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Article

The Effects of Orthography on the Pronunciation of Nasal Vowels by L1 Japanese Learners of L3 French: Evidence from a Longitudinal Study of Speech in Interaction

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Abstract: In recent decades, a vast literature has documented crosslinguistic influences on the acquisition of L2 phonology and in particular the effects of spelling on pronunciation. However, articulating these research findings in terms of taking into account the effects of L1 phonology and spelling on L2 pronunciation in language teaching remains to be examined. These studies are based on experimental cross-sectional methods and mainly focus on L2 English learning by speakers of languages with an alphabetic system. In French, there are few studies on crosslinguistic influences on the acquisition of the nasal vowels (/ã/, /õ/ and /ẽ/) and few experimental studies that point to a possible effect of orthography on the pronunciation of these phonemes. The results of experimental studies are difficult to transpose to the language classroom because they are based on word or sentence reading and writing activities, which are quite far-removed from the conversational activities practised in the classroom in interaction with peers and the teacher. Hence, we opted here for a case study of the effect of spelling on the production of nasal vowels in interaction tasks. We conducted a longitudinal study during the first year of extensive learning of French (4 hrs 30 per week). The results of a perceptive analysis by expert listeners show that (i) learners spell nasal vowels with an <n> or <m> in 98% of the obligatory contexts; (ii) most nasal vowels are perceived as nasal vowels in speech (72%), the others being perceived as vowels followed by a nasal consonant (19, 5%) or as oral vowels (8.5%); (iii) consonantisation is stronger when the learner spontaneously produces a word than when (s)he repeats it, (iv) which decreases with time (learning effect) and varies (v) according to the consonant, /ẽ/ being less consonantised than /õ/ and /ã/. Finally, we propose a didactic discussion in the light of intelligibility and influence of orthography.

Keywords: nasal vowels; L3 French; L1 Japanese; orthographic effect, crosslinguistic influence; longitudinal; spoken and written corpus



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1. Introduction

In second language acquisition, many studies focus on the development of oral or written language. However, if we are interested in acquisition in an instructed environment where the learner is doubly exposed to oral and written language, often from the initial stages, it seems essential to take into account the interaction between oral and written representations of the language. Following from the many studies on the effect of orthography on pronunciation [1–3], this study focuses, in particular, on the effects of the graphemes <n> and <m> on the acquisition of nasal vowels.

The phonological units /sõ/, /ãkɔʁ/ and /pẽ/ have in common that they are words containing a nasal vowel: /õ/, ã and ẽ/, respectively. Even if the French phonological inventory is sometimes described as containing four nasal vowels (/ã/, /õ/, /ẽ/ and /œ/),

most researchers agree, as Marquez Martinez (2016) points out, that / $\tilde{\epsilon}$ / and / $\tilde{\text{œ}}$ / have been merged in favour of / $\tilde{\epsilon}$ / in Northern Metropolitan French, the variety one usually describes and teaches as standard [4]. Therefore, we only examine these three nasal vowels: / $\tilde{\text{ɑ}}$ /, / $\tilde{\text{ɔ}}$ / and / $\tilde{\epsilon}$ /, whose spellings include the grapheme <n> <son> 'his/her/its', <encore> 'still/again', <pain> 'bread'. Since French nasal vowels appear in very frequent words and are distinct phonemes from oral vowels and nasalised allophones found in other languages [4–8], their pronunciation is central in the development and use of an intelligible lexicon. Using one nasal vowel instead of another, an oral vowel instead of a nasal vowel or a vowel followed by a nasal consonant instead of a nasal vowel can lead to a change in meaning: if / $\tilde{\epsilon}$ / is pronounced / $\tilde{\text{ɔ}}$ / in /p $\tilde{\epsilon}$ /, the meaning of the word is 'bridge' instead of 'bread'; if / $\tilde{\text{ɑ}}$ / is pronounced /a/ in / $\tilde{\text{ɑ}}$ kɔʁ/, then the meaning of the word is 'agreement' instead of 'still/again'; and finally, if /s $\tilde{\text{ɔ}}$ / 'his/her' is pronounced with a consonantised vowel /sɔn/, then the possessive determiner becomes a verb form meaning 'sound(s)'.

Phonological and phonetic accuracy thus has an impact on lexical acquisition in French as an additional language, and it is therefore relevant to know how nasal vowels in L3 French are perceived by expert listeners. In the light of studies conducted over the last 20 years, French orthography and, in particular, the nasal graphemes <n> and <m> play an important role in the acquisitional process of nasal vowels, as well as in the production process of nasal vowels in which phonological and orthographic representations are involved. Nevertheless, the graphemes <n> and <m> could play contradictory and potentially evolving roles in the acquisitional process: on the one hand, they inscribe in the orthography of the language the nasal feature inherent in the nasal vowel and could, as such, encourage the use of a nasal vowel; on the other hand, they materialise this nasality by means of the grapheme also used to write the nasal consonant /n/ and could, as such, explain the phenomenon of consonantisation of the vowel attested in several studies [4,5,9–11].

However, these effects of 'externalisation of the nasality of the nasal consonant' have been considered by most studies of nasal vowel acquisition from the angle of the influence of the phonology of first languages [4,5,11]. They explain the production of a postvocalic nasal in L2 French under the influence of first languages without nasal vowels but with nasalised vowels in perception or production. We take up the term "L2" used by the authors. In all the studies mentioned above, it refers to a language learned after the first language. In the studies by Montagu (2002) and Martinez-Marquez (2016), French is chronologically the second language learned, but in the case of Detey et al. (2010) and Li et al. (2019), it is probably the third language after English. Three studies point to a possible effect of orthography [8,9,12]. Only one study investigates the specific effect of a postvocalic nasal consonant [12].

The aim of this study is not to decide between these two explanations but to study, in an ecological context of interactive speech, the specific and evolving effect of the graphemes <n> and <m> on the use of nasal vowels by beginner Japanese-speaking learners of L3 French doubly exposed in class to spoken and written French in textbooks, on the blackboard, in exercise books and in personal notebooks.

To do this, we conducted a case study and used a bimodal (oral and written) and longitudinal corpus of oral productions in L3 French from four adult learners of L1 Japanese and L2 English collected at two points during their first year of extensive learning of French at university. We analysed the way in which the phonemes produced by the Japanese-speaking learners in place of nasal vowels are perceived by expert listeners. In particular, we analysed the phenomenon of consonantisation of the nasal vowel and its variation according to three variables: on the one hand, the production context, distinguishing between contexts frequent at the beginning stage of repetition of the interlocutor's word and contexts of spontaneous production and recovery of a lexical unit in the mental lexicon; on the other hand, the type of vowel and the greater or lesser number of graphemic equivalents; and finally, the time of learning, i.e., after 50 hours and after 120 hours of bimodal exposure to L3 French. Finally, we supplemented this study of the pronunciation

of nasal vowels in L3 French with an analysis of orthographic uses in order to examine whether the orthographic representation of the oral forms of words with a nasal vowel includes the graphemes <n> and <m>.

The results are discussed from the perspective of teaching intelligible speech in an additional language.

2. The Role of L1 Phonology and L2 Orthography in the Acquisition of Nasal Vowels in French as an Additional Language

The acquisition of nasal vowels in L2 French has attracted the attention of researchers for several reasons. On the one hand, nasal vowels are attested in only 22.6% of the world's languages. Therefore, they are relatively rare phonemes compared to nasal consonants, which exist in almost all languages, or compared to nasalised vowels, which are present in a large number of languages, particularly in the investigated first languages of adult learners producing nasal vowels in L3 French [4,5,9,11]. Therefore, the acquisition of nasal vowels in adulthood represents an interesting case of the acquisition of second language phonology and of interphonology [9,14]. On the other hand, nasal vowels have the particularity of being spelled using a set of graphemes that vary from word to word but whose invariants are the letters <n>, as in <bon> 'good', <dans> 'in' and <pain> 'bread', or <m> when the letter following the nasal vowel is <p>, or <m>, as in <comprendre> 'understand' or <jambe> 'leg'. In theory, these letters are likely to fix the distinctive nasal feature of the nasal vowel, as they can also promote the production of a postvocalic nasal consonant. In this section, we present the few studies that have focused on the acquisition or use of nasal vowels in French as a second language, a summary of the more numerous studies that have focused on the role of orthography in the acquisition of L2 new phonemes and some proposals for pronunciation teaching of new phonemes taking into account the effect of orthography.

2.1. The Acquisition of Nasal Vowels in L2/L3 French

In several studies mentioned in this section of the state of the art, the learning situations are designed from the point of view of the acquisition of an L2 by learners of a given L1. However, these learners are often multilingual and have learned other languages, such as Mandarin in the study by Li, Yin and Pu (2019) [11] or English in the study conducted by Detey et al. (2010) [9]. Even if the influence on these languages in the acquisition of French is not investigated as such, we can consider that French is an L3. This is why we adopt the term "L2/L3 French". Nasal vowels pronunciation acquisition in L2/L3 French in adulthood is commonly recognised as a particularly complex phenomenon [4,5,9,11]. The specific articulatory, acoustic and auditive properties of French phonemes have been described in several studies [6–9,11]). They differ from oral vowels in that they are produced through the lowering of the velum and in making specific modifications of the articulatory gestures and lip movements, which allow air to escape through the mouth and the nose at the same moment [6]. According to Delvaux et al. (2004) [7], those features, called gravity and compacity, respectively, are necessary for French L1 speakers to perceive the vowel as a nasal. According to Montagu (2002) [5], labiality is also a distinguishing feature between the nasal vowels / $\tilde{\epsilon}$ /, / \tilde{a} / and / \tilde{o} /, the first being characterised by a low degree of labiality [-labial], the second by a higher degree [+labial] and the last by a maximum degree [++labial]. Dherbey-Chapuy (2021) considers that a main acoustic property of nasal vowels is their second (F2) and third (F3) formants (resonance frequency of the sound wave), which are different from those of nasalised vowels [8].

The contrast between oral vowels and nasal vowels is phonemic in French [15], which means that nasal vowels play a crucial role in differentiating the meaning of words (e.g., *main* [m $\tilde{\epsilon}$] 'hand' vs. *mais* [m $\tilde{\epsilon}$] 'but' vs. *ment* [m \tilde{a}] 'lies' vs. *mon* [m \tilde{o}] 'my'). In this respect, nasal vowels must be distinguished from nasalised vowels found in many languages, which are allophones of oral vowels produced in surrounding nasal contexts. Based on the F2 and F3 values, nasalised vowels are not produced in L1 French [8]. In this study, we use

the term nasalised vowel in order to refer to the phonetic phenomenon of coarticulation with a nasal consonant in languages other than French. Therefore, we make therefore an a priori distinction between coarticulation as a phonetic phenomenon in a language used as a first language and the nasal consonantisation or nasalisation of the vowel as a phonetic phenomenon that has been observed in second languages or learner varieties: the use of a postvocalic nasal consonant.

