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The syllabification of /sw/ in Italian and the phonological status of /w/

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Abstract

This study investigates the phonetics and phonology of word-initial /sw/ clusters in Italian, aiming to discern the syllabic parsing of the sequence and the phonological status of the glide /w/. Previous studies have reported a dual status of /w/ in Italian, consonantal in loanwords versus vocalic in native lexemes, apparently dependent on the graphemic form of /w/, i.e. ⟨w⟩ and ⟨u⟩. The /s/-voicing pattern before the glide was used as a diagnostic to determine the glide's status: a consonantal glide should trigger /s/-voicing, like any other voiced consonant in Italian. Differently, vocalic glides should pattern like vowels in being unable to trigger the voicing of /s/. Two hypotheses are presented: the Loanword Phonology Hypothesis (LPH), which predicts /w/ to systematically behave as a consonant in loanwords, while the Orthographic Hypothesis (OH) predicts so only when the glide is written ⟨w⟩. The analysis was based on acoustic data originally collected, focusing on the outputs of /s/. Results show that OH better accounts for the pattern observed than LPH. Phonological implications of this finding are discussed.

Keywords: sibilant, labiovelar glide, syllable, phonology, orthography, Italian.

1. Introduction

This study presents an investigation concerning the phonetics and phonology of word-initial /sw/ clusters in Italian. The aim of the analysis is to determine the syllabic parsing of word-initial /sw/ sequences as well as the phonological status of the glide /w/ in Italian. The idea for this study stems from observations in literature concerning

the behavior of the labiovelar glide in Italian, which suggest that /w/ may have a dual status in the Italian phonology.

In fact, it has been shown that, in native lexemes, the glide /w/ behaves as a vowel, while in loanwords /w/ is apparently treated as a consonant. Such a duality was mainly observed within the definite masculine singular article allomorph selection pattern (Baroni 2020, Cossu 2023). Italian possesses three singular masculine allomorphs – *il* /il/, *l'* /l/ and *lo* /lo/ – recurring in complementary distribution according to the word-initial phonological structure of the following word (Kaye 1992, Marotta 1993, Petrosino 2018, Repetti 2020).

Glide /w/-initial native words, such as /w/*omo* 'man' and /w/*ovo* 'egg', select *l'*, the allomorph recurring before vowels (*l'*/u/*rlo* 'the scream'), while /w/-initial loanwords select *il* (e.g. *il whiskey*, cf. Marotta 1993, Bertinetto & Loporcaro 2005), which occurs before consonants, potentially followed by vowels or liquids, i.e. (branching) onsets (cf. also Baroni 2020). Analogously, before native #/sw/ clusters the article *il* is selected (*il* /sw/*ono* 'the sound'), while the same sequences in loanwords are preceded by the allomorph lo (e.g. *lo* /sw/*atch* 'the Swatch', cf. Cossu 2023), the one recurring before *s impurum*, e.g. *lo* /st/*ato* 'the state', and the so-called intrinsic geminates, e.g. *lo* /ʦː/*io* 'the uncle', *lo* /ʃː/*emo* 'the fool' (Marotta 1993, Bertinetto & Loporcaro 2005, see § 3). The pattern above is interpretable as motivated by the different treatment of the glide in native and borrowed lexemes, which in turn determines the syllabic affiliation of the glide. In native lexemes it occupies the first position in a branching nucleus (Marotta 1988) or, according to Canalis (2018), it represents the first portion of a complex vowel (cf. § 2), while in loanwords it should be analyzed as a syllable onset. In the latter case, the preceding /s/ should accordingly be treated as an *s impurum* (as the preconsonantal sibilant is traditionally called, probably due to its obscure and ambiguous word-initial syllabic affiliation, see Svolacchia 2019) while in native lexemes /s/ before /w/ is parsed as a simple onset.

Moreover, Janni (1992) observed that in the loanword 'Swatch' (the well-known Swiss watch brand) the sibilant is realized as voiced [z], while the native word *suocero* 'father-in-law' begins with a voiceless fricative [s], despite both showing the same initial string /swɔʧ/. Indeed, before vowels and glides, the word-initial sibilant is voiceless in the Italian native lexicon: [sa]*le* 'salt', [sj]*ero* 'serum', [sw]*ono* 'sound' (Bertinetto 2010), while before consonants, both obstruents and sonorants, the voice feature of the sibilant agrees with that of the following segment, e.g. [st]*ato* 'state', [zd]*egno* 'disdain' (Bertinetto & Loporcaro 2005). According to Janni's (1992) observation, the different output of /s/ in 'Swatch' and in native words should depend on the duality of /w/, which is supposed to be a vowel in indigenous words and a (voiced) consonant in foreign lexemes.

Janni (1992) claims that the consonantal behavior of /w/ in *Swatch* is triggered by the spelling ⟨w⟩, which is a consonantal grapheme, as opposed to the vocalic letter ⟨u⟩, representing /w/ (and /u/) in the Italian native orthography. Voiced outputs of /s/ preceding /w/ in loanwords (as in [zwiŋgə][1] 'swing') have also been found in Huszthy (2019, 2021), although no comparison with native identical underlying word-initial strings is provided. This kind of productions are noted by some Italian pronunciation

[1] Note that, in the donor language, i.e. English, the pre-glide sibilant /s/ is voiceless [s], as in [ˈswɪŋ] 'swing'.

dictionaries, such as *DiPI* (*Dizionario di Pronuncia Italiana*, Canepari 1999), but labeled as "neglected" and "to be avoided", favoring [sw] instead.

As far as this study is concerned, original acoustic data have been collected in order to study the output of the word-initial pre-glide /w/ sibilant /s/, according to the following assumption. The sibilant should be voiced ([z]) if the glide receives consonantal status, while it should surface as voiceless ([s]) if the glide is a vocalic segment occupying the nucleus.

Since the consonantal behavior is thus far only found in loanwords, one may hypothesize that this is a property of the loanword phonology in Italian, a view we refer to as the Loanword Phonology Hypothesis (LPH). Alternatively, following Janni (1992), Baroni (2020) and Cossu (2023), the scenario discussed may depend on the consonantal status of the grapheme ⟨w⟩, a possibility referred to as the Orthographic Hypothesis (OH).

The two hypotheses make two distinct predictions, though. According to LPH, the /w/'s consonantal behavior is predicted in every loanword including the glide; therefore, the preceding sibilants should always be voiced in this context. OH predicts instead that /w/ behaves as a C-segment only when it is written ⟨w⟩: accordingly, the sibilant should be phonetically voiced in loans like *Swatch* and *swing* (showing #/swɔ/ and /#swi/), but voiceless in *soirée* and *suite* (#/swa/ and #/swi/), where /w/ is vocalically spelled.

The paper is structured as follows: in § 2, the literature concerning the phonology of the Italian glides (§ 2.1), specifically /w/, and of sibilants and /sw/ clusters (§ 2.2) is discussed; in the latter, we comment on previous studies dealing with the affiliation of the preconsonantal /s/, with special focus on the Italian situation, and with the /s/-voicing. Section 3 discusses literature on the loanword phonology in Italian related in particular to the Loanword Phonology predictions. Section 4 explores instead the Orthographic Hypothesis predictions in light of the orthographic effect as observed in literature. The experimental setup is presented in § 5, while the results are presented in § 6; Section 7 presents the discussion and concludes the paper.

2. The phonology of the glide /w/, the sibilant /s/ and the cluster /sw/ in Italian

2.1. The glide /w/

Cross-linguistically, glides raise theoretical issues since they show variable behavior as far as the vowel-consonant distinction is concerned. In some languages glides pattern with vowels, in which case they are derived, while, in others, glides pattern with consonants; they are phonemic in this case (Levi 2011).

Italian presents two glides: the labiovelar /w/ and the palatal /j/. They show a class-internal divergence, from a distributional point of view. As Marotta (1988) and Marotta & Vanelli (2021) claim, the occurrences of /j/ are less restricted than those of /w/. On one hand, /j/ may follow each Italian consonant and precede each vowel (e.g.: pj/*anto* 'crying', /vj/*aggiare* 'to travel' /bj/*anko* 'white', /fj/*anco* 'side', /tj/*eni* 'you hold', /dj/*amo* 'we give', /sj/*amo* 'we are', /nj/*ente* 'nothing', /mj/*agola* 'it meows', /lj/*eto* 'glad', /kj/*esa* 'church', /gj/*anda* 'acorn', and /ja/*to* 'hiatus', /jɛ/*ri* 'yesterday', /je/*llato* 'unlucky', /jɔ/*dio* 'iodine', /jo/*gurteria* 'yoghurt bar', /ju/*ta* 'jute'). On the other hand, /w/ may only precede /ɔ/, as in *tuono* 'thunder' and *vuoto* 'empty', unless

it is in turn preceded by a velar stop /k g/, e.g. *squalo* ‘shark’, *guercio* ‘one-eyed’. In the latter context, both Marotta (1988) and Canalis (2018) analyze the glide as the secondary articulation of labiovelar stops /k^{w} g^{w}/.

