ORTHOGRAPHY AND THE MENTAL LEXICON: THE EFFECTS OF ENGLISH SILENT LETTERS ON FRENCH LEARNERS

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ABSTRACT

Previous L2 research has shown that direct exposure to orthographic input increases orthographic effects in L2 speech. In our previous work, we demonstrated that French learners of English produce intrusive consonants in correspondence of silent letters when directly exposed to orthographic input. The present study investigates whether this persists when orthography is not provided. 91 French undergraduate students specialising in English and enrolled in various French universities performed a picture naming task and an AB audio preference task in which a phoneme had been added to each stimulus reflecting grapheme-phoneme correspondence (e.g., *[ˈsæ**l**mən] for *salmon*). Results clearly confirm the strong effects of spelling on L2 pronunciation and phonological representations, therefore disclosing that: (i) orthographic input modulates L2 phonological knowledge and (ii) that orthography is directly activated when producing and listening to speech in a second language.

Keywords: second language acquisition; effects of orthography; silent letters; speech production; L2 phonology

1. INTRODUCTION

It is common knowledge that language teachers rely on orthographic input as well as spoken input [1], and recently there has been growing interest in the interplay between orthography and phonology in second language (L2) acquisition. Recent research provides evidence that orthographic representations can affect – positively or negatively – L2 learners' speech and perception [2]. In this respect, various experiments have shown that providing orthographic input in addition to acoustic input can lead to more target-like sounds than providing acoustic input only [3], it can assist in discriminating phonological contrasts [4], and enhance word learning [3]. Nonetheless, it has been shown that it can also lead to non-target-like productions that would not have been produced as such without exposure to orthography [3], including phone additions, omissions and substitutions (cf. [2], [5] and [6], among others). These studies provide clear evidence that exposure to the orthographic forms can affect L2 production [7], metalinguistic awareness [8] and perception: work by Bassetti and colleagues has shown that orthography can cause the importation of a phonological category of the L1 (gemination) into the L2. Henceforth, it seems important to contribute to this field to comprehend orthographic effects on L2 speech production, perception and mental representations of L2 phonological forms.

Our previous work [9] replicated Bassetti & Atkinson's study [5] on silent letters but focussed on French learners of L2 English (N=110). We demonstrated that French learners' productions contained intrusive consonants in correspondence of silent letters in spelling (e.g.*[ˈkəʊm**b**], *[ˈkɒm**b**] or *[ˈkɔ̃**b**] for *comb*) in 47% of productions elicited via orthographic input during a read-aloud task.

The present study expands on our previous work and turns to the effect of silent letters on L2 learners' mental representations. In order to test whether silent letters affect L1 French learners' mental representations of L2 English words, we ran two tests: (i) a production task in which participants were not exposed to silent letters, and (ii) an AB audio preference task where participants had to select an A or B sound corresponding to a word illustrated via an image. A and B were either the standard spoken form of a word (e.g. [ˈbɒm] for *bomb*), or a version of the word with an added consonant reflecting grapheme-phoneme correspondence (e.g., *[ˈbɒm**b**] for *bomb*).

Additionally, we analyse the interplay of orthographic effects with acquisitional variables (English proficiency, stay abroad and length of study abroad, onset of L2 acquisition, number of languages spoken and the preferred English variety) and lexical variables (written vs spoken frequencies and cognate effects).

Our main hypothesis is the following:

1. intrusive consonants in correspondence of silent letters will be present, but less frequently than in our previous study, because this time orthography is not displayed.

Additionally, we also expect that:

2. words with high spoken frequency should be pronounced less often with intrusive

consonants in correspondence of silent letters, since learners will have heard more often the pronunciation of such words and consequently will have had more chances of storing the correct phonological version;

3. cognate words will not have any evident effects on the production of intrusive consonants in correspondence of silent letters, reflecting our previous findings;
4. the number of intrusive consonants pronounced by each participant in the production task in correspondence of silent letters will be correlated to the number of stimuli with intrusive consonants selected in the AB audio preference task;
5. acquisitional variables could interact with orthographic effects. We predict that less proficient learners and those who have had less exposure to native English input will more often pronounce intrusive consonants and select stimuli with intrusive consonants.

