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"Testing the effect of synchronous speech tasks in the production of L2 speech rhythm in learners of Spanish as a Second Language."

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LIST OF ABBREVIATIONS AND SYMBOLS

CCI = Compensation/control Index

CnPVI = Consonant Normalized Pairwise Variability Index

EFL = English as a Foreign Language

F= F-test

FL = Foreign Language

IL = Interlanguage

KHz = Kilohertz

L1 = First language

L2 = Second Language

LT = Learning Theory

NL = Native language

OPM = Ontogeny Phylogeny Model

PUC = Pontifical Catholic University of Chile

PVI = Pairwise Variability Index

rPVI = Raw Pairwise Variability Index

SAMPA= Speech Assessment Methods Phonetic Alphabet

SD = Standard deviation

SFL = Spanish as a Foreign Language

SL = Second Language

SLA = Second Language Acquisition

SS = Synchronous Speech

TL = Target language

U= Linguistic Universals

UG = Universal Grammar

Varco = Variation coefficient

VarcoC = Consonant Variation coefficient

VarcoS = Syllable Variation coefficient

VarcoV = Vowel Variation coefficient

VnPVI = Vowel Normalized Pairwise Variability Index

VOT = Voice Onset Time

$\eta p2$ = Partial eta-squared

ABSTRACT

The following study tested the effect of synchronous and non-synchronous speech conditions in the production of L2 speech rhythm in Spanish. Namely, it assessed the production of American English speakers of Spanish with intermediate and upper-intermediate levels of competence in Spanish (n = 31) in comparison to the L1 speech rhythm of a control group of native speakers of Spanish (n = 32). For this purpose, speech samples were elicited from a reading aloud task, including four speech conditions: 1) Synchrony live condition; 2) Synchrony with the recording from the live condition; 3) Synchrony with a recording from a non-live condition; and, 4) Solo recording condition. The analysis of the results showed that the speech rhythm of the experimental group and the control group was modulated by the different conditions of the experimental task. Notably, non-native participants produced longer vocalic and consonantal intervals and higher vowel percentages than the native speakers of Chilean Spanish across conditions. The theoretical and pedagogical implications concerning the use of synchronous speech in the production of L2 speech rhythm are assessed and discussed.

Keywords: Speech rhythm, L2 speech rhythm, SFL, synchronous speech

The process of doing a PhD is undoubtedly choosing the road less traveled, and it is indeed one lonely road at times. Even so, these five years have given me many moments of joy, and they have taught me enormously about patience, tolerance, loyalty, resilience, hard work, and human relationships.

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1 INTRODUCTION

The following research design explores the production of L2 speech rhythm in American English speakers of Spanish. Notably, it will assess and compare the production of L2 speech rhythm of an experimental group of American speakers of English relative to the L1 speech production of a group of native speakers of Spanish by employing an experimental reading aloud task. The experimental reading task includes two types of reading materials, a narrative text and a text with meter, and four synchronous speech conditions, 1) Synchrony live condition; 2) Synchrony with the recording from the live condition; 3) Synchrony with a recording from a non-live condition; and, 4) Solo recording condition. These tasks were designed to test the effect of different speech conditions in the production of L2 speech rhythm of American English speakers of Spanish.

In the following chapters, the motivations, theoretical framework, methods, results, and discussion of this study will be introduced. Chapter One will introduce the motivations for this study. Next, in Chapter Two, the theoretical framework for this study, along with a state of the art about L2 speech rhythm both as a speech phenomenon and an interactional phenomenon, will be introduced. In Chapter Three, the research questions, objectives and methods used to explore speech rhythm both as a speech phenomenon and an interactional phenomenon, together with the methods for collecting and analyzing the data, will be described. In Chapter Four, the results of this study will be provided. In Chapter Five, the results will be discussed in light of specific L2 speech models and pedagogical implications for the teaching of L2 speech rhythm. In Chapter Six, the conclusions for this study will be presented. Finally, in Chapter Seven and Chapter Eight, the references for this work and the appendices of this research will be made available, respectively.

1.1 L2 speech

In the field of studies of L2 speech acquisition, it has been widely acknowledged that L1 phonology has a strong effect on both the perception and production of L2 phonology (Flege, 1995; Best, 1995; Best & Tyler, 2007). During the acquisition of a new language, speakers engage with two different phonological systems: the phonological system of their native language and the phonological system of the target language. The relationship between these two phonological systems has been linked to some of the phonological difficulties L2 learners find during the acquisition of their second language, both in terms of the perception and the production of L2 speech. The following sections will succinctly address several perceptual and production issues in L2 speech and the link between perception and production for L2 speech.

1.1.1 Perceptual issues in the acquisition of L2 speech

When discussing L2 perception, it is essential to note that perception is an internal and physiological process in which the perceiver recognizes and groups the incoming stimuli into mental categories (Strange & Shafer, 2008). Therefore, the perception of phonetic segments and contrasts involves not only the detection of differences in the acoustic signal but also the access to the internalized phonetic and phonological categories to categorize the stimuli (Strange & Shafer).

In this regard, Barry (2007) mentions three speech-processing phenomena which concern acoustic, temporal, and linguistic implications for the processing of L2 speech. Respecting acoustic phenomena, the author mentions that research has found that speech sounds remain as pre-categorial percepts in people's consciousness for no more than 250 milliseconds and that they are perceived as categories for only a few seconds (Crowder & Morton, 1969; Massaro, 1972; Crowder, 1978, 1993; Kallman & Massaro, 1983). These findings indicate that listeners have a very short period available to deal with speech phenomena; this is especially difficult when the speech phenomena are L2 speech phenomena.

Concerning temporal issues, Barry (2007) indicates that humans do not process time-varying signals uniformly over time, but rather, according to expectancy and perceptive salience (Quené & Port, 2005). That is to say, the mechanisms for decoding phonetic information and its properties, such as duration, stress, metrical properties, timing, among others, are attention-directed. Furthermore, the attention placed to different phenomena varies according to each language and its specific inventories (Flege & Port, 1981; Wenk, 1985; Major, 1987; Flege, 1988; Schmidt, 1995; Hazan, 2002; Quené & Port, 2005; Lengeris & Hazan, 2007). For example, the amount of attention allocated to stress in English and French is different because the lexical stress always falls on the last syllable of a word in French (Dupoux, Sebastián-Gallés, Navarrete, & Perperkamp, 2008).

In terms of the linguistic implications, Barry (2007) mentions that human decoding mechanisms seem to be primarily focused on the extraction of communicatively relevant information, such as the semantic information of an utterance. When it comes to acoustic information, there are fewer attentional-resources allocated to pronunciation analysis, such as speaker variability, because these types of cues show higher perceptual fluency, in the sense that speakers do not need to allocate many cognitive resources to process them (Palmeri, Goldinger & Pisoni, 1993). However, when it comes to L2 speech processes, high perceptual fluency cannot be expected, because speakers are not dealing with their native language phonology, but with a different phonological system. These issues will be further discussed in Chapter 2, which introduces different speech production models, and some of the research conducted up to date are introduced.

In the case of L2 perception, Flege (1995, 1999, & 2002) and Best (1995) indicate that L2 learners tend to assign L1 categories to L2 sounds. In other words, when a learner miscategorizes an L2 sound, it means that the learner is experiencing transference of L1 processing patterns. Hazan (2002), following the proposals of Best and Flege for the acquisition of L2 speech, argues that the relationship between the L1 and L2 phonological systems determines the difficulties learners face when acquiring the phonetic and phonological inventories of the new language.

Similarly, Escudero (2009) posits that at the beginning of their learning experience, L2 learners activate their L1 perception grammar and L1 perceived categories. Hardison (2013) also notes that segmentation of the speech stream is a challenging task in the early stages of L2 acquisition because adult learners rely on cues that are relevant to their L1, which can be different in the case of L2 phonology. For example, speakers of Spanish and Swedish assign a different pragmatic value to rising intonation at the end of an utterance, which results in problems for both groups of speakers when dealing with Spanish or Swedish as an L2 (Aronsson, 2016).

Relative to Barry's three speech-processing phenomena concerning acoustic, temporal, and linguistic implications for the processing of L2 speech, Best & Tyler (2007) note that many SLA perception studies have focused on L2 vowel perception. Mainly, vowel perception has been the focus of SLA perception studies because of the acoustic and articulatory differences between vowels and consonants, along with the fact that vowels place fewer constraints on lexical selection than consonants, and they affect the temporal rhythmic patterns of the second language. In particular, Best & Tyler mention that research has found that vowels that are perceived to differ from L1 vowels yield considerably more significant perceptual learning differences than vowels that are perceived to be identical or similar to L1 vowels.

Even when similarity may be a facilitator of vowel contrasts, Best & Tyler (2007) also discuss that research has found that vowel perception can improve with experience and ability; in other words, learners who have been more exposed to the L2 and that have developed a high level of linguistic competence in the L2 should be more competent in the perception of vowels in their L2. Likewise, the authors indicate that perceptual skills have been noted to be positively correlated with accuracy in producing L2 vowels. Let us note to the reader that even though the link between production and perception is not the focus of this piece of research, this link will be addressed tangentially in this study, because the participants will take part in an experimental task that involves both production and perception of the L2, since they will be producing L2 speech and listening to L2 speech at the same time.

The empirical research about L2 perception has found that L2 learners encounter difficulties with segmental and suprasegmental features of the new language. In respect to segments, learners come across issues with the vowels of the new language (Gottfried, 1984; Flege & Bohn, 1989a; Bohn & Flege, 1990; Crowther & Mann, 1992; Flege, 1995; Fox, Flege, & Munro, 1995; Polka, 1995; Levy & Strange, 2008; Melnik, 2016); and the consonants of the new language (Miyawaki, Strange, Verbrugge, Liberman, Jenkins, & Fujimura, 1975; MacKain, Best, & Strange, 1981; Mochizuki, 198; Werker, Gilbert, Humphrey, & Tees, 1981; Flege & Eefting, 1987; Flege, 1989, 1993; Best & Strange, 1992; Polka, 1991; Yamada, 1995; Zampini, 1998; Guion, Flege, Akahane-Yamada, & Pruitt, 2000; Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004).

Relative to suprasegmentals, learners experience problems with stress patterns of the new language (Dupoux, Peperkamp, & Sebastián-Gallés, 2001; Guion et al., 2004; Lin & Wang, 2008; Peperkamp, Vendelin, & Dupoux, 2010; Romanelli & Menegotto, 2015; Shin, 2016); intonation and pitch movements of the new language (Pellegrino, Salvati, & Vitale, 2012; Ortega-Llebaria & Colantoni, 2014; Brandl, González & Bustin, 2016; Nagano-Madsen, 2018); syllable detection (Tajima, Akahane-Yamada, & Yamada, 2002); and speech rhythm (Vicenik & Sundara, 2011).

In summary, this brief review of some of the pieces of research that have been published in the last 30 years shows that learners encounter multiple perception difficulties when acquiring an L2, which involve segmental and suprasegmental issues in the perception of L2 speech. Let us note that this concise presentation of different L2 phonetic perception studies is not meant to be an exhaustive review of the literature, but rather the intention is to delineate the most relevant findings reported in the empirical research about L2 speech perception.

1.1.2 Production issues in the acquisition of L2 speech

When it comes to production issues in the acquisition of L2 speech, it is generally assumed that the higher the distance between the native language and the non-native language, the more difficult it will be for learners to pronounce the target language like a native speaker (Major, 1987, 2001; Flege, 1988). However, Zampini (2008) indicates that recent research has found that the role of the L1 in the phonological acquisition of the L2 is not so straightforward. That is to say, some sounds which are very different from the sounds of the L1 of the learner may be relatively easy to acquire, while the acquisition of sounds that are similar to L1 sounds is more complicated.

Zampini (2008) also mentions that age, markedness, and social factors contribute to the acquisition of the phonology of the L2. For example, proficiency in Voice Onset Time (hereafter VOT) in L2 learners has been linked to the age of acquisition in learners with different native languages (Zampini). In the case of this study, let us remind the reader that the participants of this study are adults, late learners of Spanish, with intermediate to upper proficiency in Spanish, who are learning the L2 in an immersion context.

