

The Diphthong <ei> in Variationist Studies of Brazilian Portuguese: A Systematic Literature Review

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Abstract: This study presents a systematic literature review of the monophthongization of the diphthong <ei> in Brazilian Portuguese. Monophthongization is a sound change by which a diphthong becomes a single vowel. Thus, the output of, for example, the word *beira* ('edge') can be *b[e_i]ra* or *b[e]ra*. Our primary sources, 10 Master's theses that analyzed this phenomenon using quantitative sociolinguistic methodologies, focus on individually describing a region's variety of Portuguese. However, the results were never systematically related to each other. Consequently, these works do not present a comprehensive overview of the production of <ei> in Brazilian Portuguese. Therefore, this systematic review gathers and unifies information dispersed in these studies, aiming to offer an overview of this optional phenomenon. The overall results demonstrate that the following context was the relevant linguistic variable, while the speaker's educational level and dialect variation are the relevant non-linguistic variables for the application of the monophthongization rule.



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1. Introduction

This paper presents a systematic literature review of the monophthongization of the diphthong <ei> in Brazilian Portuguese (BP). All works analyzed herein, our primary sources, described and analyzed a regional variety of BP. However, these results were never systematically related to each other. Therefore, these studies' results do not present a comprehensive overview of the monophthongization processes of <ei> in BP. As we aim to gather and unify dispersed information, a systematic review is the best methodological approach to analyze our data. Since there are many variable phenomena in several languages that have been repeatedly studied in different populations, a systematic review may also inspire other cross-study reports. At the same time, we can establish whether our primary sources' findings are consistent and whether they can be generalized to similar studies, both in Portuguese and other languages.

A systematic literature review summarizes the results of several studies in an organized way to answer a specific question; it uses systematic and explicit methods to minimize bias, thereby providing more reliable results (Higgins et al. 2019). Additionally, a systematic review differs from a traditional one—a narrative literature review—in that it answers a specific question and requires the application of pre-established procedures (Cordeiro et al. 2007; De-La-Torre-Ugarte-Guanilo et al. 2011; Higgins et al. 2019). In sum, this type of review consists of applying explicit and systematic methods to identify and select relevant studies, called primary sources, and to collect, evaluate the validity of, and analyze data from the selected studies (Higgins et al. 2019). Primary sources, which are the unit of analysis of a systematic review, are works selected by the systematic method of the study. Therefore, in a systematic review, the methods of searching, selecting, collecting, and analyzing data are pre-established and follow a rigorous process. They are described

in a protocol that must be duly followed during the development of the review to avoid bias.

The systematic literature review methodology was initially developed for health studies by the Cochrane Collaborations (Dickersin and Manheimer 1998; Higgins et al. 2019), and is known as the Cochrane method. However, it can also be used in the humanities (Petticrew and Roberts 2006). Nevertheless, the application of this methodology has been quite limited in the area of linguistic research (Sella et al. (2013) proposed, for example, a systematic literature review of language acquisition by children born blind; furthermore, Lora et al. (2015) and Apolônio et al. (2019) reviewed the literature on teaching). In this study, we first present the systematic literature review methodology (Higgins et al. 2019) and then show how it can be applied in a review of a sociolinguistic phenomenon: the monophthongization of the diphthong <ei> in Brazilian Portuguese.

Since 1983, the most popular methodology for analyzing the monophthongization rule in BP has been quantitative sociolinguistics. In the primary sources analyzed herein, the researchers cross-checked their data obtained through sociolinguistic interviews with a group of variables in a computer software package, VARBRUL (*Variable Rules Analysis*) and GOLD-VARB (There are many versions of these computer programs. See Rand and Sankoff (1990); Sankoff et al. (2005)), which analyzes variable rules using a statistical model and calculates the relative weight of the factors of the variables. The relative weight indicates the effects of each factor on the rule's application (in the case at hand, the monophthongization rule) and suggests the following interpretation: a relative weight value higher than 0.5 indicates that the factor favors the rule application, while a value lower than 0.5 indicates that the factor disfavors its application. Simultaneously, a value equal to or close to 0.5 indicates a neutral point, with no effects on the application of the rule.

In Brazilian universities, sociolinguistics studies of diphthongs are popular, especially at the Master of Philosophy level. We identified more than 50 studies that have been made available on this topic in articles, theses, and dissertations since 1983. The majority of authors have applied quantitative sociolinguistics methods (Cedergren and Sankoff 1974; Labov 1972; Rousseau and Sankoff 1978; Weinreich et al. 1968). All primary sources' data were analyzed based on a variable rule using a statistical model of logistic regression. For this reason, studies on the diphthong <ei> are ideal candidates for a systematic literature review on BP's phonology and sociolinguistics. Therefore, our objective is to demonstrate the application of this method in a systematic literature review in sociolinguistics, specifically in the literature review of the monophthongization of the diphthong <ei> in BP.

In the present work, we selected 10 Master's theses that addressed the monophthongization of <ei> using the theoretical and methodological assumptions of quantitative sociolinguistics (see Section 3.3 for an explanation on how these works were selected). Thus, this systematic review allows for the development of a unified framework for the monophthongization of the diphthong <ei> in BP, including the frequency of the rule's application, the social and linguistic variables relevant to its application, and the factors of these variables that favor or disfavor the monophthongization of the diphthong. The text is organized as follows. In Section 2, we present a brief account of diphthongs in BP. In Section 3, we present our methodology. An analysis of the primary sources that investigated the monophthongization of the diphthong <ei> in BP using quantitative sociolinguistics is presented in Section 4. Finally, we share some final considerations in Section 5, demonstrating that the application of monophthongization is a linguistic process in BP, influenced by social factors.

