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6. Characteristics, causes and implications of orthographic effects on L+ phonology

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Chapter six discusses the findings of the project, their significance and implications. Results are briefly summarised and their significance is discussed. Then, orthography-induced gemination is presented as a peculiar OE that differs from effects previously reported in the literature on OEs, and as a peculiar phonological phenomenon that differs from phenomena previously discussed in the literature on L+ phonology. The next section discusses how a consonant length contrast can be established in the absence of supporting evidence in the spoken input. Finally, implications are discussed for theory (linguistic relativism, bilingual cognition, L+ phonology and cognitive psychology), research methodology, and language teaching practice.

Chapter six discusses the findings of the project, their significance and implications. After summarising the project's findings, this chapter discusses what such findings tell us about orthography, phonology and their interaction, and how orthographic and auditory input contribute to establishing and reinforcing L+ phonological forms. Finally, implications are discussed for theory (linguistic relativism, bilingual cognition, L+ phonology and cognitive psychology), research methodology, and language teaching practice.

Summary and significance of findings

Summary of findings

The project's main finding is that orthography can lead plus language (L+) speakers to make a phonological contrast that is not attested in the phonological system of the target language. This affects L+ learners' and users' L+ phonological systems – which feature a contrast that is unattested in the phonological systems of native speakers of the target language – and phonological lexicons – which feature mental representations of words containing a sound that is not attested in the target language.

Results show that Italian native speakers of English as a plus language ($English_{L+}$) make a contrast between a singleton consonant category and a geminate consonant category in their $English_{L+}$ phonological systems. This singleton-geminate phonological contrast is unattested in native Standard English. It corresponds to the letter-doublet (double letters) orthographic contrast in the English orthographic system, connected by <C>-/C/ and <CC>-/C:/ grapheme-phoneme correspondences, whereby a consonant letter represents a singleton and a consonant doublet represents a geminate.

Italians' $English_{L+}$ phonological system therefore has two phonological categories that correspond to the same phonological category in native speakers' phonological systems. This is not simply a phonetic longer duration of a consonant, it is actually contrastive, as shown by the existence of minimal pairs in perception and production. What are phonetic variants in the native speaker's mind actually contrast lexical items in the $Italian_{L1}$-$English_{L+}$ speaker's mind.

This phonological contrast affects Italians' English$_{L+}$ representation and processing. (1) Looking at representation, Italians' mental lexicons feature English$_{L+}$ phonological words that contain a geminate. This happens because Italians phonologically recode the orthographic forms of an English consonants as a singleton the consonant is spelled with a letter, or as a geminate if it is spelled with a doublet. This can even result in homophones being perceived and produced as a minimal pair (two different spoken words, one containing a singleton and one containing a geminate), if the homophones are spelled with single letter versus doublet. This contrast is lexically encoded, meaning that it is encoded at the level of single words, depending on their spelling. (2) Looking at processing, consonant gemination was consistently found in Italians' speech production, speech perception, awareness and learning, and it persisted in spite of lengthy naturalistic exposure and even of a teaching intervention.

To summarise, English$_{L+}$ gemination happens because:

- the English writing systems has allographs, as the same consonant can be represented with a single consonant letter <C> or double consonant letters (doublet) <CC>
- the Italian phonological system contrasts singleton consonants /C/ and geminate consonants /C:/
- the Italian writing system represents singletons with a single consonant letter (<C>=/C/) and geminates with a consonant doublet (<CC>=/C:/)

This results in a discrepancy between English GPCs and Italians' English$_{L+}$ orthographic knowledge. This discrepancy has a number of consequences:

- Italians' English$_{L+}$ phonological systems (their mental representations of English phonology) contain length as a feature of consonants, contrasting consonant pairs such as /n/ and /n:/
- Italians' English$_{L+}$ orthographic knowledge includes a <CC>=/C:/ grapheme-phoneme conversion rule, whereby a consonant doublet represents a geminate consonant
- Italians' English$_{L+}$ mental lexicons contain English$_{L+}$ word representations that feature a geminate, such as [ˈfɪnːɪʃ]
- if the mental representation of an English$_{L+}$ word contains a geminate, this affects all aspects of that word's processing, so that the consonant is perceived, produced and categorised as a geminate.

The next sections list the project's findings with regards to each of the research questions presented in Chapter 3.

Research questions and related findings

Table 6.1 shows the outcome for each of the research questions listed in Table 3.1. In summary, Italian$_{L1}$ speakers produce singleton and geminate consonants in English$_{L+}$, depending on consonant spelling, namely single letter or double letters (Question 1). However, their English$_{L+}$ geminates are about 1.5 times as long as the corresponding singletons, that is to say shorter than their Italian$_{L1}$ geminates, which are about twice as long as the corresponding singleton. Italians' English$_{L+}$ gemination is lexically contrastive (Question 2), as they produce minimal pairs that are distinguished only by the duration of a consonant, and there is no overlap in the durations of their singleton consonants and corresponding geminates. There appear to be predictors of gemination in Italian$_{L1}$ speakers' English$_{L+}$ speech production (Question 3), in particular higher English$_{L+}$ proficiency seems associated with lower degrees of gemination, and an L1 geminated cognate seems associated with higher degrees of gemination in English words. However, results were not neat and more research is needed. In particular, the effects of naturalistic exposure were unclear as differences between instructed learners and UK-based late bilinguals were inconsistent. Italian$_{L1}$ speakers categorise the same English$_{L+}$ consonant as singleton or geminate

depending on its spelling (Question 4), as they reject rhymes where the same consonant is spelled with a single letter or a doublet such as *very-merry*, and explain that the two words contain different consonants because one is long. Italian$_{L1}$ speakers also perceive the same English$_{L+}$ consonant as singleton or geminate, depending on its spelling (Question 5), as they believe they perceived different sounds in homophones such as *finish-Finnish*. Interestingly, there appears to be a correlation between perception, production and categorisation of geminates (Question 6), meaning that English$_{L+}$ speakers show similar levels of gemination across different L+ phonological processes. Looking at lexical learning, Italian$_{L1}$ learners of English$_{L+}$ learn new spoken English words as containing a geminate if exposed to word spelled with a doublet (Question 7), and just few exposures are sufficient. Only one prediction was not supported by results: learning that English has no contrastive consonant length does not reduce Italians' production and categorisation of geminates (Question 8). However, more research is needed before ruling out that teaching can reduce orthography-induced gemination.