Empirical research has found that learners experience problems in the production of both segmental and suprasegmental features of the target language. Relative to segmental features, researchers have found issues associated to the production of specific features of the sounds of the second language, such as VOT, voicing, and vowel quantity (Williams, 1977; Flege & Port, 1981; Flege 1987 & 1991; McAllister, Flege, & Piske, 2002; Choi & Cho, 2016; Aronsson, 2016); the sounds of the second language, such as vowels (Bohn & Flege, 1992; Jun & Cowie, 1994; Munro, Flege, & Mackay, 1996; Flege, Munro, & MacKay, 1996; Zetterholm & Tronier, 2012); and consonants (Caramazza, Yeni-Komshian, Zurif, & Carbone, 1973; Flege & Davidian, 1984; Flege, Munro, & MacKay, 1996; Zetterholm & Tronier, 2012; Hao & de Jong, 2016; Cabrelli Amaro, 2017).

Concerning L2 suprasegmental features, research has observed issues concerning the syllable structure of the second language (Sato, 1984; Ordin & Setter, 2008); the stress patterns of the second language (Flege & Bohn, 1989b; Archibald, 1993; Brawerman & Albini, 2014; Da Silva Junior, 2016); the intonation patterns of the second language (Grover, Jamieson, & Dobrovolsky, 1987; Santiago, 2011; Pellegrino et al., 2012; Kainada & Lengeris, 2015; Aronsson, 2016; Contreras Roa, 2016; Mok, Setter, & Nayan, 2016; Puga, Fuchs, Hudson, Setter, & Mok, 2018); the pitch boundaries of the second language (Tremblay, Broersma, Coughlin, & Choi, 2016); the pitch accents of the second language (Rasier & Hiligsmann, 2007); and, the speech rhythm of the second language (Wenk, 1985; Gutiérrez-Díez, 2001; Gut, 2003; Chen & Chung, 2008; Tortel & Hirst, 2010; Ordin, Polyanskaya, & Ulbrich, 2011; Pellegrino et al., 2012; Li & Post, 2014; Ordin & Polyanskaya, 2014, 2015; Alouache, 2016; Da Silva Junior, 2016; Droua-Hamdani, Selouani, Alotaibi, & Boudraa, 2016; Gashaw, 2017).

Therefore, it can be noted that L2 learners experience problems with segmental and suprasegmental features when producing L2 speech. In the case of this study, the focus will be the production of American English speakers of L2 Spanish speech rhythm, which is a suprasegmental feature of L2 speech. As in the previous section, let us note that this brief presentation of different L2 phonetic production studies does not intend to be a comprehensive review of the literature, but rather it is a summary of the main findings reported in the field of empirical research about L2 speech production.

1.1.3. The link between perception and production issues

According to Flege (1995), L2 segmental perception and production are correlated for late learners with high levels of competence in the L2. Best (1995) and Best & Tyler (2007) also postulate that the level of perceptual skills is positively correlated with accuracy in the production of L2 sounds as well as with the ratio of L2/L1 usage. That is to say, the higher the use of the L2 and the level of proficiency of L2 learners, the higher should be the perceptual skills of L2 learners.

Following the same line, Isbell (2016) suggests that the development of perceptual skills may facilitate the rapid production of some features of the L2 and that the degree of perceptual accuracy has a strong influence on accuracy in production. Likewise, Hardison (2013) indicates that perception training causes a significant improvement in production when production training is unavailable. Lengeris (2012) also signals that perceptual training can improve both the perception and production of L2 segmental and suprasegmental features.

The work of Isbell (2016) provides a very informative review of different works that explore the link between perception and production. An adapted version of the original table in Isbell's work (2016, p. 59) is presented below:

Table 1

Different pieces of research about perception and production in L2 speech

Study	**Participant L1 (s)**	**Target Language**	**Target features (s)**	**Results**
Sheldon & Strange (1982)	Japanese	English	/r/ /l/	Production more accurate than perception
Bradlow, Akahane-Yamada, Pisoni, & Tohkura (1999)	Japanese	English	/r/ /l/	Perception improved after perception training; production also improved
Kim & Park (1995)	English	Korean	/r/ /l/	Successful perception, major production difficulties
Aoyama, Flege, Guion, Akahane-Yamada, & Yamada (2004)	Japanese	English	/r/ /l/	Perception improvement followed by production improvement
Tsukada, Birdsong, Bialystok,	Korean	English	/i/ /ɪ/ /e/	Production exceeded reception for children, but not adults

Mack, Sung, & Flege (2005)			/ɛ/ /æ/ /ɑ/ /ʌ/	Language use was found to be a modulating factor
Baker & Trofimovich (2006)	Korean	English	/i/ /ɪ/ /u/ /ɤ/ /θ/ /ɛ/	Perception exceeded production, modulated by proficiency and age
Jia, Strange, Wu, Collado, & Guan (2006)	Chinese (Mandarin)	English	/i/ /ɪ/ /e/ /ɛ/ /æ/ /ɑ/ /ʌ/ /u/	Perception accuracy linked to production accuracy; age effect found Production lags evident
Cardoso (2007, 2011)	Brazilian Portuguese	English	Word-final coda	Production lagged behind perception
Chan (2014)	Chinese (Cantonese)	English	/θ/ /ð/ /v/ /ʃ/ /z/ /ŋ/ /l/ /r/ /iː/ /ɪ/ /uː/ /ʊ/ /ɔː/ /ɒ/ /æ/ /e/	Successful perception, major production difficulty for some consonants (e.g., /ð/). Lack of association between perception and production of other sounds
Motohashi-Saigo & Hardison (2009)	English	Japanese	Geminates /t/ /k/ /s/	Perception improved after perception training; production also improved

Note. This table was adapted from Isbell (2016, p. 59)

As it can be observed, based on Isbell's compilation presented in Table 1, many of the studies referred above found a link between perception and production. Unfortunately, these studies are only for segmental features of the L2. Even so, the literature about L2 speech does not necessarily discourage us from expecting the same effect for suprasegmentals in L2 learners (Trofimovich & Baker, 2006), especially in the case of speech rhythm.

In the case of speech rhythm, the most widely used measurements for speech rhythm have operationalized speech rhythm in terms of the duration of consonantal and vowel intervals in speech, to assess the contrast between these two types of segmental features in the production and perception of speech rhythm (Ramus, Nespor, & Mehler, 1999; Low, Grabe, & Nolan, 2000; Grabe & Low, 2002; Dellwo, 2006; White & Mattys, 2007). In other words, these metrics entail that the production of segmental features influences the production and perception of speech rhythm.

A clear example of this interference can be found in the production of voiceless plosives in absolute word-initial position by Spanish speakers of English. Unlike English, in Spanish voiceless plosives in absolute word-initial position are not aspirated; hence, Spanish speakers usually produce [p], [t], [k] instead of $[p^h]$, $[t^h]$, $[k^h]$ for voiceless plosives in absolute word-initial position. This phonological difference causes durational differences in the production of plosives for Spanish speakers of English since the aspiration of plosives in English involves a VOT of around 30 milliseconds or longer, and in Spanish, the VOT is approximately zero (Flege & Eefting, 1987; Benkí, 2005). Furthermore, these durational differences impact the whole system of connected speech by affecting the duration of both consonantal and vocalic intervals in any given utterance, causing both production and perception issues for L2 speakers.

As it has been noted before, in the case of this study, even when perception will not be explicitly trained, the task will involve both perceptual and production skills, because the learners will be listening to their L2 and reading in their L2, in synchrony with a model speaker of Spanish. Therefore, even when the perception skills of participants will not be assessed, their perceptual skills will be activated during the task.

1.2 Other issues concerning the acquisition of L2 speech

1.2.1 The disconnection between the scientific community and the foreign language teaching communities

The barriers to the acquisition of L2 speech are not just linked to the perception and production of the sounds of the new language. In the field of acquisition of non-native pronunciation, there is also a lack of connection between the research conducted about L1 transference and the creation of effective L2 teaching methodologies and materials (Munro & Derwing, 1995a, 1995b, 1999; Gut, Trouvain & Barry, 2007; Espinosa, 2016). In other words, what is tested in laboratories rarely reaches the applied linguistics books and materials for foreign language teaching.

With regard to this, multiple studies have highlighted the importance of teaching pronunciation in terms of intelligibility, pragmatic adequacy, and accent reduction (Taylor, 1981; Chela Flores, 1997a, 1997b; Cortés-Moreno, 2000; Rasier & Hiligsmann, 2007; Tortel & Hirst, 2010; Espinosa, 2016; Polyanskaya, Ordin, & Busa, 2017). Galaczi, Post, Li, Barker, & Schmidt (2016) also note that understanding what learners can and cannot do in terms of pronunciation at specific levels of proficiency can make learners more conscious about their pronunciation.

Despite all of this, there is a mutual gap between the scientific and teaching communities, in the sense that the results from the scientific research about L1 transference are not habitually disseminated to practicing teachers, and researchers rarely attend second language classrooms (Gut, Trouvain & Barry, 2007). Buss (2016) reports the use of very traditional pronunciation methodologies in Brazil for the teaching of EFL and the desire of EFL teachers in Brazil to receive pronunciation training. So, even when there is a gap between these two communities, it seems that foreign language teachers are aware of the need to change or update their practices when it comes to the teaching of L2 speech pronunciation.

1.2.2 L2 classrooms and prosody

The most evident effect of the lack of connection between the scientific community and the teaching community is the scarce attention given to the learning of L2 prosody or suprasegmental features in L2 classrooms (Wenk, 1985; Chen, Fan, Lin, 1996; Chela Flores, 1997a, 1997b; Cortés-Moreno, 2000; Gutiérrez-Díez, 2001; Espinosa, 2016). In the case of L2 speech rhythm, Gluhareva, & Prieto (2016) observe the lack of explicit instruction of this feature in the L2 classroom.

Several studies have argued in favor of the need to incorporate pronunciation activities specially designed for learners to develop and acquire the phonemic inventories of the respective L2s together with incorporating connected speech features into L2 classrooms (Pennington & Richards, 1986; Ordin et al., 2011; Espinosa, 2016). Brazil (1997), Bradford (1998) and Espinosa (2016) mention the importance of making L2 learners aware of the pronunciation of the target language, to allow them to communicate effectively, both at the perceptive and productive levels.

In the case of prosody, Gordon, Darcy & Ewert (2013) signal that even when suprasegmental instruction has shown to yield rapid improvement, there is also a lack of connection between the research about L2 instruction and the use of L2 research findings to test and explore new methodologies for teaching L2 pronunciation. Furthermore, Aronsson (2016) and Diaz (2017) indicate that the most neglected area in the teaching of L2 pronunciation is prosody. In the case of L2 Spanish prosody, Aronsson signals that teaching materials superficially cover the suprasegmental aspects of the Spanish language and that teachers usually rely on their own experience and intuition to teach prosody in the Spanish as a Foreign Language (hereafter SFL) classroom.

Another piece of evidence of this gap between researchers and foreign language teachers is that most of the empirical research conducted about speech rhythm as a suprasegmental phenomenon has aimed at finding rhythmic typologies and testing if languages are syllable-timed or stress-timed depending on their durational patterns, rather than looking at the production of rhythm in L2 learners, which could give light for the effective teaching of non-native speech rhythm (for specific information about studies about speech rhythm as an L1 and an L2, please refer to Chapter Two). Regarding this matter, this research intends to test the effect of synchronous speech tasks in the production of L2 speech rhythm in a group of native speakers of American English, to assess the theoretical and pedagogical implications concerning the production and the teaching of this suprasegmental feature of speech.

