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A Longitudinal Exploration of Perception and Production of English Codas in CLIL Settings

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Abstract: Second language speech perception and production remain an enduring concern in second language acquisition, as research evidence seems to suggest that there is not a straightforward correspondence between these two speech domains and that their interrelationship seems to be of a complex nature. The present proposal intends to contribute to the inspection of such a relationship by observing the development of perception and production skills of English codas longitudinally in a group of secondary school learners in Spain involved in a content and language integrated learning (CLIL) program, which increases exposure and production opportunities. Results point to a slight overall improvement of both sound perception and production skills during a two-year period, the coda sounds exhibiting variable realizations. Many coda sounds were found to be identified and produced at near/ceiling levels while other codas remained at less successful identification and production levels even after two years of CLIL exposure. The correlation analyses performed indicated that the two dimensions tended to correlate when the development for each coda sound was inspected. No correlations were found when students' individual overall performance in each dimension were examined, attesting individual differences.

Keywords: English codas; perception; production; CLIL

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1. Literature Review

1.1. Pronunciation Research in Content and Language Integrated Learning (CLIL)

The achievement and development of pronunciation goals in CLIL settings is a research strand which has been relatively underexplored. CLIL can be seen as a more "naturalistic" approach to language learning in formal environments, where learners are able to acquire an L2 by being exposed to a substantial amount of input and by having the need to engage in real communication (Snow 1990). The CLIL approach to L2 learning is claimed to be more communicatively meaningful than the one in regular FL lessons, where there is a focus on form, and input is often manipulated for the sake of teaching the FL (Lázaro and García Mayo 2012; Muñoz 2007). Consequently, it is worth investigating how pronunciation acquisition can develop in such a context.

Research on the acquisition of pronunciation in CLIL can be divided into those studies conducted with CLIL learners only and those works where CLIL students have been compared to other student profiles. A further subclassification of the latter can be established between research which has tackled pronunciation within the broader area of speaking skills and investigations carried out with a particular focus on the phonological component.

As for non-comparative studies, some research has revealed that there is room for phonetic improvement in L2 English in CLIL learners as they have been found to exhibit a lack of perceptual awareness of vowel reduction and poor pronunciation of schwa vowels (see Gómez-Lacabex and Gallardo-del-Puerto 2014, 2020; Gómez-Lacabex et al. 2022 for research with primary education schoolchildren). Content-based FL learners have also been reported to be only moderately understood by different listener backgrounds (see Gómez-Lacabex and Gallardo-del-Puerto 2021).

Dalton-Puffer (2008) and Ruiz de Zarobe (2011) claimed that pronunciation is one of the areas where the CLIL environment did not seem to lead to favourable outcomes so clearly. The bulk of empirical research in the last two decades where CLIL learners' pronunciation competence has been compared to that of students following traditional English as a Foreign Language (EFL) courses seems to support such a claim. A number of studies focusing on the development of the speaking skill have included the phonological dimension in their analyses. The majority of these investigations have analysed overall oral proficiency (including a pronunciation measure) in spontaneous (mostly individual) speech elicitation tasks by means of holistic, synthetic and impressionistic methods of evaluation. While some have concluded that the additional CLIL exposure results in better pronunciation (Lasagabaster 2008; Nieto Moreno-de-Diezmas 2016; Pérez Cañado 2018) others have not found consistent differences between CLIL and non-CLIL learners (Gallardo-del-Puerto and Gómez-Lacabex 2013, 2017; Pérez Cañado and Lancaster 2017; Ruiz de Zarobe 2008).

As for research focusing on pronunciation in CLIL vs. non-CLIL settings, the available literature so far has provided limited evidence of a possible CLIL advantage (Gallardo-del-Puerto et al. 2009; Rallo-Fabra and Juan-Garau 2010; Rallo Fabra and Jacob 2015). The studies by Gallardo-del-Puerto et al. (2009) and Rallo-Fabra and Juan-Garau (2010) focused on two perceived dimensions of pronunciation such as foreign accent and comprehensibility. Both studies compared these among 14/15-year-old EFL and CLIL students. They revealed no differences in the degree of foreign accent between the two groups. However, CLIL students' oral productions were judged to be more comprehensible than those of the students receiving a traditional EFL approach. The latter study also performed a longitudinal analysis, examining production after one year of CLIL exposure. Rallo-Fabra and Juan-Garau (2010) did not find improvement in students' intelligibility or foreign accent after one year of CLIL exposure. In a subsequent study, Rallo Fabra and Jacob (2015) examined vowel production accuracy and fluency along three years of CLIL and EFL exposure in late secondary education (ages 15–17 years). Their (auditory) assessment indicated that there were no differences in the realization of English vowels in the two times explored for either group. They also found that fluency (acoustically analysed) developed for the two groups similarly after two years.

1.2. The Acquisition of English Codas by L2 Speakers

There is ample evidence in research which supports that L2 learners' phonological interlanguage exhibits the development of a new syllabic structure (Cebrián 2007; Hansen 2004). While authors such as Carlisle (2001) or Drozd (2003) have provided evidence for the influence of syllable structure universals on L2 phonology, Hancin-Bhatt and Bhatt (1997) and Hansen (2004) acknowledge that not only developmental effects but also language transfer govern L2 syllable structure. As for the latter, the *Syllable Structure Transfer Hypothesis* (Broselow 1984, p. 263) interprets that L1 transfer is a significant factor in the shaping of L2 syllable structure and claims that "when the target language permits structures which are not permitted in the native language, learners will make errors which involve altering these structures to those which would be permitted in the native language". Along these lines, Huensch and Tremblay (2015) have reviewed that L1 phonotactic restrictions can affect not only L2 syllable production (Broselow et al. 1998; Broselow and Finer 1991; Carlisle 1997, 1998; Davidson 2006, 2010; Eckman and Iverson 1993; Hancin-Bhatt 2000; Hancin-Bhatt and Bhatt 1997) but also perception (Davidson 2011; Davidson and Shaw 2012; Dupoux et al. 1999; Dupoux et al. 2001; Dupoux et al. 2011; Hallé et al. 1998; Kabak and Idsardi 2007).