However, some scholars claim that the distributional constraints on /w/ do not seem to be synchronically operative, since current Italian accepts /w/-initial rising diphthongs unpreceded by velar stops and followed by non-/ɔ/ vowels, both in stressed and unstressed syllables, as in *at*[ˈtwaː]*re* ‘to carry out’, *ma*[ˈnwaː]*le* ‘handbook’, *pun*[twa]*lità* ‘punctuality’, *as*[swe]*fare* ‘inure’, [swa]*dente* ‘mellow’, *at*[ˈtwaː]*le* ‘current’, *insi*[ˈnwaː]*re* ‘insinuate’, *per*[ˈswaː]*so* ‘persuaded’, *conti*[ˈnwaː]*to* ‘continued’, [wil] *UIL* (*Unione Italiana del Lavoro*) ‘Italian Labour Union’ (cf. van der Veer 2006: 78, Krämer 2009, Bertinetto 2010, Canalis 2018). In such cases the hiatus is indicated by grammars, while the diphthong is usually produced.

Aside from the cases where the glide is preceded by /k g/, /w/ is generally analyzed as affiliated to the nucleus, together with the following vowel. According to Marotta (1988), the first two segments in e.g. *uomo* ‘man’ represent a branching nucleus, while Canalis (2018) claims that the sequence is monosegmental, i.e. a complex vowel; in both cases /w/ is vocalic, hence affiliated to the syllable nucleus; the preceding sibilant, as well as any other consonant, occupies accordingly the onset.

The vowel-ness of /w/ is basically suggested, as claimed in the Introduction, by the article selection pattern (#/w/ selects l’, the allomorph recurring before vowels, i.e. syllable nuclei, cf. Marotta 1988, Petrosino 2018) and the lack of word-initial /s/-voicing in e.g. /sw/*ono* → [sw]*ono* ‘sound’ (Bertinetto 2010).

2.2. /s/ and /sw/ clusters

The sibilant fricative /s/ is even more ambiguous than glides, phonologically, both in Italian and in a number of different languages of the world (cf. Kaye 1992, Baroni 2014), especially as far as its phonotactic behavior is concerned.

Firstly, despite being phonetically a fricative, hence an obstruent, the sibilant /s/ patterns like sonorants in Italian, from a distributional point of view. In fact, /s r l m n/[2] may precede a stop in a heterosyllabic cluster (/ˈasta/ ‘pole’, /ˈarte/ ‘art’, /ˈalto/ ‘high’, /ˈkampo/ ‘field’, /ˈkanto/ ‘chant’), while /f v/ are prohibited as first segments of coda-onset sequences[3]; on the contrary, /f v/ may precede in a branching onset (/ˈfredːo/ ‘cold’, /aˈvro/ ‘have, 1SG.FUT’), while /s r l m n/-initial tautosyllabic clusters are illegal in Italian. In particular, /s/ and nasals pattern alike: differently from liquids, they cannot follow in a branching onset.[4] Sibilant-initial clusters are accordingly analyzed as coda-onset sequences, word-internally (Nespor & Vogel 1982, Marotta 1985, Chierchia 1986, Svolacchia 2019)

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[2] The sonorants /ɲ ʎ/, as well as the sibilant /ʃ/, show more restrictions, being intrinsically geminated.

[3] Possible exceptions may be /ˈnafta/ ‘naphtha’ and /oftalˈmologo/ ‘ophthalmologist’, both of Greek origin, though. However, Italian speakers tend to insert an epenthetic vowel between /f/ and /t/ (e.g. [ˈnaf(ː)ata], suggesting that /f.t/ is not a legal cluster in Italian and it has somehow to be loosened. To our knowledge, between the sibilant and the following consonant in a sC cluster, vowel epentheses were never observed.

[4] Possible exceptions may be *psicologo* ‘psychologist’ and *pneumatico* ‘pneumatic’. However, they behave like *s impurum*, rather than *mutae cum liquida*.

Word-initially, however, the syllabification of /sC/ clusters represents a major issue in phonology, despite the fact that such clusters are cross-linguistically frequent. Such a situation is not limited to Italian, even though this language highlights the peculiarities of word-initial *spurious s* (Svolacchia 2019). Basically, #/sC/ clusters are cross-linguistically problematic since (a) they violate the Sonority Sequencing Principle, (b) they do not behave as branching onsets and (c) they are heterosyllabic word-internally (Goldsmith 2011).

Sibilant-initial clusters have been analyzed as branching onsets (e.g. Wiltshire & Maranzana 1999, Boyd 2006, Huszthy 2016), complex segments (e.g. Selkirk 1982, Wiese 1996, van de Veijer 1996, Fagan 2020), extrasyllabic (Steriade 1982), and, within the last view, as affiliated to the prosodic word (Goldsmith 1990), the foot (Green 2003) or unsyllabified at all, i.e. an appendix (cf. Steriade 1982, Vennemann 1982; for Italian, see Chierchia 1986, Davis 1990). Sibilant-initial /sC/ clusters have even been said to represent VC sequences, that is, consisting of a nuclear sibilant followed by a consonant in the onset (Polgárdi 2022). Eventually, they have been analyzed as universal coda-onset clusters, both word-internally and word-initially, within the Government Phonology framework (Kaye, Lowenstamm & Vergnaud 1990, Kaye 1992, Goad 2011, 2012). In this view, the sibilant is a coda within a rhyme whose nucleus is empty.

Each of such views has its own pros and cons. See, e.g., the criticisms discussed in Scheer (2004) as far as extrasyllabicity is concerned, as well as Kaye's (1992) concerns about his own coda-onset analysis, which is recognized to be based on a "magical" kind of coda licensing, i.e., a theory-internally unjustifiable relationship between the head C and the complement /s/.

Nevertheless, apparently, Kaye's (1992) coda analysis of preconsonantal sibilants in Italian might be on the right track. In fact, the view is able to account for the article selection pattern depicted in § 1. Assuming such a view, the article allomorphy is straightforwardly addressed by claiming that it depends on the following word-initial syllabic constituent: *il* occurs before (branching) onsets (*il cane* 'the dog', *il drago* 'the dragon'), *l'* precedes (branching) nuclei (*l'albero* 'the tree', *l'uovo* 'the egg') and *lo* before codas, both from intrinsic geminates (see § 1), as in *l*[o ʃ.ʃ]*eicco* 'the sheik', and *s*C clusters (*l*[o s.t]*ile* 'the style', *l*[o s.k]*oglio* 'the cliff'); see Faust, Lampitelli & Ulfsbjorninn (2018) for an analogous analysis within the Strict CV framework (Scheer 2004).

As far as the present study is concerned, we may assume word-initial preconsonantal sibilants as affiliated to the syllable coda. Recall from § 1 that the dual behavior of Italian /sw/ clusters (and of /w/ in general), i.e. either a CV sequence or a C.C cluster, was first suggested by the article selection pattern (cf. Janni 1992, Baroni 2020, Cossu 2023), which we have seen to be adequately described by assuming a coda-onset view of /sC/ (Kaye 1992). Thus, regardless of the hypotheses formulated in § 1 (Loanword Phonology Hypothesis and Orthographic Hypothesis), the consonantal behavior of /w/ should imply that /sw/ is parsed as a coda-onset cluster, while before nuclear glides the sibilant /s/ should be analyzed as occupying the syllable onset.

The same conclusion should be advanced in relation to the /s/-voicing pattern before /w/ noted by Janni (1992). The fact that word-initial /s/-voicing occurs before voiced consonants but not before vowels suggests that it does not depend on the mere adjacency to a voiced segment. An empirical confirmation of Janni's (1992)

observation would further corroborate this view, since one would be facing a dual voicing pattern before the same (voiced) segment /w/. Pretheoretically, this would mean that, before scanning the subsegmental composition in search for sonority, the phonological process computes the syllabic constituent domain: only when /s/ occupies the syllable coda a mechanism is triggered that imposes the segment to agree with the voicing feature of the following onset.

Thus, in order to investigate the syllable parsing of /sw/ sequences we are going to use /s/-voicing as a diagnostic. Substantially, the observation of word-initial voiced sibilant [z] before [w] will be analyzed as evidence of the affiliation of pre-glide /s/ to the syllable coda. Since before vowels, therefore, nuclei, /s/, which in this case undoubtedly occupies the onset, does not voice (Bertinetto 2010), the occurrence of #[zw] indicates that /s/ occupies instead the coda, before /w/. This entails that [w] ← /w/ pertains to the onset, therefore, /w/ is a consonant. On the contrary, the presence of voiceless sibilants [s] preceding glides [w] should indicate that /s/ occupies the onset, implying /w/ is nuclear, hence, a vocalic segment. According to the distributional pattern of consonantal and vocalic glides /w/ observed in our data, we will be able to discern between the Loanword Phonology Hypothesis and the Orthographic Hypothesis.

The following Sections present an overview of the phonological implications of both hypotheses and how we believe they should be framed in a more general discussion on loanword phonology, on one hand, and the influence of orthography on phonology, on the other.

3. The phonology of loanwords (in Italian) in light of the LPH

As asserted by Pustka (2022: 507), loanwords undergo adaptation either in accordance with the phonology of the borrowing language or are mimicked to reflect the (presumed) phonology of the donor language. The latter adaptation tends to occur predominantly when the speaker possesses relative proficiency in the L2 language from which the loan originates. Nevertheless, instances of importing (or tolerating) foreign sounds and phonological structures absent in the borrowing language are less common than cases of “nativization”.