2. Diphthongs in Brazilian Portuguese

A diphthong is understood here as the same-syllable encounter of a nuclear vowel (v) and a glide (G)—that is, a vowel-like element without prominence. Diphthongs can be classified into oral and nasal types and, further, into falling and rising, depending on the position the glide occupies in the syllable. Câmara (1970) and Bisol (1991) stated

that Portuguese only has falling diphthongs of the vG type, as, in the Gv sequence, the diphthong is usually in free variation with a hiatus or with a simple vowel.

In BP, there are generally two scenarios regarding diphthongs. In the first, diphthongs can be optionally monophthongized, as in (1). Therefore, its output can be a de facto diphthong or a single vowel. This work only concerns the case of variation, as shown in (1).

- (1) (a) The phonetic realization of an oral diphthong is optional, although the diphthong appears in writing:
- | | | |
|------------------|----------------------------------|---------------|
| <i>sapateiro</i> | [sa.pa.'tẽ.ro] ~ [sa.pa.'te.ro] | ('shoemaker') |
| <i>ouro</i> | ['õ.ɹo] ~ ['o.ro] | ('gold') |
| <i>loira</i> | ['lõ.rɐ] ~ ['lo.rɐ] | ('blonde') |

In the second scenario (2), there is a series of linguistic processes from the compulsory realization of a diphthong: with a correspondent in writing (2a), and an ambisyllabic output (2b), or in hiatus (each vowel in a different syllable, as in 2b), or without an equivalent in writing (2c), as a result of a consonant intrusion process (cf. Albano 2001).

- (2) (a) The phonetic output of an oral diphthong is compulsory, and the diphthong appears in writing:
- | | | |
|--------------|------------|------------|
| <i>peito</i> | ['pẽ.to] | ('breast') |
| <i>coisa</i> | ['kõ.zɐ] | ('thing') |
| <i>noite</i> | ['nõ.tʃi] | ('night') |
- (b) The phonetic output of an oral diphthong can be ambisyllabic or a monophthong, and the diphthong does not necessarily appear in writing:
- | | | |
|--------------|--------------------------------------|----------|
| <i>ideia</i> | [i.'dɛ̃.ɹɐ] ~ [i.'dɛ̃.ɹɐ] ~ [i.'dɛɐ] | ('idea') |
| <i>boa</i> | ['bõ.ɹɐ] ~ ['bõ.ɹɐ] ~ ['boɐ] | ('good') |
- (c) The phonetic output of an oral diphthong is optional without its equivalent in writing:
- | | | |
|--------------|----------------------|----------------|
| <i>arroz</i> | [a.'xos] ~ [a.'xois] | ('rice') |
| <i>nasci</i> | [na.'si] ~ [nã.'si] | ('I was born') |

The realization of a diphthong as such, or as a vowel, such as *peixe* ['pẽ.ʃi] ~ ['pe.ʃi] ('fish'), is an example of a dependent variable. The variable rule, in turn, controls a linguistic variable, called a dependent variable, and the possible outputs of that variable are called variants. Additionally, the linguistic variables (such as syllable stress) and social variables (such as the educational level of informants) that influence the application of the rule are called independent variables. These, in turn, have two or more factors (the factors of the variable syllable stress, for example, are unstressed and stressed).

Bisol (1989, 1991) proposed a terminology where diphthongs in Portuguese can be phonological (true diphthongs) and phonetic (false diphthongs). According to Bisol, true diphthongs must be present in the underlying structure of the language. Therefore, a syllable containing a true diphthong is formed by two vowel elements. In other words, in true diphthongs, each vowel in its sequence is associated with a temporal layer. Additionally, true diphthongs attract word-final stress. True diphthongs are considered heavy, as they are mandatory and form minimal pairs with the simple vowel, such as in *lei* ['lẽ] ('law') and *caule* ['kã.ɹi] ('stem') in contrast to *lê* ['le] ('reads') and *cale* ['ka.ɹi] ('shut up'), respectively. A syllable with a phonetic diphthong, meanwhile, has only one vowel element in its underlying structure, and therefore it occupies only one node in the skeletal tier and forms a monophonic sequence associated with only one temporal layer. False diphthongs, therefore, form light syllables, varying freely with the simple vowel, such as in *ameixa* [a.me.ʃɐ] ~ [a.'mẽ.ʃɐ] ('plum'). These have survived only due to etymology writing and have been perpetuated by formal schooling (Bisol 1994). This true/false diphthong dichotomy proposed by Bisol (1989, 1994) became very influential in BP studies. According to Bisol, false diphthongs are those that show phonetic alternation. This is a tautological

argument because one can only know that a diphthong is false if there is alternation. The literature concerning diphthongs after 1989 is therefore based mainly on Bisol's statements, with little controversy (Silveira and de Araujo 2019 argued against this dichotomy).