1.3 Exploring the production of L2 Spanish speech rhythm using a synchronic speech production task

1.3.1 English and Spanish: Two different speech rhythm systems

The primary motivation to test the production of American English speakers of Spanish L2 speech rhythm has to do with the rhythmic differences between these two languages. In particular, English and Spanish have been classically defined in the rhythm literature as stress-timed and syllable-timed languages, respectively (Pike, 1945). Nowadays, the distinction between stress-timed and syllable-timed languages has gradually shifted towards a more gradual and relative view of the phenomenon and not a dichotomous one (Roach, 1982; Dauer, 1983; Ramus et al., 1999; Nespor, 1990; Grabe & Low, 2002). This change means that in contemporary literature about speech rhythm, languages are not categorized discretely, but according to a continuum, in which some languages are considered more syllable-timed than others, which is the case for Spanish in comparison to English (for a detailed explanation of the concept of speech rhythm and the concepts of stress-timed and syllable-timed languages, please refer to Chapter Two). The following table illustrates the overall rhythmic differences between these languages.

Table 2

Phonetic and phonological features associated with the speech rhythm of English and Spanish

Rhythmic property	Stress-timed languages (e.g., English)	Syllable-timed languages (e.g., Spanish)
Vowel reduction of unstressed vowels	Yes	No
High number of complex consonant clusters, equivalent to a high number of consonants in speech	Yes	No
High durational difference between accented syllables and unaccented syllables	Yes	No
High durational difference of phrase-final and utterance-final syllables compared to non-final syllables	Yes	No

Note. This table was adapted from Galaczi et al. (2016, p. 160)

In the previous table, it can be noted that English speakers of Spanish may have problems in the production of L2 speech rhythm linked to vowel reduction, syllable structure, stress, and intonation patterns. In this respect, Lahoz (2012) notes that speakers of languages with different rhythm typologies may pronounce vowels correctly in isolation but reduce vowels in continuous speech. Therefore, testing the effect of a method that could make learners aware of these differences was deemed a relevant and original idea during the design of this project, in the sense that it could bring light into L2 speech rhythm production and, eventually, it could become an effective approach to improve the production of L2 speech rhythm.

1.3.2 Researching about prosody and specifically about speech rhythm

Galaczi et al. (2016) indicate that prosody has empirically shown to play an essential role in L2 speech comprehensibility. Namely, when acquiring the prosody of an L2, learners face challenges related to syllable types in terms of duration, reduction of vocalic material, and consonant interval variation (Galaczi et al.). In this sense, learners with an excellent articulation of segmental features may still experience comprehensibility difficulties when interacting with other speakers because of their deficient prosody.

Not only is comprehensibility affected when it comes to prosody, but also suprasegmentals have an impact on the degree of foreign accent perceived by native speakers of the target language. It has been found that the transference of vowel reduction processes and L1 intonational patterns are linked to the perception of accentedness by native speakers (Rognoni, 2012; Galaczi et al., 2016).

Relative to speech rhythm perception, Lahoz (2012) indicates that the perception of this feature by L2 learners intervenes in the way learners segment the speech continuum into discrete units for lexical access. Concerning this, several studies have found that the perception of speech rhythm affects the efficiency of the listening process in the L2 (Bouchhioua, 2016; Yenkimaleki & van Heuven, 2016a, 2016b; Cutler & Farrell, 2018; Yenkimaleki, 2018). Likewise, Derwing & Munro (2015) signal that rhythmic patterns can play a role in helping learners to determine the syntactic structure of an utterance, facilitating their comprehension of the L2.

In terms of L2 speech production, several pieces of research have found that L2 speech rhythm plays an essential role in the processing of L2 speech, because it correlates with the perception of foreign accent and learners' comprehensibility (Gordon, Darcy, & Ewert, 2013; Bouchhioua, 2016; Gluhareva & Prieto, 2016; Saito & Saito, 2016; Trofimovich, Kennedy, & Blanchet, 2017; Yurtbasi, 2018). About this matter, Lahoz (2012) says that a deficient acquisition of L2 speech rhythm can affect L2 speech meaning, in the sense that the transference of stress patterns of the L1 can cause problems of intelligibility, which can produce morphological and semantic effects when communicating with other speakers of the target language.

In other words, a poor perception of L2 speech rhythm can bring a deficient segmentation of the speech continuum, which can cause listening and comprehension problems for L2 learners, and deficient production of speech rhythm can cause intelligibility and comprehensibility problems for L2 learners. In sum, L2 speech rhythm plays a double role for learners in their process of learning a second language because it involves different dimensions of their linguistic competence in the L2. Therefore, a proper acquisition of L2 speech rhythm is essential for the learning of any target language.

1.3.3. Synchronic speech and its relationship with the production of L2 speech rhythm

The term Synchronous Speech (hereafter SS) was coined by Cummins (2002a), who successively explored the ability of native speakers to speak in synchrony with one another (Cummins, 2002a, 2003, 2007, & 2009). Namely, the author put into relevance the fact that native experimental participants needed no more instruction than being told to read a text at the same time with a native co-speaker to carry out synchronous speech tasks and achieve high levels of speech rhythm synchrony with each other. In other words, Cummins found that speakers have the natural ability to synchronize their speech with a co-speaker. Further details about the work of Cummins and more research about synchrony and speech can be found in Chapter 2.

The fact that native speakers have shown the ability to synchronize their speech rhythm with their co-speakers is especially interesting for the acquisition and production of L2 speech rhythm.

Even though the work of Cummins (2002a, 2003, 2007, & 2009) did not involve foreign-language speakers, the nature of a synchronic reading task is highly compatible with the methodologies used in the teaching of pronunciation in the foreign language classroom. Notably, the reading of text materials aloud in conjunction with the use of shadowed speech and oral rehearsals has been found to yield significant effects in the acquisition of L2 pronunciation (Nagasaki, 2016; Mishima & Cheng, 2017; Shimomura, 2018; Shimono, 2019)

Moreover, there is no evidence that this ability should be exclusive to the native language of learners. Therefore, it plausible to think that if native speakers can synchronize with other speakers during the reading of a text aloud, L2 learners should also be able to synchronize with native speakers of their target language too. In the case of L2 learners, this synchronization could bring benefits in terms of the production of L2 speech rhythm as well as in terms of the familiarization with the speech rhythm of their target language.

1.3.4 Assessing the effect of synchronized-speech in terms of teaching methodologies for the acquisition and production of L2 speech rhythm

It was previously mentioned that prosodic features are usually not a part of explicit instruction in L2 classrooms (Espinosa, 2016). This research is based on the idea that exploring the production of L2 speech rhythm using an experimental paradigm to elicit diverse productions of L2 speech rhythm from non-native speakers can provide relevant information for both the study of the theoretical aspects involved in the production of L2 speech as well as for the explicit instruction of L2 speech rhythm. Notably, if a positive effect of synchronous speech versus non-synchronous speech tasks were to be found through this experimental paradigm, synchronous speech tasks could be recommended for the explicit training of L2 speech rhythm production in the foreign language classroom (Banzina, Hewitt, & Dilley, 2014).

Explicit training of speech rhythm has been found to yield improvement of L2 pronunciation in L2 learners. Tsushima (2016) observed an effect on L2 speech rhythm training in a case study of Japanese learners of English. Pellegrino (2017) found that explicit training in Italian speech rhythm improved the production of L2 Italian speech rhythm in a group of Japanese learners. Quesada Vázquez & Romero (2018) detected a significant effect for explicit instruction of English rhythm in a group of EFL learners, native speakers of Spanish, and Catalan. Likewise, Shimono (2019) identified that repeated oral reading with chunking practice and timed reading improved the rhythmicity of a group of Japanese EFL students. Therefore, research findings support the idea that explicit instruction of speech rhythm does yield significant effects on the production of L2 speech rhythm.

Even so, most of these findings do not seem to have been taken into consideration the pedagogical implications of their results for the teaching of L2 speech rhythm. Derwing & Munro (2015) argue that the transfer of L1 rhythmic patterns to an L2 cannot be considered a discrete error of L2 speech production, because it is a feature that is likely noticeable by listeners. Therefore, and as it has been argued before in this study, the problem concerning teaching methodologies does not revolve around the lack of empirical findings of L2 speech rhythm, but rather that the empirical findings have not been translated into pedagogical recommendations, which is one of the objectives of this research.

2 THEORETICAL FRAMEWORK AND STATE OF THE ART

In the previous chapter, the motivations for this research project were discussed. Specifically, the importance of exploring the production of Spanish L2 speech rhythm using different speech conditions, involving synchronized speech and solo speech were introduced. Also, the particular interest in the production of L2 speech rhythm by American English speakers, learners of Spanish as an L2 was presented. Finally, the reader was made aware that the aim of this study is not only to provide research findings but also to offer practical recommendations for the teaching of L2 speech rhythm for learners of a second language.

In order to frame the research objectives of this study within the field of previous studies about speech rhythm and the field of studies of L2 speech rhythm, this chapter will begin by referring to the concepts of prosody and the study of L1 speech rhythm as a prosodic feature and as an interactional feature of speech. Later, different models that have been posited the processes involved in the acquisition of L2 speech will be presented. Finally, the studies that have been conducted so far about L2 speech rhythm production as both a prosodic phenomenon and an interactional phenomenon will be mentioned.

2.1. Prosody as an acoustic phenomenon and a suprasegmental feature of speech

Prosody is an essential aspect of the speech signal that is used to convey post-lexical meaning and is modulated by speakers' gender, social status, native language and dialect, discourse, emotional state, etc. (Crystal, 1969; Ladd & Cutler, 1983; Labov, 2006; Szczepek Reed, 2010; Clopper & Smiljanic, 2011). As a speech phenomenon, prosody includes all suprasegmental phenomena, such as stress, tone, intonation, and rhythm, which are produced by the interplay of pitch, intensity, and duration in stretches of speech larger than a segment (Lehiste, 1976; Ladd & Cutler, 1983; Nooteboom, 1997; Fletcher, 2010). In the case of this particular study, the prosodic feature of speech rhythm will be the phenomenon explored.

2.2. The study of speech rhythm as a prosodic feature of speech

As a prosodic feature of speech, speech rhythm has been conceptualized and defined in several different ways (Moore, 2012; Turk & Shattuck-Hufnagel, 2013; Smith, Rathcke, Cummins, Overy, & Scott, 2014; Nolan & Jeon, 2014; Cummins, 2015). Since the focus of this study is not establishing a theoretical definition of speech rhythm, the debate regarding the empirical nature of rhythm in speech will not be discussed. In this study, speech rhythm will be operationalized in terms of duration and variability of sub-syllabic units (vowels and consonants) in order to assess rhythm using different durational rhythm metrics (V%, Ramus et al., 1999; VarcoV, White & Mattys, 2007; VarcoC, Dellwo, 2006; VnPVI, CnPVI, Low et al., 2000; Grabe & Low, 2000). In the following section, some of the classic works about speech rhythm will be introduced to provide a context for this study about L2 speech rhythm.

2.2.1. The evolution of the study of speech rhythm

Classe (1939 in Couper-Kuhlen, 1993) was one of the first researchers to investigate speech rhythm under laboratory conditions. Classe based his work on the presumption of isochrony[1] for the English language. In order to test this hypothesis, he analyzed recorded sentences and made instrumental measurements of the durations between stressed syllables in the recorded utterances. Classes's results showed strict isochrony only in a specific condition: when the rhythmic groups had a similar number of syllables, and similar phonetic and grammatical structures. Therefore, he concluded that isochronous groups in English were rare because they only occurred under particular linguistic contexts. Later, Lloyd James posited that some languages had a machine-gun rhythm, based on the recurrence of syllables, and some languages had a Morse code rhythm, based on the repetition of stress (1940 in Cumming, 2010). Under this categorization, Lloyd James defined the rhythm of English as a Morse code rhythm, due to its lack of isochrony and the organization of its rhythm around stress intervals (Lloyd James, 1935, in Carley, 2013)

It was not until Pike (1945) that the distinction between stress-timed rhythm and syllable-timed rhythm was coined, which is a distinction that is still used these days in many works about speech rhythm. Pike defined stress-timed languages as languages where rhythm units are mainly dependent upon the presence of one strong stress, i.e., German and English, and syllable-timed languages as languages that are more dependent on syllable units rather than stress intervals, such as Spanish and French. Posteriorly, Abercrombie (1967) also used these two categories, stress-timed and syllable-timed rhythms, in his book *Elements of General Phonetics* and suggested, following the previous work

[1] Isochrony is a type of rhythm in which all the intervals between events have an equal duration (Ravignani & Madison, 2017)

of Classe, that linguistic rhythm was based on the isochrony or equal division of time in respect to syllables units, or isochrony according to interstress intervals.

