6 letters
7	Fluidrenol - Group 3; 10 letters
8	Bepanthene - Group 2; 10 letters
9	Zyprexa - Group 1; 7 letters
10	Tavist - Group 2; 6 letters
11	Modivid - Group 2; 7 letters
12	Kestine -Group 1; 6 letters

	Block 3[a]
1	Rytmonorm - Group 1; 9 letters
2	Ribomunyl - Group 1; 9 letters
3	Betasporina - Group 3; 11 letters
4	Qutenza - Group 2; 7 letters
5	Foradil - Group 3; 7 letters
6	Omnitrope - Group 3; 9 letters
7	Siccafluid - Group 2; 10 letters
8	Sirdalud - Group 2; 8 letters
9	Spasmoplex - Group 2; 10 letters
10	Norterol - Group 3; 8 letters
11	Lidonostrum - Group 3; 11 letters
12	Naprosyn - Group 1; 8 letters

[a] Group 1 – medicine names containing non-native graphemes, namely <k>, <y>, and <w>; Group 2 – medicine names containing non-canonical grapho- and/or phonotactics; and Group 3 – medicine names complying with the orthographic and sound system of European Portuguese.

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