The perception and production of French nasal vowels can be challenging for L2 learners whose L1 lacks equivalent phonemic nasal vowels: American English in studies conducted by Montagu (2002) [5] and Marquez-Martinez [4]; Japanese and Spanish in a study conducted by Detey et al. (2010) [9]; and Cantonese a study conducted by Li, Yin and Pu (2019) [11]. Indeed, difficulties in acquiring these phonemes might lie both at a phonological level and at a phonetic level. For example, L2 learners whose L1 exhibits nasal vowels in a different phonemic contrast compared to French nasal vowels [16]) or whose L1 does not exhibit phonemic nasal vowels at all need to develop new phonological representations in order to distinguish the target nasal vowels from nasalised or oral vowels available in their L1 or L2 phonemic repertoire [4,17]. This is the case for Japanese L2 English learners: although these languages are characterised by different vocalic systems, with English exhibiting a rich variety of vowels, while Japanese exhibits five vowels only. In both English and Japanese, nasal vocalisation is a non-phonemic feature, and the articulatory movements involved differ from the articulation of French nasal vowel' articulation [4,5,18]. In English, for instance, vowels can be nasalised through anticipatory coarticulation when they are followed by a nasal consonant (sank [sæŋk]). These nasalised vowels always co-occur with a nasal consonant and do not have distinct phonemic representations from their corresponding oral vowels (e.g., [19,20]). Furthermore, L2 learners whose L1 does not exhibit nasal vowels in their phonetic repertoire or whose L1 nasal vowels are articulated differently from French nasal vowels need to learn and coordinate specific aspects.

The intermediate pronunciation of nasal vowels in L2 French has been categorised in different terms according to theoretical frameworks and methodological approaches: rate of nasality [11], nasal unpacking or stripping [4], non-nasalisation of the vowel, residual [n] or [m], vowel substitution [21] in [4] and degrees of consonantisation [9]. By means of aerodynamic, acoustic and lip movement measures, Li, Yin and Pu (2019) analysed the different physical properties of segments corresponding to the expected nasal vowel in a reading-aloud corpus of L1 Cantonese speakers of L2 French [11]. A comparison of nasality rates in L2 French and L1 Cantonese reveals a nasalisation rate that peaks at the end of the segment 'nasal vowel' in L2 French, which corresponds to the phonetic characteristics of vowels coarticulated with the nasal consonant in L1 Cantonese. In their study of the quality of nasal vowel realisation by Japanese L1 learners in L2 French, Detey et al. (2010) perceptively evaluated three degrees of nasal consonantisation of the nasal vowels: a first degree corresponding to the absence of a postvocalic nasal consonant, a third degree of clear presence of the same consonant and an intermediate second degree of presumed nasal consonantisation [9]. In her study of the acquisition of L2 French nasal vowels by adult speakers of L1 English, Marquez Martinez (2016) adopted a different categorisation partly linked to the theoretical framework she used, according to which the pronunciation of a nasal vowel by a beginner speaker of a language with nasalised vowels corresponds phonetically to the integration of the nasal feature into the vowel and the elimination of the time unit between the oral vowel and the nasal consonant that follows [4]. According to the author, the failure of this process in L2 results in two distinct 'strategies'. The first strategy is to 'unpack' or divide the nasal vowel into two segments, i.e., an oral vowel and a nasal consonant (*maison* 'house' is pronounced /mezɔn/ instead of /mezɔ/), called nasal unpacking. This strategy was first observed as the most frequent loanword adaptation strategy in languages without nasal vowels but borrowing words with nasal vowels, for instance, Lingala borrowing words from French [25]. The second strategy attributed to faulty perception is nasal stripping (*maison* is perceived as /mezɔ/, then produced /mezɔ/). Phonetic parallels can be drawn between these different categories.

Marquez Martinez's (2016) [4] nasal unpacking category represents a subcategory of Detey et al.'s (2010)[9] category 3: 'clear presence of a nasal consonant'. However, it cannot be reduced to this. In their typology of mispronunciations of the nasal vowel in L2 French in a corpus of spontaneous reading and speaking, Kamiyama et al. (2016) also identified, among intermediate pronunciations with a nasal consonant, cases of pronunciation of a nasal vowel followed by a nasal consonant (/mezɔ̃n/) [14]. Similarly, nasal stripping is a subcategory of the absence of a postvocalic nasal consonant but cannot be reduced to it either. The production of a nasal vowel, whether expected or not, is another case of zero degrees of nasal consonancy. Liddiard (1994) also noted cases of English speakers who substitute one vowel for another, producing /ãbɛ/ instead of /ɔ̃bɛ/[21]. Finally, we note the importance of the intermediate category corresponding to category 2 of Detey et al. (2010) [9] and to the 'residual [n] or [m]' category of Liddiard (1994) [21], in which the learner produces a nasal vowel followed by a slightly audible nasal feature. Even if the presence of a postvocalic nasal consonant seems characteristic of the intermediate pronunciation of the nasal vowel by speakers of first languages without nasal vowels, a detailed characterisation of phonetic realisations cannot be performed without considering the degree of nasal consonantisation (absence, residual or clear) and the shape of the vowel phoneme (oral or nasal).

In her research conducted on the perception of L2 French nasal vowels by English-speaking learners of L2 French, Marquez Martinez (2016) showed different strategies at different stages of development[4]. According to her analysis, at the initial stage, native English speakers of French split a nasal vowel into segments that already exist in their L1 phonological inventory: an oral vowel followed by a nasal consonant. However, as their exposure to French increases, intermediate learners tend to apply the nasal stripping strategy, perceiving French nasal vowels as oral vowels. Studies on the perception of L2 French nasal vowels by Japanese-speaking learners also reveal progressive discrimination of the nasal vowels, with beginners showing some difficulties in the identification of /ã/ and/or /ɔ̃/ and intermediate learners showing difficulties in perceiving the nasal vowel only /ɔ̃/ [10,22]. In a phonological discrimination task carried out by 124 students after their first year of acquiring French as a foreign language at university, Sauzedde (2018) reported that the mean score of discrimination was 36.2% for /ã/, 48.6% for /ɔ̃/ and 76.2% for /ɛ̃/. After the second year, the same task was performed again and this mean rate increased up to 61% for /ã/ and up to 83.8% for /ɛ̃/ but not for /ɔ̃/ (50.5%) [23].

As for the production of L2 nasal vowels, results from recent studies show some variation according to the stage of development, the task and the type of nasal vowel. English-speaking L2 learners [24] and Japanese-speaking L2 learners [10] pronounce phonemic nasal vowels from the earliest acquisitional stages. Differences between beginners and advanced learners involve more allophonic than phonemic changes [18]. In other words, the phonemic feature of nasality seems to be rapidly mastered in production, and difficulties seem to lie at the identification and articulation levels [24,25]. Kamiyama, Detey and Kawaguchi [14] found that Japanese learners have difficulties in pronouncing French nasal vowels, /ɛ̃/ being pronounced [ã̃N], /ã/ [ã̃N] or [õ̃N] and /ɔ̃/ [õ̃N]. In production, Detey et al. (2010) found that the average degree of nasal consonantisation of vowels in the Japanese-speaking group varied according to several variables [9]. Consonantisation varies for instance according to the L1, the position of the nasal vowel in the word and the type of nasal vowel. Their study has shown that the pronunciation of the nasal vowel /ɔ̃/ is more accurate than that of /ã/ and /ɛ̃/. Similarly, consonantisation varies according to the task: the rate was higher in the reading task than in the word repetition task, which was confirmed by an acoustic analysis and may suggest an effect of visuo-orthographic input.

In summary, the reviewed studies show that the production of a postvocalic nasal consonant instead of an expected nasal vowel in L2 French is a well-documented phenomenon. Although the term coarticulation is not used to refer to the phenomenon observed in L2 and, indeed, would not be sufficient to describe the aerodynamic and labial properties of nasal vowels in L2, it seems to describe fairly well their phonetic characteristics as perceived by

expert listeners. However, we use the terms nasalisation and nasal consonantisation to refer to the use of a postvocalic nasal consonant in an L2 instead of a nasal vowel in an L2.

An explanation often put forward in the studies presented above to account for the production of a postvocalic nasal consonant instead of an expected nasal vowel is the lack of nasal vowels and the existence of nasalised vowels in the first languages studied (English, Spanish, Japanese and Cantonese). This leads to the attribution of the nasal feature from the nasal consonant to the oral vowel, as is the case in the first language. Thus, there is no mention of the influence of other previously learned languages, in particular L2 English, on the acquisition of L2/L3 French by speakers of L1 Japanese. However, if the L1 plays a role in the interphonology of L2 French, we cannot rule out a role of an L2 in the acquisition of nasal vowels in L3 French and a reinforced use of a nasal consonant after a vowel instead of a nasal vowel by Japanese learners of L3 French due to the presence of nasalised vowels in L2 English. This hypothetical reinforcement of postvocalic consonancy needs further investigation.

Similarly, with the exception of Detey et al. (2010) [9], another influence is overlooked in most studies, namely the effect of orthography and the Latin letters <n> or <m> pronounced as the nasal consonants /n/ and /m/, respectively, in some positions. However, there is a large body of literature suggesting that the orthography of nasal vowels is likely to influence their pronunciation, as we observe in the next section.

2.2. *The Effect of Orthography on Pronunciation*

Examining the acquisition of French nasal vowels by Japanese learners, Detey and Nespoulous (2008) highlighted the role of literacy in phonological awareness and the activation of orthographic representation by both auditory and visual stimuli [26].

A number of studies [1–3,27] have reported, based mostly on L2 English, that orthography plays a major role in shaping L2 phonology in speech perception and production. In fact orthographic forms can have a positive influence on speech perception (e.g., [28,29]) by providing cues that help learners discriminate L2 lexical items differentiated by a new phonological contrast. However, the positive influence of spelling is conditioned by the congruence of grapheme-to-phoneme correspondences (GPCs) between L1 and L2 (e.g., [30–32]). Regarding speech production, there are also contradictory results. Some studies have shown a positive effect of spelling, with orthographic input disambiguating auditory input [12,30,33,34]. Other studies have shown a negative effect of spelling in the presence of incongruent GPCs between L1 and L2, resulting in an orthographic pronunciation, e.g., the pronunciation of silent letters or double consonants or vowels [35–38]. In a recent review of the state of the art, Bassetti (to appear) considers sound additions as one type of orthographic effect, along with deletions and substitutions [39]. A frequent motivation for phonetic addition is that L2 users pronounce a silent letter that is part of a larger orthographic unit, such as a multi-letter grapheme. This is the case for English past morpheme <ed> being pronounced /t,d/ in some contexts in L1 English but sometimes /ɛd/ in L2 English because of the pronunciation of the silent <e> grapheme [40].