A few decades later, Roach (1982) discussed and tested the traditional notions of English speech rhythm coined by Pike (1945) and Abercrombie (1967) and stated that the evidence for the existence of rhythmic classes was not based on empirical data. Furthermore, Roach asserted that laboratory techniques had found that English speech rhythm did not show the expected regularity posited by Pike and Abercrombie. Also, Roach argued that it remained unclear whether the ground for the distinction between stress-timed and syllable-timed speech rhythm was based on what speakers produced and perceived as speech rhythm.

A year later, Dauer (1983) conducted an experiment using texts in English, Thai, Spanish, Italian, and Greek to test the isochrony hypothesis. The results of Dauer showed that interstress intervals in English were not more isochronous than interstress intervals in Spanish. In this sense, Dauer argued that the tendency for stresses to occur regularly appeared to be a language universal property, rather than a language-specific one. Likewise, Dauer (1987) affirmed that speech rhythm was a multifactorial phenomenon, involving the interaction of different components. Expressly, Dauer indicated that length (duration of accented syllables, type of syllable structure and quantity distinctions regarding accented syllables); pitch (intonation in regard to accent and tone in respect to accented syllables); quality (vowel quality, consonant quality); and, function of accent (word-level phonological accent versus absence of accent) were involved in the phenomenon of speech rhythm.

Dauer's works (1983 & 1987) set a milestone in terms of looking at speech rhythm as a multifactorial phenomenon rather than just a one-factor phenomenon. Additionally, Dauer's studies were also one of the first experimental approaches to the empirical and experimental study of speech rhythm. In 1999, Ramus, Nespor & Mehler proposed a series of acoustic measurements to research speech rhythm in natural languages, such as the percentage of vowel intervals and the deviation of consonant and vowel intervals. Later, Grabe and Low (2002), based on Low et al. (2000), introduced an index to measure rhythm, which tested the pairwise variability of consonant and vowel intervals in stretches of speech (PVI). Besides, Dellwo (2006) introduced the VarcoC to measure the normalized duration of consonantal intervals, and White & Mattys (2007) introduced VarcoV to measure the normalized duration of vowel intervals. The specific rhythm metrics that will be used to assess the experimental data of this study will be mentioned in Chapter Three.

In the following table, some of the empirical work that has been conducted about speech rhythm since the seminal paper published by Roach (1982) is introduced. Let us note that many of these studies were conducted to test the notion of rhythm classes in natural languages and to find rhythm typologies for natural languages. For studies of L2 speech rhythm, please refer to section 2.5.1.

Table 3

Studies about speech rhythm as an L1

Author(s)	**Language (s)**	**Main findings**
Roach, 1982	French, Telugu, Yoruba, English, Russian, & Arabic	- Languages are not totally syllable-timed or totally stress-timed; - All languages display syllable-timed and stress timing; - Languages differ in which type of timing predominates.
Dauer, 1983	English, Thai, Spanish, Italian, & Greek	- Stress-timed and syllable-timed languages differ in terms of syllable structure, vowel reduction, and the phonetic realization of stress and its influence on the linguistic system.
Deterding, 1994	Singapore English and British English	- Greater variability was found in the duration of syllables in Singapore English in comparison to Southern British; - Results confirm that Singapore English is more syllable-timed than Southern British.
Ramus, Nespor, & Mehler, 1999	English, Dutch, Polish, French, Spanish, Italian, Catalan, & Japanese	- The data obtained supported the notion of rhythm classes.
Low, Grabe & Nolan, 2000	British English & Singapore English	- The results support the notion that Singapore English is syllable-timed and that British English is stress-timed.
Deterding, 2001	British English & Singapore English	- Significantly greater variability in syllable-to-syllable duration for British English than Singapore English; - Singapore English is more syllable-timed than British English.
Grabe & Low, 2002	British English, German,	- Findings support the

	Dutch, Thai, Tamil, Spanish, French, Singapore English, Japanese, Polish, Catalan, Estonian, Greek, Luxembourg, Malay, Mandarin, Rumanian, & Welsh	classification of English, Dutch and German as stress-timed and French and Spanish as syllable-timed; - Durational values for Japanese were similar to those from syllable-timed languages.
Ramus, Dupoux, & Mehler, 2003	English, Dutch, Spanish, Catalan, and Polish.	- Results support the hypothesis that English and Dutch are stress-timed and that Spanish and Catalan are syllable-timed. - Polish did not fit into any rhythm categories.
Moon-Hwan, 2004	Korean	- Results indicated that Korean is a mora-timed language.
White & Mattys, 2007	English, Dutch, Spanish, & French	- Results showed that speech rate-normalized metrics of vocalic interval variation and the index of the relative duration of vocalic and consonantal intervals could discriminate between hypothesized rhythm classes.
Toledo, 2010	Aragon Spanish, Canarias Spanish, & Granada Spanish	- The results from different varieties of Spanish confirm the status of Spanish as a syllable-timed language.
Mairano, 2011	Arabic, Mandarin Chinese, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Icelandic, Italian, Japanese, Polish, Portuguese, Romanian, Russian, Spanish, Swedish, & Turkish.	- Overall, data reflect a scalar distribution of languages belonging to the traditional categories of stress-timing and syllable timing.
De Pinho, 2013	Castilian Spanish & Spanish	- The results show that both Castilian and Spanish can be classified as syllable-timed language.
Sawanakunanon, 2013	Khmer, Vietnamese, & Mon	- In a continuum between stress-timed and syllable-timed languages, the data indicate that Khmer is a stress-timed language, Vietnamese is a syllable-

			timed language, and Mon can be found halfway in the continuum, but closer to Khmer, which is a stress-timed language.
Tan & Low, 2014	Malaysian English & Singapore English	-	It was found that the rhythm of Malaysian English can be classified as syllable-timed.
Santiago & Mairano, 2017	Mexican Spanish & Castilian Spanish	-	Mexican Spanish was found to be less syllable-timed than Castilian Spanish.
Espinosa, 2018	Patagonian Argentinian Spanish, British English, & American English	-	The results indicated a clear typological difference between Patagonian Argentinean Spanish and British and American English.
Nocetti, Pérez, & Figueroa, 2019	Spanish	-	The results show that Chilean Spanish is a syllable-timed language, although it displays values slightly closer to stress-timed languages than Castilian Spanish.

As it can be observed in Table 3, most of the studies about L1 speech rhythm have been conducted either to test the rhythm class hypothesis or to typologically discriminate natural languages and the different dialectal varieties of natural languages. Even if this study is concerned with L2 speech rhythm, these studies are an essential reference for this work, because most of them have used rhythm metrics to categorize different languages and specific dialectal varieties successfully.

2.3. The study of suprasegmentals and speech rhythm as an interactional resource

As a communicative phenomenon, suprasegmentals can also be understood as an interactional resource that speakers use during social interactions, as well as a means for the completion of actions and activities (Couper-Kuhlen, 1993; Cowley, 1994; Schegloff, 1995; Couper-Kuhlen & Selting, 1996; Cutler, Dahan, & Van Donselaar, 1997; Auer, Couper-Kuhlen, & Müller, 1999; Szczepek Reed, 2009, 2010, 2012; Barth-Weingarten, Reber, & Selting, 2010; Ogden & Walker, 2013).

In the case of speech rhythm, this feature has often been reported as a device employed by speakers to manage the flow of communication (Couper-Kuhlen, 1993; Cowley, 1994; Couper-Kuhlen & Selting, 1996; Auer et al., 1999; Couper-Kuhlen & Ford, 2004; Couper-Kuhlen, 2007; Szczepek Reed, 2009), either by controlling the turn-taking patterns, or to direct the attention of interlocutors, and regulate the degree of their involvement in interaction, or even for online coordination of interpersonal cooperation in joint action (Keller, Novembre, & Hove, 2014).

The core mechanism for this resource is the ability of a biological organism to entrain to the rhythm of the environmental signal, which also means that all behavioral processes incorporate an inherent rhythm, which is modified in its phase and periodicity by external influences, such as sensory input (Oatley & Goodwin, 1971). Importantly, biological organisms can entrain to the signal emitted by a different biological system, which leads to coordinated and reciprocal interaction behavior (Phillips-Silver, Aktipis, & Bryant, 2010).

In humans, entrainment has been explored in terms of signal entrainment and social entrainment. As for signal entrainment, tapping-tasks, speech cycling tasks, and dancing tasks have shown the ability of human beings to entrain to a rhythmic sensory input signal (Cummins & Port, 1998; Repp, 2005; Eerola, Luck, & Toiviainen, 2006, Merchant, Grahn, Trainor, Rohrmeier, & Fitch, 2015). Concerning social entrainment, studies about dancing, ensemble music performances, massive rituals, and sport practices have revealed the ability of human beings to entrain their motor output to the motor output of other individuals by benefiting from cues of perceptual input (Ancona & Chong, 1999; Keller, 2008, 2014; Merker, Madison, & Eckerdal, 2009; Lucas, Clayton, & Leante, 2011; Reddish, Fischer, & Bulbulia, 2013).

In the case of speech rhythm, it has been found that native speakers can entrain to the beats produced by another speaker when reading aloud, and in synchrony, without any previous training needed (Cummins, 2002a, 2003, 2007, & 2009; Bowling, Herbst, & Fitch, 2013). These findings indicate that speech rhythm can act as a device for speech entrainment in synchronic speech, a topic that will be addressed in the following section.

2.3.1. Speech rhythm and synchronized speech: an interactional view of rhythm

Cummins (2002a, 2003, 2007, & 2009) was the first to test empirically the idea that speech rhythm could act as a device for speech entrainment. The author explored speech rhythm concerning the ability of native speakers to speak in rhythmic synchrony with one another, which he labeled as Synchronous Speech (SS). Remarkably, Cummins designed an experimental paradigm that included reading aloud and in synchrony in different experimental conditions, such as reading in synchrony with another native speaker and reading in synchrony to a recording of another native speaker. Through this experimental paradigm, Cummins brought to relevance the fact that native experimental participants need no more instruction than being told to read in time with their co-speaker in order to carry out synchronous speech tasks and achieve high levels of speech rhythm synchrony. Later, Bowling et al. (2013) also tested the ability of German native speakers to achieve synchronization using an experimental paradigm that involved reading nonsense phrases aloud with and without partners. The researchers found that synchronous reading resulted in greater regularity of durational intervals between words.

Both Cummins (2002a, 2003, 2007, & 2009) and Bowling et al. (2013) put into relevance the fact that speakers do not need any training to synchronize to the speech of a different speaker, and that synchrony in speech can lead to the development of temporal regularity in vocalizations, which is why this experimental paradigm was chosen for this research design.

2.4.Models to understand the perception and production of L2 speech

In the following lines, three foundational models for the acquisition of L2 phonology will be discussed. Notably, we will present the formal model of learning L2 prosodic phonology (Archibald, 1994), the ontogeny phylogeny model (Major, 2001), and the unified model of language acquisition (MacWhinney, 2005).

2.4.1.Archibald (1994). A formal model of learning L2 prosodic phonology

Based on his empirical work (Archibald, 1992, 1993, in Archibald, 1994), Archibald (1994) proposed a formal model for the learning of the phonology of a second language. This model was based on both the principles of UG (Chomsky, 1981) and several learning theories (Dresher & Kaye, 1990; Newson, 1990; Saleemi, 1992). A figure of Archibald's model is introduced below.