In the case of Northern Peninsular Spanish speakers' pronunciation of English, we may accordingly expect L1 syllabic patterns to be carried over to the L2 given that English and Spanish present differences in syllabic distributions. Coda position is one of them as Spanish mainly presents a very frequent open syllable final structure; it therefore allows /-n/, liquids /-r, -l/ and some continuants such as /-s/, /-x/ or /-θ/ in singleton V(C) (*so**n**, i**r**, so**l**, crisi**s**, relo**j**, pa**z***)[1] and limited cluster V(CC) /-nθ, -ls/ (*Sa**nz**, va**ls***)[2] codas. In addition, it restricts stops (which can be spirantized) to medial distributions (*o**b**tener, a**p**to, a**d**quirir, e**t**nia, do**g**ma, a**c**to*)[3] and displays a very limited number of word-medial complex codas, all of them ending in /-s/ (*pe**rs**picaz, i**ns**tante, o**bs**truir, e**x**terior*)[4], which very often succumb to consonant cluster simplification in informal speech. The literature has provided evidence for the fact that both developmental processes and transfer are at play in the acquisition of English codas by Spanish speakers. As for the former, Drozd (2003) found that Spanish speakers produce some errors in L2 English consonant clusters owing to sonority rather than L1 interference. As for the latter, Gallardo-del-Puerto (2005) discovered that the word-final English codas that were available in the learners' mother tongue obtained higher rates of pronunciation accuracy than those English codas that were 'new' to learners as they did not exist in Spanish or Basque. Finally, relevant to the group of speakers investigated in the present paper is the degree of contact of Northern Peninsular Spanish with Basque. Unlike Spanish, Basque allows the singletons /-t/ (*du**t***) and /-k/ (*ni**k***) in coda position, which are inflectional morphemes for first person singular, as well as more cluster combinations than Spanish such as /-nt, /-st/, /-nt(s)/, /-lt/ or /-rk/ (*arru**nt**, bo**st**, nora**ntz**, no**rk**, Laxa**lt***)[5].

1.3. Acquisition of L2 Sound Perception and Production

One of the main concerns in the field of L2 pronunciation acquisition is the degree to which the domains of sound perception and production are connected (Casserly and Pisoni 2010; Sakai and Moorman 2018). Authors such as Gorba and Cebrian (2021) or Nagle and Baese-Berk (2022) have recently acknowledged the limitations, both from a conceptual and methodological viewpoint, in this type of research. Most investigations have mainly focused on the role that speech perception plays in speech production in an attempt to determine whether production (in)accuracies may derive from perceptual problems or if they are solely caused by articulatory constraints. In that regard, Huensch and Tremblay (2015) had previously reviewed that, while there is a bulk of research suggesting that L2 learners' pronunciation mistakes are driven by the non-native-like timing of gestures (Colantoni and Steele 2008; Zsiga 2003), other investigations conclude that L2 speech distortions may be the consequence of prior problems with L2 sound perception (Brannen 2002; Broselow 2009; Flege 1995; Flege et al. 1999; Peperkamp and Dupoux 2003; Rochet 1995). As for the latter, Cardoso (2011) compared the perception of singleton word-final English stops by L1 Portuguese speakers to the results of the same phonetic targets in a previous production study (Cardoso 2007) and concluded that "perceptive competence develops in a manner that is comparatively parallel to the later development of productive competence" (p. 543). Evidence in favour of the claim that perception precedes production can also be found in other studies. Walden's (2014) study on L1 Chinese speakers' acquisition of onset stop+liquid codas demonstrated that although L2 English perception and production errors were of the same nature, sound changes in production were far more abundant than in perception. Along the same lines, Gallardo-del-Puerto's (2005) study on the acquisition of word-final codas by Spanish and Basque speakers revealed that the English codas that are not permitted in the L1s were produced (but not perceived) less accurately than those allowed in the L1. This finding could indicate that perception precedes production, since some coda distributions which are not present in the L1s could have been perceived successfully, though not produced so accurately.

These findings as regards the relationship between sound perception and production would also agree with some results attested in research on the effect of phonetic training. Lopez-Soto and Kewley-Port's (2009) study demonstrated that a perception-based training of singleton and cluster coda distributions administered to Spanish adult learners of English led to an improvement in the production of these codas. Furthermore, they observed that several consonants which exhibited higher improvement after training also exhibited large gains in production. In a similar vein, Huensch and Tremblay (2015)'s Korean learners of English improved their perception and production of palatal codas after perceptual training. Nevertheless, these authors acknowledge that the lack of a one-to-one correspondence between perception and production gains, which they found when they correlated each participants' perception and production gain results, may indicate that the representations underlying these two L2 speech dimensions could be different. All in all, while it is highly likely that both learners' perception and articulation are involved in production (in)accuracy, the degree to which L2 learners' perception and production systems are connected remains unresolved (Nagle and Baese-Berk 2022; Sakai and Moorman 2018). In fact, recent considerations of such a relationship tend to abandon a precedence relationship in favour of interpretations of co-evolution (Flege and Bohn 2020) and intersection (Casserly and Pisoni 2010) as data have accumulated in favour of a 'bidirectional connection without a perfect correspondence' (Flege and Bohn 2020, p. 30).