Research on the nature of the variation of oral diphthongs in BP is not a novelty. Amaral (1920) first mentioned the phenomenon of variation in oral diphthongs in the 'caipira' dialect of BP. Amaral (1920) addressed dialectal differentiation as a result of changes in the manifestations of provincial life; that is, the author dealt with the phenomenon as a change in the social environment. Câmara (1970, p. 56) also addressed the issue of variation in oral diphthongs in the Rio de Janeiro dialect, referring to the monophthongization process of the diphthong, such as [ou̯] > [o], as a feature of informal speech. While addressing this issue, both authors emphasized monophthongization (cf. Xavier and Mateus 1990). Regarding the monophthongization process—such as those exemplified in (1)—(Naro 1973, p. 69) stated that the generalization of two rules, namely degemination and elision, resulted in a rule that “suppresses homorganic semivowels after all the vowels they agree with by rounding and retraction (In the original: “suprime semivogais homorgânicas depois de todas as vogais que concordam em arredondamento e retração”). This could explain the reduction in the diphthong [ou̯] > [o], evincing an already complete change in “approximately all dialects, both European and American” (In the original: “aproximadamente todos os dialetos, tanto europeus, como americanos”), as well as reductions in [ei̯] > [e] and [oi̯] > [o] (Naro 1973, p. 69). This would occur in many Brazilian dialects, although some forms have still maintained the diphthong in all styles (Naro 1973, p. 69). Furthermore, Lemle (1978) studied the reduction in the diphthong <ei> by verifying the phonetic contexts that favored the preservation of the glide. Additionally, the author stated that the reduction in some diphthongs in Rio de Janeiro was already advanced to such an extent that it would have ceased to be perceived as a non-standard speech mark (Lemle 1978, p. 68). Likewise, elsewhere in Brazil, stigmatization is not associated with monophthongization anymore.

3. Methodology

Any systematic review begins with a research question, its main objective, and a review project. A search is then conducted with the objective of identifying the greatest possible number of studies related to the issue to be analyzed, as per the Cochrane method. Once this is done, the criteria for selecting primary sources are applied, and data are collected from the studies, followed by an assessment of the risk of bias in these studies. The analysis itself is then conducted. When the studies are similar to each other, a meta-analysis is performed, which consists of a statistical analysis that synthesizes the studies' results in the systematic review (De-La-Torre-Ugarte-Guanilo et al. 2011; Higgins et al. 2019; Mulrow 1994). We will not provide a meta-analysis in the present study because our primary sources did not make all their linguistic data available.

3.1. Systematic Literature Review of the Diphthong <ei>: Data Compilation and Analysis

The Cochrane method was developed for systematic reviews in health sciences (Dickersin and Manheimer 1998). It allows for the development of criteria for the selection, collection, compilation, and comparison of relevant data obtained from primary studies by eliminating any biases that may affect the result of the synthesis. However, it has also been applied in the humanities (cf. Petticrew and Roberts 2006). The Cochrane method is divided into steps, which we followed with adaptations whenever necessary, as it has specificities that do not apply to a review of studies that investigate a linguistic phenomenon, such as the monophthongization of <ei> in BP.

3.2. Formulation of the Research Question

In the first step, we defined the research question: how do Master's theses that have investigated the monophthongization of <ei> in Brazilian Portuguese (BP), using a quantitative sociolinguistics methodology, correlate linguistic and social variables? We

thus delimited the eligibility criteria and the theoretical framework. The research question is therefore related to a linguistic phenomenon.

3.3. Identification and Selection of Primary Sources

In this step, we identified and selected our primary studies. The search aimed to identify works that investigated the phenomenon of the monophthongization of <ei> in BP. Initially, we searched the CAPES Thesis and Dissertations Catalog website (CAPES (Coordination for the Improvement of Higher Education Personnel) is a Brazilian government agency responsible for financing and evaluating all graduate programs). In the CAPES Catalog search, we entered as keywords ‘ditongo, ditongos, ditongos orais, ej (The variations [ej] ~ [eɪ], [oɔ] ~ [ow], etc. are irrelevant to the purpose of this paper), ei, monotongação, variação, português brasileiro, sociolinguística’ (diphthong, diphthongs, oral diphthongs, ej, ei, monophthongization, variation, Brazilian Portuguese, and sociolinguistics, respectively). We identified 90% of our primary sources after performing this search. We then conducted a manual search of the references contained in the primary sources of the works, which provided us with data from studies that had not been found in the CAPES database. Finally, we emailed the authors of the works that were not available in a digital version (some works were conducted before 1995). In cases where we did not receive feedback from the authors, we contacted the libraries of the universities, and they made available the missing studies in digitalized or printed versions. After the search, we identified 17 studies on the diphthong <ei> in BP.

Once the bibliographic search was completed, we began to select relevant studies according to the following eligibility criteria: (a) the study must analyze the monophthongization of the diphthong <ei> individually in some variety of Portuguese spoken in Brazil, and (b) the study must use a quantitative sociolinguistics methodology and statistically analyze the data, generating relative weights for each factor that influences (favoring or disfavoring) the application of the monophthongization rule. After reading the selected works, seven studies were excluded, three for not meeting the first criterion and four for not applying the statistical analysis of variation in sociolinguistics (Cabreira (1996) developed a particular study, dividing the data into three groups: first, <ei> followed by [ɾ]; second, <ei> and <ai> followed by [j] or [ɜ]; third, the diphthong [ow]. Due to the specification of posterior phonetic contexts and the grouping of <ei> and <ai> in the second group, the results of this analysis are not comparable with the data obtained in other studies). Thus, 10 studies (all Master’s theses) were selected for inclusion in this systematic review, as shown in Table 1.

Table 1. Selected studies.

Author (Year)	Title	
	Original	Translation
Palladino Netto (1995)	<i>Do latim ao português: revisitando os ditongos</i>	“From Latin to Portuguese: Revisiting diphthongs”
Silva (1997b)	<i>O processo de monotongação em João Pessoa</i>	“The monophthongization process in João Pessoa”
de Araújo (1999)	<i>A alternância/ej/-/e/no português falado na cidade de Caxias, MA</i>	“The alternation/ej/-/e/in the Portuguese spoken in the city of Caxias, MA”
Araújo (2000)	<i>A monotongação na norma culta de Fortaleza</i>	“Monophthongization in the standard norm of Fortaleza”

Table 1. Cont.