In the context of this study, it is important to note that, as frequently observed by scholars investigating loanword phonology, the adaptation process often entails a degree of orthographic influence, commonly referred to as the Buben Effect, named after Buben (1935), as in the studies of Rando (1970), Levitt (1978), LaCharité & Paradis (2005), Vendelin & Peperkamp (2006), Calabrese & Wetzels (2009), Boersma & Hamann (2009), Friesner (2009), Cohen (2009), Hamann & Colombo (2017), Martin *et al.* (2022), among many more. In accounting for the orthographic influence evident in a considerable array of loanwords, Pratt (1980) makes a clear distinction between ear loans, which are assimilated through oral communication, and eye loans, which are adopted via written communication. Presently, eye loans are notably more prevalent than in previous eras, owing to historical factors such as widespread literacy characteristic of the 20th and 21st centuries compared to earlier periods. Additionally, the global proliferation of audio-visual media—including newspapers, magazines, and, more recently, social networking platforms like *Facebook*, *X*, *Instagram*, etc., as well as instant messaging applications like *Whatsapp* and *Messenger*—has contributed

significantly to the proliferation of eye loans. This trend is observed not only in European languages but also in languages such as Korean, Mandarin, Japanese, and numerous others (cf. Calabrese & Wetzels, 2009, eds).

Although the phonology of loanwords in Italian seems to show a certain degree of orthography-based adaptation (Rando 1970, Erasmi 1983, Repetti 1993, 2012, Morandini 2007, Broniś 2016, Hamann & Colombo 2017, Bassetti 2017, Brozbă & Ungureanu 2018, among others; cf. also the volume edited by Calabrese & Wetzels 2009), a confirmation of our LPH would be a counter-example of the above trend.

Indeed, LPH predicts that the glide /w/ consonantal behavior would occur regardless of the glide's spelling, therefore, we cannot assume that such a deviation from Italian phonology is dependent on, e.g., the "eye" status (see Pratt 1980) of the loans including /w/, i.e. the fact of being adapted from written forms. In this view, it would appear instead appropriate to assume a stratified lexicon for Italian, consisting of at least two strata, native and foreign, similarly to the line adopted for Japanese in Itô and Mester (1999, 2017). The native stratum would correspond to the core lexicon, while the foreign one will represent the periphery lexicon. According to the LPH, in the core lexicon labiovelar glides /w/ would represent nuclear segments. The native glides behavior would thus be vocalic, as observed in relation to the article selection pattern (Marotta 1993, Baroni 2020, Cossu 2023; see also § 2.1). In the periphery lexicon labiovelar glides would instead be consonantal; they will accordingly occupy the syllable onset, at least in prevocalic position as in the loanwords *wombat*, *whiskey* and so on, as well as when following a sibilant /s/. In this case, the /sw/ clusters in loanwords investigated in this study are instances of coda-onset clusters as any other preconsonantal /s/ in Italian. One may note that, within this scenario, the phonotactic constraints of Italian are respected also in the periphery lexicon: a preconsonantal /s/ would be treated as a coda within both strata. Indeed, the divergence between core and periphery, as far as the scope of this investigation is concerned, would be represented by the phonological status of the glide /w/: its different syllabifications represent an epiphenomenon of the status (consonantal or vocalic) Italian speakers attribute to the glide. It is hard to formulate a plausible hypothesis to deal with the emergence of the glide consonantal behavior, considering its vocalic status in the core lexicon, which should represent the unmarked condition for native speakers. It may be claimed, e.g., that it stems from the consonantal status of the glide in English, which would have been extended to loans from other languages too. It would be, roughly speaking, a matter of frequency: since English borrowings outnumber other languages borrowings, some phonological features of the former (such as the C status of /w/) might be elaborated as the default condition concerning the glide /w/ in loans from any language, i.e. in the periphery lexicon.

4. Orthographic influence on phonology in light of the OH

Differently from the LPH (§ 4), the Orthographic Hypothesis predicts the process /s/ → [z]_/w/ to occur, i.e. /s/-voicing, only when the glide is written ⟨w⟩. Loanwords like *Swatch* and *switch*, accordingly, should present /s/-voicing, while in non-native lexemes as *soirée* and *suave* a word-initial voiceless [s] is predicted to occur.

This scenario cannot be analyzed in terms of lexical strata as discussed in § 4. Indeed, foreign, or periphery, lexicon should be in turn sub-divided in (1) a more

external one, including loanwords showing /w/ consonantal behavior, and (2) a more internal, or intermediate, stratum, in which the glide is vocalic, analogously to the native lexicon. However, the different glide behavior on which the strata identification is based would eventually be analyzable as orthography-driven. Indeed, it would appear that the only difference in the lexemes in (1) and (2) above is the spelling of /w/. This view would be corroborated by the fact that the grapheme ⟨w⟩ recurs in loans from other languages than English, such as Swahili, as the glottonym itself shows, and Chinese, as e.g. in *wok*[5] (used as a stimulus in Cossu 2023), in which glides would show a consonantal behavior as well. Therefore, in this case, one does not need to advocate to lexical strata and to properties of the loanword phonology in Italian.

The distribution of voiced and voiceless /s/ outputs would be an orthographic effect: the different status of the glide depends on the graphemic representation of the segment. Of course, this fact raises theoretical issues as far as phonological representations are concerned. Indeed, the confirmation of the OH implies that information relative to a signal other than the acoustic one (i.e. speech), as the visual signal (e.g. writing), is able to influence the phonological representation.

In psycholinguistic studies, the influence of orthography on phonology is mostly accepted. It is interesting to note that such an influence is not only observed in the adaptation of loanwords (see § 4), but also during L1 processing, in particular in perception of spoken language. The pioneering study of Seidenberg & Tanenhaus (1979) showed that English native speakers find challenging to recognize that a word couple rhymes when lexemes have different spellings, as in "pie-guy", while rhyme detection is faster and leads to less erroneous responses when the couple of words show the same orthographic "rhyme", as in "pie-tie". Similarly, Ehri & Wilce (1980) reported that English native speakers count an additional segment in "pitch"-like words as compared to "rich"-like words, specifically the alveolar stop /t/, due to spelling inconsistencies (the presence of ⟨t⟩ in the former, contrary to the latter). In the lexical decision task involving English native speakers discussed in Stone, Vanhoy & Van Orden (1997), English lexemes were recognized as actual words, rather than pseudo-words, more slowly if their phonological representation, at least the medial-final portion, may be heterogeneously spelled (as /ip/ in *heap* vs *deep*), than when only one spelling is possible, as /Ob/ in *probe* and *globe*. In the latter situation, the lexical decision is provided faster and more accurately. Analogous results are presented in Ziegler & Ferrand (1998) for French, who administered a lexical decision task as well. Based on similar results, Treiman & Cassar (1997a) claim that speech processing appears to not be entirely independent from written language processing and such a dependency is set when the speaker (usually a 5-6-year-old child) acquires reading-writing skills (i.e. the native letter-sound correspondences and the orthographic structure; see also Frost & Ziegler 2007). Such an acquisition would imply the formation of strong associations between written and spoken words, i.e. between orthography and phonology. Once established, such associations enhance the sensitivity of the lexemes' phonological representations to the corresponding written

[5] Whoever knows the meaning of *Swahili* evidently also knows that it is not an English word. Similarly, although no data is available, *wok* is much likely to be correctly understood as a Chinese (or Cantonese) loanword since it only refers to Chinese cuisine, just like *sushi* cannot be associated to other languages than Japanese.

forms (cf. Ziegler & Ferrand 1998: 686). It is noteworthy that they seem to occur at the very early stages of literacy acquisition (cf. Treiman & Cassar, 1997b: 775).

In brief, in contrast to purely linguistic studies, psycholinguistic and neurolinguistic literature has extensively acknowledged that both phonology and orthography – *ça va sans dire*, among literate individuals – along with semantics, are concurrently activated in language processing (cf. Seidenberg & McClelland 1989) and exert mutual influence on each other (Van Orden & Goldinger 1994).

Internally to this research field, however, the causes of such an influence, which manifests through the so-called orthographic effect, are a matter of debate. Basically, two main views exist.

First, orthography and phonology may be co-activated online as soon as a speech signal is received. In this scenario, although the orthographic lexicon is said to be strongly connected to the phonological one, both psychologically and neurologically, the two lexica are separately represented; the phonological information, stored before the acquisition of orthographic knowledge, has not been "contaminated" by written language. The co-activation view is adopted, e.g., in Ziegler, Muneaux & Grainger (2003) and Ventura *et al.* (2004). In the strong version of this view, the co-activation would be automatic and bimodal, i.e. both phonology and orthography are activated when processing both visual and auditory signal. In a weaker version, the co-activation – especially when observed in spoken language processing – may simply be a strategy speakers adopt in order to perform metaphonological tasks, such as lexical decisions, phoneme counting, and rhyme detection, as in the studies discussed above; when processing speech in non-experimental environments, orthography would play almost no role. The weaker view also represents the major criticism towards the possible influence of orthography on phonology (e.g. Olson 1996), said to depend on the tasks employed, which are metaphonological; such experimental assignments would lead participants to access orthography only in order to facilitate the task performance. However, Taft *et al.* (2008) have observed that the orthographic activation during speech processing is unavoidable and automatic in a task in which resorting to orthography is detrimental, rather than beneficial, suggesting that it might not be merely a strategic device.