2. DATA AND METHODS

Our tests were hosted on a website and run remotely. This enabled us to: (i) gather a significant sample of participants (N=91), (ii) recruit participants from different parts of France, and (iii) compare the results with our previous study, which was run online on a similar platform.

2.1. Participants

Participants were 91 French undergraduate students (women=73, men=18; these figures are indicative of a gender bias typically present in the Departments of Foreign Languages in France) specialising in English in various French universities at BA level: 30 first-year, 19 second-year and 42 third-year students with no reported language or reading impairments, aged 18 to 65 (M=21, MD=20, SD=5.17). The median self-reported CEFR level of English was B2 and ranged from B1 to C2. 2 participants had one English-native speaker as a parent, but none of them claimed to be early bilinguals. On average, participants started to learn English at the age of 8 (MD=7, SD=2.46), and had been studying English for approximately 13 years. 12 participants (13%) had lived in an English-speaking country (the UK, the US, and New Zealand) with an average duration of 8.42 months (MD=7, SD=6.5). On average, participants spoke 3.37 languages (including French and English, MD=3, SD=1.05). Participation was voluntary and unpaid.

2.2. Tasks

Two tasks were developed for this study: a production task (a picture naming task, inspired by [10]) and a listening task (an AB audio preference task, inspired by [11], in which a phoneme had been added to each stimulus, e.g., *[ˈsæ**l**mən] for *salmon* via Mbrola resynthesis [12]). Before each task, written instructions were given in English.

In the picture naming task, participants were given an image and were asked to name it by recording themselves within a timeframe of 3 seconds. In order to make sure that participants would recognise each word correctly, a pilot study (N=10) was conducted. Considering that the experiment was performed remotely, a 'Retry' button was inserted, to be used in case of technical problems (but participants were advised to be spontaneous and refrain from using it for other than technical problems). A bar at the top tracked their progress through each task. Once they had named each of the forty stimuli, they could continue with the second task.

In the AB audio preference task, participants were provided with the same pictures along with two audio stimuli: one with the native pronunciation and one with an added or deleted consonant in correspondence of a silent letter (e.g., *[ˈbɒm**b**] for *bomb*, or *[ˈiːtʃ] for ***b**each*) via Mbrola resynthesis (using the British English voice). Stimuli such as *beach* with a deleted phoneme served as distractors. As for target words, we added a sound taking into account the duration of the preceding or following consonant (e.g., the added /l/ of *half* had the same duration as the adjacent /f/).

Participants were instructed to select the sound corresponding to the word pictured in the image. In order to do so, they had to press <w> on their keyboards to select the first sound or <n> for the second sound.

Finally, a follow-up test was performed to check the familiarity of participants with the orthography of target words: they were provided with the images along with the audios and had to spell out the target stimuli.

2.3. Stimuli

The target stimuli (cf. Table 1) were chosen considering three aspects: words with which French learners struggled the most in our previous work [9], that is, words in <mb> (e.g., *thumb*) and <al + C> (e.g., *almond*), the frequency of words containing silent letters and congruency with French cognates (e.g., *bomb*(EN)*/bombe*(FR)).

In addition, we considered lexical frequency in COCA (Am. Eng.) and BNC (Br. Eng.) because the

degree of exposure to different English varieties varies significantly among our participants.

Target	COCA	BNC
ha**l**f	219.35	294.66
i**s**land	99.49	99.1
clim**b**	50.17	59.81
bom**b**	53.33	43.33
knee	51.67	42.97
mus**c**le	42.81	37.66
colum**n**	36.82	42.41
wrap	44.76	25.62
knife	36.13	32.63
autum**n**	9.74	38.22
lam**b**	12.31	21.45
thum**b**	18.85	14.29
psychologist	18.43	13.23
sa**l**mon	14.29	14.07
bisc**u**it	5.35	15.62
tom**b**	7.91	8.75
com**b**	8.2	7.63
a**l**mond	5.87	5.49
cha**l**k	5.11	10.18
plum**b**er	3.27	2.86

Table 1: The series of 40 chosen words for the two tasks classified by total frequency extracted from COCA (Corpus of Contemporary American English) and the BNC (British National Corpus) (in lemma, per mil).