Some recent studies have shown that exposure to orthographic and auditory input, compared to auditory input alone, promotes lexical learning [41–44]. Indeed, learners are faster and more accurate in naming pictures after being exposed to the orthographic and auditory modality compared to the auditory modality alone. However, the presence of orthographic input during learning has a detrimental effect on the quality of production, leading to a non-native-like pronunciation of the target phonemes. As such, the impact of L1 GPCs on L2 pronunciation has been observed, even for non-alphabetic languages on the pronunciation of L2 alphabetic languages (i.e., [45], L1 Japanese on L2 English). Sokolović-Perović et al. (2020) [45] has shown that advanced Japanese L1 learners of L2 English are, indeed, influenced by L2 orthography and L1 pronunciation rules when it comes to consonant and vowel duration. As these findings have not been reported in studies on orthographic effects on phonology across scripts in beginner learners of English

[29,46,47], a possible interpretation for this orthographic effect is that the L2 learners already knew the orthographic form of the word.

However, the influence of orthography on production may be limited to the lexical stage of speech processing, since Ventura et al. (2004) found no orthographic effect for non-words and no effect in a repetition task. Since the repetition task does not necessarily rely on the participants' lexical representations, it could explain why their pronunciation was less impacted by orthography in a repetition compared to spontaneous speech [48]. Detey et al. (2010) found nasal consonantisation in repetition and reading tasks but attributed the more accurate pronunciation of nasal vowels by Japanese learners of L2 French in repetition than in reading to the effect of orthography [9].

To summarise the effects of spelling on L2 phonology, Hayes-Harb and Barrios [3] proposed four variables influencing the effect of spelling on learners' L2 phonological development. The first variable relates to the systematicity of the relationships between phonemes and graphemes in the target language (transparency vs. opacity of a writing system). If a new phonological contrast is systematically represented by the same graphemes in the L2, then learners will be able to rely on orthography to make inferences about the phonological structure of words. The second variable concerns the familiarity of one or more L2 graphemes and is modulated by the third variable: the congruence between L1/L2 GPCs. For L2 graphemes familiar in the L1, they may or may not have the same GPCs in the L1 and L2. If the GPCs are different, grapheme familiarity does not help and may even shape the L2 phonological development. Finally, the last variable is perceptibility, i.e., the learners' ability to perceive a new contrast.

Applied to the acquisition of nasal vowels in L3 French by Japanese-speaking learners, the findings of previous studies on the effect of orthography on L2 phoneme pronunciation [49] suggest that the orthography a nasal vowel, a plurigrapheme with one or more graphemes <a, e, i, o, u> followed by <n> or <m> and, optionally, other silent or non-silent graphemes, could recall the nasal feature inherent in the nasal vowel because of the systematic use of <n> or <m> in writing in the target language and promote its pronunciation. However, in order to investigate the effects of orthography on pronunciation in spontaneous speech, it seems necessary to examine if learners have those orthographic representations, especially the <n> or <m> grapheme. Another possible effect is the use of the GPC rules of L2 English in L3 French. Even though the graphemes <n> and <m> do not exist in the syllabic alphabets of Japanese, Japanese-speaking learners are familiar with the Latin alphabet from a very early age, and we can therefore postulate a familiarity with these graphemes at the time of learning new contrastive phonemes in French due, in particular, to exposure to this graphic system during the often early learning of English. Nevertheless, there is no congruence between the French GPCs and those of previously acquired languages, as we show in the next section. This is why the orthography of nasal vowels can also have a negative effect on pronunciation, namely the production of a nasalised vowel instead of the pronunciation of the nasal vowel. Effects linked to the task and the stage of development are also to be expected. However, they require further research.

2.3. Awareness of Orthographic Effects on Pronunciation: Some Didactic Proposals

Is the aim of teaching the pronunciation of nasal vowel phonetic correction and the production of the acoustic, articulatory and auditive properties of the French nasal vowel or simply the production of one or more phonemes that can be interpreted as a nasal vowel?

A number of tips or suggestions for teaching nasal vowel pronunciation in French have emerged from L2 studies that have been carried out. Li, Yin and Pu (2019) advised that L1 interference should be taken into account in teaching [11]. Montagu (2002) suggested emphasising the role of labiality [5] in phonetic correction lessons. Detey et al. (2010) emphasised the need to offer a variety of activities in written and oral modalities in order to develop balanced phonetic-phonological and phonographic competence [9]. These interesting proposals focus on the pronunciation of nasal vowels and do not specify the

degree of intelligibility of a French word containing a nasalised vowel instead of a nasal vowel. Do these intermediate pronunciations disturb the intelligibility of an utterance? This question seems all the more important, since, according to Dherbey-Chapuis (2021), there is, at the phonetic level, a “high variability in the pronunciation of nasal vowels (NVs) among French speakers”, which “makes it hard to compare the formant values of the NVs pronounced by learners with a native-like norm” [8].

Recent research on the acquisition of L2 pronunciation has been mainly conducted on L2 English as a lingua franca in international communication, suggesting that the aim of pronunciation teaching in English should not be the mastery of a native norm and accent reduction but word intelligibility, fluency and comprehensibility of discourse in interaction [3,39,50–52]. Following [51], intelligibility may be defined as “the extent to which a speaker’s message is actually understood by a listener” and may be operationalised using a technique of word-by-word sentence transcriptions made by listeners, as reported by Munro and Derwing (2020). This means that a phoneme like a nasal vowel may be transcribed as a nasal vowel even if it does not have all the acoustic properties of the nasal vowel in the target language. According to Levis (2018), teaching intelligible pronunciation does recognise the importance of acquiring the contrastive phonemes of a language, since an error in a word’s phoneme can impair speech intelligibility [51]. If we look at nasal vowels, we can ask ourselves what the conditions for a vowel to be intelligible in a given context are and which activities or interactional feedback could favour the use of intelligible nasal vowels.

To build a curriculum with the aim of intelligibility of pronunciation, one proposal has emerged: focus on distinctive phonemes or phonemes with a high functional value (past time morphemes, for instance) [50,52] common to a set of varieties of the language [52]. Even if Derwing (2017) [50] and Colantoni et al. (2021) [52] agree on the importance of setting the goal of intelligibility from the earliest stages, the type of activities needed to achieve these goals is less clear. For example, integrated activities are proposed, either aiming at showing the lexical or grammatical functions of a phoneme (minimal pairs like *pain* ‘bread’ vs. *pont* ‘bridge’) or focusing on its articulation with other components.

However, these studies do not address the question of the impact of exposing learners to the written forms of words in addition to their exposure to the spoken forms. To the best of our knowledge, only four works have transposed the results of studies on orthographic effects into didactic proposals [3,8,42,53]. Among these, one focused on experimental didactics [8]. Some studies have, nevertheless, experimentally used unfamiliar scripts to explore the effect of unfamiliar orthographic forms on word learning and syllable discrimination, since L2 orthography and L1 GPC rules may influence L2 phonology. These studies have shown contradictory results, a facilitative effect [29,46], no effect [47] or a negative effect [54,68].

Another way to look into supporting the phonological development of L2/L3 learners at initial stages is to identify (un)intelligible pronunciations in conversational contexts, such as those occurring in the classroom, and to analyse the variable use of nasal vowels according to the amount of exposure, contexts of production and type of nasal vowel.

3. The Phonetic vs. Phonemic Role of Nasality in French, Japanese and English

In this section, we present some descriptive elements of nasality and its orthography in languages in contact, which is essential for discussing phonological and orthographic influences, as well as the role of nasal vowels graphemes <n> or <m> in acquisition of L3 French by Japanese-speaking learners in the initial stages: the presence of nasal vowels in the phonological inventory or allophone nasalised vowels of oral vowels, their frequencies, the writing system(s), grapheme-to-phoneme rules and vice-versa.

3.1. Nasality in French: Three Nasal Vowels and More Than Twenty Corresponding Graphemes

In French, at the phonemic-level nasal vowels are contrastive phonemes that need to be learned because this phoneme may determine the lexical or grammatical meaning of

the word. At the phonetic level, the vocal nasality is a very complex phenomenon at the articulatory, acoustic and aerodynamic levels [7]. However, nasal vowels are produced variably and tendentiously differently by the majority groups in northern and southern France. In southern French, from the Basque Country to Provence via Gascony, speakers “have a variable degree of nasalisation depending on the speaker and are followed by a more or less prominent nasal appendage” [13]. Thus, in southern French, there are four distinctive nasal vowels: / $\tilde{\epsilon}^n$ /, / $\tilde{\text{œ}}^n$ /, / $\tilde{\text{ɔ}}^n$ /, / $\tilde{\text{ɑ}}^n$ /, with / $\tilde{\text{ɑ}}^n$ / being the variable nasal appendage [14]. Even though nasal vowels are contrastive phonemes in French, they are realised differently depending on the region and the speaker. This case of variation shows the limits of the notion of accuracy or native-likeness and the value of a measure of intelligibility that takes into account the speaker’s perception.

The French nasal vowels $\tilde{\text{ɑ}}$, $\tilde{\text{ɔ}}$ and $\tilde{\text{ɛ}}$ are not as frequent as their vocal counterparts. According to Planton’s investigation of the Lexique Database (2014: xviii) [55], the vocal vowels in initial and final positions in words are more frequent than the nasal vowels for two of them: /a/ (18334) vs. / $\tilde{\text{ɑ}}$ / (15344) and / ϵ / (18907) vs. / $\tilde{\text{ɛ}}$ / (6816), except for / $\tilde{\text{ɔ}}$ / 8943 vs. / ɔ / (992) vs. /o/ (4450), although they are still frequent in French words (see Table 1). In both the Gougenheim and Lexique 3.83 corpora [56], words with a nasal vowel are very frequent and the three most frequent words with a nasal vowel are the monophonemic words *on* / $\tilde{\text{ɔ}}$ /, *en* / $\tilde{\text{ɑ}}$ / and *un* / $\tilde{\text{ɛ}}$ / (Table 1). The Gougenheim corpus is a corpus of spoken French collected in the early 1950s to provide the lexicon of elementary French, i.e., 1500 frequent French words. Lexique 3.83 is a vast corpus of spoken and written French. We have used the sub-corpus “Sous-titres de films populaires”, which includes the French subtitles of 9474 films or series, representing a total of 50 million words. The subtitles come from four categories of films: French films (1.9 million words) (e.g., Camille Claudel), Anglo-Saxon films (26.5 million words) (e.g., Arizona Dream, Schindler’s List), Anglo-Saxon films and series, (19.5 million words) (e.g., Friends, Ally McBeal) and non-English European films (2.5 million words) (e.g., Cria Cuervos, Good Bye Lenin!).