Table 6.1. *Project's research questions and findings*.

Aspect of phonology	Research Question	Findings
Production	**Q1.** Do Italian$_{L1}$ speakers produce singleton and geminate consonants in English$_{L+}$, depending on consonant spelling?	✓
	Q2. Is Italian$_{L1}$ speakers' English$_{L+}$ gemination lexically contrastive?	✓
	Q3. Are there predictors of gemination in Italian$_{L1}$ speakers' English$_{L+}$ speech production?	✓
Awareness	**Q4.** Do Italian$_{L1}$ speakers categorise the same English$_{L+}$ consonant as singleton versus geminate, depending on its spelling?	✓
Perception	**Q5.** Do Italian$_{L1}$ speakers perceive the same English$_{L+}$ consonant as singleton or geminate, depending on its spelling?	✓
All	**Q6.** Is there a correlation between perception, production and categorisation of geminates in English$_{L+}$?	✓
Learning:	**Q7.** Lexical learning: Do Italian$_{L1}$ speakers learn new spoken English words as containing a geminate if they learn it with a double-letters spelling?	✓
	Q8. Phonological learning: Does learning that English has no contrastive consonant length reduce Italians' production and categorisation of geminates?	✗

Significance of findings

Two aspects of this project's findings constitute new contributions to the field of orthographic effects (OEs) on L+ phonology. Findings provide the first experimental evidence of an L+ phonological contrasts that is not attested in the target language, and the first systematic empirical evidence that the same OE affects all aspects of L+ phonology. Finally, this was the first evidence that participants' views, elicited through qualitative methods, can confirm and explain OEs.

An unattested phonological contrast. This was the first study to investigate and demonstrate experimentally a phonological contrast in the phonological systems of L+ speakers that is not attested in the phonological systems of native speakers. This is novel, because L+ phonology research investigates the acquisition and processing of the phonological contrasts of the target language, not of phonological contrasts that are not attested in the target language.

Prior to this project, the available evidence was limited to anecdotal evidence and non-experimental studies of beginners. These do not constitute evidence of an L+ phonological contrast. An unpublished report of a descriptive study of English$_{L+}$ pronunciation errors in a small group of Italian first-year primary-school children remarked

that children read aloud the word *apple* with a long [p] (Browning, 2004). This was one word in early beginners with minimal exposure to the target languages. A study of the production of stop consonants in Spanish$_{L+}$ beginners (Zampini, 1994) found frequent substitutions of [b] with [v] in words spelled with <v>, although in Spanish [v] is not attested as either a phoneme or allophone, and <v> is an allograph of <b>. This was not an experiment, and this substitution may simply reflect an early stage in L+ phonological development, as it was more frequent among first- than second-year students, and in reading aloud than in conversation, and was also later demonstrated experimentally in naïve listeners upon first exposure to Spanish (Rafat, 2016). This project then provided both the first experimental evidence and the first evidence from experienced L+ speakers, showing experimentally that orthography can lead L+ speakers beyond the very early stages to make a categorical distinction between two L+ sounds that belong to the same category to a native speaker.

A pervasive orthographic effect. The project provides the first systematic empirical evidence that the same OE is found across all aspects of L+ phonology — perception, production, awareness and learning. Consonant doublets in orthographic words result in illusory perception of geminates in speech perception, production of geminates and singletons in reading-aloud and in speech production, categorisation of the same consonant as geminate or singleton in awareness tasks, and the learning of new words as containing a geminate. Previous OE studies mostly focused on production or perception, or occasionally awareness, with various studies of lexical learning. The same OE was sometimes studied more than once in replications or extensions of previous research, but there was not a single study that investigated the same OE across all phonological processes.

The importance of participants' views. Finally, this was the first study to elicit participants' views to confirm and explain an OE. Previous experimental research had never asked participants their thinking about the OE. Rather than assuming that participants were perceiving and producing geminates, this study elicited their views. Participants' views indeed confirmed the researchers' interpretation of their experimental findings. It is then to be hoped that future research will include this type of qualitative data.

Confirming and extending previous research on orthographic effects

This section discusses the characteristics and peculiarities of orthography-induced gemination vis-a-vis other previously reported orthographic effects (OEs), while the next section looks at previous research on L+ phonology. English$_{L+}$ gemination aligns with other OEs in that it falls under the category of L1-influenced unattested GPCs, and it meets Bassetti's (2008, 2023) criteria for identifying OEs, confirming both the orthographic nature of English$_{L+}$ gemination and the validity of Bassetti's criteria. Yet, English$_{L+}$ gemination also differs from previously reported OEs, crucially because it results in a L+ phonological category that is not attested in the target language, but also because it affects a whole class of consonants, and the outcome sounds are in-between the L1 and L+ sounds. Finally, the section discusses studies by other scholars that found the same OE in native speakers of different L1s, confirming the present findings.

English$_{L+}$ gemination is a sound substitution caused by an L1-induced unattested GPC

Looking at the classification of OEs in Chapter 2, L+ gemination can be classified as a sound substitution. For instance, [n:] is substituted to [n]. This is not an unusual finding, as substitutions are the most frequently reported OEs in the literature.