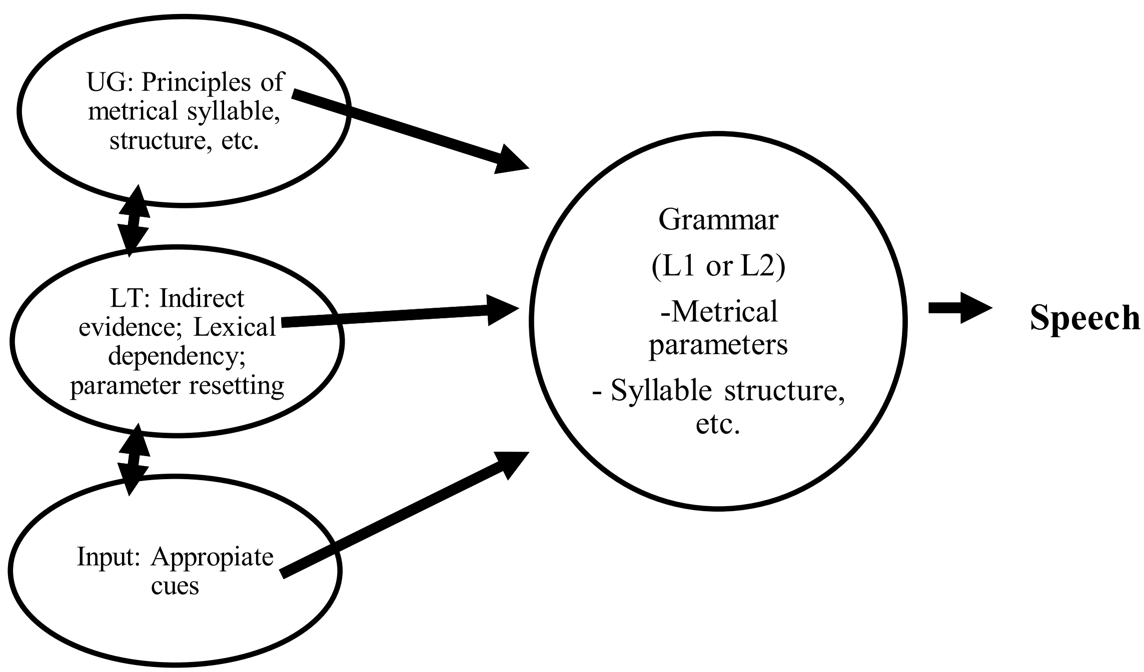

Figure 1. A formal model of learning L2 prosodic phonology (adapted from Archibald, 1994, p. 217).

Namely, Archibald's 1994 model integrates three components: a) UG principles (UG module) in respect to phonological processes, such as metrical principles, syllable structure, stress placement b) Learning Theory (LT), in the sense of positive and negative indirect evidence for language acquisition; and, c) L2 input, regarding parameters appropriateness. According to Archibald (1994), this theory gives an account of the structural characteristics of the metrical structure of interlanguage grammar as well as the period it takes learners to reset and to acquire the parameters from an L2. Archibald proposes that this formal model is also productive for identifying stages in interlanguage development, proving how interlanguage grammars change in time, and observing the relationship between input cues and parameter resetting (appropriateness).

In the case of this study, this model will be taken into account, because Archibald (1994) proposes that UG principles, such as syllable structure and stress placement play a role in the production of L2 speech in the sense that there is a transfer of specific patterns from the L1 of the speaker onto the L2 of the speaker in the case of stress patterns, which are linked to rhythm production. Since the participants of this study are native speakers of American English, a language that tends to be stress-timed, it is expected that the speech rhythm from their L1 will transfer to the production of speech rhythm in Spanish, which is a language that tends to be syllable-timed.

Archibald (1994) also indicates that both positive and negative evidence influence the production of L2 speech, in the sense that learners use pieces of information about well-formed structures and ill-formed structures as input; this is also the reason why learners are continually resetting their parameters in Archibald's model. Mainly, learners use the information they receive to produce utterances in their L2. Positive evidence also acts as an appropriate cue in this case, which is another one of the elements Archibald mentions in his model. It is expected that in the case of the three synchronous speech conditions of this experimental paradigm, learners will be able to obtain well-formed and appropriate cues, which will affect the production of their L2 speech rhythm.

2.4.2.Major (2001). The Ontogeny Phylogeny Model

Major's (2001) ontogeny phylogeny model (hereafter OPM) is based on Major's 1986 ontogeny model, which he postulated as a general model to explain performance in L2 speech concerning developmental and transfer processes. Major introduced OPM to account for linguistic competence and variability both in native language acquisition and second language acquisition. In respect to SLA, the model proposes three components for IL and defines their respective interactions concerning the processes of acquisition and change in an L2.

The model posits that L2 acquisition processes are an interaction of three linguistic components a) L1; b) L2; and, c) and linguistic universals (hereafter U). L1 consists of NL phonology, L2 comprises TL phonology, and U is the set of properties of the human language plus the universal characteristics of languages. Notably, U also includes anatomical, functional, and processing properties to the human mind; in other words, U encompasses all the universals of language that are not a part of the respective L1 or L2 systems. These three linguistic components are part of the process of construction of the IL, and they are more or less pervasive according to the different L2 phenomena encountered by learners and their respective L2 learning conditions (time, input, among others[2]).

Concerning the development of IL, the model posits four corollaries regarding the evolution of the IL: a) Chronological development of the IL; b) Stylistic variation of IL; c) Structural similarity of L1 and L2 systems; and, d) Markedness. Relative to the effect of time in the development of IL, Major (2001) postulates that during the first stages of development of a second language, L1 influence is powerful and that the L1 prevents U from exerting its universal influence. However, as time progresses, learners realize, consciously or unconsciously, that the L1 system is not an adequate substitute for the L2 system. For this reason, during the intermediate stages of L2 competence, U processes increase. Later, as the learner acquires a higher competence in the L2, U processes decrease, and the L2 becomes more developed. A set of charts of how this process develops is presented below.

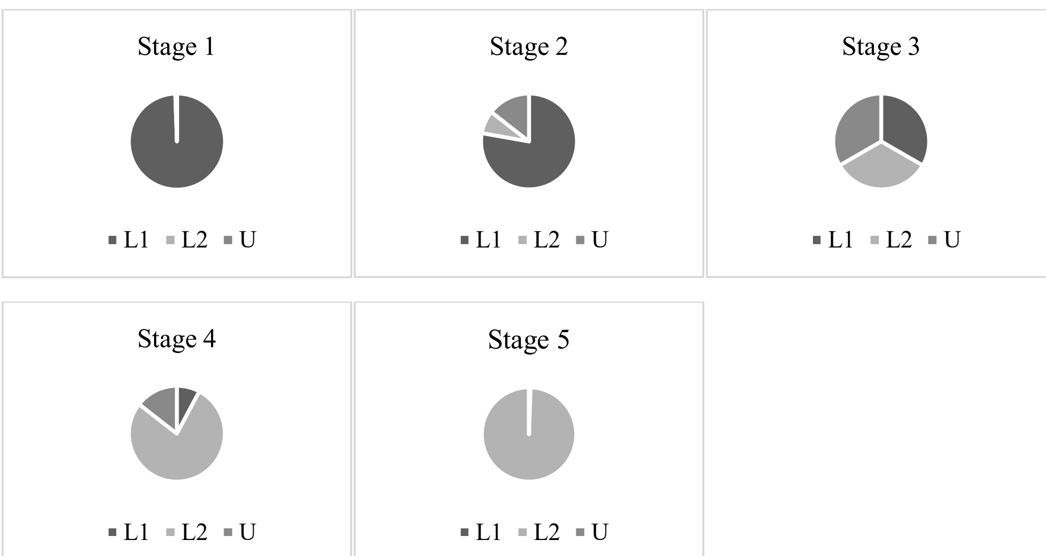

Figure 2. Chronological development of the IL (adapted from Major, 2001, pp. 86-87).

[2] Major's model (2001) does not specify how the development of the IL in L2 learners' occurs; therefore explicit and implicit instruction are not taken into consideration in this model.

As it can be seen in these five pie charts, which represent five particular stages of the development of the L2, we see that stage 1 is the beginning of the IL and that stage 5 is the final L2 stage[3]. In these charts, we can note that the initial stages of L2 development have a more pervasive influence of the L1, which decreases in time. As for the L2 and U, these systems seem to advance along in stages 2 and 3, but later, in stages 4 and 5, L2 phonology becomes more prevalent and takes over the IL system.

Concerning stylistic variation, the model postulates that the three components of IL, namely L1, L2, and U, vary stylistically in the same manner as they do chronologically. However, in the case of style, the variable that affects the development of the different developmental stages is the degree of formality, not time. That is to say, as the L2 speaker's style becomes more formal, the L2 system increases, the L1 decreases, and U increases and then decreases, similarly to the five stages in Figure 2. Therefore, in Figure 2, stage 1 would correspond to the less formal stage, and stage 5 would be the most formal.

Regarding linguistic similarity, the model proposes that when two categories are perceptually similar, the IL develops chronologically. First, the L2 increases slowly; secondly, the L1 decreases gradually, and U increases and decreases slowly. A figure with charts depicting the development of similar linguistic categories is presented below.

[3] It is important to note that Major (2011) does not consider the IL of learners as an autonomous and dynamic system, but rather as a linguistic system that learners overcome when achieving a proficient L2 competence.

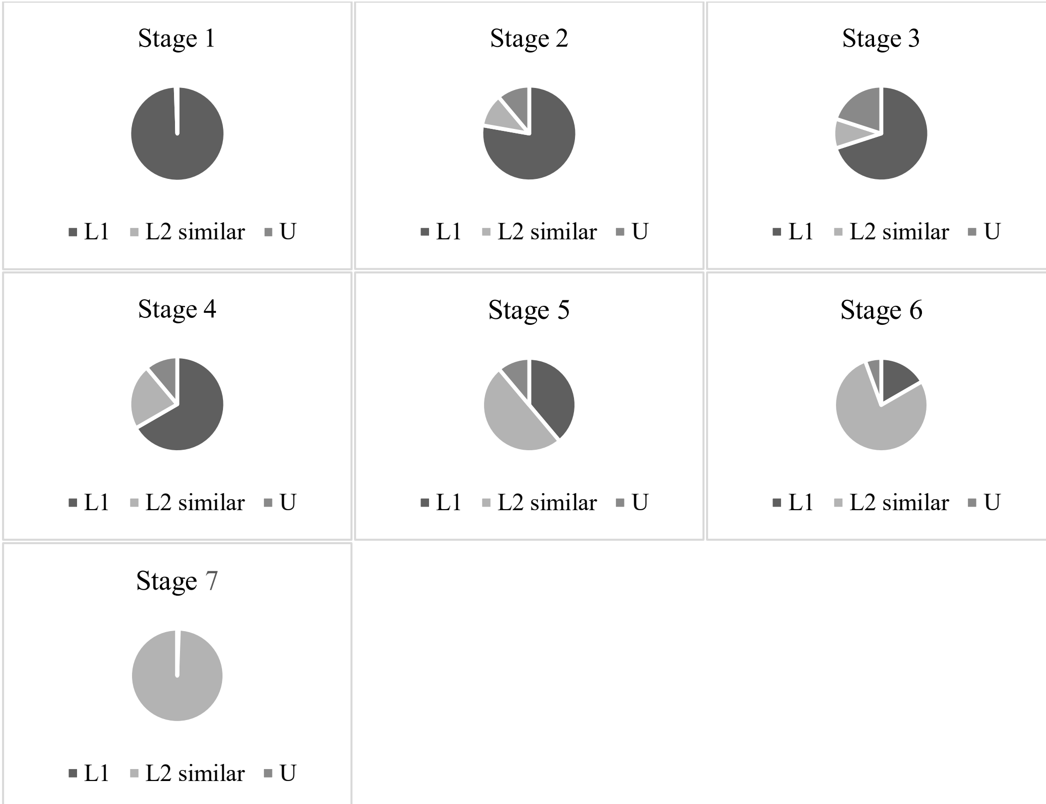

Figure 3. Development of similarities in IL (adapted from Major, 2001, pp. 102-103).