The second possibility, assumes instead that the phonological structure is fundamentally reshaped once the native orthographic structure, relative to alphabetic scripts, is acquired (cf. Goswami 2002, Muneaux & Ziegler 2004, Goswami, Ziegler & Richardson 2005, Taft 2006, Perre *et al.* 2009, Davidson 2019). Taft (2006) has run a homophony detection task involving words and pseudo-words in a non-rhotic variety of English, such as Australian English. Stimuli differed in the presence/absence of a preconsonantal /r/, such as *corn* and the pseudo-word *cawn*, both evoking the phonological string /kɔn/. Results show that participants produced more errors and higher reaction times when preconsonantal graphemic ⟨r⟩ was present only in one of the items. According to Taft (2006), also for non-rhotic speakers words like *corn* and *thorn* include a preconsonantal /r/, as well as in rhotic varieties (e.g. American English); among the former, this is due to the permanent phonological restructuring caused by the orthographic knowledge. Some studies have suggested that speakers not possessing an orthographic lexicon based on alphabetic orthographies, such as illiterates (Morais 1987) and literates in non-alphabetic scripts (Read, Zhang & Ding 1986), such as Chinese *hanzi* and Japanese *kanji* and *kana* scripts users, are unable to

manipulate phoneme-size units, in e.g. segmental deletion and phonemic substitution tasks.

As far as our Orthographic Hypothesis is concerned, the first possibility is not easily discernible, since it only predicts that phonology and orthography should be activated simultaneously whenever a signal from either spoken or written language is perceived. This fact alone appears to not be able to account for a potentially real action of orthography onto the phonological representation. The co-activation view may account for delayed reaction times in, e.g., lexical decision tasks, since it implies the activation of two lexica, rather than just one, requiring additional time to be processed. In general, the orthographic effect should only be superficial in the co-activation view. Contrarily, the confirmation of OH would imply that spelling is able to influence the CV status of segments in the phonological representation, at least of the glide /w/, hence the syllabic affiliation; the difference is phonetically substantiated qua the presence/absence of voicing in the outputs of /s/, in our study. Accordingly, the second circumstance, i.e. the phonological restructuring view, would better describe the mechanism governing the differences in voicing. In fact, the triggering of a phonological process cannot be attributed to the "noise" provoked by the orthographic activation "disturbing" the phonological processing. It depends on the phonological structure and occurs when relevant phonological conditions are met. Therefore, if a process is triggered – as e.g. the /s/-voicing, in this contribute – based on an orthographic variable, one should assume that such a variable has been phonologically embedded. In this scenario, one may further argue that it may either represent a reshaping of /w/, entailing its consonantal behavior in certain lexemes, or the introduction of a new phonological category, i.e. the consonantal glide /w_c/, beside the vocalic glide /w_v/, natively present.

5. Experimental setup

In order to test the two hypotheses presented in § 1 and more exhaustively discussed in § 3 (LPH) and § 4 (OH), this study investigates the output of the word-initial pre-glide /w/ sibilant, in loanwords and native lexemes, in light of the /s/-voicing. Acoustical data have been collected through a reading task (cf. below).

As claimed, LPH predicts that every #/sw/ clusters in loanwords is realized [zw] by Italian speakers, while OH predicts so only when /sw/ is written ⟨sw⟩, as in ⟨Swatch⟩ and ⟨swahili⟩, while in ⟨soirée⟩ and ⟨suite⟩ the initial sibilant is voiceless.

The stimuli presented to the speakers thus included #/sw/ words having different origin (native and borrowed) and different /w/-spelling (consonantal and vocalic). Naturally, native lexemes may only show vocalically-spelled glides /w/, since ⟨w⟩ is not a native grapheme. On the other hand, loanwords were selected among those showing *Swatch*-like vs. *soirée*-like written forms, i.e., loanwords showing either the consonant letter ⟨w⟩ or the vowel letters ⟨u⟩/⟨oi⟩ (/w/ and, in French, /wa/).

The *Swatch*-like words group includes ⟨Swatch⟩, ⟨swahili⟩, ⟨swing⟩, ⟨switch⟩ and ⟨swag⟩, while the *soirée*-like word-set presents ⟨soirée⟩, ⟨suite⟩, from French, and ⟨Suarez⟩, ⟨suave⟩[6], from Spanish. /sw/-initial native lexemes are: ⟨suocero⟩ 'father-in-

[6] Such loanwords may have different or restricted meanings as compared to the donor language. Aside from *Swatch*, *Swahili* and *Suarez*, which are proper names of a watch brand,

law', ⟨suono/i⟩ 'sound/s', ⟨suolo/e⟩ 'ground/soles', ⟨suora⟩ 'nun', ⟨suadente⟩ 'mellow', ⟨suicida/io⟩ 'suicide'.

Pre-stop sibilants were included as a control group, i.e., in order to check for the effective /s/-voicing activity among the recruited speakers. This group of stimuli included the two triplets of voiced and voiceless stops following /s/: /s/+velar as in ⟨scalo⟩ 'seaport', ⟨sconto⟩ 'discounting', ⟨sgarro⟩ 'affront', ⟨sgolato⟩ 'hoarse'; /s/+alveolar as in ⟨stato⟩ 'state/condition', ⟨stalking/stalker⟩ *identical*, ⟨sdebitarsi⟩ 'to get out of debt', ⟨sdentato⟩ 'toothless'; /s/+labial ⟨spinta⟩ 'push', ⟨sponsor⟩ identical, ⟨spalla⟩ 'shoulder', ⟨sberla⟩ 'slap', ⟨sbattere⟩ 'to slam'.

Thirty-one speakers were recruited in this study (age range: 23–32 years, average = 26.4). In order to be selected, speakers (a) had to be Italian native speakers, (b) must not possess a L2 (English, Spanish and French) competence higher than the CEFRL B1-level at the time of the data collection, and (c) have no prior academic study in linguistics, particularly in phonetics and phonology. The researcher conducted brief interviews preceding each recording session to gather the aforementioned information. Participants failing to meet the specified criteria were excluded from the study's data collection process.

Since the word-initial preconsonantal /s/-voicing is a pan-Italian phenomenon (cf. Bertinetto & Loporcaro 2005, Huszthy 2019), the diversity of regional backgrounds was emphasized by recruiting speakers from various regions of Italy. These regions include Lombardy, Veneto, Emilia-Romagna, Liguria (northern regions), Tuscany, Abruzzo, Latium (central regions), Campania, Apulia, Sicily, Calabria and Sardinia (southern and insular regions).

The elicitation of the data consisted, as claimed *supra*, in a reading task. Speakers were asked to read aloud meaningful sentences in Italian presented in Power Point slides (black font on white background). Each sentence included one of the target words listed *supra*. Target words recur twice in the corpus, but in different sentences.[7] The acoustical analysis, conducted in Praat (6.1.53), focused on the outputs of /s/. In order to discriminate between the sibilant's voiced and voiceless outputs, we controlled for the presence vs absence of (1) pulses in the waveform (cf. Nocchi & Filipponio 2012), (2) the voicing bar (Jansen 2007) and (3) periodicity in the waveform (Lisker & Abramson 1964), which are three acoustic correlates of voicing (i.e. of glottal vibration); outputs were also (4) evaluated perceptually by the author. Based on the parameters above, a classification of the tokens is provided (§ 6.1). As a side analysis, we also measured length of sibilants /s/, glides /w/, post-sibilant voiced and voiceless stops /b d g p t k/, and post-glide vowels (see § 6.2).

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a language and people, and a football player, respectively, the other might not be transparent to non-Italian speakers. *Swing* denotes the musical genre born in America during the 1920's; switch may either signify the *Nintendo* console (*Nintendo Switch*) or the 'network switch hardware'; *swag* is utilized by young people for 'stylish', especially referring to luxury clothes: even if the word has a more restricted diastratic and diaphasic spread, it has gained great notoriety in the last ten years thanks in particular to American hip-hop and music and culture; *soirée* refers to 'gala evenings', usually involving dances; *suite* may either refer to an hotel room or a musical composition; suave, akin to *swag*, is known primarily through music media, specifically Latin music and culture.

[7] For instance, *Swatch* occurred in *mi hanno regalato due 'Swatch' originali* 'they gifted me two original Swatch watches' and *ho trovato uno 'Swatch' nel locale* 'I found a Swatch watch in the pub'.

6. Results

6.1. Spectrographic analysis

Regarding the qualitative findings, our analysis revealed the presence of three allophones rather than the expected two. Alongside the voiceless [s] and the voiced [z], a partially voiced or devoiced sibilant emerged, regardless of the place of articulation of the following consonants. This particular sound appears analogous to those documented in prior studies such as Baltazani (2006) for Greek and Nocchi & Filipponio (2012) for Leghorn Italian. In the latter study, it is designated as lenis [z̥]. Although this sound lacks both pulses and consistent voicing throughout its duration, its perceptual characteristics closely resemble those of [z] (Nocchi & Filipponio, 2012). Additionally, its waveform displays periodic signals for the majority, if not the entirety, of its segmental duration (cf. Baltazani, 2006), while a slight degree of constriction is discernible in the spectrogram (cf. Nocchi & Filipponio, 2012). See Figures 1-3 below.

Figure 1. Spectrogram and waveform of the /s/ voiceless output [s] in *stato* ‘state’, male speaker.