The cause of English$_{L+}$ gemination is an *L1-influenced unattested GPC* (see Chapter 2). It is unattested, because this GPC is not present in native speakers' orthographic knowledge, as English natives do not recode doublets as geminates. It is L1-influenced, because – as is often the case with this type of GPCs – it originates in an incongruence between the GPCs of the L1 and the L+. This L1-L+ incongruence results in a difference between the GPCs of the English writing system on the one hand, and the orthographic knowledge in the minds of Italian$_{L1}$-English$_{L+}$ speakers. In English, single letter <C> and doublet <CC> are homographs – different written forms of the same phoneme /C/. However, Italians' English$_{L+}$ phonological system has two phonological categories that correspond to the same phonological category in native speakers' phonological systems.

English$_{L+}$ gemination is an orthographic effect

Gemination in English$_{L+}$ meets all of the criteria proposed by Bassetti (2008, 2023) to determine the orthographic nature of an L+ phonological phenomenon. As a general principle, an OE should have an orthographic explanation, and should not be explainable in terms of phonology alone. English$_{L+}$ gemination meets all the criteria as follows.

1) *Attributable to orthography*. English$_{L+}$ can be explained by orthography, because in Italian$_{L1}$ a consonant doublet represents a geminate.

2) *Not solely attributable to L1 phonology or the L1 phonological lexicon*.

L1 lexical gemination is a necessary condition – obviously if there was no gemination in the L1, there would not be gemination in the L+ – but is not a sufficient condition. English$_{L+}$ gemination cannot be explained solely by the following:

(2a) Italian phonology (phonological categories, phonological contrasts or phonotactic rules). As evidence, singletons can occur in the same contexts where geminates are produced (for instance both [n] and [nː] are possible in [fɪ_ɪʃ]), Italian$_{L1}$ speakers who acquired English$_{L+}$ early and naturalistically do not geminate in correspondence of doublet spellings (Repetti, 2009), and Italians tend not to geminate in new spoken English$_{L+}$ words they have learnt without exposure to orthographic forms.

(2b) the phonological form of L1 cognates. As evidence, gemination is found in English$_{L+}$ CC-words with no Italian$_{L1}$ cognate (*kitty*) or with a cognate that contains a singleton, such as *pepper*, in Italian *pepe*). An Italian$_{L1}$ geminated cognate is not necessary for gemination to occur (if anything, it may make gemination stronger, but the evidence is not conclusive).

3) *Not solely attributable to other phonological factors*: the phonology of the L+, its acquisition, or universals of phonological development:

3a) L+ phonology. Contrastive length is not attested in English$_{L1}$ speech (for a detailed discussion, see 'How phonological input can reinforce gemination in L+ lexical representations' below)

3b) characteristics of phonological development. Gemination is not attested in English$_{L1}$ infants' language acquisition (or indeed Italian-English early bilinguals)

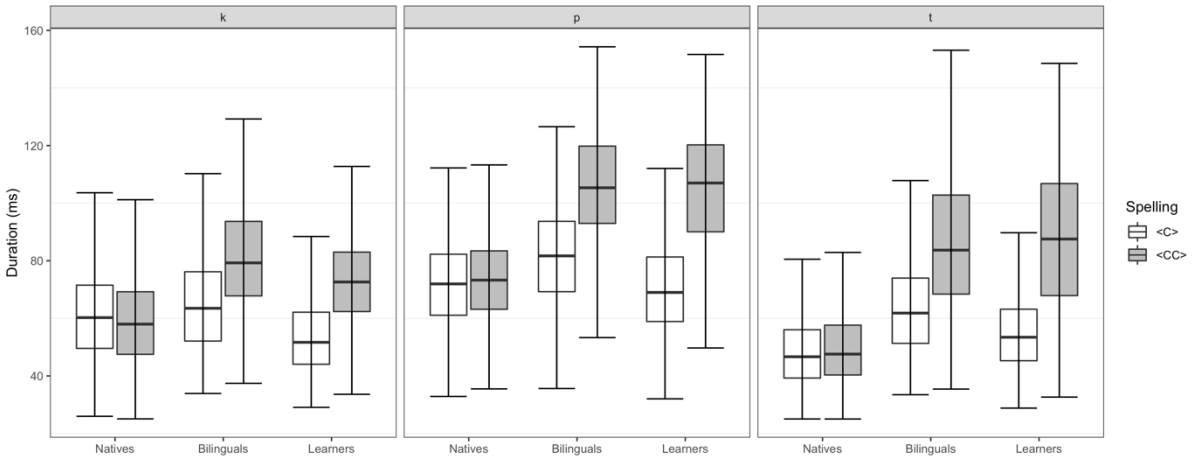
3c) universals of phonological acquisition. Gemination is marked — relatively rare among world languages (it featured in less than 4% of the languages surveyed by Maddieson, 1984) — hence unlikely to emerge in phonological development.

English$_{L+}$ gemination is a peculiar orthographic effect

Orthography-induced gemination is also peculiar within the OE literature. First, the outcome is the substitution of an L+ sound with a sound that is not attested in the L+ phonological system of the language. Second, the sound that is produced is in-between an L1 and an L+ sound. Finally, the cause is not a single GPC, but the correspondence between an orthographic feature and a phonological feature, which results in various unattested GPCs.

The outcome contrast is not attested in native phonological systems. Unlike all previous findings in the literature, the present OE results in a contrast that is not attested in English natives' perception, production and awareness (see 'Significance of findings' above). So far, research has documented sound substitutions whereby a target sound is replaced with another L+ sound – [d] for [t], [b] for [β] – or L+ allophone – [t] for [ɾ] (see Chapter 2). As Figure 4.3 shows, English native speakers did not produce either a singleton-geminate contrast, or consonants as long as Italian's English$_{L+}$ geminates. The sound produced by Italians is not an English sound or allophone, but a sound that is not attested in native speakers' production, where such long consonants were not found. These long consonants are only a different sound in the phonological system of Italian-English speakers and in the Italian variety of English (see 'The phonological inventory of Italian English' below).