2. Research Questions

RQ1. Can perception of English codas undergo improvement after two years of CLIL?

Previous research on pronunciation development in CLIL is scant (Section 1.1). Aspects such as comprehensibility, fluency or vowel accuracy production have been investigated in this context, however, perception skills have not been frequently addressed. While production skills have been found to develop narrowly, perceptual skills remain to be observed.

RQ2. Can production of English codas undergo improvement after two years of CLIL?

The few longitudinal explorations conducted in CLIL (Rallo-Fabra and Juan-Garau 2010; Rallo Fabra and Jacob 2015) seem to indicate that pronunciation gains are limited. Aspects such as comprehensibility, fluency or vowel accuracy production have been investigated. The present study intends to contribute to the longitudinal phonological development in CLIL by analysing consonants in coda position, a phonetic context which has not been explored yet.

RQ3. Is there a relationship between CLIL learners' perception and production of English codas?

The observation of perception and production skills within the same study design helps to interpret their intricate relationship (Casserly and Pisoni 2010). We intend to observe how these two domains may interrelate in this study by examining results per each coda sound as well as results per individual speakers in the two times explored.

3. Method

3.1. Participants

Twenty-two Spanish/Basque students were selected for this study. In the geographical area of the Basque Autonomous Community (BAC) in which the study was conducted Spanish is a dominant language, Basque being a language for instruction at school. Ten students were male participants and twelve students were female participants. They attended a government-subsidized institution with a CLIL program in English for all the students. The institution included Basque as a language for instruction in the educational system. Spanish was the language of instruction in the Spanish Language and Spanish Literature subjects only. The CLIL program was being developed during secondary school years on a 4 h/week basis in subjects such as History, Geography, Technology and Religion. CLIL instructors were non-native speakers with an intermediate/advanced level of English; these speakers tended to ascribe to a standard British accent, not frequently exhibiting other accent features. The present sample was longitudinally tested in their third year of secondary education (aged 15 years) and in their fifth year of secondary education (aged 17 years). Hence, the younger group had been receiving CLIL instruction for three years whereas the older group had been receiving CLIL lessons for five years. These CLIL students attended extracurricular EFL lessons and 12 of them had stayed abroad for one month on average. English coda perception and production scores of these 12 students did not differ significantly at time 1 ($p > 0.05$) or at time 2 ($p > 0.05$) from those of the students who had not stayed abroad (Avello et al. 2013).

3.2. Identification Testing

Eleven word-final codas were identified according to phonotactic occurrence in Spanish. Three coda distributions were identified as fully allowed, or also present word-finally in Spanish (/-nθ, -n, -θ/); four coda distributions were identified as partially allowed, as they appear word-medially in Spanish (/-g, -k, -p, -ks/); and four coda distributions were identified as not allowed (/-v, -ŋ, -lk, -nt/). Basque coda distributions were considered secondarily, given that this language is less present in the community. Perception testing consisted of a four-alternative identification task in which: a) a singleton coda position was presented along with usually misperceived/mispronounced sounds on account of previously known languages as in *bath* (/-θ, -ð, -δ, -t/); and b) a cluster coda position was presented along with three phonotactic alternative distributions considering the dropping of one element and position distributions as in *tenth* (/-nθ, -n, -θ, -θn/). The sounds were recorded in real and frequent English words (*pen*, *bath*, *tenth*, *cup*, *back*, *pig*, *backs*, *love*, *song*, *bent* and *milk*) by an English female native speaker with a Southern Standard British accent. The tests were administered in a classroom in small groups so that all the students would be equally close to the audio player. The singleton and cluster codas were administered in separate tests. Students performed two identification trials for each coda. The tests included distractors and four demo items. Sounds were presented using phonetic symbols. Given the age of the students and the limited set of target sounds, it was concluded that phonetic labelling could be used. This codification was new to the learners, so they received light training. In addition, symbols which were deemed not to access sounds directly such as /θ/ or /ð/ on the part of the students were included in a list (i.e., θ: t**h**ink, **z**apato) which was permanently displayed for the students while conducting the test. A total of 968 stimuli were analysed (22 students × 2 times × 2 trials × 11 items).

3.3. Production Testing

A total of 484 productions were elicited by using an interface that presented each targeted item represented in picture form accompanied by a small font orthographic representation below so as to reduce orthography effects, but also help learners elicit the word. The same words used in perception were presented in this production task. The production recordings were conducted before the perception tests were completed for each student. Productions were digitally recorded in a quiet room at the school premises using lapel microphones. The students were approached individually for production sessions. Productions were assessed by one non-native English phonetics expert who rated them in an answer sheet and coded correct and incorrect productions as well as mispronunciations qualitatively.

4. Results

Perception and production results were coded for correct answers and for error type. The results section presents perception results, production results and perception–production results separately. Section 4.1 presents perception results computed as the average of the two trials for each coda that the students performed in percentage of correct answers in data collection time 1 (T1) and time 2 (T2), which were two years apart. Section 4.2 presents production results which were also coded for correct answers in the two times explored. Section 4.3 presents data from the perception and production performance computed as total number of correct responses and total number of errors for the production data and the first trial of the perception data. These two sets of data were correlated to explore a potential relationship between the two domains. Given that codification/analysis also examined error type, Section 4.4 section presents perception and production confusion matrices for the codas.