Table 1. Words with a nasal vowel among the 200 most frequent words in the corpora of Gougenheim and Lexique 3.83.

Gougenheim Corpus (1954) Unit = Type	Lexique 3.83 Corpus Unit = Token
<p>on- /$\tilde{\text{ɔ}}$/ ‘we’, un- /$\tilde{\text{ɛ}}$/ ‘a/one’, en- /$\tilde{\text{ɑ}}$/ ‘in’, dans- /$\tilde{\text{ɑ}}$/ ‘in’, en- /$\tilde{\text{ɑ}}$/ ‘of it’ -pronoun, non-$\tilde{\text{n}}$ ‘no’, enfin- /$\tilde{\text{ɑ}}$/, /$\tilde{\text{ɛ}}$/ ‘at least’, quand- /$\tilde{\text{ɑ}}$/ ‘when’, mon-$\tilde{\text{m}}$ ‘my’, ben- /$\tilde{\text{ɛ}}$/ discourse particle, prendre- /$\tilde{\text{ɑ}}$/ ‘to take’, rien- /$\tilde{\text{ɛ}}$/ ‘nothing’, un peu- /$\tilde{\text{œ}}$/ ‘a little bit’, encore- /$\tilde{\text{ɑ}}$/ ‘still/again’, hein- /$\tilde{\text{ɛ}}$/ interjection, grand- /$\tilde{\text{ɑ}}$/ ‘big’, temps- /$\tilde{\text{ɑ}}$/ ‘time/weather’, eh bien- /$\tilde{\text{ɛ}}$/ - interjection, an- /$\tilde{\text{ɑ}}$/ ‘year’, son-$\tilde{\text{s}}$ ‘his/her’, cent- /$\tilde{\text{ɑ}}$/ ‘hundred’, comprendre- /$\tilde{\text{ɔ}}$, $\tilde{\text{ɑ}}$/ ‘to understand’, maintenant-$\tilde{\text{ɛ}}$, /$\tilde{\text{ɑ}}$/ ‘now’, bon-$\tilde{\text{s}}$ ‘good’, matin- /$\tilde{\text{ɛ}}$/ ‘morning’, évidemment- /$\tilde{\text{ɑ}}$/ ‘obviously’, avant- /$\tilde{\text{ɑ}}$/ ‘before’, seulement- /$\tilde{\text{ɑ}}$/ ‘just/only’, pendant- /$\tilde{\text{ɑ}}$, $\tilde{\text{ɑ}}$/ ‘during’, français- /$\tilde{\text{ɑ}}$/ ‘French’, entendre- /$\tilde{\text{ɑ}}$, $\tilde{\text{ɑ}}$/ ‘to hear’, un- /$\tilde{\text{ɛ}}$/ ‘one’-pronoun, commencer- /$\tilde{\text{ɑ}}$/ ‘to start’, un- /$\tilde{\text{ɛ}}$/ ‘one’-numeral, rendre- /$\tilde{\text{ɑ}}$/ ‘to give back’, tellement- /$\tilde{\text{ɑ}}$/ ‘so’, trente- /$\tilde{\text{ɑ}}$/ ‘thirty’, quand même- /$\tilde{\text{ɑ}}$/ ‘still/anyway’, moment- /$\tilde{\text{ɑ}}$/ ‘moment’, vingt /$\tilde{\text{ɛ}}$/ ‘twenty’, comment- /$\tilde{\text{ɑ}}$/ ‘how’, moins- /$\tilde{\text{ɛ}}$/ ‘less’, vraiment- /$\tilde{\text{ɑ}}$/ ‘really’, franc- /$\tilde{\text{ɑ}}$/ -old French money, cinq- /$\tilde{\text{ɛ}}$/ ‘five’, enfant- /$\tilde{\text{ɑ}}$, $\tilde{\text{ɑ}}$/ ‘child’, demander- /$\tilde{\text{ɑ}}$/ ‘to ask’</p>	<p>un- /$\tilde{\text{ɛ}}$/ ‘a/one’, on /$\tilde{\text{ɔ}}$/ ‘we’, en- /$\tilde{\text{ɑ}}$/ ‘in’, dans- /$\tilde{\text{ɑ}}$/ ‘in’, bien- /$\tilde{\text{ɛ}}$/ ‘good’, non- /$\tilde{\text{ɔ}}$/ ‘no’, mon- /$\tilde{\text{ɔ}}$/ ‘my’, en- /$\tilde{\text{ɑ}}$/ ‘in’, rien- /$\tilde{\text{ɛ}}$/ ‘nothing’, quand- /$\tilde{\text{ɑ}}$/ ‘when’, son- /$\tilde{\text{ɔ}}$/ ‘his/her’, ton- /$\tilde{\text{ɔ}}$/ ‘your’, sont- /$\tilde{\text{ɔ}}$/ ‘are’, encore- /$\tilde{\text{ɑ}}$/ ‘still’, temps- /$\tilde{\text{ɑ}}$/ ‘time/wheather’, maintenant- /$\tilde{\text{ɛ}}$, $\tilde{\text{ɑ}}$/ ‘now’, sans- /$\tilde{\text{ɑ}}$/ ‘whithout’, vraiment- /$\tilde{\text{ɑ}}$/ ‘really’, viens- /$\tilde{\text{ɛ}}$/ ‘come’, comment- /$\tilde{\text{ɑ}}$/ ‘how’, bon- /$\tilde{\text{ɔ}}$/ ‘good’, monde- /$\tilde{\text{ɔ}}$/ ‘world/people’, besoin- /$\tilde{\text{ɛ}}$/ ‘need’, ans- /$\tilde{\text{ɑ}}$/ ‘years’, quelqu’un- /$\tilde{\text{ɛ}}$/ ‘someone’, donc- /$\tilde{\text{ɔ}}$/ ‘then’, gens- /$\tilde{\text{ɑ}}$/ ‘people’, maison- /$\tilde{\text{ɔ}}$/ ‘house’, bonjour- /$\tilde{\text{ɔ}}$/ ‘hello’, comment- /$\tilde{\text{ɑ}}$/ ‘how’</p>

Among the 200 most frequent lemmas in the Gougenheim corpus, there are 46 lemmas with a nasal vowel, and among the 200 most frequent occurrences in the corpus of French subtitles of popular American films in the Lexique 3.83 database [56], 30 occurrences contain at least one nasal vowel. These frequent words with a nasal vowel are grammatical words (*on* 'we', *dans* 'in', *mon* 'my'); discourse particles (*ben*, *hein*, *eh bien*); and lexical words, including nouns (*bonjour* 'hello', *matin* 'morning', *maison* 'house'), adjectives (*bon* 'good', *français* 'French'), verbs (*prendre* 'to take', *demander* 'to ask', *rendre* 'to give back') and adverbs (*seulement* 'just/only', *évidemment* 'obviously', *encore* 'still/again'). Some of these frequent words often contain two nasal vowels, such as *enfin* 'at least', *enfant* 'child', *pendant* 'during', *comprendre* 'to understand', *maintenant* 'now' and *entendre* 'to listen'. To sum up, all listeners of French are immediately and recurrently exposed to nasal vowels.

According to Hayes-Harb Barrios (2021), a crucial point in predicting the effect of orthography on pronunciation is the consistency of phoneme-to-grapheme and grapheme-to-phoneme correspondences. In this respect, French has a deep orthographic system, and it is not easy to establish a measure of consistency in languages with deep orthography. In his research, Planton (2014: xx) took up this challenge and listed the phoneme-to-grapheme correspondences of 142,000 orthographic forms in the Lexique 3.8 database, given their position in the words (initial, median and final). He included inflected forms, for example, the feminine and plural forms of nouns, and excluded monophonemic words such as <un>, <on> and <en>. His aim was to account for the phoneme-to-grapheme consistency of the French phonemes, a so-called opaque language, in order to model as reliably as possible the consistency of the correspondences between phonological sequences and orthographic units in the French language. If we take the three nasal vowels, his analyses show that /ã/ has 7 possible spellings in word-initial position (by frequency range, en (most frequent), em, an, am, han, ham and hen) and 26 in word-final position (by frequency range, ant (most frequent), ent, ans, and, emps, ents, ants, an, end, ens, ends, ands, anc, ang, ancs, amp, amps, angs, aon, engs, eng, aons, am, empt, en and ams), giving a total of 33 possible spellings (not including phonemes in the median position). The nasal vowel /õ/ has 5 possible spellings in word-initial position (on, om, hon, hom and un) and 17 in word-final position, for a total of 22 different spellings, and the nasal vowel /ẽ/ has 7 possible spellings in word-initial position (in, im, ain, un, hin, hum and ein) and 28 in word-final position, for a total of 33 different spellings. In other words, even though the nasal vowel system is generally very inconsistent in French, the nasal vowel /õ/ is the one whose spelling varies the least.

3.2. Japanese: Nasalised Vowels

Japanese speakers have a repertoire of five vowels /a, e, i, ɔ, u/, all of which can be short or long, making it possible to distinguish between two lexical words. Japanese also has two nasal units: /n/ and /N/. /n/ is a nasal consonant, whereas /N/ is a so-called mora, a basic longer phonological sequence. The Japanese nasal mora /N/ has a variable realisation, at least in coda position, including coronal, velar-to-uvular and even as a nasalised glide [57,58] (We thank an anonymous reviewer for this precision). Youngberg (2021) even proposed that "in the place of a nasal consonantal coda, the Tōkyō variety has a nasal vowel, Ōsaka has a syllabic nasal and Kagoshima has a nasal coda" [59]. In Japanese, vowels may be nasalised, but this phonetic feature does not change the lexical meaning of the word. Vowels may be nasalised in front of a vowel, in front of the phonemes /s/ or /ʃ/ or at the end of a word [60]. Japanese is otherwise a moraic language with essentially open and simple syllables and no consonant clusters.