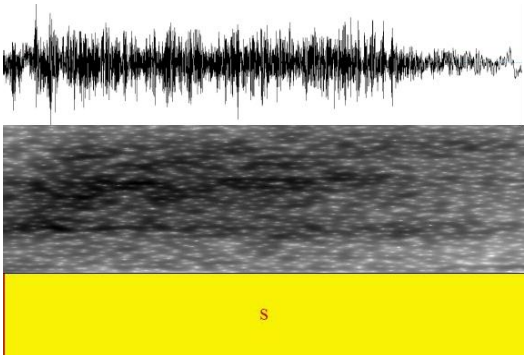


Figure 2. Spectrogram and waveform of the /s/ lenis output [z̥] in *sdegno* ‘disdain’, male speaker.

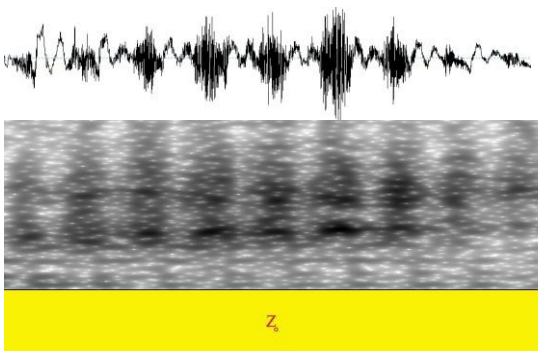
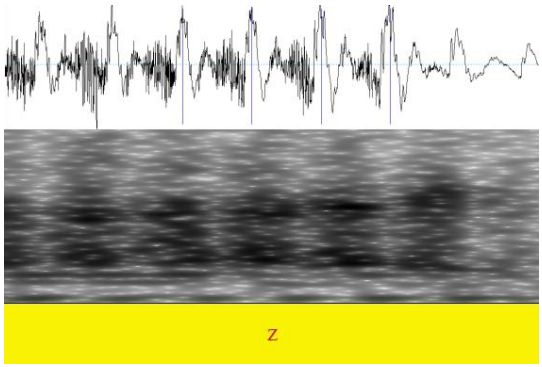


Figure 3. Spectrogram and waveform of the /s/ voiced output [z] in *sbattere* ‘to slam’, male speaker.



As depicted in Figure 2 and Figure 3, both the *lenis*, or devoiced, [z̬], and voiced [z] manifest periodicity in the signal, differently from the voiceless [s] in Figure 1. The outputs [z] and [z̬] manifest a high degree of perceptual and spectro-acoustic similarities, often rendering them indistinguishable, despite the latter may lack pulses and/or the voice bar. Consequently, in accordance with Nocchi & Filipponio (2012), we group the voiced [z] and lenis [z̬] together, distinguishing them from the voiceless [s]. As will be elucidated subsequently, phonetic observations align with phonological patterns: the voiced and perceptually-voiced (lenis) variants emerge in identical contexts (/_$C_{[+voiced]}$/) while collectively they complementarily distribute with the voiceless allophone [s], occurring solely before /$C_{[-voiced]}$/[8]. In essence, /s/ manifests two allophones distinguished by the feature [±voiced] (for a gradient view of the /s/-voicing phenomenon, based on the occurrence of “partially voiced” segments in Greek, see Baltazani 2006).

Relative to the quantitative results, we obtained 992 tokens relative to (1) #/sw/ and 992 tokens of (2) #/s/+stop clusters (total$_{/s/}$ = 1984). Concerning group (1), 558 tokens are relative to loanwords and 434 to native lexemes. In native lexicon, the glide /w/ is always spelled vocalically as ⟨u⟩, while in loanwords it may recur either consonantally, as ⟨w⟩, (342 tokens), like in the English *swing*, or vocalically, as ⟨u⟩/⟨oi⟩, (216 tokens), the latter representing the French diphthong /wa/.

Commencing from the control group, Table 1 presents the distribution of /s/ realizations. Utilizing the classification system predicated on the aforementioned criteria, we differentiated between /s/+voiced stop and /s/+voiceless stop contexts.

[8] Nocchi & Filipponio (2012) arrive at the same conclusion by observing the intervocalic /s/-voicing. That is, in their study, the context was consistently intervocalic: only a variation in the production could be inferred, but not a generalization in phonological terms. In the cited study, the decision to treat [z̬] and [z] collectively was not based on a comparison with the behavior of /s/ in other context, but only on spectro-acoustic and perceptual cues. This aspect, coupled with our findings, reinforces the perspective that [z̬] merely constitutes a phonetic variation of [z], both serving as outcomes of /s/ voicing. In essence, such phonetic difference holds no phonological relevance. Nevertheless, However, it is imperative to consider them during allophone classification, with careful attention directed towards the (spectro)- acoustic structure.

Despite both voiced and lenis outputs occurrence being governed by identical phonological conditions, they are segregated in token enumeration for the purpose of comparative analysis with findings from other studies.

Table 1. Distribution of the outputs of /s/ in the control group (#/s/+stop).

֍	#/s/+/p t k/		#/s/+/b d ɡ/	
	tokens	%	tokens	%
Total	620	100	372	100
[s]	620	100	3	0.8
[z]	0	0	181	48.7
[z̥]	0	0	187	50.2

As Table 1 illustrates, before voiceless stops, the sibilant is systematically voiceless in the surface, as expected (Marotta 1995, Bertinetto & Loporcaro 2005). Before voiced stops, only three allophones correspond to the voiceless [s], while circa 99% of the tokens consist of voiced [z] and *lenis* [z̥] realizations. Note that the number of tokens according to the variable [˳] is almost identical (181 and 187), suggesting that their occurrence is likely to be dependent on some configurational and aerodynamical aspects of the cluster articulation, which however nothing have to do with the phonological intentions of the speakers.

In Table 2 we show the distribution of the /s/ outputs before the glide /w/ according to the orthographic context. That is, by separating the outputs of /s/ before /w/ consonantally written ⟨w⟩ and those occurring before the glide vocalically written, either as ⟨u⟩ or ⟨oi⟩.

Table 2. Distribution of the outputs of /s/ before the glide /w/ either consonantally (#/s/+⟨w⟩) or vocalically written (#/s/+⟨u/oi⟩).

֍	#/s/+⟨w⟩		#/s/+⟨u/oi⟩	
	tokens	%	tokens	%
total	340	100	652	100
[s]	13	4	646	99
[z]	105	31	3	0.5
[z̥]	222	65	3	0.5

The results presented in Table 2 indicate that speakers predominantly voiced the word-initial sibilant (manifesting as both [z] and [z̥]) in 96% of the total tokens pertaining to *Swatch*-like words. Conversely, during the reading of *soirée*-like stimuli, which encompassed native words as well, voicing was observed in only 1% of the total tokens (compared to 99% for [s]). Notably, the majority of voiceless outcomes in the *Swatch*-like group were associated with the production of *Swahili*. Interestingly, this loanword exhibited a non-systematic behavior in the article selection pattern, as studied by Cossu (2023): within the analyzed corpus, it occasionally selected *il* rather than *lo*, contrary to the consistent behavior observed with other *Swatch*-like words. It was observed that the occurrences of ⟨il swahili⟩ peaked during the same decades when the partially-Italianized form ⟨suahili⟩ was most prevalent (i.e., between the 1940s and the 1960s). The latter form consistently selected *il* (cf. Cossu 2023: 188). Notably, two speakers who produced [swa]*hili* mentioned that the orthographic form ⟨swahili⟩ was

not the most encountered one in texts, as compared to ⟨suahili⟩. This observation aligns with the Orthographic Hypothesis. Regarding *soirée*-like words, it is noteworthy that the very few voiced outputs were predominantly associated with native lexemes rather than loanwords. Even more surprising was the observation that these voiced outputs occurred before /wɔ/ diphthongs, as exemplified by /ˈswɔni/ ‘sounds’ and /ˈswɔle/ ‘(shoe) soles’. See Table 3.

Table 3. Distribution of the outputs of /s/ before /w/ vocalically written, by distinguishing loans and native lexemes.

֍	/sw/ in *soirée*-like loanwords		/sw/ in native lexemes	
	tokens	%	tokens	%
total	216	100	434	100
[s]	216	100	428	99
[z]	0	0	3	0.5
[ʐ]	0	0	3	0.5

Indeed, the occurrence of voiced outputs in such a context is unexpected, particularly within the native lexicon, regardless of the phenomenon under consideration. As outlined by Marotta (1988), words such as *suicidio* ‘suicide’ and *suadente* ‘mellow’ feature a sibilant followed by a hiatus (/u.i/ and /u.a/), rather than a diphthong (/wi/ and /wa/). Consequently, /s/ would consistently precede a nuclear position. Furthermore, in word-initial position the sibilant remains unaffected by voicing, even when preceded by a word ending in a vowel (as in *du*[e s]*uoni* ‘two sounds’), which would theoretically create an environment conducive to intervocalic voicing (cf. Bertinetto & Loporcaro, 2005).[9] It could be conjectured that a limited control of laryngeal activity due to a high speech rate may occasionally hinder the vocal cords’ sufficient stiffening required for the production of a voiceless segment, resulting in a voiced output; the sonority of such voiced outputs is not phonologically determined.[10]

In Figure 4 and Figure 5 are shown the realizations of the stressed string /swɔ/, yielding initial voiceless [s], in the native lexeme *suole* ‘soles’, and initial voiced [z], in the loanword *Swatch*, respectively.

[9] Which appears to be blocked by /#/.

[10] The voiced realization in e.g. *du*[e z]*uoli* is felt as non-native by Italian speakers. The voicing of word-initial /s/ as well as of the rest of the voiceless obstruents is in fact generally used when imitating the supposed pronunciation of North African speakers.