Figure 4.3. *Singleton and geminate durations across the three production experiments*



The outcome sound is in-between an L1 and L+ sound. The outcome sound is unattested not only in English speech, but also in native Italians' speech, as Italians realise English$_{L+}$ geminates with half of the durational difference between Italian singleton and geminate consonants (Bassetti+, 2018). This project found a mean CC:C ratio of 1.33 in bilinguals and 1.55 in learners (see Chapter 4), whereas geminates are twice as long as their singleton counterparts in the participants' native variety of Roman Italian (Esposito & Di Benedetto, 1999). Indeed, Bassetti and colleagues (2018) directly compared participants' production of intervocalic geminates in Italian$_{L1}$ and English$_{L+}$, and found that geminates were more than twice as long as corresponding singletons in Italian$_{L1}$ (mean CC:C ratio = 2.47), but only about 1.4 times as long as singletons in English$_{L+}$. The duration of Italians' English$_{L+}$ geminates is then in-between the durations of L1 geminates and L+ consonants.

The cause is not a single GPC. Orthography-induced gemination does not happen at the level of a grapheme-phoneme correspondence, but at the level of orthographic and phonological features, which affect a whole class of GPCs, as Italians establish a correspondence between the orthographic feature [±double] in their English$_{L+}$ orthographic knowledge and the [±long] feature in their English$_{L+}$ phonological systems. This is a special case of L1-L+ orthographic incongruence, as the incongruent written representation of length, where doublets represent gemination in the L1 but not in the L+, affects a whole set of consonants. This is a rare finding in the literature; only Barrios and Hayes-Harb (2020) looked above the level of GPCs, as they argued that orthography-induced voicing of word-final stops in German$_{L0}$ is an effect of orthography on a phonological process rather than a phonological category. The present findings show effects of orthography on a class of consonants rather than a single phoneme.

Further evidence: Beyond Italian$_{L1}$-English$_{L+}$ speakers

Finally, it should be noticed that this project's first findings led to a number of studies by other researchers that investigated – and confirmed – orthography-induced L+ gemination. These results show that orthography-induced gemination is not limited to L+ English but also appears in L+ French, and it is found in L1 speakers of some languages other than Italian.

The first two studies, which both appeared in 2018, were led by two postdoctoral fellows on this project. Sokolović-Perović, in collaboration with the present author and a graduate student (Sokolović-Perović+, 2020), used the same task as Bassetti (2017), and found gemination in the consonant production of Japanese$_{L1}$-English$_{L+}$ speakers living in the UK. In the same year, a conference presentation by Mairano and colleagues (Mairano+, 2018b) found gemination in Italian$_{L1}$ university students of French, another language that has no lexical gemination.

Orthography-induced gemination was then also found in Jordanian Arabic$_{L1}$ speakers of French$_{L+}$ (Nawafleh, 2022), and in Korean$_{L1}$ but not in Farsi$_{L1}$ speakers of English$_{L+}$, possibly because Farsi has a less transparent writing system (Rafat+, 2021). Finally, Mitterer (2021) found no evidence of gemination in Maltese$_{L1}$-English$_{L+}$ early bilinguals using Bassetti's (2017) task, probably because early bilinguals are not influenced by orthography.

These studies only investigated production, so this project's evidence from perception, awareness and learning will need to be replicated. An interestingly exception is Nawafleh (2022), who also investigated perception, and found that Arabic$_{L1}$ listeners indeed perceive English$_{L+}$ geminates produced by fellow Arabic$_{L1}$ speakers as geminates, although this may be due to the effects of orthography on their perception rather than the actual duration of the consonants they heard. Overall, these findings suggest that orthography-induced L+ gemination is widespread beyond the Italian$_{L1}$-English$_{L+}$ population.

Extending previous research on L+ phonology

The consonant length contrast in English$_{L+}$ is a peculiar phenomenon within the L+ phonology literature, as it is a rare case of two-to-one categories scenario. Furthermore, it is persistent in spite of being arguably not particularly difficult to acquire, and it arguably results in differences between the phonological inventories of Standard English and Italian English.

The two-to-one category scenario

The project revealed a scenario that that has not received attention in L+ phonology research: The L1 has two phonological categories that align with one category in the L+. Both theory and empirical research so far focussed on L+ phonological contrasts that align to one category in learners' L1.

The typical scenario — where the L1 has one category corresponding to singleton and geminate in the L+— causes difficulty in both learning and processing L+ consonant length contrasts, which L+ listeners cannot perceive. This is well established across languages, including Italian$_{L+}$ (De Clercq+, 2014; Sorianello, 2014). In this scenario, L+ learners have difficulty perceiving length, tend to have fuzzy rather than categorical boundaries and when they do have categorical boundaries these do not coincide with native's boundaries

This study reveals the opposite: It is not the presence but the absence of durational contrasts that is hard to perceive. It appears that it is difficult to ignore or unlearn an L1 phonological contrast that is not attested in the L+, both among learners and experienced users. Implications for models of L+ phonological development are discussed below. At any rate, these results are novel in that they reverse the usual approach in L+ phonology research.

The persistence of orthography-induced gemination

Given that training usually has a positive impact on L+ phonology, the lack of effects of this project's intervention may indicate that OEs are more resistant to change than other factors — such as the effects of L1 phonology — that are not reinforced by orthographic input. This is an unknown, given that no other study has investigated the impact of training on L+ OEs.