4.1. Identification Results

The sample was tested for normality (Kolmogorov–Smirnov). The identification sample did not exhibit a normal distribution (D (21) = 0.180; $p < 0.001$) so we proceeded to analyse differences between the two times with Wilcoxon Signed rank tests. A significant difference was found between the two times when all the codas analysed were computed ($z = -2.06$; $p < 0.05$). The overall means were 76.03% for T1 and 80.70% for T2, indicating that we can interpret some improvement in the perception of these coda sounds after two years. When inspecting sounds separately, none of the analyses revealed significance. As Figure 1 shows, it can be observed that several sounds scored above 80% at both times: /-nθ/ (T1: 86.3%; T2: 95.4%), /-p/ (T1: 86.3%; T2: 95.5%), /-k/ (T1: 100%; T2: 88.6%), /-g/ (T1: 86.3%; T2: 93.2%), /-ks/ (T1: 93.2%; T2: 90.9%), /-nt/ (T1: 81.8%; T2: 88.6%),%), /-lk/ (T1: 100%; T2: 100%). Four coda sounds were found to be perceived below 80%: /-n/ (T1: 70.1%; T2: 79.6%), /-θ/ (T1: 63.6%; T2: 72.7%), /-v/ (T1: 38.6%; T2: 43.2%), /-ŋ/ (T1: 29.6%; T2: 40.9%).

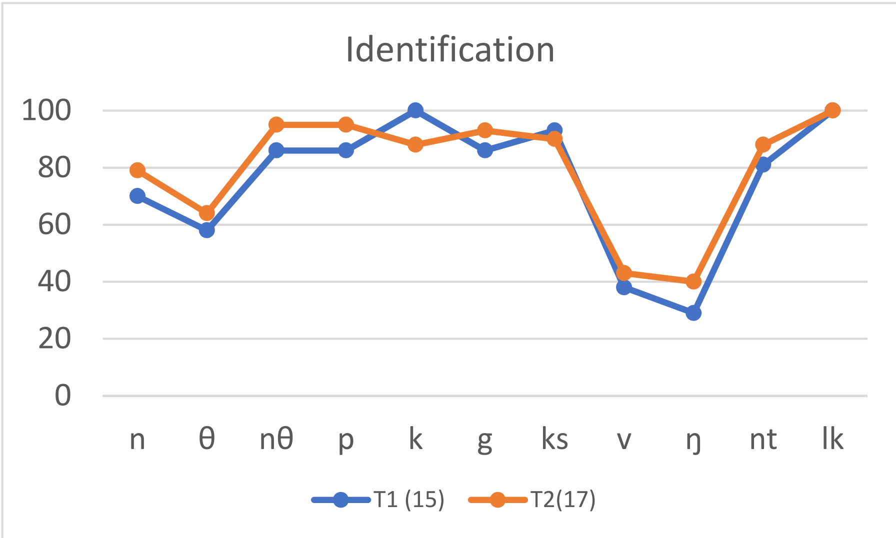

Figure 1. Correct percentage identification of English codas.

4.2. Production Results

Differences between times in the production data were analysed with non-parametric Wilcoxon Signed rank tests, as the distribution of the sample was not normal (D (21) = 0.215; $p < 0.001$). Significance was also found between the two times for overall production of codas ($z = -2.22$; $p < 0.05$). The means were 75.03% for T1 and 83.01% for T2. This difference indicated some overall improvement in the production of the coda sounds after two years. When inspecting sounds separately, as can be seen in Figure 2, three sounds were significantly better produced in time 2: /-nθ/ ($z = -2.00$; $p < 0.05$), /-g/ ($z = -2.53$; $p < 0.05$) and /-v/ ($z = -2.24$; $p < 0.05$). In this production performance it was also observed that some sounds were rather successfully produced (above 80% and ceiling) at both times: /-n/ (T1: 100%; T2: 100%), /-θ/ (T1: 95%; T2: 82%), /-p/ (T1: 100%; T2: 100%), /-k/ (T1: 100%; T2: 100%), /-ks/ (T1: 100%; T2: 95%), /-nt/ (T1: 90%; T2: 100%), /-lk/ (T1: 100%; T2: 100%). Two of the coda sounds which left room for improvement underwent changes from T1 to T2: /-g/ (T1: 24%; T2: 64%), /-v/ (T1: 0%; T2: 27%). However, the sound /-ŋ/, which was averagely pronounced (T1: 38%; T2: 45%), did not undergo significant changes from T1 to T2.

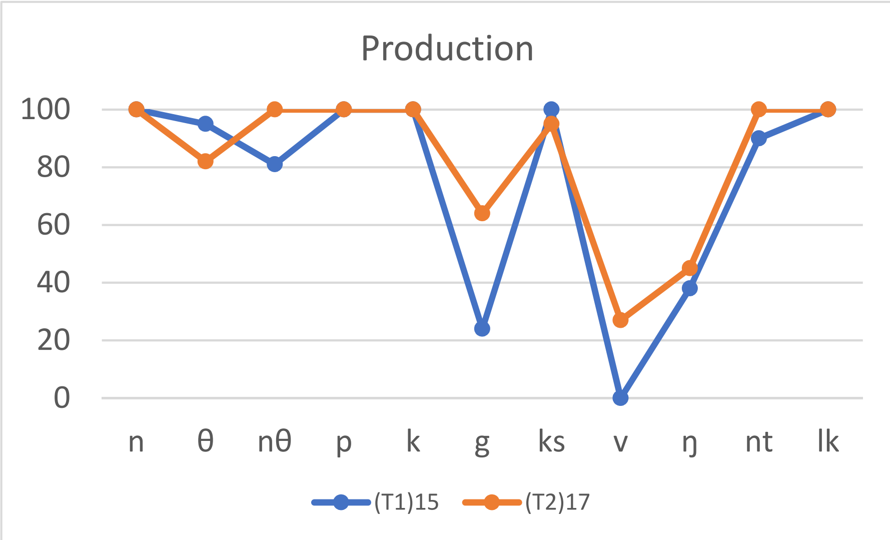

Figure 2. Correct percentage production of English codas.