Author (Year)	Title	
	Original	Translation
Lopes (2002)	<i>A realização variável dos ditongos/ow/ej/no português falado em Altamira-PA</i>	“The variable performance of the diphthongs/ow/and/ej/in the Portuguese spoken in Altamira, PA”
de Farias (2008)	<i>Distribuição geo-sociolinguística do ditongo [ej] no português falado no estado do Pará</i>	“Geo-sociolinguistic distribution of the diphthong [ej] in the Portuguese spoken in the state of Pará”
Toledo (2011)	<i>A monotongação do ditongo decrescente [ej] em amostra de recontacto de Porto Alegre</i>	“The falling diphthong monophthongization of [ej] in a recontact sample in Porto Alegre”
Santos (2012)	<i>O ditongo/ej/nas capitais do norte do Brasil: um estudo geossociolinguístico</i>	“The diphthong/ej/in the capitals of northern Brazil states: A geo-sociolinguistic study”
Cysne (2016)	<i>A monotongação do ditongo/ej/no falar popular de Fortaleza</i>	“The monophthongization of the diphthong/ej/in popular speech in Fortaleza”
Freitas (2017)	<i>Estudo da monotongação dos ditongos orais decrescentes na fala Uberabense</i>	“Study on the monophthongization of falling oral diphthongs in the speech of Uberaba”

3.4. Data Collection

In this step, we collected data that would later be considered in the analysis. We analyzed the results of each study in detail following the same collection order. We considered (a) the geographic region covered by the study; (b) numerical data—the percentage rate of application of the monophthongization rule considering the sample size (total number of occurrences analyzed); (c) the linguistic and social variables tested; (d) the linguistic and social variables selected, as relevant to the rule application; and (e) the component factors of the variables selected, as relevant in each study, as well as the percentage of the rule’s application for each factor and its relative weights. Factors that demonstrated knockout—that is, when a rule was applied in 100% of the cases—were excluded from the analyses by the authors of the studies because the VARBRUL/GOLDVARB software ignores categorical rules. However, when such results were reported in the analyses of the 10 studies, they were also extracted at this step. Appendix A summarizes the main data collected.

3.5. Critical Evaluation of Studies: A Discussion on the Application of the Sociolinguistics Method

In this step, we analyzed the application of the quantitative sociolinguistics methodology. We verified the ways in which the interviews were conducted, how the variables were selected and tested, the application of the statistical model for the quantitative treatment of the data, and their presentation and discussion. All primary sources selected met the basic prerequisites. Thus, we highlighted only two questionable points related to applying the quantitative sociolinguistics methodology, as verified in some works.

The first was the fact that two studies (de Araújo 1999; Palladino Netto 1995) assessed the variable informant’s speech speed, which was divided into slow, medium, and fast. Neither study specified exactly what was meant by slow, medium, or fast. For example, there are no acoustic correlates that determine how fast a person needs to speak for his/her speech to be considered fast. The classification of the analyzed speech rate was thus performed in an impressionistic way by the authors of both studies. Therefore, this variable may be non-replicable.

The second problematic point was data presentation, which is crucial when using a statistical method of analysis. The data must be synthesized in such a way as to facilitate understanding of the studied phenomenon and allow future analyses. Freitas (2017) presented data in a partial way, as none of the study's tables contained the relative weights of factors of the analyzed variables. Only the frequency values and percentage rates were presented. Additionally, when the percentage data were presented by graphs, tables with frequencies were omitted. Instead, the values of relative weights were mentioned throughout the analysis. However, not all relative weights were reported. The factors occlusive consonant and nasal consonant of the variable following context, for example, were considered in the analysis. However, their relative weights were not informed. Thus, the absence of standardization in synthesizing the results of a statistical study makes it difficult to understand and compare them in further analyses.

4. Analysis and Synthesis of the Data

We analyzed the extracted data by conducting a comparative study, considering the application percentages of the monophthongization rule in each study while considering the covered geographic area. The variables were selected only if relevant in at least 40% of the studies. Data from at least three studies in which the variables were mentioned were compared. The effects of component factors of these selected variables exerted by the relative weight of each factor in each study were also considered. These data will be synthesized in tables that follow the same layout pattern.

Table 2 shows the application percentages of the monophthongization rule to the diphthong <ei> in each city and the calculation of the arithmetic mean (AM) between percentages, the mean absolute deviation (MAD), and the absolute deviation of each percentage in relation to the mean.

Table 2. Application rate of the monophthong rule by city.

Author	Region (Dialectal Cluster)	Application Rate of the Rule by City	Absolute Deviation
Palladino Netto (1995)	Rio de Janeiro-RJ (carioca)	47% (668/1427)	14
Silva (1997b)	João Pessoa-PB (nordestino)	44% (2150/4902)	17
de Araújo (1999)	Caxias-MA (gaúcho)	47% (615/1305)	14
Araújo (2000)	Fortaleza-CE (nordestino)	58% (1480/2562)	3
Lopes (2002)	Altamira-PA (norte)	54% (782/1456)	7
de Farias (2008)	Belém-PA	48% (180/374)	13
	Jacareacanga-PA	58% (92/159)	3
	Soure-PA	63% (120/192)	2
	Bragança-PA (norte)	76% (110/144)	15
Toledo (2011)	Porto Alegre-RS (gaúcho)	37% (667/1791)	24
Santos (2012)	Belém-PA	59% (164/276)	2
	Boa Vista-RR	65% (236/364)	4
	Porto Velho- RO	77% (236/305)	16
	Rio Branco-AC	77% (239/312)	16
	Macapá-AP	78% (302/387)	17
	Manaus-AM (norte)	79% (325/413)	18

Table 2. Cont.