Figure 4. Realization of a voiced [s] in *suole*, female speaker, 10 kHz view range.

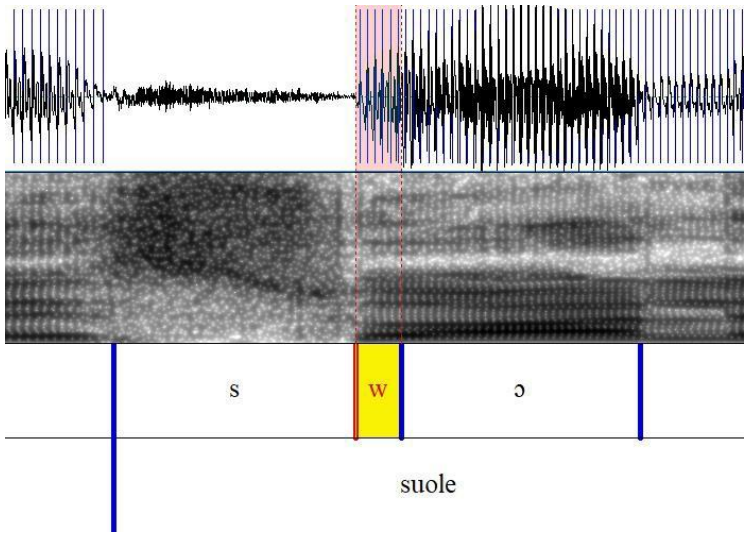
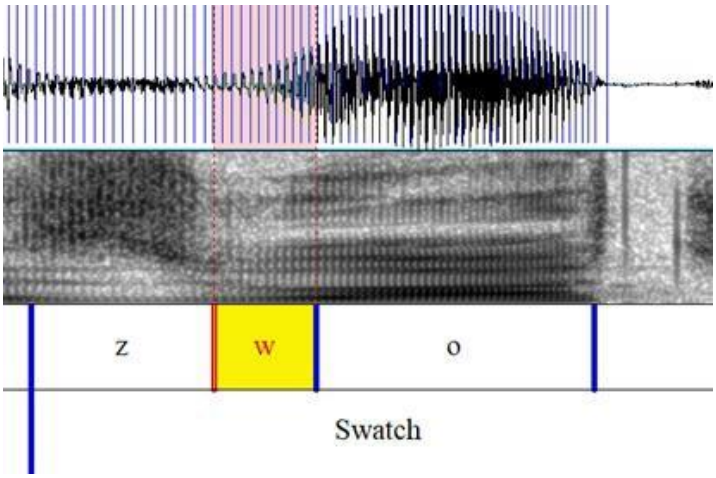


Figure 5. Realization of a voiced [z] in *Swatch*, male speaker, 10 kHz view range.



As will be elaborated on in § 7, the results presented above suggest that the glide behaves as a consonant only when written ⟨w⟩, triggering /s/-voicing like voiced stops (see Table 2 and Table 3 above), in line with the Orthographic Hypothesis. Therefore, as anticipated in § 5, it would be interesting to compare length measures among the segments involved, i.e. glides, vowels, sibilants and stops, in order to preliminarily verify whether the different syllabifications assumed (see § 1) for the string /swV/ are reflected in duration differences.

6.2. Analysis of duration

A durational analysis was run in order to check whether the voicing pattern observed in this study might be reflected on segmental length. Indeed, according to OH, both /s/ and /w/ receive different syllable parsing based on the glide /w/ spelling. In this view, it is recalled that a consonantally spelled glide ⟨w⟩ should occupy the syllable onset, while the preceding sibilant should be parsed as the coda (see § 1 and § 4). A vocalically-spelled glide should instead occupy the nucleus and preceding /s/ should

accordingly affiliate to the onset, in this case. Such syllabic differences might be corroborated by length differences. A consonantal glide in the syllable onset should be longer than a vocalic glide in the nucleus, since the former autonomously occupies a syllabic constituent, while either the latter shares its affiliation to the nucleus with the following vowel (Marotta 1988) or it is just a secondary articulation of the vowel (Canalis 2018). Conversely, a consonantal glide should show a similar length as (voiced) stops, since both occupy the same syllabic position.

At least when comparing glides, vowels and preceding sibilants, we limited the durational analysis to paroxytone bisyllables as far as word-initial /sw/ clusters are concerned.[11] In the resulting more balanced corpus, the analysis is therefore limited to the outputs of (a) *soirée*-like words, as *suoni* 'sounds', *suole* 'soles', *suolo* 'ground', *suave* 'softly', *suora* 'nun', *suite* 'hotel room', and (b) *Swatch*-like words such as *Swatch*, *swing*, *switch*, *swag*. All the stimuli in group (b) and *suite* in (a) were produced as penultimate stressed bisyllables: a schwa always followed final consonants /ʧ ɡ t/[12] (see also Repetti 1993, Broniś 2016). Word-initial *s*C clusters in more-than-two syllables words (as *stalking*, produced with a final schwa as the third nucleus, *sbattere* 'to slam' and *sdebitarsi* 'to get out of debt') have been maintained in order to not detrimentally reduce our sample as claimed above.

We see first a comparison between glides according to the spelling, as well as the whole diphthong. See Table 4.

Table 4. Length values of the glide /w/ and /wV/ diphthongs according to the spelling of the glide.

Length (ms)					
/w/ (total)		/w/ : ⟨C⟩		/w/ : ⟨V⟩	
Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
48	15.7	66.8	19.2	29.3	12.3
/wV/ (total)		/wV/ : ⟨CV⟩		/wV/ : ⟨VV⟩	
Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
150	70	175.1	41.8	131.2	60

Consonantal glides are on average more than twice longer than vocalic glides /w/, which are very brief productions (less than 30 ms). Consistently, diphthongs including the former are longer than those including the latter. We fitted a linear mixed model[13] ('LMM'; lmer() function, lme4 package, Bates *et al.* 2015) to check whether *spelling* has an effect on glides length (*w_length*). The model included *speaker* and *word* as random effects and glide /w/ *length* as a dependent variable (cf. Table 5).

[11] As for #/s/+stop stimuli, trisyllables were maintained in such a reduced dataset, as the pro-paroxytone sbattere 'to slam' and sdebitarsi 'to get out of debt'; other initial /s/+stop clusters occur in bisyllables and may include oxytones, as soirée, in order to avoid an excessively uneven distribution of tokens between voiced and voiceless stops as well as among the other variables.

[12] In two sentences, the consonant-final stimulus was followed by a vowel initial word, as in *due Swatch originali* 'two original Swatch watches' and *swag è parte* 'swag is part of'. In such cases, the schwa epenthesis did not occur, possibly since a lexical vowel was already present to allow final consonants to be resyllabified as onsets (final obstruents are illegal in Italian, see Bertinetto & Loporcaro 2005).

[13] All statistical analyses were run in R (R Core Team 2022).

Table 5. Linear Mixed Model with *w_length* as a dependent variable. Reference level (intercept): spelling = ⟨w⟩). Observations = 427; random factor: N *speaker* = 31 (variance: 31.21; standard deviation: 5.58); N *word* = 10 (variance: 67.6; standard deviation: 8.22). Marginal R2 / Conditional R2 =.40/ .71.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	105.340	9.387	8.969	11.222	< .001
spelling ⟨w⟩	-37.593	5.527	8.457	-6.801	< .001

Although the corpus is unbalanced (87 tokens correspond to consonantal /w/ and 340 to vocalic glides), it appears that the written form of the glide /w/ affects its length, as shown in Table 6. If /s/-voicing is triggered by the different /w/ syllabification (as predicted by OH), this represents an interesting result, since it suggests that different syllabifications imply different durational patterns, as far as /w/ is concerned. Indeed, the very brief duration of vocalic glides (ca. 30 ms, see Table 5) may be effect of their syllabification as vowel onsets, within the monosegmental view of Italian rising diphthongs (cf. Canalis 2018). On the contrary, the longer duration of consonantal glides may be attributed to their syllable onset status. Before investigating duration of consonantal glides and stops in the same syllabic position (i.e., post-sibilant /s/ and prevocalic syllable onset, see Table 8), a comparison between vowels following consonantal and vocalic glides is provided. According to the Orthographic Hypothesis and consistently with previous results, such vowels should not show length differences. In both contexts, they should occupy the syllable nucleus in the same prosodic position (stressed open syllable).

In Table 6 we show length measurements of post-/w/ vowels.

Table 6. Length values of vowels following consonantal (Post /w/ : ⟨C⟩ vowel) and vocalic glides /w/ (Post /w/ : ⟨V⟩ vowel).

Length (ms)					
Post /w/ total		Post /w/ : ⟨C⟩ vowel		Post /w/ : ⟨V⟩ vowel	
Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
105.1	45.4	108.3	30.9	101.9	60

The post-glide /w/ vowel, which was not controlled for quality, does not seem to vary its duration according to the spelling of the glide: post-/w/ : ⟨C⟩ vowels are only 6.4 ms longer than vowels following vocalic glides.

The potential effect of *spelling* on the following vowel was investigated through a linear mixed model (lmer(), lme4 package, Bates *et al.* 2015), in which we only substituted *w_length* with *v_length* (vowel length) from the previously showed LMM (cf. Table 5). The effect of *spelling* is statistically non-significant ($p < .001$; see Table 7.