Three writing systems are used by Japanese speakers: the kanji system, with ideographs, which are in a deep relationship to phonology; the hiragana system, which is a moraic system in a transparent relationship with phonology (one mora CV, one character); the katakana system, which is a transparent moraic system as well but devoted to the writing of foreign words; and the Romaji system, which is alphabetic, corresponding to the Latin

alphabet and used for specific purposes (proper names of foreigners, locations in the public transport network, labels, etc.)

3.3. English: Nasalised Vowels

The vowel inventory of English is larger (there are usually 7 short vowels and 10 long vowels in the standard American English variety). But vowels are vocalic, and nasal vowels do not belong to English phonemes. There are nasalised vowels when a vocalic vowel precedes or follows a nasal consonant /n, m, ŋ/, but they are just considered allophones of the oral English vowels. The English writing system is alphabetic, and the phoneme-to-grapheme and grapheme-to-phoneme correspondences are known to be deep. Nevertheless, the graphemes <n>, <ng> and <m> regularly encode nasal consonants. Note that a number of words in English and French are homographs, such as <France>, pronounced [fʁɑ:ns] in standard English (as prescribed in a dictionary) and [fʁɑ̃s] in standard French or [fʁɑ̃ˈs] in meridional French.

In summary, Japanese learners of L3 French have to learn at a phonological level that nasal vowels are contrastive phonemes, and they have to learn to pronounce new sounds (articulations, lip movements and duration).

4. Research Questions and Hypotheses

Our study aims to examine whether the orthographic representation of the nasal vowels in L3 French has an impact on their pronunciation. More specifically, it attempts to verify whether the plurigraphemic representation of nasal vowels including the grapheme <n> or <m> (<V(V)n/m(CC)>) leads to the use of a postvocalic nasal consonant by Japanese learners using L3 French in interaction at the initial stages. The influence of orthography has been observed in experimental reading-aloud and repetition tasks (e.g., [2,35,37,45,49]). According to previous studies on the effect of orthography on pronunciation, the grapheme <n> could favour the retention of the nasality feature but favour a nasalisation of the vowel, especially at the initial stages [4].

In the light of previous studies and the phonological and orthographic properties of the languages involved (L1 Japanese, L2 English and L3 French) our hypotheses are outlined as follows:

1. H1: The graphemes <n> and <m> influence the pronunciation of nasal vowels and give way to nasal consonantisation or nasalisation, i.e., the use of a vowel followed by a nasal consonant, as observed in other studies [4,9,11].
2. H2: This effect of the graphemes <n> and <m> decreases with time of exposure to L3 French, mainly due to increasing exposure to the acoustic forms of nasal vowels.
3. H3: Nasalisation of vowels in L3 French is more frequent in spontaneous speech—a word retrieved from the mental lexicon, where the oral and written forms co-exist—than in repeated speech—a word repeated from the feedback of the interlocutor [9,48].
4. H4: Nasalisation should vary according to the phoneme-to-grapheme consistency and to the frequency of the nasal vowel in the production context; the nasal vowel /ɔ̃/ will thus be less nasalised than the vowels /ã/ and /ɛ̃/ because of its relatively stronger phoneme-to-grapheme consistency [3,55].
5. H5: Japanese learners of L3 French use the graphemes <n> or <m> to write words with nasal vowels at the initial stages.

The results of this study will be discussed in order to contribute to the didactic proposals already made with respect to nasal vowel teaching and to outline some possible avenues for a research agenda that could be relevant for teaching practices related to the interfaces between phonology and discourse, the effects of orthography and translinguistic influences.

5. Methodology

To answer the two questions and test the five hypotheses, we carried out an analysis of perception of nasal vowels in a longitudinal corpus of conversational and narrative speech produced by 4 Japanese learners of L3 French interacting with a speaker of L1 French. We also analysed the learners' orthographic productions. Although the sample is limited to 4 participants, their productions present two important advantages with regard to our research question and hypotheses. First, the productions were collected in a face-to-face conversational setting that has not been extensively studied until now. This oral corpus thus enables us to observe two production situations: when the learner produces a known word and when he repeats an unknown word given by his interlocutor. These two situations allow us to ecologically observe the effect of orthographic knowledge of the word in the production process. The second reason is that the corpus includes both written and oral productions, enabling comparative analysis of the phonology and orthography of the same learners. To the best of our knowledge, such an ecological, bimodal corpus has not yet been analysed. We come back later and in the conclusion to the limitations raised by the sample size.

5.1. Participants

Four Japanese students aged 19–20 (one male and three females) who were enrolled in an optional French course at a Japanese university participated in this study. All of them are multilingual, having learned Japanese in the Kanto area from birth, then English when entering secondary school, with a tested level of at least 500 points in TOEFL up on entering university, where they began to learn French as a third language (Table 2).

Table 2. Participants.

ID	Gender	Age	L1, L2
JL1	female	19	Japanese, English
JL2	female	19	Japanese, English
JL3	male	19	Japanese, English
JL4	female	20	Japanese, English

5.2. Exposure to French

The first recording (T1) took place in July, three months after the beginning of the French course. The four young adults had then benefited from about 50 hours of institutional exposure to spoken and written French. The second data collection time (T2) took place five months later, which corresponded to a further 70 hours of exposure to French, i.e., a total of 120 hours of instruction (4.5 hours a week (3 × 90 min)).


During the first year of French learning, the weekly exposure to input took place mainly in the classroom with two bilingual teachers, a teacher of L1 Japanese and L2 French and a teacher of L1 French and L2 Japanese. The L1 French teacher speaks a standard variety of French and gave listening comprehension and oral production classes that can be described as orolographic. The term orolographic, as used by Bouchard [61], refers to the fact that the learner in a language class is exposed both to the flow of phonemes and to the orthographic chain, whether it be the text in the handbook or the words or sentences written on the board, such as the words /ãglɛ/, /ãglɛz/ that are repeated orally by the teacher and then written <anglais(e)> on the board (turn a) in (1). Learners are therefore simultaneously exposed to the phonemic and graphemic forms of the words.

- (1) Ishikawa Corpus [62], 1 week before T1: Interactive correction of an exercise in the handbook *Spirale. Méthode de français pour débutants*. T = teacher; A8 and A1 are identified students, unlike An. Transcription conventions: / small pause; (3 s) pause whose length is 3 seconds; syllables perceived as stressed because of their higher volume or longer duration are transcribed in capitals.

- a. T: BRAVO !/ très très bien anglais hein ? (T. writes on the black board <anglais(e)>)/ anglais anglaiSE !/ adjectif (3s) BONJOUR ! (GREAT!/ very very good, anglais, no?/ (P. writes on the black board <anglais(e)>)/ anglais anglaiSE !/ adjective (3s) HELLO !)
- b. A8: bonjour (hello)
- c. T: ON CONTINUE !/ on continue s'il vous plaît !/ « le mont Blanc » ! (2s) (Let's go on!/ let's go on please !/ « le mont Blanc » ! (2s))
- d. A1 : c'est/ c'est en France (it's/ it's in France)
- e. T: très très BIEN !/ c'est en France/ À ? (very very GOOD!/ it's in France/ in?)
- f. A1: À Chamonix (in Chamonix)
- g. T: BRAVO !/ VOUS CONNAISSEZ BIEN !/ OUI :::!/ à Chamonix !/ à Chamonix (GREAT!/ YOU KNOW WELL!/ YES:::/ in Chamonix!/ in Chamonix)
- h. An: Chamonix ?/ Chamonix ?
- i. T: Chamonix/ Chamonix/ on écrit comme ça/ regardez/ à Chamonix (2s) (P. writes on the black board <Chamonix>) / c'est près de Genève ! (Chamonix/ Chamonix/ you write it like this/ look/ in Chamonix (2s) (P. writes on the black board <Chamonix>) / it's near Genève !)

These interactions in the language classroom show the omnipresence of words with nasal vowels right from the start of the learning process, either in the lexicon used in the read aloud dialogues or in the different activities (*en anglais 'in English', Mont Blanc, en France 'in France'*). Nasal vowels were also present in the frequent and more or less emphasised feedback given by the teacher (*très bien bien 'very very good' turn a ; très très BIEN turn e, VOUS CONNAISSEZ BIEN 'YOU KNOW WELL'!* in turn g) or in interactional management (*BONJOUR 'HELLO' to greet a student entering the room in a and ON CONTINUE !/ on continue s'il vous plaît 'WE GO ON !/ we're going on please'!* in c).

An analysis of the two textbooks used in the course, *Spirale* [63] and *Bonjour, Paris* [64], shows that the written forms of words in French are also transliterated in the first lessons. In other words, their pronunciation is transcribed in one of the two syllabaries used in Japanese: *katakana*, which is often used to write foreign words [23,65]. The inflected forms of the verb *être* that the learner can listen to are thus doubly transcribed in the textbook: orthographically with the Latin alphabet system usually used for French and between square brackets moraicly with the *katakana*, which is usually used to write foreign loanwords (Figure 1).

③ être の直説法現在形 

être [エートル]			
je suis [ジュ・スエイ]	nous sommes [ヌ・ソム]		
tu es [チュ・エ]	vous êtes [ヴ・ゼット]		
il est [イ・レ]	ils sont [イル・ソン]		
elle est [エ・レ]	elles sont [エル・ソン]		

Figure 1. Inflectional paradigm of the verb *to be* in *Bonjour Paris*, p. 12.

The transliteration of French with the *katakana* syllabary was very frequent in textbooks published until 2008 (Sauzedde 2014: 112). It associates an adapted, simplified phonological sequence with the graphemic word. For instance, the 3rd person plural form /sɔ̃/ is doubly transcribed with the Latin alphabet as <son̄t> and with two kanas respectively pronounced /sɔ̃/ and /N/. This leads to two graphemic and phonological representations for the same word: /sɔ̃/, which might be heard in the classroom, and /sɔ̃.N/, which might be read in the textbook. Moraic transliteration as in Figure 1 thus favours the use of a postvocalic nasal consonant.

In our study, participants were exposed to phonemic and graphemic representations of a variety of words containing nasal vowels at T1 and T2, namely to their bi- or tri-graphemic forms provided in the textbook or on the blackboard and to bi-moraic written forms provided in the textbook and possibly used by learners in their own notebooks.

5.3. Corpus

The investigated data set is a longitudinal corpus of productions elicited through three tasks (two spoken and one written production task) carried out at two data collection times, T1 and T2, after 50 and 120 h of exposure (+70 h) to French in the university, respectively. The recordings took place in an ordinary room and allow for perceptive analysis but do not have the quality required for acoustic analysis.

The two oral tasks consist of :

1. A semi-guided interview conducted between the interviewer and each participant;
2. A picture story in the form of vignettes about a boy who loses his cat and goes looking for it. .