Author	Region (Dialectal Cluster)	Application Rate of the Rule by City	Absolute Deviation
Cysne (2016)	Fortaleza-CE (nordestino)	68% (1020/1491)	7
Freitas (2017)	Uberaba-MG paulista-mineiro	64% (500/779)	3
		AM: 61%	MAD: 11

Table 2 shows that the highest application percentages of the rule occurred in cities in the northern region of Brazil (77% in Porto Velho and Rio Branco, 78% in Macapá, and 79% in Manaus), and the lowest occurred in the south (37% in Porto Alegre). Considering the arithmetic mean of the application percentage rates of the monophthongization rule (61%), the MAD showed high variability in the data. The two highest values of absolute deviation were those of Porto Alegre (24) and João Pessoa (18), which presented the lowest application rates of the rule (37% and 44%, respectively). The other two values were from northern Brazilian cities, Manaus (18) and Macapá (17), which had the highest monophthongization rates (78% and 79%, respectively). These numerical data suggest a diatopic variation; it is possible to verify the greater or lesser presence of the investigated phenomenon in different cities (Cardoso 2010) and show the importance of the variable geographic location in the study of the monophthongization of <ei>.

Regarding the comparative analysis of the tested and selected variables as relevant in the studies included in this systematic review, one was a social variable, and five were linguistic variables. In (3), we present a brief description of these variables according to the criteria used in the literature and the number of times the variables were relevant in the studies.

- (3) (a) The education level corresponds to the level of education of the informants. The levels analyzed were generally no school, elementary school, high school, and higher education. This variant proved to be relevant in six studies.
- (b) The following phonological context refers to the element immediately adjacent to the diphthong. Consonants, vowels, and pauses, which are the factors of this variable, are commonly examined. This variant proved to be relevant in all 10 studies.
- (c) Syllable stress considers the syllable prominence in which the diphthong occurs. In general, the words are separated into two groups according to the type of syllable in the diphthong: stressed or unstressed. This variant proved to be relevant in seven studies.
- (d) The morphological nature is related to the type of morpheme in which a diphthong occurs. The types of morphemes analyzed are generally radicals and suffixes. This variant proved to be relevant in five studies.
- (e) The word class facilitates observation of the grammatical class of the word in which the diphthong is found. The main controlled classes are nouns and verbs. This variant proved to be relevant in four studies.
- (f) The number of syllables of a word refers to the number of syllables in a word that contain the diphthong considering the following possibilities: one, two, three, or more than three syllables. This variant proved to be relevant in four studies.

We then analyzed the effects of the factors that make up these variables in each of the studies that considered them relevant for the application of the rule. First, we compared the variable education level, a social variable.

Table 3 shows that speakers with no formal education and those with the lowest level of education (elementary school) were the ones who applied the monophthongization rule the most. The most educated speakers (high school and higher education), in contrast, disfavored the monophthongization of <ei>, with relative weights between 0.24 and 0.48,

indicating that a high education level affects the speaker's linguistic behavior. In this sense, there is a sociolinguistic factor acting robustly in the application of the rule.

Table 3. Effects of the factors of the variable *education level*.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
Silva (1997b)	No school	45% (1845/4136)	0.55
	Higher education	40% (305/766)	0.24
de Araújo (1999)	No school	83% (357/428)	0.63
	Schooled (9–10 years)	69% (258/373)	0.35
Lopes (2002)	No school	56% (289/512)	0.66
	Elementary (complete or incomplete)	55% (278/508)	0.51
	High school	49% (215/436)	0.31
de Farias (2008)	Elementary (complete or incomplete)	62% (394/635)	0.54
	Higher education	46% (108/234)	0.38
Santos (2012)	Elementary (4 years)	82% (843/1032)	0.64
	Higher education	64% (659/1025)	0.36
Cysne (2016)	Elementary 1 (0–4 years)	73% (336/463)	0.56
	Elementary 2 (5–9 years)	66% (344/520)	0.47
	High school (9–11 years)	67% (340/508)	0.48

Table 4 shows that, in all the studies, an alveolar tap consonant [ɾ] in the following context favored the application of the monophthongization rule. The relative weights ranged between 0.62 and 0.99, and the application percentage rate was between 82% and 99%. Considering the relative weights, the fricatives [ʃ] and [ʒ] revealed an unsteady situation that sometimes favored and sometimes disfavored monophthongization, as the relative weights varied between 0.20 and 0.93, with percentage rates between 47% in the north region and 95% in João Pessoa.

Furthermore, the presence of occlusive consonants created unfavorable contexts for the application of the rule, except for data from two studies: de Farias (2008) reported that the occlusive [g] had a relative weight of 0.64 in Pará, and Cysne (2016) reported that [g] was categorical in favoring monophthongization (12/12) in Fortaleza, indicating that this occlusive differs in behavior from the others. Some occlusive consonants categorically prevented the application of the rule—a knockout situation—such as [b] in Silva (1997b), [t], [d], and [k] in de Araújo (1999), [p], [d], [k], and [b] in Araújo (2000), and [t] in Cysne (2016). In Lopes (2002) and Toledo (2011), the consonants were grouped according to the place of articulation, and the blocking contexts of the rule were the velar and coronal consonants and the labial consonants in the first and second studies, respectively. Nasal consonants also inhibit or even block the application of the rule, as verified for [m] in de Araújo (1999) and Cysne (2016), [n] in Araújo (2000), and all nasals in Toledo (2011). Aside from Araújo (2000), who reported that the open vowel [a] has a relative weight of 0.61 and a rate of rule application of 71% (34/48), the vowels disfavored the application of the rule. In some cases, they blocked monophthongization categorically: [e], [i], and [u] in Silva (1997a), [o] in de Araújo (1999), posterior vowels in Lopes (2002), [i] and [u] in de Farias (2008), and all vowels in the analyses of Toledo (2011) and Freitas (2017). The following context pause was categorical in the sense of disfavoring monophthongization in studies that considered it (Araújo 2000; de Araújo 1999; de Farias (2008); Freitas 2017; Lopes 2002; Toledo 2011). However, Silva (1997a) must be excluded, as the application rate of the rule before a pause was only 5%, showing that, despite this context, it does not prevent monophthongization and is a strong inhibitor of the rule application.