Table 7. Linear Mixed Model with *v_length* as a dependent variable. Reference level (intercept): spelling = ⟨u⟩). Observations = 425; random factor: N speaker = 31 (variance: 286.5; standard deviation: 16.93); N word = 10 (variance: 1096.6; standard deviation: 33.11). Marginal R2 / Conditional R2 =.66/ 5.30e-03.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	109.429	17.147	8.912	6.382	< .001
spelling ⟨u⟩	-8.305	21.676	8.196	-0.383	.702

Results in Table 7 corroborates the previous observation that the post-/w/ vowel length is not affected by the phonological status of the glide. This is not surprising, as argued above, since the following vowel is the only segment in the whole scenario which does not alter its syllabic affiliation according to the spelling of the glide; the vowel occupies the stressed nucleus in any case.

As suggested above, the longer duration of consonantal glides as compared to vocalic ones (see Table 4) may be due to a difference in syllabification: the former occupy the post-consonantal onset, while the latter precede the vowel within the nucleus (as predicted by OH). Therefore, as anticipated, we have compared consonantal glide and voiced stop lengths. According to the Orthographic Hypothesis, both should be syllabified as post-consonantal onsets and, therefore, should present similar duration values (possibly influenced by the manner of articulation of segments involved, i.e. stops vs glides). We excluded voiceless stops from the comparison in order to balance segments based on voicing (glides are always voiced). See Table 8.

Table 8. Length comparison between consonantal glides /w/ and voiced stops /b d g/ in post-sibilant /s/ position.

Length (ms)			
Post sibilant /w/ : ⟨C⟩		Post sibilant voiced C	
Average	St. Dev.	Average	St. Dev.
66.8	19.2	68.4	13.9

Post-sibilant consonantal glides /w/ and voiced stops /b d g/ show very similar length values (the former being ca. 2 ms longer), as expected. Including voiced stops length values in the dataset, another LMM was fitted in order to investigate the possible effect of the kind of segment involved (*segment*), i.e. labiovelar glides /w/ and voiced stops /b d g/, on the segment's *length* (*speaker* and word as random factors and length as the dependent variable). See Table 9.

Table 9. Linear Mixed Model with *length* as a dependent variable. Reference level (intercept): segment = /w/). Observations = 452; random factor: N speaker = 31 (variance: 23.92; standard deviation: 4.891); N word = 11 (variance: 59.57; standard deviation: 7.718). Marginal R2 / Conditional R2 = 0.003 / 0.296.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	70.122	3.143	10.204	22.308	< .001
segment /w/	-2.146	5.172	9.915	-0.415	.678

According to the results in Table 9, no effect of *segment* on *length* is observed, corroborating the glide consonantal analysis. Moreover, albeit limited to the glide /w/ vs voiced stops /b d ɡ/ comparison, such results suggest that syllable onsets may show much similar durational values regardless of the associated melody.

This finding strongly supports the onset syllabification view concerning glides triggering /s/-voicing (see § 4 and § 6.1). In addition to phonologically behave as voiced consonants in triggering /s/-voicing, such glides also show a different phonetic guise from vocalic glides, as already showed in Table 5). Indeed, their duration approaches that of voiced consonants in the same prosodic position, both from the syllabic constituency and stress point of view At least as far as length is concerned, it appears that the phonological consonantal status of glides is reflected on its durational properties.

Eventually, we show length values concerning sibilants. First, we present the length difference between pre-consonantal and pre-vocalic glide sibilants. According to the Orthographic Hypothesis, they should be differently parsed: the former in the syllable coda and the latter in the onset. Coda sibilants are said to be weaker as compared to post-consonantal sibilants in the onset, the former showing lower oral pressure and a less intense frication (at least in Spanish, cf. Solé 2010: 302). It is thus predictable that they will show length differences based on their syllabic parsing. However, as already seen in Table 2, pre-consonantal glide sibilants are mostly voiced while pre-vocalic glide ones are prevalently voiceless. Therefore, the difference likely observable might also be relative to voicing, or even possibly due to it. See Table 10.

Table 10. Length values of sibilants /s/ preceding consonantal and vocalic glides /w/.

Length (ms)					
Pre /w/ sibilant total		Pre /w/ : ⟨C⟩ sibilant		Pre /w/ : ⟨V⟩ sibilant	
Average	St. Dev.	Average	St. Dev.	Average	St. Dev.
103.9	39.9	88,7	18	115.8	49

As one can see from Table 10, pre-vocalic glide sibilants are ca. 27 ms longer than pre-consonantal glide /s/. Such a length difference is in line with the dual syllabification view, as argued. A linear mixed model (function lmer() of package 'lme4', Bates *et al*. 2015) was fitted to predict /s/ *length* to interact with glide's *spelling* (*speaker* and *word* as random effects; length as the dependent variable). See Table 11.

Table 11. Linear Mixed Model with sibilant *length* as a dependent variable. Reference level (intercept): segment = /w/). Observations = 427; random factor: N speaker = 31 (variance: 200.07; standard deviation: 14.14); N word = 10 (variance: 79.15; standard deviation: 8.897). Marginal R2 / Conditional R2 = 0.079 / 0.323.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	93.615	6.092	17.058	15.367	< .001
spelling ⟨u⟩	23.625	6.800	9.922	3.474	< .001

It appears that the different spelling of the glide has an effect on the sibilant length. Pre-vocalic glide sibilants /s/ are longer than pre-consonantal glide ones. As said, this is in line with the syllabification of the former in the onset and of the latter

in coda. However, as claimed, such length difference may also be due to the voicing difference between the two consonants.

To exclude this, we compared (α) pre-vocalic glide sibilants and pre-voiceless stop sibilants, as well as (β) pre-consonantal glide sibilants and pre-voiced stop sibilants. Table 12 show results for both groups.

Table 12. Length values comparison between (α) pre-vocalic glide /w/ sibilant /s/ and pre-voiceless stop sibilant /s/, and between (β) pre-consonantal glide /w/ sibilant /s/ and pre-voiced stops sibilant /s/ 'T' and 'D' indicate voiceless /p t k/ and voiced /b d g/, respectively.

	Length (ms)					
	/s/ total		Pre /w/ : ⟨V⟩ sibilant		Pre-T /s/	
Group (α)	Average	St.Dev.	Average	St.Dev.	Average	St.Dev.
	95.6	49	115.8	49	75.5	49
	/s/ total		Pre /w/ : ⟨C⟩ /s/		Pre-D /s/	
Group (β)	Average	St.Dev.	Average	St.Dev.	Average	St.Dev.
	75.7	14.6	88.7	18	62.8	11.3

As one can see, in Group (α) sibilants preceding a voiceless stop /p t k/ are 40.3 ms briefer than /s/ preceding vocalic glides /w/. In Group (β), pre-voiced stop sibilants are only 12.9 ms shorter than the outputs of /s/ preceding consonantal glides (see Table 12). First, we fitted a linear mixed model to predict /s/ *length* to interact with the following segment (*foll_seg*) in Group (α) (i.e. by considering sibilants before vocalic glides and /s/ before voiceless stops). *Speaker* and *word* were used as random factors, while /s/ *length* as the dependent variable. See Table 13.

Table 13. Linear Mixed Model with sibilant *length* as a dependent variable. Reference level (intercept): following segment *foll_seg* = w). Observations = 427; random factor: N speaker = 31 (variance: 99.21; standard deviation: 9.960); N word = 16 (variance: 97.58; standard deviation: 9.878). Marginal R2 / Conditional R2 = 0.271 / 0.496.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	80.734	3.620	20.718	22.304	< .001
segment [w]	32.170	4.746	17.368	6.778	< .001

The effect of *segment* reveals significant, according to our model (see Table 13), with pre-glide /s/ being longer than pre-voiceless stop /s/. This suggests that the sibilant's length is affected by the following segment, at least as far as vocalic glides /w/ and voiceless stops /p t k/ are concerned. This is in line with OH, since it may be associated with a difference in syllable parsing (i.e., as an onset before vocalic /w/, as a coda before (voiceless) stops).

Eventually, an analogous LMM was fitted concerning data in Group (β). In this sub-dataset we do not expect *segment* to interact with the sibilant *length*: in both cases the sibilant should occupy the syllable coda; therefore, /s/ length should not vary. See Table 14.

Table 14. Linear Mixed Model with sibilant *length* as a dependent variable. Reference level (intercept): following segment *foll_seg* = /w/). Observations = 427; random factor: N speaker = 31 (variance: 97.07; standard deviation: 9.852); N word = 11 (variance: 30.73; standard deviation: 5.543). Marginal R2 / Conditional R2 = 0.153 / 0.357.

Predictors	*Estimates*	*Standard error*	*df*	*T value*	*p*
(Intercept)	70.113	2.948	16.086	23.784	< .001
segment [w]	24.798	4.334	11.153	5.722	< .001

As one can see from Table 14, it appears that also for Group (β) the following segment (consonantal glide vs voiced stop) has an effect on the sibilant length.

On one hand, these results suggest that voicing features might not play a role in the observed length pattern. Length difference between sibilants in Group (α), should be interpreted as an epiphenomenon of the different syllabic affiliation (onset vs coda), according to the Orthographic Hypothesis. On the other hand, the length difference in Group (β) should not occur, as the Orthographic Hypothesis posits that /s/ occupies the syllable coda in both instances—whether it precedes a consonantal glide or a (voiced) stop. However, since length measures of such two post-sibilant segments (consonantal glides and voiced stops) are nearly identical, as seen in Table 8, the difference highlighted in Table 9 may be due to the following segment's phonological class, specifically approximant vs obstruent.