4.3. Perception–Production Interplay Results

So as to attempt a correlation between perception and production, two analyses were conducted. Firstly, the total number of correct answers for each individual coda sound were estimated. Means and standard deviations were calculated, and a Pearson correlation coefficient was obtained. This approach exhibited a moderate correlation (r (9) = 0.64; $p < 0.05$), as can be seen in Figure 3. See also Table 1 for detailed scores.

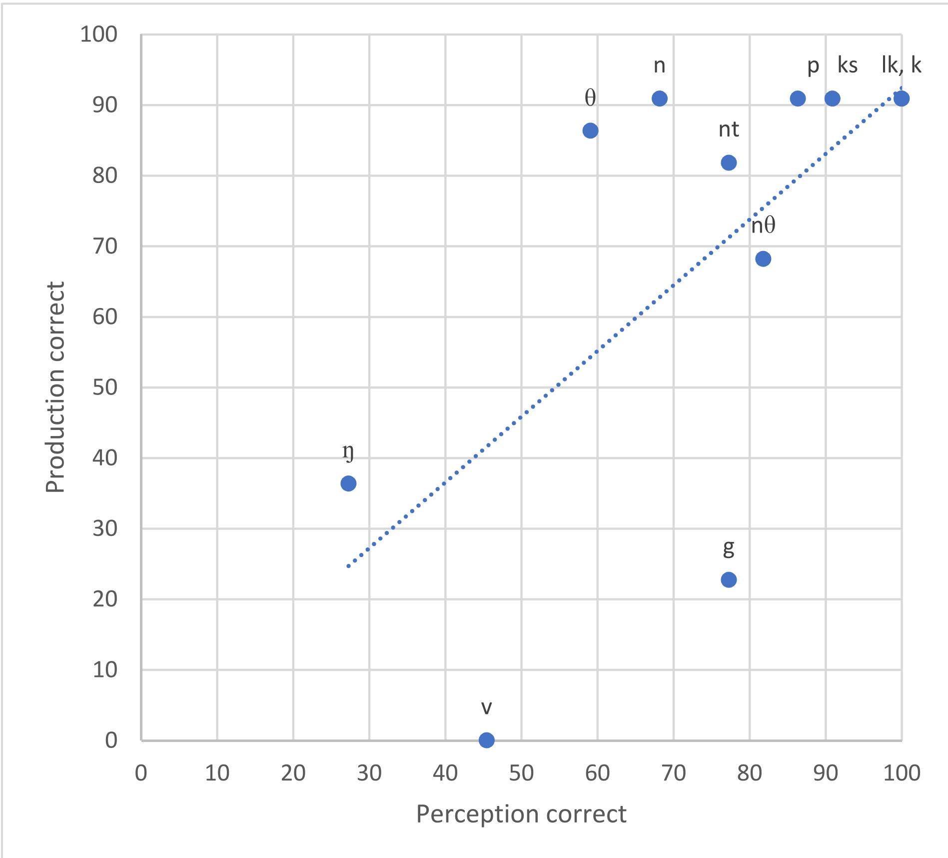

Figure 3. Scatterplot for perception/production for each coda sound in T1.

Table 1. Percentages correct for perception and production for each coda in time 1.

Coda Sound	Perception	Production
n	68.18	90.9
θ	59.09	86.36
nθ	81.81	68.18
p	86.36	90.9
k	100	90.9
g	77.27	22.72
ks	90.9	90.9
v	45.45	0
ŋ	27.27	36.36
nt	77.27	81.81
lk	100	90.9

Second, we calculated perception and production percent correct answers for each student in time 1 (T1), time 2 (T2) and gain score. See Table 2 for descriptive statistical detail.

Table 2. Percentages correct for each participant's perception and production at T1 (15 years old) and at T2 (17 years old) and gain score (T2 minus T1).

	Perception			Production		
Student	**T1**	**T2**	**Gain Score**	**T1**	**T2**	**Gain Score**
1	0.64	0.91	0.27	0.82	0.73	−0.09
2	0.91	0.73	−0.18	0.73	0.91	0.18
3	0.73	0.82	0.09		1.00	
4	0.55	0.64	0.09	0.82	1.00	0.18
5	0.64	0.82	0.18	0.73	0.73	0.00
6	0.82	0.91	0.09	0.73	0.82	0.09
7	0.73	0.82	0.09	0.55	0.73	0.18
8	0.82	0.64	−0.18	0.64	0.73	0.09
9	0.55	0.73	0.18	0.91	0.73	−0.18
10	0.64	0.82	0.18	0.73	0.82	0.09
11	0.64	1.00	0.36	0.91	0.91	0.00
12	0.91	0.80	−0.11	0.91	0.91	0.00
13	0.91	0.91	0.00	0.82	0.91	0.09
14	0.73	0.82	0.09	0.82	0.91	0.09
15	0.82	0.91	0.09	0.73	0.82	0.09
16	0.91	1.00	0.09	0.64	0.73	0.09
17	0.45	0.73	0.27	0.73	0.64	−0.09
18	0.64	0.55	−0.09	0.73	0.73	0.00
19	0.73	0.73	0.00	0.73	0.73	0.00
20	0.73	0.73	0.00	0.55	1.00	0.45
21	0.82	1.00	0.18	0.91	0.91	0.00
22	0.82	0.64	−0.18	0.73	0.91	0.18