The intervention reversed the usual approach to L+ training. Interventions usually train L+ speakers to notice differences they learned to ignore in the process of L1 phonological acquisition, which are needed to discriminate L+ sounds. Conversely, this project's intervention trained L+ speakers to unlearn to discriminate, ignoring a difference that is relevant to L1 but not L+ phonology.

Training has positive effects on L+ consonant length contrasts in the usual one-to-two scenario (no length contrast in the L1, two length categories in the L+), for instance in Japanese$_{L+}$ (Sadakata & McQueen, 2013), but did not impact this arguably easier two-to-one scenario. Various explanations are possible, including perhaps issues with the design or implementation of the intervention, but it is also possible that orthography-reinforced effects are more resistant to change than purely linguistic effects. This point was made by Mairano and colleagues (2018a) in their comparison of VOT and gemination in Italians' English$_{L+}$ production. To address this issue, future research should further test the effects of teaching, possibly comparing its effects on similar L+ phenomena, only one of which is caused by orthography.

The phonological inventory of Italian English

In light of these findings, linguistic descriptions of the phonological repertoire of Italian English should then include the feature of consonant length. If one embraces the view that phonological repertoires should include separate phonological categories for singletons and their corresponding geminates, then the Italian variety of English would have a much larger number of consonant categories compared with standard varieties of English.

This consonant length contrast is only found in the Italian variety of English used in Italy, not in the English of Italian emigrant communities in English-speaking countries. Repetti (2009) found no orthography-induced gemination in the Italian community in Canada, whose gemination was non-lexical, caused by phonological processes, and unrelated to consonant spelling.

Explaining orthography-induced gemination: The orthography-phonology interface

This section argues that there may be sources of reinforcing evidence, other than orthographic input, that may explain the persistence of orthography-induced English L+ gemination in Italian speakers, despite the lack of durational differences in target-like spoken input. The proposed sources include: 1) targetlike input (produced by L1 or L+ speakers), 2) non-targetlike input, and 3) other sources. Specifically, reinforcing evidence may include: 1a) the strategic ignoring of target-like spoken percepts, 1b) the misperception of spoken input due to orthography, 1c) the presence of non-contrastive gemination in target-like speech, 1d) the absence of negative evidence, 2a) gemination in non-target-like input produced by native speakers of Italian or other geminated languages, 2b) gemination in the L+ speaker's own output, and 3) sources other than English language input. The proposed sources of evidence are not mutually exclusive, and more than one may be at play. A more detailed discussion follows.

1a. Strategically ignored targetlike spoken input

Italian$_{L+}$ listeners may overextend a successful strategy for L+ listening, namely relying on orthography and ignoring their own percepts. This strategy is successfully

employed by L+ listeners who cannot perceive a phonological contrast. For instance, English$_{L+}$ listeners who cannot discriminate two English vowels can ignore their perceived similarity and rely on vowel spellings to identify the correct vowel (Escudero+, 2008), as indeed Italian$_{L1}$-English $_{L+}$ listeners do (Piske et al., 2002; Bassetti+, 2018, 2020). Italian$_{L+}$ listeners who cannot perceive Italian$_{L+}$ consonant length contrasts can ignore the perceived similarity and rely on consonant spelling to distinguish geminates and singletons. Italian$_{L1}$-English$_{L+}$ listeners, who cannot perceive a durational difference in English$_{L+}$ consonants because there is not one, may erroneously adopt the same strategy.

1b. Corroborating evidence: orthography-influenced intake

L+ listeners' phonological intake may provide evidence of gemination even though it is not present in their input, due to orthography-induced misperception of the spoken input. Italians illusorily perceive geminates in English native input because of top-down influences caused by the orthographic form of words, for instance perceiving [fɪnɪʃ] as [fɪnːɪʃ]. Hence, a geminate that is not present in the spoken input may be present in the L+ listener's intake.

1c. Corroborating evidence: Non-contrastive gemination in targetlike speech. Italians may erroneously attribute a phonological status to the false gemination present in native or non-native targetlike English speech (longer consonants at morpheme boundaries in compounds and derived words such as *top pick, unnamed;* see 'Consonant length in English' in Chapter 3). Italians may for instance consider the shorter and longer [p] in *topic-top pick* as evidence of lexical gemination.

1d. Corroborating evidence: Lack of negative evidence. Lack of negative evidence can also constitute corroborating evidence. Unlike vowel duration, gemination does not result in either communication disruptions or feedback from interlocutors. If Italians produce a long vowel in *ship*, their interlocutor may hear *sheep*, triggering miscommunication, which can result in noticing the gap (between what the speaker wanted to say and what the interlocutor understood) or receiving feedback. However gemination is unlikely to affect intelligibility, because geminates and singletons are allophones to listeners with no L1 contrastive consonant length.

2a. Gemination in non-targetlike input. Gemination may be frequent and salient in non-targetlike input, produced by native speakers of Italian and of other geminated languages. It is probably frequent for instructed learners who interact with peers, or those living in an English-speaking environment who interact with native speakers of geminated languages, including Arabic, Japanese and Korean. Italian listeners would find it salient because it has a contrastive function, allowing them to differentiate for instance *aloud* from *allowed*.

2b. Gemination in own (overt and covert) output. Gemination is also present in the L+ speaker's own output. This constitutes input too, and includes overt speech production, inner speech (talking to oneself in one's mind) and silent reading.

3. Other sources of evidence. There may be other sources of indirect evidence of contrastive consonant length, including gemination in English loanwords to Italian, and English vowel duration which is contrastive to Italians. Sources of indirect evidence for contrastive consonant length include gemination in English loanwords to Italian, and English vowel duration that is contrastive for Italians. Clarification of the relationship between loanword phonology and L+ phonology, as well as between vowel and consonant length, is necessary to determine whether these sources provide supportive evidence.