Distractors were chosen to include phonological contrasts with which French learners of L2 English are known to struggle (e.g., *hungry/angry*), and homophones used in Bassetti & Atkinson [5], in order to mislead participants' attention from silent letters: *hungry, angry, flour, flower, write, right, through, squirrel, beach, sandwich, clothes, jewellery, photographer, always, medal, salt, hospital, fruit, stomach,* and *apricot.*

2.4. Data analysis

The recordings of the twenty target words in the production task were examined for each student. Based on auditory and spectrographic analysis via Praat [13], each target consonant was coded as realised or as silent. As for the AB preference task, the test recorded the selected stimulus and the reaction time (RT) for each pair.

3. RESULTS

Results reveal that although participants were not exposed to orthography during the task, 31% of the target words were produced with an intrusive consonant during the picture naming task and 27.4% of the words selected during the AB audio preference task included an intrusive consonant. 97% of participants pronounced at least one intrusive consonant in the picture naming task and 98% of them selected at least one stimulus with an intrusive consonant in correspondence of a silent letter. As seen in Figure 1, silent letters with which participants struggle the most were in the context of <al + C> (*salmon, almond*) and <mb> (*thumb, bomb*, *plumber, comb*, *lamb* and *climb*).

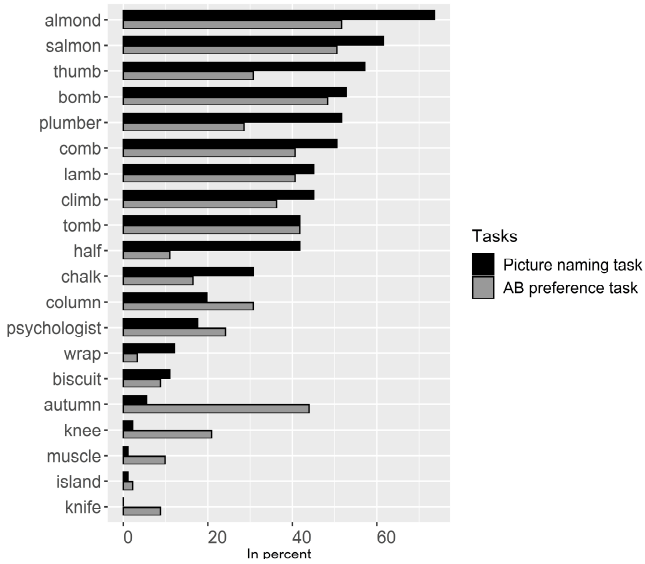

Figure 1: A clustered column chart showing the percent of silent letters realised in the picture naming task and selected in the AB preference task.

The correlation between the percentage of intrusive consonants produced in the first task and selected in the second task by each *participant* was fairly low and barely tended to significance ($r \approx 0.19$, $p \approx 0.07$), revealing that participants who produced more intrusive consonants in the first task were not necessarily the same participants who selected more stimuli with intrusive consonants in the second task. We also ran a linear mixed-effects model with lme4 ([14]) on R to predict the rate of silent consonants that were pronounced in the picture naming task vs selected in the audio preference task, with word and participant as random effects with by-task random slopes: the effect of task turned out to be non-significant, suggesting that on average participants did not perform better or worse in one task than in the other.

Nonetheless, the correlation of intrusive consonants produced in the first and selected in the second task for each *item* was high and significant ($r \approx 0.72$, $p < .001$), suggesting that words for which the silent letter was realised most often in the production

task tended to be selected with an intrusive consonant in the AB audio preference task.