The picture story features situations whose descriptions are likely to trigger the production of frequent lexical units with nasal vowels: /garsɔ̃/, written <garçon>, meaning 'boy'; /ɑ̃fɑ̃/ <enfant> 'child'; /ʃɑ̃bʁ/, <chambre> 'room'; /parɑ̃/ <parent> 'parent'; /mɛzɔ̃/, <maison> 'house'; /vwaʒɑ̃/ <voisin> 'neighbour'; /pwazɔ̃/ <poisson> 'fish'; /ʃjɑ̃/ <chien> 'dog'; /jɑ̃dɑ̃/ <jardin> 'garden', to mention but a few examples of names used to refer to the main protagonists and places in the story as in (2).

(2) JL3, Cat Story, T1.

- a. et /garsɔ̃n/ (.) /tuvə/ a CHAT /tuvə/ a chat (..) avec /pwazɔ̃n/
and boy (.) find a CAT find a cat (..) with fish
'and the boy finds a cat finds a cat with a fish'

The spoken longitudinal corpus of conversational and narrative speech in interaction makes it possible to analyse the variable pronunciation of nasal vowels by Japanese learners according to a set of variables. These two oral tasks allow for examination of the following factors:

- How the L1 Japanese learners produce expected nasal vowels in L3 French: as a nasal vowel, an oral vowel or a nasalised vowel, as observed in previous studies;
- How the pronunciation of expected nasal vowels evolves with increased exposure to French between T1 and T2;
- How the pronunciation of expected nasal vowels varies according to the micro-context of production: if the nasal vowel is spontaneously produced in a word retrieved from the mental lexicon such as JL4's *bonjour*, /bɔ̃ʒuʁ/, 'hello' in (3) or repeated as a word immediately given before by the interlocutor such as JL4's /fwɑ̃sɛ/ 'French' in 4f;
- How the pronunciation of expected nasal vowels varies according to the type of nasal vowel, i.e., the consistency of their phoneme-to-grapheme correspondences.

(3) Interview, T1, JL4 enters the room where the interviewer is.

- a. JL4: xx *bonjour* (*hello*)
- b. INT: *bonjour* E mm *asseyez-vous j'vous en prie* (*hello mm sit down please*)
- c. JL4: *mercé* (*than you*)

(4) Interview, T1, presentation phase.

- a. INT: d'accord d'accord j'ai compris et euh JL4 vous étudiez le français? (*ok ok I understand and euh JL4 do you study French?*)
- b. JL4: *vousétu* (*doyoustu?*)
- c. INT: vous vous étudiez le français? et quoi? (*do you study French and?*) (*Let's go !/ let's go please !/ « le mont Blanc » ! (2s)*)
- d. A4: *et quoi? kanshoizume* (*and kanshoizume*)
- e. INT: oui nononon à XX [=name of the town] YY [=name of the university] vous étudiez le français avec ZZ [= name of the teacher] (*yes nonono in XX YY do you study French with ZZ?*)
- f. JL4: *lel fwançais and they anglais* (*the Flench and they English*)
- g. INT: *anglais aussi très bien* (*English as well very good*)

- h. JL4: oui yeh yeh anglais (*yes yeh yeh English*)
- i. INT: très bien français et anglais (*very very good, French and English*)

The written task is a narrative task involving the retelling of two extracts from the movie *Modern Times* that the student watches in a sequence. They watch the first extract (approx. 1 min) in which a woman steals a loaf of bread, runs away and is arrested by the police - the participants have 10 min to write about this passage. Then they watch the second extract, which lasts about a minute and, again, have 10 min to recount the scenes they have seen. The participant writes by hand and does not use any lexical or grammatical aids. This task is also likely to trigger the use of plurigraphemic units <a,e,u,i + n> to encode nasal vowels such as <pain> 'bread', <prend> 'takes', <entre> 'enters', <mange> 'eats' and <restaurant> 'restaurant', in addition to grammatical units such as <un> 'a'/'one', <dans> 'in', etc. The written corpus makes it possible to check the orthographic knowledge of the nasal vowels / \tilde{o} /, / \tilde{a} /, / \tilde{e} / at the initial stage.

5.4. Coding and Analysis

In the spoken corpus, coders identified the units with nasal vowels, and each unit with an expected nasal vowel in French was considered a target token and analysed by four expert French listeners who coded the following elements:

- The expected type of nasal vowel: / \tilde{a} /, / \tilde{o} /, / \tilde{e} /;
- The perceived phonemes as corresponding to the target nasal vowel or not;
- The context of production: repeated versus spontaneously produced and retrieved;

The expert listeners were four female, multilingual expert teachers of L2 French and researchers in L2 acquisition living in the south of France at the time of coding and who socialised in various places. Table 3 shows the distribution of the coding task according to coders.

Table 3. Distribution of coders.

Coder	Participant
C1	JL1, JL2
C2	JL2, JL1
C3	JL3, JL4
C4	JL4, JL3

The categories used for coding were identified by the four coders based on data analysis. Overall, seven categories of nasal vowel realisations were found: (1) NV, nasal vowel: / $\tilde{p}\tilde{a}\tilde{s}$ /, *pense*, 'think'; (2) NV + N, nasal vowel followed by a nasal consonant: / $\tilde{f}\tilde{a}\tilde{t}$ / *chante*, 'sing'; (3) OV + N, oral vowel followed by a nasal consonant /n/, / $\tilde{d}\tilde{a}\tilde{n}$ / *dans*, 'in'; (4) OV + M, oral vowel followed by a nasal consonant /m/, / $\tilde{k}\tilde{o}\tilde{m}\tilde{p}\tilde{r}\tilde{i}$ /, *compris*, 'understood'; (5) OVS + N, substitution of the oral vowel (/e/ instead of / \tilde{e} / followed by a nasal consonant /n/, / $\tilde{f}\tilde{e}\tilde{n}$ / for *chien*, 'dog'; (6) OV, oral vowel, / $\tilde{f}\tilde{a}\tilde{b}\tilde{r}$ / *chambre*, 'room'; (7) OVS, substituted oral vowel, /a/ *un*, 'a'.

In the quantitative analyses, the seven categories used in the data-driven coding are merged into three pronunciation categories of the three nasal vowels \tilde{a} , \tilde{o} and \tilde{e} as follows:

- NV: nasal vowel;
- V + N : vocalic or nasal vowel followed by nasal consonant (merging categories NVN, OVN, OVM and OVSN);
- OV: oral vowel (merging categories OV and OVS).

In the written narratives, we selected the target words, e.g., <mange> 'eats', <nombreux> 'numerous' and <restrant> 'restaurant', as in (5), and coded the accuracy of the graphic encoding of the nasal vowel, regardless of the other surrounding syllables and consonants. Thus, we considered that the nasal vowel in the word <restrant> was correctly spelled, using the two graphemes <a> and <n>, unlike in the word <nombreux>, where the bigraph <um> does not match the expected bigraph <om>.

- (5) JL2, *Modern Times*, Written retelling, Restaurant scene (The examples provided are the learners' spellings).

a. <Il mange nombreux déjeuner à réstrant.>

The analyses of the pronunciation and spelling of the French nasal vowels by the four beginner Japanese-speaking learners are presented in the following section.

6. Results

The analysed corpus includes 520 tokens (i.e., syllables) with an expected nasal vowel: 467 in oral production (Table 4) and 53 tokens in written production. Despite a small sample limited to four speakers, the number of analysed occurrences is higher or equivalent to that of previous experimental studies [9,11]. Since our research question concerns the effect of the graphemes <n> and <m> on the pronunciation of nasal vowels, our analyses focus first and foremost on the spoken corpus and the pronunciation of the nasal vowels. Analysis of the learners' written corpus and the learners' orthography will be addressed at the end of this section.

Table 4. Interactional Corpus: duration and number of expected nasal vowels (NV).

ID	Duration (mn)	NV T1 + T2
All	172	467
JL1	36	90
JL2	53	114
JL3	40	143
JL4	43	120

There are individual differences in the use of syllables, with expected nasal vowels ranging from 1 to 1.5 between JL1, who uses 90 syllables with an expected nasal vowel, and JL3, who uses 140.

6.1. Pronunciation

Each syllable with an expected nasal vowel was evaluated by two raters in terms of correction and type of error where applicable. The raters have congruent perceptions in correction and type of error in 335 of the 467 occurrences (71.7%). A closer look into the most frequent words in the learner's corpus (*non* 'no', *un* 'a/one', *français* 'French', *chien* 'dog', *garçon* 'boy', *en* 'in', *son* 'his', *poisson* 'fish', *dans* 'in' and *content* 'happy') reveals an inter-rater rate over 90 %, except for *son*.

Furthermore, the raters agree on perceived nasalisation in one form or another: nasal vowel (NV) or vowel + nasal consonant (V + NC) in 109 cases (Table 5). In the remaining 23 cases, they disagree on a perceived oral vowel (OV) and perceived nasalisation of some type (NV or V + NC). In total, there is agreement on perceived nasalisation in 444/467 (95.1%) of the syllables with expected nasal vowels.

Table 5. Common perception of the expected nasal vowels.

Expected Nasal Vowels (N = 467)	Perceived Phoneme(s)	(Dis)agreement
335	Nasal or Oral Vowels O, NV	
109	Nasal(ised) Vowels NV vs OV + N	
444		Agreement on orality or nasality (95.1%)
23	Oral or Nasal(ised) Vowel OV vs NV or OV + N	Disagreement on orality or nasality (4.9%)

The pedagogical consequences in terms of intelligibility of this agreement on nasalisation but disagreement on the type of nasalisation will be further discussed in Section 7.

Here, we concentrate on the 335 cases where both raters agree on the type of pronunciation. The main reason for this is that we do not investigate the pronunciation of the nasal vowels per se but whether it is possible to observe influences of orthography on the oral production in a corpus study, as it has been shown in experimental studies (e.g., [2,35,37,45,49]), and when the L1 has a non-alphabetic script [45]. The results are presented in the order of the four hypotheses.

6.1.1. First Hypothesis: The <n> Spelling Leads to the Pronunciation of the Nasal Consonant Following the Vowel (V + N)

The first hypothesis is that the pronunciation of French nasal vowels is affected by their spellings, leading to the pronunciation of the nasal consonant following the vowel to be nasalised.

The analysis of the 335 congruently perceived sounds shows that 72% (241/335) of them are perceived as expected nasal vowels, 19.5% (66/335) as a vowel followed by a nasal consonant and 8.5% (28/335) as oral vowels (Table 6).

Table 6. Distribution of the perceived phonemes (n = 335) in % and number of occurrences per participant and category (#).