In summary, orthography-induced gemination is evidence of the complex relationship between orthographic and auditory input. While orthography is the main cause and reinforcement of gemination in English$_{L+}$, this section speculated that various types of non-orthographic input may also reinforce gemination. This is all speculative but testable.

Implications

This final section discusses the implications of the project's findings for theory, methods and practice. Looking at theory, the project mostly contributes to theorising in linguistic relativism and bilingual thought, but also has implications for models of L+ phonological development and for cognitive psychological research on language representation and processing. Looking at methodology, the project demonstrates the importance of qualitative research in L+ phonology, contributes tasks and materials, and provides indications for future research. Finally, looking at practice, the project shows that language teachers need to be aware of OEs but should not yet draw conclusions for classroom practice.

Theoretical implications

Implications for linguistic relativism and bilingual cognition

Whether the languages we know affect our thinking is one of the most fundamental questions in the study of language and cognition, and the question behind all my research, including this project. As stated in Chapter 3, the project was theoretically grounded in linguistic relativism and multi-competence. Results support and expand linguistic relativism research by showing that language affects categorisation. It is argued that the categorisation both of language sounds and of continua provide good evidence of linguistic relativity, and that not only spoken but also written language affect thought. Results also support multi-competence, showing that knowledge of more than one language affects thinking about language.

Language as evidence of linguistic relativity. The study supports linguistic relativity, because the same perceptual stimulus (a linguistic sound) was categorised differently by English speakers and Italian-English speakers. Effects were found in both explicit categorisation – rhyme judgment and related open questions – and implicit categorisation – the perception task, and arguably the word repetition tasks.

Researchers have been debating whether effects of language on thinking about language count as evidence of linguistic relativity. While some objected that these are not effects of 'pure' linguistic relativity, there is no obvious difference between categorising linguistic sounds based on their (perceived) duration, and categorising colours based on their brightness (perceived luminous intensity), or non-linguistic sounds based on pitch. Indeed, language is possibly the cognitive domain where effects of language are easiest to show and evidence of linguistic relativity more plentiful (see Bassetti & Filipović, 2022).

Written language as a source of linguistic relativity effects. The effects were due to written rather than spoken language. This shows that linguistic relativity effects can be multi-modal, with the written modality affecting the spoken modality. This study then contributed to a long line of evidence that written language affects diverse aspects of linguistic and non-linguistic cognition, from concepts of phoneme and word, to the directionality of time and the recognition of facial emotion (Bassetti & Cook, 2011). While the phonological categories of native languages are based on first language speech perception, and alphabetic literacy only brings them to consciousness resulting in phonemic awareness (Cook & Bassetti, 2005), the phonological categories of L+s reflect not only L+ speech perception, but also L1 perception and the written representations of the L+.

The categorisation of continua as evidence of linguistic relativity. The study also confirms that the categorisation of continua can provide strong evidence of linguistic relativity. Language often affects the categorisation of a continuum, including the number of categories and categorical boundaries. For instance, speakers of different languages divide the colour spectrum into different colour categories, and have different prototypes and

boundaries for their colour categories. Looking at speech sounds, speakers of different languages divide the same acoustic continuum into different categories — such as English /r-l/ versus the Japanese single liquid category — or have different categorical boundaries – for instance between /b/ and /p/ on the voice onset time continuum. This study indeed shows that Italians divide the English consonant duration continuum into two phonological categories, and English speakers do not.

Linguistic relativism and the multi-competent user of more than one language. Finally, results confirm that bilinguals think differently than monolingual speakers of their two languages, supporting the tenets of multi-competence. Among the four types of bilingual concepts proposed by Bassetti & Cook (2011), English geminates belong to the 'one-integrated-concept' type, that is to say a concept that falls in-between an L1 and an L2 concept. A typical example is English-Greek bilinguals' concepts of 'blue' which is darker than L2 *blue* and lighter than L1 *blu*. Similarly, the Italian-English speaker's concept of geminate is shorter than an L1 geminate and longer than an English consonant.

In a more traditional approach, Italians' English$_{L+}$ gemination may be considered evidence of cross-language transfer. Yet, this is not transfer, because a new, in-between category is created, and because this category plays a function in the Italian variety of English, allowing Italians to distinguish minimal pairs in English in speech production (and future research could investigate whether it also facilitates the recognition of English$_{L+}$ words spoken by fellow Italians).

Implications for models of L+ phonological development

Findings raise issues that should be addressed by models of L+ phonological development. It is argued that two models that inspired most empirical research — PAM-L2 and SLM-4 (see Chapter 1) should consider that orthography affects auditory input, and include the two-to-one phonological category scenario.

SLM-r (Speech Learning Model revised, Flege & Bohn, 2021), which aims at modelling naturalistic L+ speech learning, should consider that orthography is likely to affect naturalistic learners too, for the reasons discussed in 'Explaining orthography-induced gemination: The orthography-phonology interface': Gemination is present in the English$_{L+}$ speech produced by native speakers of geminated languages, and intake can include gemination even when not present in the input. Finally, as Young-Scholten (2015) argued, naturalistic learners may not be exposed to written language in the classroom but are still exposed to environmental written language. Double letters in the linguistic landscape will be recoded as geminates by Italian naturalistic learners of English who are literate in Italian. Hence SLM-r, which acknowledges the role of accented spoken input in naturalistic exposure, should also include orthography-influenced auditory input, and also orthographic input.

PAM-L2 (Perceptual Assimilation Model, Best & Tyler, 2007), which aims at modelling the acquisition of L2 contrasts, could add one more pattern of assimilation. The model includes three patterns of assimilation of two L+ contrasting sounds, depending on the number of L1 sounds: Single-category, two-category, and uncategorised (respectively, the L1 has one, two or no categories corresponding to the two L+ contrasting sounds). It could then add a pattern of assimilation whereby the two contrasting sounds are in the L1, and the L+ has only one category, to cover situations where learners establish an L+ phonological contrast that corresponds to two L1 categories and one L+ category, as in Italians' pattern of assimilation of English$_{L+}$ consonants to two length categories.