In Table 5, the results of the variable syllable stress are shown. Palladino Netto (1995) proposed a separation between pre-stressed, stressed, and post-stressed syllables. Silva (1997a),

Araújo (2000), and de Farias (2008) classified the contexts between stressed and pre-stressed, while all others were limited to stressed and unstressed contexts, without specifying whether it was an unstressed syllable that preceded or succeeded the syllable that carries the main stress.

Table 4. Effects of the factors of the variable following context.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
Palladino Netto (1995)	tap [ɾ]	98% (592/606)	0.98
	fricatives	50% (52/103)	0.11
	nasals	27% (3/11)	0.02
	occlusive	7% (18/251)	0.01
Silva (1997a)	tap [ɾ]	98% (1687/1714)	0.99
	fricative [ʃ]	95% (350/367)	0.93
	fricative [ʒ]	72% (38/53)	0.69
	occlusive [g]	39% (7/18)	0.33
	open vowel [a]	12% (36/308)	0.15
	occlusive [t]	2% (25/1629)	0.01
	mid vowel [o]	1% (4/296)	0.01
de Araújo (1999)	tap [ɾ]	89% (479/541)	0.85
	open vowel [a]	71% (34/48)	0.61
	occlusive [g]	59% (10/17)	0.47
	fricative [ʃ]	59% (62/105)	0.46
	fricative [ʒ]	39% (23/59)	0.18
	nasal [n]	35% (7/31)	0.12
Araújo (2000)	tap [ɾ]	94% (1235/1313)	0.82
	fricative [ʃ]	88% (138/156)	0.89
	Vowel	29% (62/211)	0.18
	occlusive [t]	3% (14/425)	0.01
	fricative [ʒ]	74% (20/27)	0.71
	nasal [m]	13% (5/40)	0.05
	occlusive [g]	22% (2/9)	0.08
Lopes (2002)	tap [ɾ]	98% (542/554)	0.99
	palatal [ʃ, ʒ]	96% (198/209)	0.64
	open vowel [a]	37% (37/100)	0.05
	bilabial [m]	1% (1/87%)	0.00
de Farias (2008)	tap [ɾ]	82% (416/506)	0.79
	occlusive [g]	68% (17/25)	0.64
	fricative [ʃ]	51% (36/70)	0.47
	fricative [ʒ]	47% (27/58)	0.42
	affricate [tʃ]	12% (4/36)	0.10
	open vowel [a]	2% (1/55)	0.02
	occlusive [t]	1% (1/80)	0.01
Toledo (2011)	tap [ɾ]	96% (572/594)	0.57
	palatal fricative	51% (89/172)	0.25
Santos (2012)	tap [ɾ]	82% (1273/1545)	0.62
	occlusive [g]	58% (34/59)	0.43
	fricative [ʃ]	61% (83/136)	0.29
	fricative [ʒ]	48% (84/174)	0.20
	open vowel [a]	20% (28/143)	0.08
Cysne (2016)	tap [ɾ]	99% (859/863)	0.52
Freitas (2017)	tap [ɾ]	95% (374/392)	0.85
	fricative	79% (116/146)	0.67

Table 5. Effects of the factors of the variable *tonicity*.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
Palladino Netto (1995)	Pre-stressed	57% (51/90)	0.81
	Post-stressed	43% (9/21)	0.77
	Stressed	46% (608/1316)	0.47
Silva (1997b)	Pre-stressed	55% (296/542)	0.67
	Stressed	43% (1854/4370)	0.48
de Araújo (1999)	Stressed	83% (524/631)	0.71
	Unstressed	54% (91/170)	0.20
Araújo (2000)	Stressed	71% (1327/1871)	0.54
	Pre-stressed	48% (149/310)	0.27
de Farias (2008)	Stressed (penultimate)	62% (457/742)	0.51
	Unstressed (Pre-stressed)	53% (45/85)	0.42
Cysne (2016)	Stressed	73% (872/1188)	0.52
	Unstressed	49% (148/303)	0.34
Freitas (2017)	Stressed	74% (432/586)	0.56
	Unstressed	48% (66/136)	0.24

Regarding the morphological nature of the word, Table 6 shows that the application of the monophthongization rule was favored when the diphthong is at the radical of a word, with relative weights varying between 0.52 and 0.70. Suffix morphemes, on the other hand, disfavored the rule application, especially flexional suffixes, in which the maintenance of the diphthong was almost categorical. As for derivational suffixes, the most recurrent one was the suffix *eiro(a)*, which favored monophthongization. Moreover, this suffix has a consonant tap in a following context, which significantly favored the rule's application (Araújo 2000; Palladino Netto 1995; Silva 1997a; Toledo 2011).