As it can be observed in Figure 3 in comparison to Figure 2, the role of the L1 decreases more slowly. This phenomenon occurs because speakers rely more on their respective L1s when they perceive linguistic structures that are similar to the structures of their L1s. Even so, both L2 and U still increase slowly. Finally, in stages 5 and 6, it can be noted that the L2 acquires a more prevalent role, which finally overtakes the whole system in stage 7.

Lastly, for markedness, the model posits that the IL develops in time in the following manner: first, the L2 increases slowly, then the L1 decreases at an average rate and then decreases slowly, and U increases rapidly and then decreases slowly. A figure of this process is shown below.

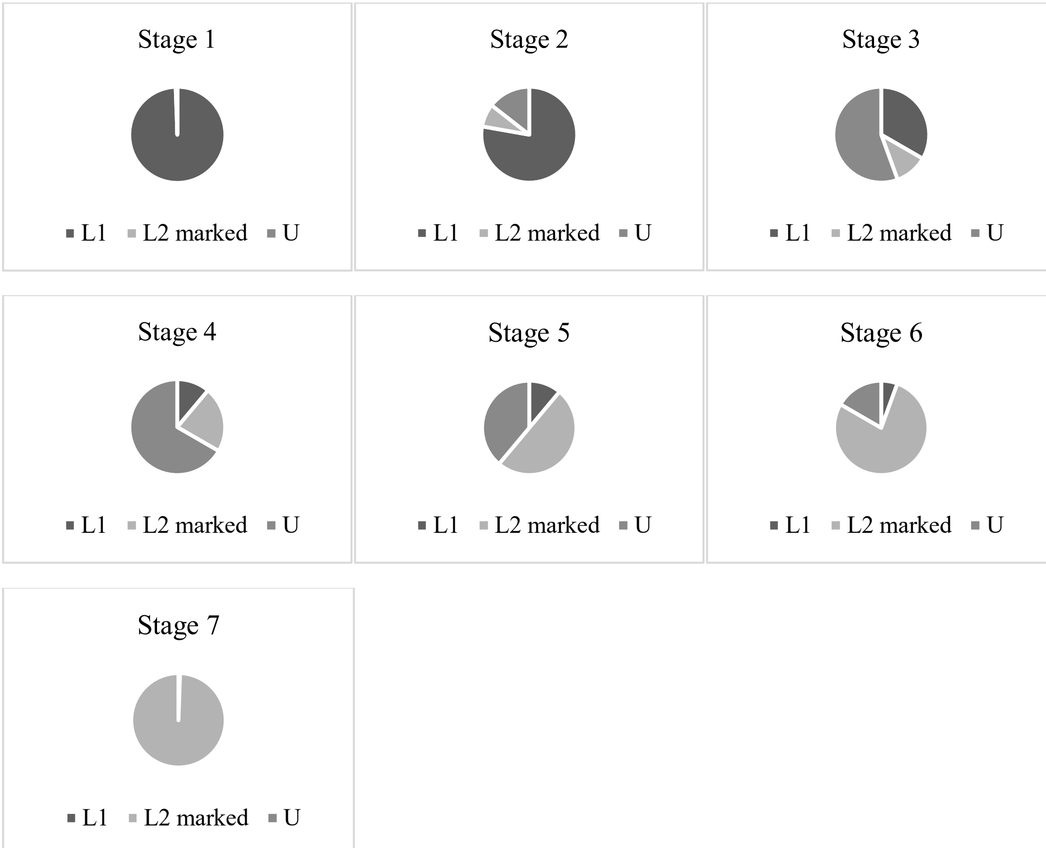

Figure 4. Development of marked structures (adapted from Major, 2001, pp.108-109).

In the figure above, it is possible to note that L1 decreases normally during the beginning stages but then decreases more slowly in the final stages (stages 5, 6, 7). In respect to the L2 marked phenomena, it can be observed that L2 marked phenomena increases slowly, due to the presence of L1 and U processes. Concerning U processes, it can be seen in the charts of Figure 4 that these increase rapidly throughout the stages and persist until the penultimate stage; the evolution of these stages implies that when learners are faced with marked phenomena, they rely more on U resources to acquire the marked structures in their respective L2s.

In summary, OPM proposes the interrelationship of three systems in SLA acquisition, L1, L2, and U, relative to time, style, similar structures, and markedness. In the case of this study, the results will be discussed in light of this model, because even when the study will not explore time and style, it will explore the acquisition of different prosodic structures and markedness. Notably, the English speakers of Spanish will have to produce the speech rhythm of Spanish, which is a language with a tendency to be syllable-timed, unlike English. In this sense, the speech elicited from participants will be used to assess the effect of the conditions of the experimental task in the production of these different structures. Relative to markedness, the results will be assessed in light of this model because

English, being a stress-timed rhythm exhibits more marked phenomena at level of the syllable than Spanish (Ordin & Polyanskaya, 2015), which is something that the data from this study can show if the L1 of the non-native participants of this study is pervasive and does not let them produce the speech rhythm of Spanish.

2.4.3. MacWhinney (2005). A unified model of language acquisition

MacWhinney (2005) came up with the Unified Model of Language Acquisition based on the idea that it is impossible to construct a model of L2 learning that does not take into consideration the structure of the L1. In this sense, MacWhinney believes that it is more productive to postulate a unified model for L1 and L2 acquisition rather than attempting to build two different models for these acquisition processes. Namely, MacWhinney's unified model places the mechanisms of L1 learning as one more of the subsets of mechanisms for L2 learning (Flynn, 1996 in MacWhinney, 2005). A figure of MacWhinney's model is presented below.

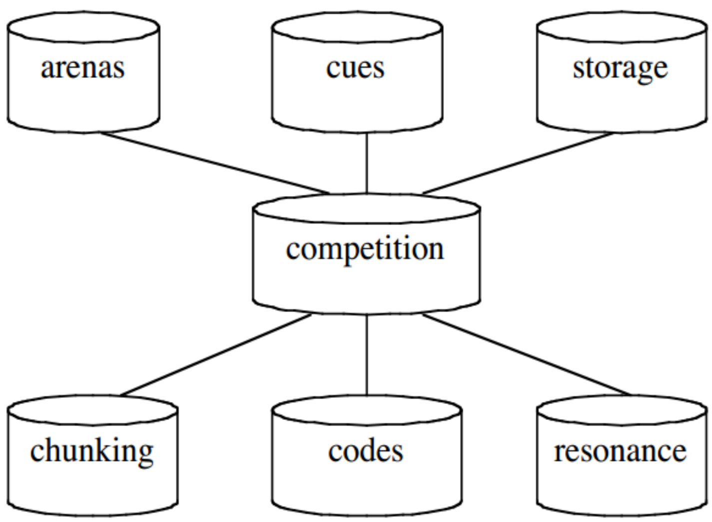

Figure 5. A unified model of language acquisition (taken from MacWhinney, 2005, p. 50).

As it can be observed in Figure 5, this model is composed of seven interrelated structural and processing components. At the core of the model, the competition component can be found. This component processes the selection of various options or cues based on relative cue strength during language acquisition. The other six components, although not core, are also crucial to this model of language acquisition: a) Arenas; b) Cues; c) Storage; d) Chunking; e) Codes; and, f) Resonance. The Arena component takes into consideration the linguistic level where the competition occurs. In the case of L2 speech rhythm, the arenas would be NL phonology, TL phonology, and IL phonology. The Cues component is related to linguistic forms and functions. MacWhinney (2005) posits that linguistic forms are cues for perception and comprehension and that linguistic functions serve as cues for production.

Another component in this model is Storage. This component refers to linguistic mapping in both short-term and long-term memory. This component is based on the notion that both of these memory systems constrain the role of cue validity during language processing and acquisition. Further, the Chunking component is concerned with the size of specific linguistic mappings, in terms of linguistic combinatorial possibilities. Chunking enables combinatory perception and production processes, such as syllable processing in word phonology. The Codes component is grounded on the theory of code activation and competition. Namely, the two components of this theory are transfer and code interaction. Therefore, this component takes into consideration both L1 transfer processes and code selection, such as switching and mixing.

The Resonance component plays a central role in this model. It accounts for code separation, age-related effects, and the micro-processes involved in linguistic learning and processing. According to MacWhinney (2005), resonance is based on the repeated coactivation of reciprocal connections. In this sense, during second language acquisition, the set of resonant connections grow and allow for cross-associations and mutual activations in the construction of the IL. Specifically, if a particular language is being repeatedly accessed, such as the TL of learners in an immersion context, the language will be in a highly resonant state, generating the improvement of reaction times in specific communicative tasks.

The results of this study will be discussed in light of this model because it is believed that the synchrony conditions are a high state of resonance for learners and that the task involves both linguistic forms and linguistic functions because it involves both the perception and the production of speech. In this sense, it is believed that the production of L2 Spanish rhythm should drastically improve in synchronic conditions because the learners will be perceiving the language as well as producing it.

2.5. State of the art: Empirical research of L2 speech rhythm as a prosodic feature of speech and as an interactional phenomenon using synchronized speech

2.5.1. Empirical research about L2 speech rhythm as a prosodic feature of speech

Since the primary studies about speech rhythm as a native language have already been introduced, in this section, several studies about L2 speech rhythm as a prosodic feature of speech will be presented. In the following table, some of the most relevant research for L2 speech rhythm will be displayed. Let us note that although some of these studies do not explicitly indicate that their focus is

L2 speech rhythm, they have been included in this review because they deal with vowel reduction, stress placement, and syllable duration, which are some of the features that need to be mastered for a competent production of L2 speech rhythm:

Table 4

Empirical research about L2 speech rhythm

Author (s)	**L1**	**Target language**	**Target feature**	**Main findings**
Wenk, 1985	French	English	Stress & vowel reduction	- Differences were found in the speech rhythm of French speakers of English with different competence levels: beginner, intermediate and advanced; - Beginners showed higher levels of transfer than advanced learners do and that advanced learners seem to overcome L1 transference.
Flege & Bohn 1989b	Spanish	English	Stress & vowel reduction	- English stress seemed to pose less of a learning problem than vowel reduction for Spanish speakers; - Stress seems to be acquired earlier than vowel reduction in unstressed syllables.
Chela-Flores, 1997b	Spanish	English	Syllable duration and vowel reduction	- Fossilization of errors of syllable length and vowel reduction in the majority of speech produced by the Spanish speakers of English.
Trofimovich & Baker, 2006	Korean	English	Stress timing, peak alignment, speech rate, and pause frequency.	- The production of specific suprasegmental features, such as stress timing, was related to the amount of L2 experience or exposure; - A connection with experience and exposure was not found for speech rate, pause duration, and pause frequency; rather, these variables seemed to be linked to the age of arrival of the participants to the target language country.
White & Mattys, 2007	Spanish English	Spanish English	Speech rhythm	- Native English speakers showed lower vowel percentages than Spanish native speakers or English speakers of Spanish. - Spanish speakers of English had an intermediate rhythm between their native language and their second language;

				- Native English speakers of Spanish produced higher vowel percentages than native Spanish speakers; - English speakers of Spanish produced higher durational contrast than Spanish speakers did between unstressed vowels and stressed vowels.
Ferjan, Ross & Arvaniti, 2008	German Italian Spanish Korean	English	Speech rhythm	- Spanish and Korean speakers of English produced more consonantal variability in their L2 speech in comparison to their L1 speech.
Grenon & White, 2008	English Japanese	Japanese English	Speech rhythm	- The production of L2 English rhythm by Japanese speakers is comparable to native English speakers in all metrics; - Japanese speakers of English were not proficient in making the stressed-unstressed contrasts in English; - English speakers of Japanese exhibited comparable scores to native Japanese speakers, both in vowel percentages and the normalized standard deviation scores of vocalic intervals; - English speakers of Japanese showed more considerable variation in consonantal interval durations, and their raw pairwise comparison of consonantal interval scores were closer to the scores of the native English-speaking group.
Ordin & Setter, 2008	Russian	English	Speech rhythm	- Russian English and British English exhibited similar speech rhythm patterns, which seems to be an indication of the transference of the speech rhythm patterns from Russian, which has been described as a stress-timed language.
Dellwo, Gutierrez-Díez & Gavalda, 2009	Spanish	English	Speech rhythm	- Spanish speakers of English produced higher values for consonantal and vowel intervals duration than English native speakers.
Monroy, 2011	Spanish	English	Vowel and consonant phonological processes	- A dominant role of L1 phonology in the production of L2 English for Spanish speakers was observed.