As for learner-level variables, a Pearson test disclosed that participants' self-reported proficiency correlated with the number of realised or selected intrusive consonants in the two tasks ($r \approx -0.225$, $p \approx 0.032$; $r \approx -0.29$, $p < .001$), suggesting that L2 proficiency has an effect on performance. Nonetheless, no other correlation was significant for learner-level variables such as length of stay abroad ($r \approx 0.085$, $p \approx 0.79$; $r \approx -0.37$, $p \approx 0.24$), number of languages spoken ($r \approx -0.115$, $p \approx 0.278$; $r \approx -0.1$, $p \approx 0.322$), and onset of L2 acquisition ($r \approx -0.08$, $p \approx 0.42$; $r \approx -0.11$, $p \approx 0.28$).

In addition, congruency status with French cognates did not affect the number of intrusive consonants produced or selected ($r \approx 0.084$, $p \approx 0.818$ for the first task; $r \approx -0.385$, $p \approx 0.271$ for the second task). However, a Spearman test revealed significant lexical frequency effects for the picture naming task (written frequency: $r \approx -0.442$, $p \approx 0.05$ and spoken frequency: $r \approx -0.451$, $p \approx 0.046$) and for the AB audio preference task for spoken frequency only ($r \approx -0.516$, $p \approx 0.02$). No significant written frequency effect was instead found for the AB audio preference task ($r \approx -0.317$, $p \approx 0.173$).

4. DISCUSSION

The present study have investigated the effects of orthography on the acquisition and processing of L2 words and provides further evidence for orthographic effects in L2 production and mental representations. The findings add support to Bassetti & Atkinson [5] and our own previous study [9]. While previous results showed that Italian and French learners of English produced a significant number of intrusive consonants during a reading aloud task (47% of French learners, 80% of Italian learners), we found that orthographic effects were reduced in a picture naming task where spelling is not shown (31% of the target words were produced) and that stimuli with intrusive consonants were selected as preferred in 27.4% of the target stimuli.

Two (possible) competing explanations could justify such effects [15]. One argues that learning a written language influences the structure of the system of spoken language and that consequently, orthographic representations are automatically activated during the processing of spoken language, as demonstrated for the L1 ([16]). Another concentrates on the learning process, during which learners are exposed to orthographic forms, therefore influencing phonological representations. Connine & Ranbom [11], Whatmough et al. [17], Ehri & Wilce [18] and Taft & Hambly [19] argue that L1 phonological and orthographic representations in the mental lexicon are intrinsically linked; our findings show that this is also the case in an L2. The present results provide evidence that orthographic and phonological information are co-activated during lexical retrieval. The lexicon of L2 learners is nonetheless orthographically biased: orthographic representations modulate phonological knowledge, therefore directly affecting the mental representations of L2 learners and resulting in non-target-like L2 pronunciations (as also seen in [8]). As Young-Scholten [20] and Bassetti [2] also suggested, it is as if "the orthographic input has somehow moved from the page to the mind of the learner" ([2], p7). Future studies could investigate whether this could be avoided when L2 learning is not orthographically-based (e.g., in a non-formal context, as in [15]).

These results provide further support that although French has an opaque orthography and includes silent letters, L1 French learners of L2 English are nonetheless affected by the opaqueness of the English orthographic system, and in particular, their silent letters, as it was already shown by [9] with direct exposure to orthography. This further blurs the hypothesis [21] that L2 learners with an L1 opaque writing system tend to rely less on L2 orthographic input than those with an L1 transparent writing system. In this view, the decoding skills acquired in the L1 do not seem to affect the way L2 words are learned, retained, and produced as opacity and French cognates did not yield significant effects on our results. This further stresses the importance of orthographic input in a L2 phonological context in which acquisition mechanisms should be better apprehended.

These findings add further implications for L2 phonology acquisition theory and for language teaching practices. While exposure to orthography cannot always be avoided [22] and can also be beneficial [3], rules for grapheme-phoneme conversion during classes may not always be effective ([23] and [9]). From a theoretic perspective, we once more argue for the need to include the effects of orthography within L2 phonological models (which currently do not consider spelling, e.g. [24] and [25]).

Other factors such as lexical frequency and proficiency also seem to play a role, and many learner-individual variables that we have not tested may also have an effect, such as the type of memory used by learners (e.g., visual or auditory [3]). Future studies could investigate the influence of visual memory on L2 production and perception with respect to orthographic effects.

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