ID	NV	V + N	OV	Total
All	72 (241)	19.5 (66)	8.5 (28)	100 (335)
JL1	84 (61)	11 (8)	5 (4)	100 (73)
JL2	79 (61)	21 (16)	0 (0)	100 (77)
JL3	62 (65)	30.5 (32)	7.5 (8)	100 (105)
JL4	67.5 (54)	12.5 (10)	20 (16)	100 (80)

When an NV is not perceived, a postvocalic nasal consonant (V + N) is the most frequent perception, i.e., 19.5 % (66/335). Nevertheless, there is an important inter-individual variation. The perceived production of JL1 contains fewer postvocalic nasal consonants (V + NC) than JL3' (11 vs 30.5%). Expected nasal vowels are frequently perceived as oral vowels by both raters in JL4's production (20%), whereas they are absent in JL2's.

6.1.2. Second Hypothesis: Pronunciation of V + N Is Less Frequent at T2

The second hypothesis is developmental and predicts a trade-off effect: the impact of orthography on pronunciation decreases when French oral exposure increases. Out of the 247 (53%) expected vowels in the first recording and 220 (47%) in the second, both raters agreed in perception on 181 vowels at T1 and 154 at T2. If we look, in particular, at the rate of perceived postvocalic nasal consonants between T1 and T2, it decreases overall from 23% to 16% (Table 8).

Table 7. Part of postvocalic nasal consonants in % and raw values at T1 and T2.

	T1 n = 181		T2 n = 154	
All	23	(41/181)	16	(25/154)
JL1	2	(1/44)	24	(7/29)
JL2	26	(13/49)	11	(3/28)
JL3	43	(21/49)	19.5	(11/56)
JL4	15.25	(6/39)	10	(4/41)

In three of the four participants (JL2–4), the nasalised pronunciation vowel + N decreases, while it increases in JL1. A proportion of 43% of the phonemes produced by JL3 are perceived as vowels with a nasal consonant at T1 but only 19.5% at T2. The opposite trend is observed for vowels produced by JL1: only 2% are perceived as followed by a nasal consonant at T1 compared to 24% at T2.

6.1.3. Third Hypothesis: The V + N Pronunciation Is More Frequent in Retrieved Words Compared to Repeated Words

If we consider the third hypothesis, the nasal consonantisation should be more frequent in retrieved than in repeated words.

If we look into the production of the postvocalic /n/, this tendency seems to be confirmed. A proportion of 77% (51/66) of the V + NCs are pronounced in spontaneous speech (Table 8).

Table 8. Distribution of the perceived postvocalic nasal consonants in %.

	Retrieved	Repeated
V + N n = 66	77.5 (51)	22.5 (15)

In retrieved words (n = 188), the postvocalic /n/ is present in 27% (51/188) of the occurrences, while it is only present in 10% (15/147) of the repeated occurrences. As a comparison, NVs are pronounced in 64% (121/188) of the spontaneous productions and in 82% (120/147) of the repeated occurrences (Table 9). A chi-square test of independence reveals that there is a significant difference between the retrieved and repeated words ($\chi^2(2) = 15.425, p < 0.001$). The pronunciation of French nasal vowels seems better in the repetition than the spontaneous context.

Table 9. Distribution of the perceived postvocalic nasal consonants (N = 335) in %.

	Retrieved n = 188	Repeated n = 147
NV	64 (121)	82 (120)
V + N	27 (51)	10 (15)
OV	9 (16)	8 (12)

The repetition of a spoken model leads to the pronunciation of a nasal vowel. On the contrary, retrieving a word from the lexicon leads to a consonantised pronunciation of the nasal vowel.

6.1.4. Fourth Hypothesis: Pronunciation of the Nasal Consonant Following the Vowel

The fourth hypothesis is that graphemic consistency has an impact on the pronunciation of the nasal vowels. According to Planton (2014) [55], a nasal vowel should be less consonantised when it is more consistent. Therefore the nasal vowel / \tilde{o} / should be less consonantized because it has fewer graphemic correspondences than the other nasal vowels (/ \tilde{a} / and / \tilde{e} /), .

Table 10. Distribution of perceived postvocalic nasal consonants according to the type of nasal vowel.

Type of nasal vowel	/ \tilde{o} / n = 123	/ \tilde{a} / n = 128	/ \tilde{e} / n = 84
V + N perception (%)	25 (31)	23 (29)	7 (6)

Overall, 19.5% of the expected nasal vowels are perceived as consonantised vowels and the nasal consonantisation depends on the type of vowel. Among these, 7% of instances of the nasal vowel / \tilde{e} / are perceived as a vowel followed by a nasal consonant by both raters, whereas 25% and 23% of the nasal vowels / \tilde{o} / and / \tilde{a} / are perceived as consonantised (Table 10). Nasal consonantisation depends of the type of nasal vowel but not as previous studies hypothesised.

6.2. Orthographic Use of Words with Nasal Vowels

The written texts are quite short and contain 53 syllables that should be pronounced as a nasal vowel and written with a graphic vowel and the <n> or <m> grapheme.

Table 11. Orthographic corpus size.

ID	<n>-Segments		
	T1 + T2	T1	T2
All	53	17	36
JL1	21	7	14
JL2	17	7	10
JL3	12	2	10
JL4	3	1	2

Almost all syllables (54 out of 55, i.e., 98%) are written as expected bigraphs (vowel + the correct nasal consonant <n> or <m>) (Table 11). In a few cases, the vowel in the bigraph is misspelled : <pan> for <pain> (6/8 occurrences), <en> for <o> (2/2), <en> for <un> (1/5) and <nombreux> for <nombreux> (1/2). The only occurrence where the bigraph (vowel + nasal consonant) is not respected is <a> for the indefinite article <un>.

Some of these misspellings could be explained by crosslinguistic influence, either the use of the Japanese L1' word /pan/, which is closely related to the French word /pɛ̃/ and <pain>, as in 6a, or the use of the English (L2) indefinite monophonemic article <a> as in 6b. In 6c, the spelling <nombreux> may be explained by the words <numerous> having the same meaning as <nombreux> but starting with <num> instead of <nom>.

- (6) a. Elle prend un *pan.
She take.3SG a pan.JAP?
'She takes a pan.'
- b. Une femme veut *a pain.
A.FEM woman want.3SG a.EN? bread.
'A woman wants un bread.'
- c. Il mange *nombreux déjeuner à réstrant.
He eat.3SG numerous.EN? lunch in restrand.
'He is eating a lot of dishes in the restaurant.'

The analysis of this small corpus of written retellings provides evidence of the stability of orthographic representations of words containing nasal vowels, which allows us to conclude that these are overall target-like. Even at T1, the expected bigraphs are used. Most of the misspellings illustrate the multilingual competence of the participants and can be explained by crosslinguistic effects from their L1 or L2.

7. Discussion

To sum up, the results of this analysis of expert listeners perceptions show that (i) beginner Japanese learners of L3 French spell French nasal vowels with an <n> or <m> in 98% of the obligatory contexts; (ii) in speech, most expected nasal vowels are perceived by expert listeners from the initial stages as nasal vowels (72%), the others being perceived as vowels followed by a nasal consonant (19.5%) and as oral vowels (8.5%); (iii) consonantisation is stronger when the learner spontaneously produces a word than when (s)he repeats it; and (iv) it decreases with time (learning effect) and (v) varies according to the consonant, /ɛ̃/ being less consonantised than /ɔ̃/ and /ɑ̃/.

The state of the art reveals that overall, researchers have studied the influence of previously acquired languages on the pronunciation of nasal vowels without necessarily taking into account the effects of orthography. Even if these effects are suggested by the findings of those studies, they were not at the center of the investigation, hence Detey et al.'s (2010) call to explore the effect of orthography on the acquisition of L2 French nasal vowels [9]. Particularly, in research on French as a second language, crosslinguistic phonological influences and orthography effects are poorly articulated. In fact, the phenomenon of nasal consonantisation observed in L2 French is either attributed to the phonology and phonetics of the first languages or to the orthography of the newly acquired language. In our study, we cannot decide between the two possibilities because the data do not allow us to distinguish between the effects of L1 Japanese phonology and those of L3 French orthography, except for supposed new words that the learner hears and uses orally during interaction (without exposure to their written forms). Nevertheless, we hope to have provided answers regarding whether Japanese learners of L3 French produce nasal or nasalised vowels in the initial stages of acquisition specifically in an ecological situation of interaction with an expert speaker.

Before discussing the results, it is noteworthy from previous studies that the nasal consonantisation in the production of L2 French nasal vowels is mainly observed in learners whose L1 lacks nasal vowels and has nasalised vowels, like English, Spanish, Japanese and Cantonese. Conducting comparative studies with learners whose L1 has nasal vowels would bring insights into whether L2 nasal vowel' production is facilitated by the existence of equivalent phonemes in the L1. If not, the use of a postvocalic consonant could be explained by a common path of development in initial stages: first, the use of a vowel followed by a consonant, then a nasal vowel. Such a system would make it possible to distinguish between L1, phonological development in L2 and even the influence of another

L2. In any case, it would be interesting to also consider the influence of other languages previously acquired by the learner, like L2 English. Indeed, the possible influence of English on the appropriation of the phonological system of L3 French cannot be excluded, especially given that French and English share a common writing system and a number of similar words (e.g., those ending in 'tion', like construction). Historically, English has borrowed a good proportion (varying between half and a third depending on the authors) of its vocabulary from French [66]. This explains a set of homographs but different grapheme-to-phoneme correspondence rules, i.e., for a certain number of graphemes orthographically common to both languages (the <an> of <restaurant>) pronounced using nasalised vowels in English and nasal vowels in French. This lexical proximity could favour a nasalised pronunciation of the nasal vowel in L3 French. A comparison of the pronunciation of nasal vowels in L3 French by various speaker profiles (Group A: L1 with nasal vowel, L2 English, L3 French; Group B: L1 with nasalised vowel, L2 English, L3 French) would make it possible to measure, all other things being equal, the impact of the nasalised vowel in L1 learners knowing L2 English.

Furthermore, the comparative studies of nasal vowel acquisition in L2 French carried out to date have mainly focused on single-speaker tasks (reading aloud or repetition of sentences or words) conducted, for acoustic reasons, in a quiet room. From a didactic perspective, one limitation of these studies is that the machines produce diagnoses that are partly inaccessible to human perception, which generates results that are difficult to transpose into pedagogical scenarios. To the best of our knowledge, there are no studies on conversational or narrative data by learners of French in ecological interaction situations. In this respect, our study makes it possible to account for pronunciation in situations close to typical classroom conversational activities. Moreover, the data illustrate the different production possibilities in interaction for beginner learners, i.e., the repetition of words given with the expert speaker's support or the spontaneous production of a word retrieved from the mental lexicon without mediation by the expert. Another advantage of analysing pronunciation in verbal interactions is that it allows us to account for the intelligibility of speech, understood as the ability to identify the lexical units produced based on, among other things, phonemes' recognition.