Ordin & Polyanskaya, 2014	German French	English	Vocalic sequences and consonant aggrupations	- German learners reached a level of length for vowel and consonant variability similar to the one produced by native British English speakers; - French learners showed a lower level of variability, which did not match the level of variability of British English.
Kawase, Kim, & Davis, 2016	Japanese	English	Mean duration of phoneme intervals	- The mean duration of phoneme intervals was relatively longer in L2 speech, particularly in the participants with the lowest levels of competence; - Inexperienced L2 talkers exhibited the least vowel durational variability, with the English talkers having the most; - The influence of L1 speech rhythm on L2 speech rhythm production decreased as a function of L2 experience.
Aloauche, 2016	Arabic	English	Speech rhythm	- Participants' L2 speech rhythm is somewhat 'intermediate,' in the sense of being halfway between stress-timed and syllable-timed speech rhythm.
Ding, 2016	Mandarin Chinese	English	Speech rhythm	- L2 English speech rhythm of Chinese speakers is more syllable-timed than native English speech rhythm; - The analysis showed that vowel epenthesis, non-reduction of vowels, and no stressed/unstressed contrast could contribute to the auditory impression of syllable-timed rhythm of their L2 English.
Droua-Hamdani, Selouan. Alotaibi, & Boudraa, 2016	Arabic	English	Speech rhythm	- Significant differences were found between native and non- native speakers in terms of speech rhythm in consonant and vowel durations.
Alouache, 2017	Arabic	English	Speech rhythm	- Informants' speech rhythm is a merge between stress-timed and syllable-timed speech rhythm.
Kim, 2017	Korean	English	Fundamental frequency & vowel duration	- Learners substituted fundamental frequency variability for duration variability.

Lima Jr & García, 2017	Brazilian Portuguese	English	Unstressed vowel reduction	- The mixed speech rhythm from Brazilian Portuguese facilitates the acquisition of the rhythmic patterns of English, a stress-timed language, in terms of unstressed vowel reduction.
Ozaki, Yazawa, & Kondo, 2017	Japanese	English	Speech rhythm	- Less proficient learners had lower variability in the duration of both vowels and consonants; - Learners with higher proficiency showed more variability and produced more native-like speech.
Zhou, Cruz, & Frota, 2017	Mandarin Chinese	European Portuguese	Speech rhythm	- The rhythm of the interlanguage evolves from L1 to L2, reflecting the proficiency level in the acquisition of the second language; - Evidence was found for the influence of L1 on the phonology of the interlanguage.
Yune, 2018	Japanese	Korean	Speech rhythm	- L1 Japanese speech rhythm transfer effects in the production of Korean L2 speech rhythm.
Mairano, Mois, De Iacovo, & Romano, 2018	English	Italian	Speech rhythm	- The results partially support the hypothesis that learners produce intermediate rhythmic patterns between their L1 and their L2; - No significant effects were found for other variables in L2 acquisition, such as years of study, length of stay, and linguistic competence in other Romance languages
Nguyễn, 2018	Vietnamese	English	Speech rhythm	- Variation in duration of vocalic and consonantal intervals in the L2 is higher on speakers with advanced proficiency levels and lower in speakers with beginner levels, indicating that beginners may transfer their L1 rhythmic patterns onto English; - Speech rhythm in L2 English develops from more syllable-timed towards more stressed-timed patterns as acquisition progresses.
Van Maastricht, Krahmer, Swerts, & Prieto, 2018	Dutch Spanish	Spanish Dutch	Speech rhythm	- Spanish learners of Dutch and Dutch learners of Spanish showed transfer effects from their L1; - Syllable structure complexity affected L2 rhythm acquisition, and to a substantially more considerable extent, for the Spanish learners of

	Dutch compared to the Dutch learners of Spanish.

In summary, two elements stand out from the research conducted by the authors reviewed concerning this study. First, most research indicates the importance of taking into consideration the native language of L2 learners when researching second language speech rhythm. Secondly, the studies reviewed show the urgent need to conduct more research about L2 speech rhythm for languages other than English. In this sense, this study aims to be a contribution to the lack of research about L2 speech rhythm for languages other than English.

2.5.2. Empirical research about L2 speech rhythm as a synchronous phenomenon

Banzina, Hewitt, & Dilley (2014) researched the effect of synchronous speech in the production of L2 speech rhythm in English. Namely, they conducted a quasi-experimental design, which included a pre-test and a post-test. Banzina et al. worked with an experimental group (n=3) and a control group (n=3) of foreign teaching assistants working in a Midwestern University in the United States, who had shown previous problems with English suprasegmentals. Both participant groups received explicit synchronous speech instruction about speech rhythm production in English, and the experimental group received implicit instruction by taking part in synchronous speech tasks. In order to measure the effect of instruction on English speech production, participants were recorded at the beginning and at the end of the period of instruction, which lasted six weeks in total.

After the instruction period was over, the participants' recordings were low-pass filtered in order to remove all segmental information. Later, the recordings were analyzed by a group of naïve native language pathologists, who assigned impressionistic ratings to their speech for a) rhythmic pattern accuracy; b) speech rate acceptability; and, c) overall speech acceptability as instructional speech. Their rhythmic performance was assessed using a continuous scale from 1 to a 100, where 1 was non-native rhythm, and 100 was native-rhythm.

Even when the sample size was small, and therefore, the results cannot be generalized to a larger population, the study revealed some interesting facts about the use of synchronous speech and L2 speech rhythm production. Overall, two out of the three participants who received implicit instruction, that is to say, the experimental group that took part in synchronous speech tasks, showed an improvement in terms of their speech production in English. Therefore, Banzina et al. (2014) results are an essential piece of work in terms of the use of synchronous speech in instructional settings.

3. RESEARCH QUESTIONS AND OBJECTIVES

In the following sections, the research questions and objectives for this quasi-experimental and cross-sectional research will be presented.

3.1 Research questions

- Do synchronous speech conditions have an entrainment effect in the production of speech rhythm in controlled and synchronous speech tasks for non-native speakers of Spanish?
- Do the group of non-native speakers of Spanish and the group of native speakers of Spanish show any entrainment differences in the production of speech rhythm in controlled and synchronous speech production tasks?

3.2 Objectives

3.2.1 General objective

- To test the effect of synchronous speech tasks in the production of speech rhythm by non-native speakers of Spanish.

3.2.2 Specific objectives

- To describe the production of Spanish speech rhythm by American English speakers using an experimental task, involving four experimental conditions and two different text materials.
- To describe the production of Spanish speech rhythm by native speakers of Spanish using an experimental task, involving four experimental conditions and two different text materials.
- To compare the effect of different speech conditions and text materials, namely the Synchrony live condition (1), the Synchrony with recording from live conditions (2), the Synchrony with recording from non-live condition (3), and the Solo recording condition (4) and a narrative text (1) and a text with meter (2), in the production of L2 speech rhythm by English speakers of Spanish and the production of L1 speech rhythm by native speakers of Spanish.
- To discuss pedagogical implications for the teaching of L2 speech rhythm in light of the results of this experimental paradigm in the production of L2 speech rhythm.

3.3 Methods and materials

The experiment reported in this manuscript was conducted following the policies of research of the Social Sciences and Humanities Ethics Committee at the Pontifical Catholic University of Chile (henceforth PUC) and the National Commission for Scientific and Technological Research. Participants gave written informed consent, and they were informed that they could withdraw from the experiment at any time without any consequences. All data were stored anonymously.

3.4 Type of research

This study is a quasi-experimental design since participants were not randomly selected. It is also a cross-sectional study because the samples were collected in four weeks.

3.5 Dependent variables[4]

- V%
- VarcoV
- Varco C
- VnPVI
- CnPVI
- Onset synchrony alignment

3.6 Independent variables

- Nativeness: 2 levels: Non-native, native (Between-group variable);
- Texts: 2 levels: a) Narrative text (Within-group variable variable), and b) Text with meter (Within-group variable);
- Experimental conditions: 4 levels: 1) Synchrony-live condition; 2) Synchrony with a recording from synchrony live condition; 3) Synchrony with a recording from non-live condition; and, 4) Solo recording condition (Within-group variable).

3.7 Participants

This experiment included two groups of participants: a) A control group of native speakers of Spanish, and b) An experimental group of non-native speakers of Spanish, speakers of American English. A description of these two groups is presented in the following table.

Table 5

Description of the control and experimental groups

Group	Label	Number of participants	Mean age	Group composition
Non-native speakers Spanish, native speakers of American English	Experimental group	31	22.22 (SD = 3.69)	27 female 4 male
Native speakers of Spanish	Control group	32	24.21 (SD = 4.31)	23 female 9 male

[4] For information about the operatilization of these variables, please refer to Table 8.

The 63 participants were recruited using different social media websites. Participants with specific training in activities involving synchronic behavior or entrainment of suprasegmental features were excluded from the study. Background demographic information about both groups of participants was obtained using a questionnaire that was completed at the beginning of each recording session.

3.7.1 Native group

The native group, which was the control group, was composed of 32 participants (Mean age = 24.21; SD= 4.31). Twenty-two participants were female, and nine participants were male. All participants were native, monolingual speakers of Spanish, who had never lived outside of Chile for longer than six months.

3.7.2 Non-native group

The non-native group, which was the experimental group, was composed of 31 participants (Mean age = 22.22; SD= 3.69). Twenty-seven participants were female, and four participants were male. All participants were native speakers of American English, who were residing in Chile and receiving formal instruction in Spanish. The experimental participants had different levels of competence in Spanish, ranging from intermediate to upper-intermediate competence levels. Initially, the level of competence was going to be included as a factor for the analysis of the results of this study. However, due to the low number of participants for each level of linguistic competence and the lack of a proper standardized instrument for the assessment of the different levels of competence of participants, who belonged to different Spanish programs with different competence assessment instruments, competence level will not be assessed as a variable in this study.

3.8 Design

3.8.1 Experimental conditions

The 63 participants were recorded reading three different materials in four different conditions. The combination of these conditions was counterbalanced. These four conditions are described in the following table.

Table 6

Description of conditions

Condition	Name	Description	Synchronic condition
(1)	Synchrony-live	Participants were recorded reading aloud and in synchrony with a female native speaker of Spanish (henceforth model speaker)	Yes
(2)	Synchrony with a recording from live condition	Participants were recorded reading aloud and in synchrony with the recording of the model speaker obtained from the Synchrony-live condition (1)	Yes
(3)	Synchrony with a recording from non-live condition	Participants were recorded reading aloud and in synchrony with a recording of the model speaker obtained from a non-synchronous condition	Yes
(4)	Solo recording	Participants were individually recorded reading aloud	No

As it can be noted in Table 6, in the first condition, participants read aloud and in synchrony with a native speaker of Spanish, the model speaker, who was a female monolingual speaker of Spanish. The model speaker was selected because she had previous experience in acting. In the second condition, participants listened to the recording from the model speaker reading with them in the first condition, and read in synchrony with that recording. In the third condition, all participants listened to a non-synchronic recording from the model speaker, which was recorded in a previous individual session, and read in synchrony to that recording. The recording for the third condition was the same for all 63 participants. Finally, in the fourth condition, participants read aloud individually. Therefore, three out of the four conditions were synchronic reading conditions.

3.8.2 Materials

The materials read by the participants in the four conditions were three different texts. A description of these texts is found in Table 7 below.