In this case, students' scores in perception and production of the English codas analysed did not correlate in T1 ($p > 0.05$) or in T2 ($p > 0.05$). We found moderate negative correlation when we inspected gain scores in each speech skill on the part of the 22 students (r (20) = −4.45; $p < 0.05$). As can be seen in Figure 4.

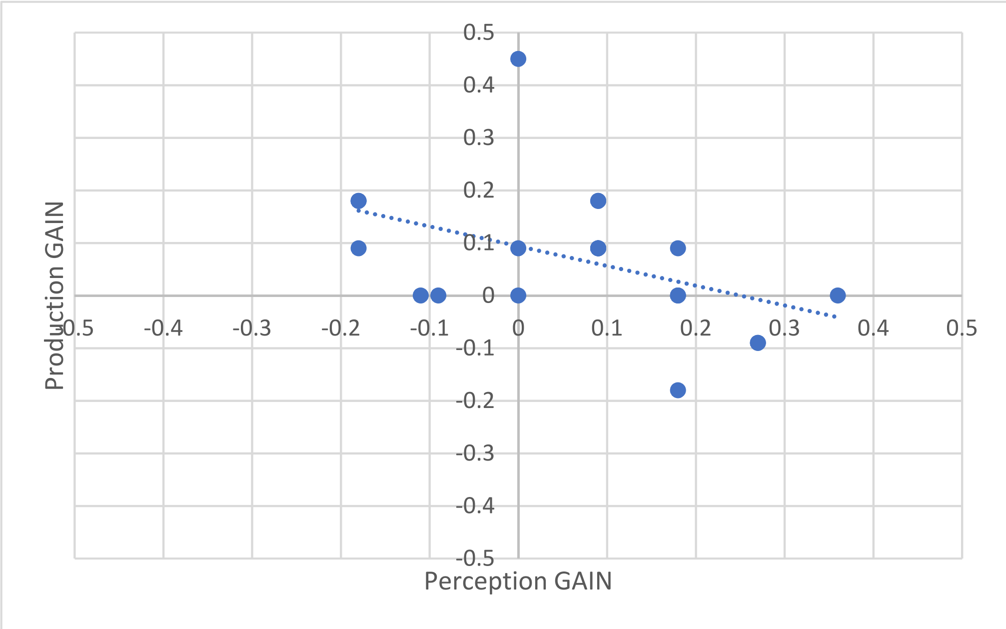

Figure 4. Scatterplot for perception/production for each student's gain scores.

4.4. Error Analyses

We also explored perception and production errors qualitatively. Some interesting results emerged, as can be seen in Tables 3 and 4. In the case of identification, Table 3 displays average percentages of the two times (T1 and T2) the sounds were collected. It can be observed that those codas which are also present in Spanish (/-n, -θ, -nθ/) were rather successfully identified. It shall be noted that the alveolar nasal was sometimes identified as a velar nasal in the word *pen* and the voiceless dental fricative was sometimes misperceived as a labiodental fricative or a voiced dental fricative in the word *tenth*. These slight differences could be due to confusion with the (IPA) symbols or the auditory conditions as they were not conducted in a soundproofed environment. In those cases in which a dental fricative was wrongly identified with a /d/ symbol, the learners may be exhibiting the fact that both sounds can actually be allophonically assimilated in this coda position in Spanish as in *pare**d***, represented with a <d> grapheme. This could mean that the students could not, at times, discern graphemes and sounds (via phonetic symbols). The three stop sounds investigated in coda position were also fairly well perceived by the students in the words *cup*, *back* and *pig* as well as the cluster combination /-ks/ in *backs*. Finally, those codas which are not present in Spanish presented interesting results. The cluster combinations explored exhibited good identification rates in *milk* and in *saint*, the latter being present in Basque. A velar nasal and a voiced labiodental fricative were only successfully perceived 40% of the time in the words *song* and *love* respectively. Interestingly, the most frequent confuser for the labiodental fricative was a voiceless labiodental fricative /-f/, indicative of the fact that the students heard the frication but missed the sonorous quality. In the case of the velar nasal, it also seems that the students were able to identify the velaric articulation of the sound but decided to most frequently represent it with a double sound representation (/-ng/) rather than with a single one (/-ŋ/), making it a labelling error rather than an auditory one, and exhibiting that /-ŋ/ does not form part of the phonemic repertoire in the Spanish accent they speak.

Table 3. Identification confusion matrix (%).

%	**n**	**θ**	**nθ**	**p**	**k**	**g**	**ks**	**v**	**ŋ**	**nt**	**lk**
n	75		4.54						11.36		
θ		63.63	4.54								
nθ			90.9								
p				88.63							
k					95.45		4.54				
g					4.54	81.81					
ks							90.90				
v								40.90			
ŋ	22.7								40.90		
nt										84.90	
lk											100
m									1.6		
f		11.36				18.18		59.09			
ð		11.36									
d		11.36									
ng	2.27								52.27		
b				2.27							
t				9.01						15.90	
θn											
sk							2.27				

Note: the figures correspond to the first perception trial.