Furthermore, when discussing the different pattens of assimilation, the model could also consider the orthographic form of the sounds involved. Best and Tyler (2007) considered spelling as a factor in establishing the equivalence between an L+ and an L1 phonological

category, arguing that French$_{L1}$ learners may assimilate English$_{L+}$ voiced alveolar liquid [ɹ] and the very different French$_{L1}$ voiced uvular fricative /ʁ/ to the same phonological category /r/ partly because both are written as <r>. The model could then formally integrate orthographic forms among the sources of input.

Other models and approaches are not discussed here, but similar considerations would apply. In general, L+ phonology scholars should model the effects of orthography on L+ phonological categorisation. In conclusion, orthography-induced gemination, as other L2 OEs, can contribute to theorizing in L+ phonology.

Implications for language processing research: The locus of OEs

While this project was not intended to address the question of the locus of OEs, a few reflections are possible. Researchers investigating OEs in native speakers have long been debating the issue. Some argued that OEs are caused by the co-activation and conflict between orthographic and phonological representations during speech processing (Ziegler & Ferrand, 1998); others argued that orthographic forms affect phonological representations, and these orthography-influenced phonological representations in turn result in the observed OEs in speech processing (Muneaux & Ziegler, 2004; Taft, 2006). In the case of English$_{L+}$ gemination, the first approach predicts that the English$_{L+}$ speaker co-activates the orthographic representation of *Finnish* and the phonological representation [fɪnɪʃ], and the conflict results in [fɪnːɪʃ]; the second approach predicts that the written form <finnish> is recoded as [fɪnːɪʃ], resulting in the phonological representation [fɪnːɪʃ] that in turn leads to the production of [fɪnːɪʃ].

It is argued that L+ OEs are most likely caused by orthography-influenced phonological representations, for instance orthography-induced English$_{L+}$ gemination is most likely caused by a phonological representation that contain a geminate. This is because L+ speakers are exposed to copious orthographic input in the absence of a mature phonological system or native-like phonological representations, and often learn L+ words mostly – or even exclusively – from written input, and as shown in this book they learn English$_{L+}$ words containing a geminate after very limited exposure to a word spelled with a geminate.

However, the effects of orthography-influenced L+ phonological representations may be compounded by the co-activation of L+ orthographic forms. The CC-word's orthographic representation may be co-activated during speech processing, and its doublet, phonologically recoded using a <CC>=[Cː] correspondence, could reinforce the geminate already present in the phonological representation of the word.

This project cannot contribute to the debate on L1 OEs, because it was not designed to test these two proposals, and more importantly because theories developed to account for L1 OEs should not be assumed to explain L+ OEs, and vice versa. This is because there are huge differences in the nature of OEs in L1 and L+ speakers: There are qualitative differences, because some OEs reported in chapter 2 are only possible in those who know more than one spoken and written language, and quantitative differences, because OEs are likely more frequent and stronger in L+ speakers than in L1 speakers, who establish their phonological system and phonological representations well before learning orthography. Future research could compare orthographic effects in the L1 and in additional languages to clarify the relationship between the two.

In summary, this project shows that research on orthographic effects on speech sound categorisation can contribute to research on L+ phonology, linguistic relativism, bilingual cognition, and language processing.

Methodological implications

This study aimed at showcasing ways to address at least some of the methodological issues with OE research that have been discussed in the section on 'Characteristics of the project' in Chapter 3. The study contributed to the advancement of research methodology first of all by being the first research to investigate the effects of one orthographic phenomenon on perception, production, awareness, and phonological and lexical learning. It also introduced the use of qualitative data to support and explain experimental evidence of OEs. Finally, it created new tasks and msaterials for research on L+ phonology.

This was the first study of OEs in L+ phonology to include qualitative data to support and explain experimental results. The present author has argued elsewhere (Bassetti & Filipović, 2022) that qualitative evidence may be useful in confirming linguistic relativity researchers' interpretation of their experimental findings by adding an emic perspective to data collection and analysis.

This study also contributed a useful set of tasks and materials to study L+ phonology in any situation where most widely-used tasks cannot be used because the L+ sound under analysis is not attested in the target language. The delayed word repetition task (Bassetti, 2017; Bassetti+, 2020) will be useful to elicit words when it is not possible to use images (for instance, non-imageable words) and orthographic input should be avoided (as it would impact results). The consonant perception task (Bassetti+, 2021) will prove useful for testing the perception of sounds that are not present in the spoken input (not only geminates, but also for instance silent letters). The rhyme judgment task (Bassetti+, 2020) will be useful for research on phoneme or rime awareness. In terms of materials, word lists created for this project, and particularly the list of orthographic minimal pairs, will be useful for future research on gemination in L+ English, but can also be used to research the spelling of doublets. Furthermore, the study validated some of these tasks by showing a correlation between the awareness task and the production tasks, which is evidence of the validity of both tasks.

The study also shows that studying linguistic phenomena that do not occur in the English language can broaden horizons not only in theorising but also in methodology. Much of the methodological innovation described above came into existence because orthography-induced gemination in English had not been studied before: Tasks created to study discrimination of a phonological contrast were not suitable to study the illusory discrimination of a non-existing contrast; there were no word lists for comparing consonants spelled with letter or doublet. It is hoped that as OE research explores new phenomena, existing methods will find new applications, and new methods will emerge, to respond to the needs caused by investigating new language phenomena.

The study also addressed the previously mentioned (see Chapter 3) needs for sample sizes that provide sufficient power (based on power analysis), an interdisciplinary team with expertise in the various aspects of OE research (phoneticians, psychologists), and a declared theoretical background to provide testable hypotheses and explanations for results (in this case, linguistic relativity and multi-competence).