Table 6. Effects of the factors of the variable morphological nature.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
Palladino Netto (1995)	Radical	53% (424/798)	0.65
	Suffix	41% (244/589)	0.31
Silva (1997a)	Radical	56% (1445/2577)	0.70
	Suffix	30% (705/2325)	0.28
Cysne (2016)	Lexical morpheme	63% (1087/1725)	0.52
	Derivational morpheme	96% (382/399)	0.53
	Flexional morpheme	12% (7/57)	0.06
Lopes (2002)	Radical	55% (550/991)	0.70
	Suffix	50% (232/465)	0.14
Toledo (2011)	Radical	90% (350/389)	0.63
	Suffix	82% (311/377)	0.36

Table 7 shows that, in three of the four studies in which the variable grammatical class was selected, the application rule was disfavored in verbal items, with relative weights varying between 0.07 and 0.35. However, this was not observed in Santos (2012), in whose study the verbal class favored monophthongization. The numeral class behaved differently in each study. Furthermore, the adjective class appeared in only two studies favoring the rule's application (RW 0.59 and 0.60). In addition, nouns make up a large majority of the data in all studies, this word class had relative weights close to the neutral value (0.47, 0.49, and 0.55). This variable was a condition for the application of the rule in Toledo (2011), who organized words into only two groups: verb and non-verb.

Table 7. Effects of the factors of the variable grammatical class of the word.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
de Farias (2008)	Adjective	67% (94/141)	0.59
	Noun	62% (361/579)	0.55
	Numeral	42% (13/31)	0.35
	Verb	29% (34/118)	0.23
Toledo (2011)	Non-verb	96% (627/652)	0.60
	Verb	30% (34/114)	0.07
Santos (2012)	Numeral	93% (51/55)	0.78
	Adjective	83% (163/197)	0.60
	Verb	59% (69/116)	0.56
	Noun	72% (1219/1689)	0.47
Cysne (2016)	Name	75% (724/969)	0.54
	Numeral	64 (154/240)	0.49
	Verb	49% (134/234)	0.35

Regarding the variable number of syllables, according to Araújo (2000) and de Farias (2008), the words with the greatest number of syllables favored monophthongization (RW 0.62 and 0.71). Words with only two syllables, in contrast, disfavored the rule's application, with relative weights of 0.22 and 0.36 (By analyzing the rule's application percentages, the results of Palladino Netto (1995) seem to agree with Araújo (2000) and de Farias (2008). However, the relative weights contradicted the percentage values, which led us to consider the possibility that Palladino Netto (1995) data was inverted. Palladino Netto (1995) acknowledges that other variables could have influenced his variable number of syllables; however, he could not confirm it). As for the results of Cysne (2016), the relative weights were close to the neutral value (0.50). According to Table 8, the factors of the variable syllable stress were not uniformly applied in all analyses. In two studies (Palladino Netto 1995; Silva 1997a), the stressed syllables (RW 0.47 and 0.48) disfavored the rule application, while, in others, the relative weights of the stressed factor in these two studies were very close to the neutral value (RW 0.50). In the other five studies, the stress effect is consistent, while in the studies by Palladino Netto (1995) and Silva (1997a), the data are inconclusive due to a skewed distribution. Conversely, the unstressed syllable constituted a context that favored monophthongization in both studies, with relative weights between 0.67 and 0.81. In the other studies, this very factor disfavored the application of the rule, with relative weights between 0.20 and 0.42.

Finally, the rule's application was categorically blocked in words with one syllable (Araújo 2000; Cysne 2016; Palladino Netto 1995). de Farias (2008) did not consider this factor in analysis.

Table 8. Effects of the factors of the variable number of syllables.

Study	Factor of the Variable	Percentage of Rule Application	Relative Weight (RW)
Palladino Netto (1995)	Two syllables	18% (55/310)	0.67
	Three syllables	61% (439/720)	0.47
	More than three syllables	72% (174/241)	0.38
Araújo (2000)	More than three syllables	77% (449/585)	0.62
	Three syllables	72% (846/1178)	0.49
	Two syllables	43% (181/418)	0.36
de Farias (2008)	More than three syllables	78% (212/273)	0.71
	Three syllables	64% (217/340)	0.56
	Two syllables	29% (73/256)	0.22
Cysne (2016)	Two syllables	70% (221/314)	0.55
	Three syllables	75% (622/843)	0.50
	More than three syllables	66% (177/270)	0.45

5. Final Considerations

The systematic literature review of the diphthong <ei> in BP presented herein offers a unified account of the application of the monophthongization rule. Hence, this study offers an overview that may support future analyses, benefiting from the knowledge of the grouped studies that this review provides. Thus, the highest application percentages of the monophthongization rule were documented in cities in the northern region of Brazil (77%, 78%, and 79%), and the lowest percentages occurred in a city in the south (37%). Therefore, this diatopic variation revealed the importance of the geographic variable in the study of the monophthongization of <ei>, as the first crucial socially conditioned variable. The analysis of the variable education level revealed that speakers with no formal education are prone to apply the rule the most, while highly educated individuals have the lowest application rates. Simultaneously, we observed that the following context was the relevant linguistic variable in all studies, and the consonant alveolar tap [ɾ] favored the rule's application in general. Conversely, occlusive consonants, vowels, and pauses did not favor it, and the pause categorically blocked the rule's application. As for the morphological nature of the word, the rule's application was favored when the diphthong was in the radical of the word and disfavored when it was in a flexional suffix. The syllable stress and grammatical class factors showed mixed results. However, in five out of seven studies, unstressed syllables disfavored monophthongization, while stressed syllables favored it. Finally, the variable number of syllables also showed controversial results, but words with more than three syllables tended to favor monophthongization, while words with two syllables disfavored it. Simultaneously, monosyllabic words blocked the rule, although Palladino Netto (1995) and Silva (1997a) data are inconclusive, as shown. Furthermore, verbal items tended to disfavor the rule's application, while adjectives tended to favor it. Again, many studies focused on nouns. Therefore, verbal items disfavoring the rules' application has little relevance.