Table 4. Production confusion matrix (%).

%	**n**	**θ**	**nθ**	**p**	**k**	**g**	**ks**	**v**	**ŋ**	**nt**	**lk**
n	100		9.1						4.54	4.54	
θ		86.36						2.27			
nθ			88.63								
p				100							
k					100	4.54	2.27				
g						43.18					
ks							95.45				
v								13.63			
ŋ									40.90		
nt										93.18	
lk											100
f								81.81			
ng/nx									52.27		
t		4.54									
d		6.81									
x						50					

As for production (see Table 4), those codas present in Spanish were also rather successfully produced (/-n, -θ, -nθ/). The production of the voiceless bilabial (partially allowed in Spanish) and velar plosives (allowed in Basque) investigated was at ceiling in the words *cup* and *back*. Unlike in the identification task, the production of the voiced velar plosive /-g/ was only targeted 43.18% of the times. Its most frequent confuser/misproduction was a velar fricative /x/, representative again of this tendency to weaken voiced plosives in coda position by Spanish speakers. A devoiced confuser /-k/ was also noted for this voiced plosive, representative of Spanish speakers' tendency to devoice consonantal sounds in coda position. As for those productions of the codas not presented in the L1, as in the identification task, the cluster sequences observed did not pose major production problems to these speakers in the words *saint* (present in Basque) and *milk* (here the lateral was mainly realized as a clear lateral approximant /-l/ by the students), while the voiced labiodental and the velar nasal were only produced accurately 13.63% and 40.90% of the times, respectively. As in the identification data, a voiced labiodental fricative was mainly mispronounced as a voiceless labiodental fricative /f/ (81.81%) in the word *love* while in the case of the velar nasal in the word *song*, learners realized the velar place of articulation with plosive or fricative manners of articulation /-ng/ or /-nx/ (52.27%).

5. Discussion

The present study aimed to explore the development of perception and production skills of some English codas on the part of teenage learners undergoing additional exposure to the language in the form of CLIL instruction. Their performances were tracked longitudinally in two testing times with a two-year gap. So as to answer our first research question, when it comes to perception results, an overall improvement was observed which did not result in individual codas significantly improving after two years. Those codas which are allowed or partially allowed in Spanish such as /-n, -θ, -nθ, -p, -k, -g, -ks/ were well identified (via phonetic symbols) by these CLIL learners with the exception of the voiceless dental fricative, which was frequently misperceived as a labiodental /f/, a confusion that can be deemed likely to occur given the acoustic similarity between /f/ and /θ/ (Levitt et al. 1988) and that the tests were not conducted in soundproofed conditions, but in quiet school premises. As for those English codas which are not allowed in Spanish, the two cluster combinations presented /-lk, -nt/ were also successfully identified by the learners. Several reasons may be considered here. First, data suggest that a coda distribution which complies with sonority scale is not likely to pose difficulties for learners (Hansen 2004; Drozd 2003). Secondly, the presence of these clusters in borrowings (*folk)* or some proper nouns (*Kant*) as well as the occasional occurrence of similar clusters in Basque (*Laxalt*, *arrunt*) may also have contributed to these positive cluster identifications. Two singleton codas posed challenges for the learners: a voiced labiodental fricative /-v/ and a voiced velar nasal /-ŋ/. In the first case, error analysis elucidated that the learners frequently missed the voiced quality of the labiodental, a feature which could be interpreted as cross-linguistic influence, given that Spanish does not exploit voicing phonemically for fricatives. In the second case, the error analysis data revealed that the learners noticed a velar quality at 90% but decided to identify it with a double symbol representation /-ng/ most frequently. Here, we could consider some limitations in the identification tools we gave to these learners, who may not have interpreted well the differences between /-ŋ/ and /-ng/ symbols and treat them as similar labels for a velar nasal. These errors could have been avoided had the learners been able to develop more robust phonetic symbol codification skills.

In the case of the production data, which our second research question targeted, overall performance also indicated significant improvement after two years of CLIL. In addition, some significant differences were observed in individual coda sounds. While partially allowed /-n, -θ, -p, -k, -ks/ codas were produced at ceiling levels, as in the identification data, cluster allowed /-nθ/ and singleton partially allowed /-g/ obtained worse results at T1, which were significantly improved after two years, the former reaching ceiling level while the latter improving from low scores to average. Error analysis details revealed that the most frequent mispronunciation of this voiced velar plosive at T1 was a voiceless velar fricative in the word pig (/pix/), which exhibited a clear L1 transfer effect as Spanish spirantizes voiced plosives also in coda position (*agnóstico*). In the case of those sounds not allowed in the L1, results mirror the identification data rather closely. Cluster combinations /-lk, -nt/ were also produced at ceiling levels by the learners. Possible reasons for such successful production may have been their realization in borrowings such as *folk* or Basque coda occurrences, which occasionally allow for similar combinations (*Laxalt*, *arrunt*). These data could also be suggesting that canonical coda distributions can be well produced by L2 learners (Drozd 2003). The same singleton codas which posed challenges for the Spanish learners in identification, a voiced labiodental fricative /ð/ and a voiced velar nasal /ŋ/, were also less frequently produced. In the first case, error analysis indicated that the learners produced a voiceless labiodental 80% of the time. In the second case, the error analysis data revealed that they produced it as a nasal followed by a velar plosive /-ng/ or a velar fricative /-nx/ most often (52.27%). Interestingly, while if only observing perception data we could interpret this performance as a labelling limitation, the fact that production data exhibit these features opens the possibility of considering that a production feature could be being carried over to perception skills. This could further be investigated.