Moreover, given that this is a longitudinal and bimodal study, it has provided insights into different phenomena involved in the production of nasal vowels. In fact, our findings suggest that, despite the fact that previously acquired languages lack nasal consonants, the L3 French Japanese learners produce, from the earliest stages, phonemes that are identified by expert listeners as nasal vowels in 72% of cases and as nasalised vowels in 19.5% of cases. The first hypothesis claims that the graphemes <n> or <m> influence the pronunciation of the nasal vowels and give way to the use of a vowel followed by a nasal consonant, as observed in other studies [4,9,11]. Since learners produce phonemes that are identified as nasal vowels in two-thirds of the obligatory cases, this consonantisation hypothesis is thus rejected. This figure is higher than the rate of transcription accuracy observed in Detey et al.'s experimental study with more advanced learners (B2–C1) [9]. French non-expert listeners had to hear words pronounced by advanced learners and write them orthographically. The accuracy rate was 64.5%. The analysis of nasal vowels in L2 speech in interaction differs from the results observed experimentally, since a larger part of L2 phonemes are identified as nasal vowels in the initial stages. These differences confirm the already mentioned importance of varying the tasks, particularly from a didactic perspective.

But can we completely rule out an effect of spelling on the production data? Such an influence is possible, but as an anonymous reviewer mentioned it, an equally likely possibility is that the postvocalic nasal consonant results from mistiming of the oral and nasal (i.e., velum closing) gestures. One way of looking at the effect of spelling is to compare cases of oral production with and without spelling knowledge of the word. Spontaneous conversation at the initial stage in the L2 presents these conditions because the learners use the lexicon they learned in its written and oral forms and because the interlocutor

constantly provides the lexicon orally at the learner's request, enabling him/her to reuse it and elaborate his/her discourse. The comparative analysis of words and nasal vowel perception in these two contexts confirms an effect of spelling on the oral production process (H3), which corroborates the differences observed in other studies [9,48], according to which word repetition leads to a better pronunciation of nasal vowels than reading aloud because repetition is a phenomenon that does not call up the mental lexicon and the interference of orthographic representations in phonological encoding. Consonantisation is more frequent in spontaneous production when an orthographic representation of the word can be assumed, even though it remains marginal compared to the production of a nasal vowel. Most of the postvocalic nasal consonants are pronounced in spontaneous speech (51/66), indicating a possible impact of the written form of the retrieved word from the mental lexicon. It is sometimes possible to follow this orthographic influence when the learner repeats the word given by his interlocutor and understands which word is pronounced by the interviewer, then retrieves it from his/her mental lexicon, adjusting the pronunciation to the following nasal consonant (see the following examples 7 and 8).

(7) JL3, Cat story.

- a. JL3: boy
- b. INT: OUI un GARÇON GARÇON (YES a BOY BOY)
- c. JL3: /garson/ ah:: OUI (BOI ah yes)
- d. INT: garçon (boy)
- e. JL3: /garson/ (boi)

In (7), JL3 first spontaneously repeats the word *garçon*, pronounced [garsõ], with the nasal vowel given by his interlocutor in the oral retelling task, then understands the word and reproduces the word [garsõn] and thus pronounces all the graphemes in the word. This behavior seems to indicate a retrieval of the orthographic form in the mental lexicon in order to understand which word has been given by the interviewer. The retrieved visual form of the word (inner vision) then impacts the following pronunciation of the word, and this is observed in all of the recordings (in total, 25 occurrences), even though [garsõ] with a nasal vowel is used at two other times by the interviewer. Sometimes, when the learner pronounces a word that has the same graphic form in English and French, like <restaurant>, and uses, in French, the postvocalic nasal consonant, as in (8), it is difficult to know whether this is a direct phonological influence of English or if the learner encodes the homographic form phonologically with the English grapheme-to-phoneme correspondence rules. Analysis of the production of nasal vowels in an interactional context makes it possible to isolate a few very clear cases of the influence of a phonological decoding mechanism by mental graphic transcription and registration in the multilingual repertoire. This is the case in (8) in the oral retelling task. Initially, in 8a, the interlocutor provides the word 'poisson' (fish) [pwasõ] to the learner, who does not know it and repeats it identically. Then, after a few statements, in 8b, she describes the final image in which the child finds his cat with a fish in its mouth. The narrator then retrieves the word 'fish' given earlier, which we consider to be a spontaneous use, and produces a transformed series of phonemes /pɔj/ /pɔjszɔn/ /pɔjzɔn/, which cannot be explained by the translinguistic influence of English alone.

- (8) a. i. INT: ça c'est /pwasõ/ (this it's fish)
- ii. JL4: /pwas/, /pwasõ/ a /pwasõ/
- b. i. JL4: and euh: da /pɔj/ /pɔjszɔn/ /pɔjzɔn/ (and euh da fri frish frish)
- ii. INT: /pwasõ/ (fish)
- iii. JL4: /pwasõ/ une /pwasõ/ (fish a fish)

This English-like pronunciation is only made possible by the existence of a mental graphic form made up of several graphemes. The interaction thus reveals an automatic processing of mental transcription. As in the study by Detey et al. (2010) [9], orthography is one factor among others influencing phonology in the L3. Particularly, the task also seems to affect the production of nasal vowels by learners or their identification by listeners.

Furthermore, our study shows that it makes sense from the beginner stages onward to postulate an effect of orthography and, in particular, of the graphemes <n> and <m> because the analysis of written productions shows that learners use them correctly in 98% of cases (H5). The written forms of the words are present from the very beginning in instructed contexts and could favour spelling and influence L2 pronunciation [38,67]. This may be because of the 'transparent' storage of an opaque language like French in the mental lexicon (one grapheme = one phoneme). This may also have the positive consequence of retaining silent consonants in orthographical memory; in other words, the association of /dans/ with <dans> instead of /dã/ leads to a better spelling of the word. This is an argument in favour of teaching suggestions tailored to the real needs of learners. But if mastery of oral language takes precedence over mastery of written language, then other suggestions may apply, like learning the International Alphabetic Alphabet, even if experimental studies exploring the effect of unfamiliar orthographic forms on word learning and syllable discrimination have shown contradictory results (positive effect [29,46], no effect [47] or a negative effect [54,68]). More research on this topic would help to understand what is going on at the grapheme/phoneme interface.

Above all, our analyses have shown that nasal consonantisation decreases over time for most learners (H2), and this may be explained by greater exposure to nasal vowels and better control of orthographic interference over time. This is a real contribution to research on L3 French pronunciation, given the absence of longitudinal studies.

Lastly, this study has shown differences in consonantisation between vowels in a direction that does not correspond to the predicted one: the nasal vowel / $\tilde{\text{ɔ}}$ / is the most consonantised, although it has the fewest orthographic correspondents (H4). Nevertheless, there are 22 of them, and at this stage of irregularity, the difference between nasal vowels may not be very significant. Following the example of Detey et al. (2010), another possible study would be to test phonotactic hypotheses, i.e., whether the position of the vowel in the word (initial, medial or final) and its consonantal environment modifies its pronunciation. As this parameter was not controlled, it could explain the differences observed between vowels.

Our study has mainly shown that lexical or grammatical items with an expected nasal vowel produced by Japanese learners of L3 French were identified by listeners of interactive discourse, regardless of the phonemes perceived. Whether the listeners perceive a nasal vowel, a nasalised vowel or an oral vowel instead of an expected nasal vowel, the word in which this or these phonemes are found is identifiable in speech. In other words, the nasalised or even oralised pronunciation of the nasal vowel does not affect intelligibility, even in the initial stages, after a few dozen hours of exposure to French. Several explanations may be put forward, starting with the predominance of target pronunciation (72%), which makes words interpretable. In addition, the words are produced in a context which contributes to meaning construction. Furthermore, the interactional situation, particularly during the image description task, creates a shared experience where a certain number of words can be interpreted with reference to the context. Finally, even though nasalised vowels are not part of the phonological inventory of French, it cannot be ruled out that the nasal feature conveyed in the nasalised vowel is helping the expert listener to reconstruct the nasal vowel and identify the word produced. However, according to previous studies, these results raise questions about learners' perception and articulation, as well as about the role of phonotactic constraints. Indeed, Marquez Martinez's (2016) perceptual study shows that English speakers adopt perceptual strategies when they are naïve or beginners. The results of her study indicate that naïve listeners mostly heard French nasal vowels as sequences of oral vowel+nasal consonant (perceptual unpacking). But after exposure to French instruction, learners initially heard French nasal vowels as oral, thus applying the nasal stripping strategy. Keeping nasality in the vowel and adding a residual nasal consonant is the third stage of development according to Marquez-Martinez (2016). The fact that the beginner learners studied are at stage 3 of perception may be surprising, and it would be interesting, in a future study, to compare

ecological oral production data and perception data for the same sample of learners in order to understand whether the perception of nasal vowels in learner speech by expert speakers is correlated with a perception of the inherent nasality feature by these learners and a target articulation of nasal vowels or whether it is a matter of phonological reconstruction of the nasal vowel by expert listeners in the speech context. Further research is needed to better understand the relationship between perception, production and intelligibility.

8. Conclusions

This longitudinal study conducted on ecological and bimodal data contributes to an articulation of phonological and orthographic explanations of pronunciation in L3 French and to a better understanding of the interaction of these effects in production tasks, which are close to conversational activities carried out in the language classroom. Our results provide, with intelligibility in mind, to insights into how to adjust teacher feedback and to adapt activities to different learner profiles in the language classroom. The fact that mispronunciation of nasal vowels does not interfere with the intelligibility of the words is an incentive to evaluate pronunciation in conversational contexts. In this respect, this study has shown that L2 speech in interaction is an interesting context in which to investigate pronunciation. The classroom may also be an interesting laboratory to investigate crosslinguistic influences at the interface between phonology, orthography, lexicon and discourse. However, these results are based on a corpus of four speakers' productions, and individual differences were observed in terms of nasalised pronunciation frequency and development over time. The intelligibility of nasalised pronunciation of nasal vowels in context therefore needs to be investigated in a larger sample. Similarly, the higher frequency of nasalised pronunciation in retrieved words than in repeated words is an interesting clue as to the role of orthography in the lexical production-and-retrieval process, but would require confirmation in a separate more controlled study.

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