Considering all primary studies included in this systematic review, an essential issue is the possibility that the monophthongization of the oral diphthong <ei> is a linguistic process that is influenced by two social factors: the speaker's educational level and the dialect variation. We may conclude this by observing that the selected variables—relevant to the application of the monophthongization rule of <ei> with a significant frequency—are linguistic variables and these social factors. In this sense, the results of studies conducted in the northern region of Brazil, where it is still possible to find populations with low or no education, are opposed to those in the south-southeast regions where these social factors are less relevant, due to the phenomena of urbanization, schooling, and dialectal homogeneity. These findings confirm the early claims observed in some of our primary sources that social variables affect monophthongization (Araújo 2000; de Araújo 1999; Cysne 2016; de Farias 2008; Lopes 2002; Santos 2012; Silva 1997b). Thus, this review confirms the results of

the studies indicating that the phenomenon is linguistic, and the remarkable influence of social issues is apparent. Therefore, the very application of the assumptions of quantitative sociolinguistics to studies on the monophthongization of <ei> in BP is of great relevance.

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Appendix A. Details of Primary Sources

Table A1. Details of primary sources and their relevant variables.

Author (Date)	Geographic Region	Rule Application (%)	Controlled Variables	Selected Variables
Palladino Netto (1995)	Rio de Janeiro-RJ	46.8% (668/1427)	<ul style="list-style-type: none"> • Preceding context • Following context • Number of syllables of the word • Diphthong position (stressed or unstressed syllable) • Morphological nature • Speech speed • Diphthong position (in a sentence) • Record type • Gender • Age group • Geographic location 	<ul style="list-style-type: none"> • Following context • Speech speed • Number of syllables of the word • Syllable stress • Morphological nature • Age group
Silva (1997b)	João Pessoa-PB	44% (2150/4902)	<ul style="list-style-type: none"> • Preceding context • Following context • Phonological status • Position of the next element in relation to the syllable • Morphological nature • Syllable stress • Age group • Education level • Gender 	<ul style="list-style-type: none"> • Following context • Morphological nature • Syllable stress • Phonological status • Education level
de Araújo (1999)	Caxias-MA	47% (615/1305)	<ul style="list-style-type: none"> • Preceding context • Following segment (sound) • Syllable stress • Number of syllables of the word • Diphthong position • Word class • Speech speed 	<ul style="list-style-type: none"> • Following context • Speech speed • Following segment sound • Syllable stress • Education level • Age group

Table A1. Cont.

Author (Date)	Geographic Region	Rule Application (%)	Controlled Variables	Selected Variables
Araújo (2000)	Fortaleza-CE	58% (1480/2562)	<ul style="list-style-type: none"> • Preceding context • Following context • Syllable stress • Morphological nature • Number of syllables of the word • Position of the next element in relation to the syllable • Phonological status • Record type • Age group • Gender 	<ul style="list-style-type: none"> • Following context • Morphological nature • Record type • Syllable stress • Number of syllables of the word • Gender
Lopes (2002)	Altamira-PA	54% (782/1456)	<ul style="list-style-type: none"> • Preceding context • Following context • Syllable stress • Diphthong position • Phonological status of the diphthong • Morphological nature • Word class • Origin/use of the word • Gender • Age group • Education level • Income 	<ul style="list-style-type: none"> • Following context • Morphological nature • Origin/use of the word • Education level
de Farias (2008)	Belém-PA Bragança-PA Soure-PA Jacareacanga-PA	58% (502/869)	<ul style="list-style-type: none"> • Following context • Number of syllables of the word • Diphthong position • Word class • Syllable stress • Geographic location • Gender • Age group • Education level 	<ul style="list-style-type: none"> • Following context • Number of syllables of the word • Diphthong position • Word class • Syllable stress • Geographic location • Education level

Table A1. Cont.

Author (Date)	Geographic Region	Rule Application (%)	Controlled Variables	Selected Variables
Toledo (2011)	Porto Alegre - RS	37% (667/1791)	<ul style="list-style-type: none"> • Following context • Syllable stress • Morphological nature • Word class • Gender • Age group 	<ul style="list-style-type: none"> • Following context • Morphological nature • Word class
Santos (2012)	Belém-PA Boa Vista-RR Macapá-AP Manaus-AM Porto Velho-RO Rio Branco-AC	73% (1502/2057)	<ul style="list-style-type: none"> • Following context • Syllable stress • Number of syllables • Diphthong position • Word class • Gender • Age group • Education level • Geographic location • Research instrument • Nature of the answer 	<ul style="list-style-type: none"> • Following context • Word class • Education level • Nature of the answer • Research instrument • Geographic location • Gender
Cysne (2016)	Fortaleza-CE	68% (1020/1491)	<ul style="list-style-type: none"> • Preceding context • Following context • Syllable stress • Number of syllables of the word • Morphological nature • Word class • Record type • Gender • Age group • Education level 	<ul style="list-style-type: none"> • Following context • Word class • Number of syllables of the word • Syllable stress • Education level
Freitas (2017)	Uberaba-MG	36% (279/779)	<ul style="list-style-type: none"> • Following context • Syllable stress • Number of syllables of the word • Gender • Age group • Education level 	<ul style="list-style-type: none"> • Following context • Syllable stress

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