The present perception and production data ascribe to the previous literature which has inspected pronunciation development in CLIL learning contexts and which has attested that longitudinal development of phonological competence is limited (Rallo-Fabra and Juan-Garau 2010; Rallo Fabra and Jacob 2015). Our data revealed that some codas were well perceived and produced and that a few codas posed challenges to the Spanish and Basque speakers. Interestingly, these still remained challenging after two years of CLIL and towards the end of the education period.

Our third research question aimed at investigating perception–production links. Data revealed that production gains were higher than perception gains. They also revealed some correlation between these two speech domains on the part of these CLIL learners. The added value of the error analyses allowed us to qualify these connections closer. First, ceiling performance of partially/allowed codas such as /-n, -nθ, -p, -k, -ks/ and non-allowed cluster codas /-nt, -lk/ in both perception and production indicate that despite cross-linguistic influence, some codas can be expected to be well acquired in both skills. In addition, error analysis of non-allowed /-v, -ŋ/ singleton codas also indicated the same tendency in both perception and production as the former was mostly misidentified as a voiceless fricative and was also frequently mispronounced as such. In the same vein, a velar nasal was frequently misidentified with a two-sound label /-ng/, which was also the most frequent mispronunciation of this sound. The clearest L1 phonetic feature intervening in these data is spirantization of voiced plosives codas in Spanish. This gave interesting results regarding how perception and production skills interrelated. Both skills evinced some association of a voiceless dental fricative sound with a plosive realization /-d, -t/ in the case of production; in addition, /-θ/ was also identified as /-d, -ð/ in a few instances, possibly associating the fricative sound with the voiced plosives given that it is allowed allophonically in Spanish. These data also exhibited some instances of perception and production skills not developing so parallelly. Performances of the voiced velar plosive /-g/ showed that this sound could be very well identified (81.81%) but less frequently pronounced correctly (43.18%), and was half the time realized as a velar fricative (50%). On the contrary, the voiceless interdental fricative /-θ/ was less frequently perceived (63.63%) than produced (86.36%). Likewise, the perception of the voiced labiodental fricative /-v/ turned out to be better than its production (40.90% vs. 13.63%). In these lines, we did not find correlations between perception and production skills of these English codas when these were inspected for each participant either at time 1 (T1) or at time 2 (T2). Our data also provide further evidence of the fact that individuals do not exhibit similar progress rates in these type of inspections (Kartushina et al. 2015). Finally, gain scores exhibited some negative correlation, possibly indicative of the fact that learners experienced larger gains in production (especially for the /-g/ and the /-v/

sounds) than in perception, which exhibited lower gains overall (especially for /-g/ and /-v/ sounds). All in all, even if we were able to identify some one-to-one relationships at this developmental stage when we inspected the development of English codas sounds, our data did not reveal a clear precedence of perceptual skills over production skills (Broselow 2009; Cardoso 2011; Flege 1995; Flege et al. 1999) providing evidence that production can exhibit higher performance and/or improvement than perception. In addition, our data revealed correspondences between perception and production when individual sounds were inspected but not when individual students' scores were examined, adding to the literature which reveals a complex connection or correspondence between speech perception and production skills (Casserly and Pisoni 2010; Gorba and Cebrian 2021; Flege and Bohn 2020; Huensch and Tremblay 2015).

6. Conclusions

The present study explored the development of L2 sound acquisition skills in learners of English longitudinally. More specifically, we examined the development over a two-year period of identification and production of word-final codas in English by learners engaged in a secondary education CLIL program. Additionally, we attempted to investigate the link between speech perception and production domains.

Overall, results point at a modest phonological development when inspecting English coda perception and production along two years in a secondary CLIL program. Findings also reveal that phonotactically allowed and partially allowed codas in the L1 are well perceived and produced by intermediate learners of English. Phonotactic sequences that are not available in the L1 seemed to leave room for improvement, which was limited within a two-year time span for these CLIL learners. Perception and production tended to correlate in this study although slight differences could be observed when error types were considered.

As for further research, it would be interesting to analyse other codas, particularly complex sequences that rank differently in the sonority scale (e.g., /-nt/ vs. /-st/ vs. /-pt/) to better explore the effect of language universals as compared to those of cross-linguistic influence. Further research should look into the acquisition of these sound structures in groups of learners instructed only through traditional foreign language lessons so as to compare their performance to that of CLIL learners. Such a comparison would legitimately allow us to verify whether additional CLIL instruction exerts any influence on the perception and production of L2 English speech. Ideally, as phonetic development seems to happen in earlier stages of acquisition (Derwing and Munro 2013), we make a final call for exploring these pronunciation phenomena in younger L2 learners in both CLIL and non-CLIL settings.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of the University of Cantabria (protocol code 000029; 17 March 2022).

Informed Consent Statement: Informed consent was obtained from the students involved in the study.

Data Availability Statement: The data presented in this study are available on request from the authors. The data are not publicly available due to privacy.

Conflicts of Interest: The authors declare no conflicts of interest.

Notes

[1] English translation: *(they) are, to go, sun, crisis, watch, peace.*
[2] English translation: *Spanish surname, waltz.*
[3] English translation: *to obtain, apt, to acquire, ethnicity, dogma, act.*
[4] English translation: *sharp, instant, to obstruct, exterior.*
[5] English translation: *ordinary, five, where to, who (with transitive verb), Basque surname.*

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