Limitations and areas for future research

Being an exploratory first study of a phenomenon (orthography-induced gemination), the project suffers from some limitations, which can be addressed in future studies.

Confounds. These are variables that co-occur with the predictor of interest, so that it is unclear whether it was the predictor or the confound or both that indeed caused the effect, or the predictor's effects may have mitigated by the confound. Looking at participants, the effects of naturalistic exposure were investigated by comparing sequential bilinguals living in the UK with instructed high-school students in Italy, but proficiency ad age of onset of acquisition were both confounds, because bilinguals had not only naturalistic exposure, but

compared with learners also had higher proficiency — which could have reduced OEs — and later age of onset — which could have strengthened OEs. Also, learners were tested in Italy and bilinguals in the UK, and gemination may be stronger when participants are tested in an Italian-speaking environment, compared with testing the same participant in an English-speaking environment. Looking at materials, all experiments involved between-items comparisons, meaning that differences between sets of targets and sets of controls could be at least partly due to intrinsic differences between the two sets.

Sample selection. Participants may not be representative of the populations of interest, because participation was voluntary, and this self-selected group may differ from the general population of English learners and users, for instance having a stronger interest in research or in language, or higher self-perceived proficiency. Indeed, learners in the perception study (which required knowledge of some less common words) had better vocabulary knowledge, higher proficiency and a higher proportion of spoken language input compared with typical high-school fourth-year students. A perception study that does not require this level of vocabulary knowledge may test learners with lower proficiency and may reveal stronger OEs. Also, all learners were fourth-year high-school students. Future research should investigate learners with different lengths of study, and in particular the intervention study may have been more successful in beginner learners. Furthermore, the strong OEs found in this study may be due to Italians' transparent native orthography, or perhaps to the traditional approach to English language teaching in Italian schools. Future research should investigate learners/users with other language combinations, including L1s and L+s with different levels of phonological transparency and with non-alphabetic writing systems, and different educational backgrounds.

Tasks and materials. Time and money limitations both prevented the use of more expensive technologies such as eye-tracking, and limited the amount of triangulation, so that awareness, perception, and minimal pair production were all investigated with just one experiment each. For instance, it would be interesting to investigate minimal pair production without orthographic input, and to investigate perception using a shadowing task to establish whether effects appear prelexically. Also, this study adopted almost exclusively an experimental approach, but future research could investigate gemination in real-life communication, to establish whether consonant duration is used to disambiguate homophones in everyday conversation, and if so whether it is used only with Italian$_{L1}$ interlocutors or also with natives. The study used not only objective measures (for instance for language proficiency), but also a number of self-reported variables, collected by means of ratings in questionnaires; future research could instead use objective measures. Finally, the study's findings generated new research questions that could not be investigated within this project, for instance future research could investigate the location of the singleton-geminate boundary in Italian English by investigating categorical boundaries in speech perception.

In conclusion, to make this study's results more generalisable, future research should disentangle the effects of confounds, investigate other types of speakers using different methods, and tackle the various new research questions that stemmed from the new evidence produced by this study.

Practical implications for language teaching

No recommendations for language teaching practice can be made based on a single intervention study that yielded null results, but some issues can already be addressed.

First, teachers of languages that are written with the roman alphabet — including English — should be aware that native speakers of languages that have gemination may geminate consonants in the L+. This issue is never discussed in materials aimed at English$_{L+}$ teachers. Whether this is an issue worth addressing will be the teacher's decision, depending

on the importance attached to accentedness. Teachers should decide what is the best pronunciation to teach to their students, in light of both current developments in L+ theorising, and what their students want. The present study found that Italian high-school students highly value a native-like pronunciation, and students' desires are an important factor for instructional decisions, albeit not the only one.

Second, in spite of the lack of results of the teaching intervention reported in Chapter 5, teachers may still explicitly teach L+ GPCs (called 'phonics' in English-speaking educational circles), in a way that is suitable for the linguistic and orthographic background of the students. One cannot conclude that training is ineffective just because a one-off half-hour intervention was not successful. In particular, we do not know whether GPC teaching may be effective earlier in the learning process, perhaps at the very beginning when English orthography is introduced. GPCs could be discussed in the context of learners' native phonology and orthography, based on the findings of research on orthographic effects or, if there is no research evidence, using a contrastive approach. Clearly, phonics lessons devised for English native children do not need to state that doublets do not represent long consonants, but this may help English$_{L+}$ learners whose L1 has geminates. Explaining that English doublets do not represent geminates may be useful regardless of whether the L1 uses doublets or other marks for gemination, as doublet-induced gemination was also found in Japanese speakers of English, whose L1 marks gemination with a different symbol. Teachers will need to wait for research to find out whether other types of training can help.

Third, teacher should not expect gemination to be reduced with more exposure to native-speaker input, such as study abroad or native-speaking teachers. Years of naturalistic exposure had no effects in this study's immigrants to the UK, possibly because they perceive geminates in English native-speaker input (Chapter 5)

It is too early to draw other conclusions. For instance, researchers proposed to teach words' phonological forms first, and introducing word spellings later (Rafat & Perry, 2019), but the proposal has not been tested. Indeed, it is not known whether, once established, a L+ lexical representation is robust enough that it cannot be modified by later exposure to orthographic forms, or whether it would be modified reflecting the word's spelling. This is an empirical question that is worth investigating. It is hoped that the rapidly increasing body of empirical evidence will provide answers to this and other issues related to the teaching of L+ phonology.

Envoy

The project reported in this book aimed at providing a blueprint for future research on orthographic effects on L+ phonology. The project made contributions to evidence, theory and methods, both within and beyond applied linguistics. It is hoped that this project will provide inspiration for researchers and language teachers to further explore this exciting topic.

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