Regrettably, our corpus lacks examples of sibilants preceding the sonorants /m n r l/, as in *smodato* 'excessive', *slegato* 'untied', and in the loanwords *smog*, *slalom* 'identical'. Additionally, it does not include instances of sibilants preceding voiced fricatives, such as in *sviare* 'divert') and *Svezia* 'Sweden'. Including such /s/-initial clusters in analogous future research could provide an opportunity to further examine whether the observed length differences between tokens in Groups (α) and (β) (refer to Table 12), depends on the fact that the following consonants belong to different phonological classes. Sibilants preceding sonorants and voiced fricatives may exhibit greater similarity to sibilants preceding consonantal glides than to those preceding voiced stops, likely due to the continuant feature. In subsequent research, this variable should be controlled to further substantiate the consonantal interpretation of glides as suggested by their orthographic representation.

7. Discussion

The aim of this study was to investigate the syllable parsing of /sw/ clusters and the phonological status of /w/ in Italian. The analysis involved acoustic data collected from Italian native speakers producing the aforementioned clusters. Sections 1 and 2 provide an overview indicating that /w/ in loanwords is typically treated as a consonant, whereas in the native lexicon it functions as a vowel (Janni, 1992; Baroni, 2020; Cossu, 2023). The phenomenon of preconsonantal /s/-voicing was employed as a diagnostic tool. Considering that word-initial preconsonantal /s/-voicing is triggered by a voiced consonant following /s/, voiced outputs before /w/ were considered evidence of the consonantal status of the glide, whereas voiceless outputs of /s/ were interpreted as indicating a CV parsing of /sw/ clusters, thus suggesting a vocalic analysis of /w/ in such instances. It has been suggested (cf. Section 1) that this duality

may be either a characteristic of loanword phonology in Italian or, as proposed by Janni (1992), Baroni (2020), and Cossu (2023), dependent on the graphemic representation of the glide itself.

The results presented in Section 6 demonstrate that, contrary to the predictions of the Loanword Phonology Hypothesis (LPH), the phenomenon of /s/-voicing is not systematically triggered when the sequence /sw/ occurs in loanwords. Specifically, in the group of *soirée*-like words, where the glide /w/ is orthographically represented by vowel letters (⟨u/oi⟩), similar to native lexicon words, the /s/-voicing is not observed. Within this group, the word-initial sibilant /s/ consistently maintains its voiceless realization [s], mirroring the pattern observed in native lexemes with the same initial cluster /sw/. Conversely, in the *Swatch*-like group, only 4% of related tokens exhibit voiceless realizations of the sibilant. Thus, the Orthographic Hypothesis (OH) emerges as a more suitable explanation than LPH for predicting the outcomes of /s/-voicing before /w/ in this study.

Even the durational analysis presented in § 6.1 revealed interesting results in this sense. Such an analysis, though, is to be considered a preliminary durational investigation of /sw/ clusters length. Indeed, more control should be adopted as for the quality of post-/w/ vowels as well as that of pre-sibilant one in the preceding word-final position. Moreover, sonorants and voiced fricatives should be included as post-sibilant segments in order to balance the comparison between the contexts based on segmental continuancy: due to our dataset limitations, we are able to only perform a comparison between continuant segments (glides) and non-continuant segments (stops). Eventually, a wider corpus including much more tokens for each investigated prosodic and segmental context is surely recommended.

Nevertheless, our length analysis cautiously corroborates the Orthographic Hypothesis. It appears that pre-sibilant /s/ consonantal glides /w/, supposed to occupy the syllable onset, are as long as voiced stops occupying the same position. This result, as claimed in § 6.1, may be understood as a strong indicator of the syllabic parsing of consonantal /w/ in the onset (prevocalic voiced stops undoubtedly occupy the same constituent, being impossible nuclear segments). Additionally, voiceless sibilants occurring before vocalic glides and voiceless stops, both systematically realized as voiceless [s], showed significant length differences. Such a result is consistent with the implications of OH: before vocalic glides, hence nuclear segments, the sibilant occupies the syllable onset; it occupies the syllable coda before a consonant, on the contrary. The following vowel length does not seem to be influenced by the /w/'s spelling. Such a result was expected, since the vowel syllabic affiliation would not be dependent neither on the glide's written form nor phonological status: therefore, no length variation should be predicted to occur.

The voicing pattern as was observed in this study (and, less strikingly, the durational patterns) appears to be contingent upon the distinct orthographic representation of the glide. Specifically, within the scope of this study, orthographic influence appears to operate at the level of CV representation (McCarthy 1985, Clements & Keyser 1983). In essence, our findings suggest that the phonological status of the glide is determined orthographically: depending on the grapheme, /w/ may function either as a consonantal (C-) or a vocalic (V-) segment, consequently influencing the organization of syllable structure. When categorized as a consonant, it is syllabified in the onset position, leading the preceding sibilant to behave as an *s impurum*. Conversely, when analyzed as a vowel, it is syllabified in the nucleus

position, resulting in the preceding /s/ occupying the onset. In the former scenario, /s/-voicing is triggered due to the voiced nature of /w/; in the latter, we observe /s/ maintaining its voiceless realization [s], as expected for word-initial prevocalic /s/ in Italian (Marotta, 1995).

It is relatively uncommon to observe orthographical influences of this nature, as typically orthographic influence tends to affect perception, rather than production. However, Bassetti (2017) and Hamann & Colombo (2017) documented cases of orthography-driven gemination among Italian speakers in English L2 and loanwords from English, respectively, where double letters, as in *kitty* and *shopping*, are interpreted as phonological geminates (/tː/, /pː/) and consequently realized as [tː], [pː]. Although this affects the structure of the first syllable, resulting as coda-final in the Italian pronunciation, it primarily stems from the orthography-driven distinction between singleton and geminate consonants. In our study, however, the orthographic effect seems to operate at a higher level than the segmental one, specifically at the CV-level (Clements & Keyser 1983).

Indeed, as posited, the influence of orthography in this study does not directly affect the melody or syllabic affiliation of /w/ (as e.g. in Morandini 2007). Rather, it seems to operate at the level where segments are represented as consonants and vowels, at least as far as this contribute is concerned. This observation carries significant theoretical implications. The study demonstrates that the Italian phonological system is capable of incorporating information from sources beyond strictly speech-related input, notably written language, at a deep level of representation.

By making this assertion, we do not imply that phonological representations are not inherently grounded in speech. Rather, we suggest that among literate speakers, particularly in segmental shallow orthographies like Italian, knowledge of letter values and orthographic rules may play a phonological role when encountering ambiguities, such as those posed by glides (cf. Levi, 2011). In our analysis, speakers appear to rely on orthography when considering /w/, probably given its lack of an unequivocal status in Italian phonology: it may represent a secondary articulation of velar stops (Marotta, 1988; Canalis, 2018), the initial element of a branching nucleus (Marotta, 1988), or, as suggested by Canalis (2018), the first component of a complex vowel.

Nevertheless, the ability of phonologically computing written inputs at the CV level, as well as in other levels of phonological representation, is controversial, since the "substance" of the computation is assumed to be merely phonetic. However, as Hale & Reiss (2000: 162) put it, phonology may be understood as "a set of formal properties (e.g., organization into syllables and feet, feature spreading processes) that are modality independent and thus not based on phonetic substance". This viewpoint aligns with the perspective of Slowiaczek *et al.* (2003: 257), who, drawing from English data, assert that "lexical representations are connected based on orthographic and phonological information".

Recalling the two possibilities discussed in § 5 relative to the orthographic effect's underlying mechanism, our data appear to align more closely with the restructuring view rather than the simple co-activation hypothesis. Consistent with Taft *et al.* (2008) conclusions, we posit that simple co-activation alone cannot adequately explain why, in instances where both orthographic and phonological information could be accessed during spoken productions, the orthographic influence predominates (as evidenced by our results showing a high consistency of the

orthographic effect among speakers: 96% of orthographically influenced productions within the *Swatch*-like set and 100% within the *soirée*-like group).

According to the restructuring view (e.g. Perre *et al.* 2009), such influence is directly addressed by positing that lexical storage, or the underlying representation, is permanently altered to incorporate orthographic information (such as the consonantal status of /w/ in the present study), which is inevitably processed by the phonological system of literate speakers; the effects of this incorporation may be observed phonetically. However, our data may also be understood as showing that a new phonological category has been created based on orthography, i.e. the consonantal glide /w/, rather than showing a mere restructuring of a previously stored phonological representation of labiovelar glides. According to our study, literate Italian native speakers include two labiovelar glides /w/ in their phonological inventory, a consonantal and a vocalic one. These two glides may recur within the same segmental neighborhood, as in /sw$_c$aˈili/ 'Swahili' and /sw$_v$aˈdɛnte/ 'mellow', /sˈw$_c$ing/ 'swing' and /ˈsw$_v$it/ *suite*, as well as /sˈw$_c$ɔʧ/ 'Swatch' and /ˈsw$_v$ɔno/ 'sound' (in these examples, 'w$_c$' and 'w$_v$' stand for consonantal and vocalic glides, respectively).

Further research is certainly warranted to gain a deeper understanding of the mechanisms underlying orthographic influence on phonological processing. Specifically, more investigations are needed to enhance our comprehension of the nature of phonological representations.

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