Table 7

Experimental materials

Materials	Description	Objective
Text 0	16 sentences	Warm-up: 16 sentences were created to habituate participants to the synchrony-reading task, as well as to introduce them to some specific vocabulary of texts 1 and 2, in order to prevent any semantic or phonological interferences.
Text 1	A Spanish version of *The North Wind and the Sun* (Coloma, 2016)	Experimental: A phonetically balanced text, including every segmental sound in Spanish, was selected.
Text 2	A poem written in octosyllabic verse, consisting of two stanzas (Parra, 1988).	Experimental: A text with meter was selected.

In respect to the materials, it is essential to mention that in the case of text 0, the use of this instrument had two purposes. First, this text served as a warm-up phase for participants to get used to the paradigm of synchronic reading. Secondly, the 16 sentences of text 0 were created thinking of potential difficulties in terms of phonological and semantic interference in texts 1 and 2, in order to prevent an effect of novelty, which could cause fluency problems or semantic interferences in participants' oral production.

3.9 Procedures

Each participant was entirely recorded in one session, which lasted from 40 to 60 minutes, depending on the participant. Both groups of participants were asked to read the three texts in all four conditions. Before starting any recordings, the model speaker would read at the same time with the specific participant each one of the three materials one time, so that the participant could become familiarized with the texts and the task. In addition to this, non-native participants were asked to review the vocabulary from each text before reading with the model speaker, to prevent any semantic interference before the experimental task. At all times, the only instruction given to participants during the task was to try to "read in synchrony with the native participant (model speaker), and to avoid repeating after the other participant" in conditions (1), (2), and (3). No mention was made to correct pronunciation, timing, or any other aspect related to rhythm, beat, or periodicity.

For the Synchrony-live condition (1), the model speaker sat next to the participants and read in synchrony with all participants. For the Synchrony condition with the recording from live condition (2), and the Synchrony with the recording from non-live condition (3), the participants wore headphones to listen to the recording from the model speaker. The volume of the recording was adjusted to a comfortable threshold defined by each participant before starting the experimental task. Finally, during the Solo-recording condition (4), participants read aloud individually.

All recordings took place in a quiet room at PUC. Two head-mounted microphones (WH20XLR Shure) were used to record the speech of both the model speaker and the participant at the same time. Headphones (Sony MDR-NCS) were used to play the recordings during the Synchrony condition with the recording from the live condition (2) and the Synchrony condition with the recording from the non-live condition (3). A TASCAM DR-40 recorder was used to record the participants and the model speaker throughout all conditions (sampling rate =44.1 KHz, 16 bit).

3.10 Data analysis

The assessment of rhythmic duration took into consideration consonantal and vocalic segments. The speech data was labeled using as reference the orthographic transcription of the reading materials (Texts 1 and 2). For this, the acoustic software analysis *Praat* (Version 6.0.19; Boersma & Weenink, 2016) and *EasyAlign,* a Praat plugin for forced text-to-speech alignment (Goldman, 2011), were used. The *EasyAlign* plugin was employed to segment and label the recordings into phonemic units that were based on the orthographic transcription of the texts the participants read during the tasks.

Respecting the analysis, for each recording, either from the model speaker or the participant, *EasyAlign* (Goldman, 2011) would be run, using the corresponding orthographic text to obtain a macro segmentation of the speech signal according to the phrases of the orthographic text. Secondly, the plugin would be run to obtain a phonetic transcription of the macrosegments that were previously identified and labeled. Finally, *EasyAlign* would be run a third time to segment the phonetized macrosegments into phonetic units or segments.

The labeled data for each participant, condition, and text were saved into a single TextGrid file, which contained different tiers for each transcription. The transcriptions were all in SAMPA, a machine-readable phonetic alphabet. Subsequently, and since forced alignment is not a 100% accurate, the annotations were manually checked. Once the tiers from each TextGrid file were thoroughly checked, the TextGrids from each recording were saved as the data for each speaker, condition, and text. After this was completed, the TextGrids from all four conditions were analyzed using different methods to assess temporal patterns and onset synchronization.

3.10.1 Assessment of temporal patterns

The following metrics were used to assess rhythm and speech temporal patterns: %V; VarcoV; VarcoC; VnPVI; and, CnPVI. These metrics were computed using the software for rhythm computation *Correlatore* (Mairano & Romano, 2010). A summary of these metrics can be found in the table below.

Table 8

Rhythm metrics

Measurement	Unit of analysis	Operationalization	Reference
V%	Vowel	The percentage of the total duration of the vocalic intervals in every single interpausal stretch of speech [1]	Ramus et al.,1999
VarcoV **VarcoC**	Vowel Consonant	The standard deviation of the duration of all intervals either vocalic, consonantal or syllabic, in every single interpausal stretch of speech, normalized for speech rate[1]	White & Mattys, 2007; Dellwo, 2006
VnPVI **CnPVI**	Vowel Consonant	Pairwise comparison of two subsequent intervals, either vocalic or consonantal interpausal stretch of speech, normalized for speech rate[1]	Low et al., 2000; Grabe & Low, 2002

Note: [1]Precise formulas can be found in the original research.

As it can be observed in Table 8, these speech rhythm metrics capture the variation between vocalic and consonantal intervals in the speech of participants. Namely, to assess the duration of vocalic and consonantal intervals, both the VARCOs and the PVIs were selected because the VARCOs only provide the normalized standard deviation of vowel and consonant intervals, while the PVIs also compare subsequent vowel and consonant intervals in interpausal stretches. Also, V%, VarcoV, VarcoC, VnPVI, and CnPVI are widely used in different studies about speech rhythm; the use of these metrics make it possible to compare and discuss the results of this research in light of other studies about L2 speech rhythm.

3.10.2 Assessment of speaker synchronization

Synchronization metrics for segment onsets were computed using an in-house 3.6 *python* script (see Chapter 8) to compare and calculate vocalic and consonantal onset time differences between the transcription of the recordings of the model speaker and the experimental participant.

Notably, the TextGrids from the model speaker and experimental participants were compared as two columns. The script compared each row of the experimental participant column with the native participant column, in order to find a vocalic or consonantal match and compare the starting-point differences for the specific phone. For this comparison, row breaks in the analyzed TextGrids after specific phones were inserted before running the script so the timing differences between the model speaker and the experimental participant would not cause a problem when comparing segments on both lists; also, rows were inserted to prevent incorrect comparisons for repeated segments. For this procedure, only the comparisons that achieved 85% of matched and compared segments were used as data. A summary of the onset metrics is presented in Table 9 below.

Table 9

Measurement for speaker synchronization

Measurement	Unit of analysis	Operationalization
Onset starting point	Vowels and consonant	Comparison of starting time point of onset of vocalic or consonantal intervals[1]

Note.[1]The script can be found in Chapter 8.

4. RESULTS

Once the previous metrics were obtained, repeated measures tests were run on SPSS (version 25; IBM, 2017) to compare the two factors for all the measurements previously described.

4.1. Vowel measurements

4.1.1. Vowel percentage in non-native participants

Intra-subject effect tests with Greenhouse-Geisser correction showed a significant effect for Condition (F (2.357, 66.007) =11.375; $p<0.0005$) and Text (F (1, 28) = 156.893; $p<0.0005$). The Pairwise Contrasts with Bonferroni correction indicated that the Synchrony-live (1) & the Synchrony with recording from non-live conditions (3) ($p<0.0005$); the Synchrony with recording from live (2) & the Synchrony with recording from non-live conditions (3) ($p<0.0005$); and, the Solo-recording (4) & the Synchrony with recording from non-live conditions (3) ($p<0.0005$) were significantly different. For the factor Text, Pairwise Contrasts with Bonferroni correction confirmed significant differences between the narrative text (1) and the text with meter (2) ($p<0.0005$).

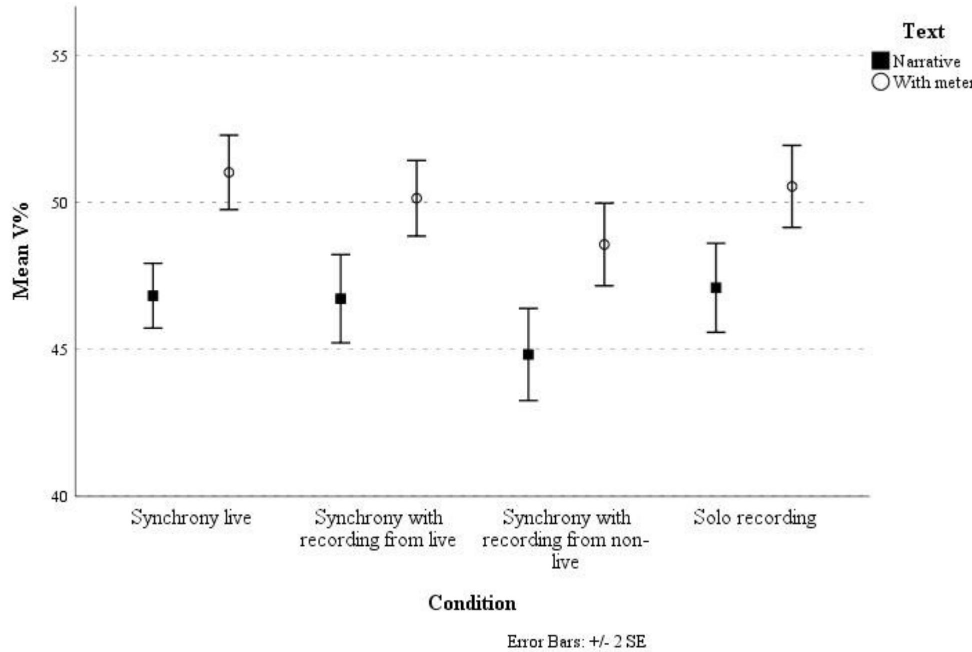

Figure 6. Results for V% for non-native participants

Figure 6 displays the significant differences found between conditions and texts for the percentage of vocalic intervals. Also, it exhibits the significant differences between Synchrony with recording from non-live condition (3) relative to the Synchrony-live (1), the Synchrony with recording from live (2), and the Solo-recording conditions (4). Furthermore, the effect of Text in the production of V% is shown.

These results indicate that there were significant differences in the production of vocalic intervals in the synchronic condition with the lowest degree of synchrony, the Synchrony with recording from non-live condition (3). In other words, participants produced a lower percentage of vocalic intervals in the Synchrony with recording from non-live conditions (3) and higher percentages of vocalic intervals in the conditions with higher degrees of synchrony, namely the conditions Synchrony-live (1) and Synchrony with recording from live conditions (2). Let us note that both these conditions included reading with a person entraining to participants' speech.

Also, in this figure, a higher percentage of vocalic intervals in the Solo-recording condition (4), which was an asynchrony condition, can be observed; this phenomenon will be addressed in the discussion section in Chapter 5. Finally, differences were also found for the factor Text; participants produced a higher percentage of vocalic intervals when reading the text with meter (2), showing that the text with meter (2) increased the percentage of vocalic intervals in the speech of participants, which is a sign of the modulation produced by meter in the production of syllable-timed speech. This finding will also be discussed in Chapter 5.

4.1.2. Vowel percentage in native participants

Intra-subject effect tests with Greenhouse-Geisser correction showed a significant effect for Condition ($F(2.375, 64.116) = 14,556$; $p<0.0005$) and Text ($F(1, 27) = 281.132$; $p<0.0005$). The Pairwise Contrasts with Bonferroni correction indicated that the Synchrony-live (1) & the Synchrony with recording from live conditions (2) ($p = .027$); the Synchrony-live (1) & the Synchrony with recording from non-live conditions (3) ($p<0.0005$); the Synchrony-live (1) & the Solo-recording conditions (4) ($p = 0.001$); and, the Synchrony with recording from live (2) & Synchrony with recording from non-live conditions (3) ($p=.001$) were significantly different. For the Texts, Pairwise Contrasts with Bonferroni correction confirmed significant differences between the narrative text (1) and the text with meter (2) ($p<0.0005$).

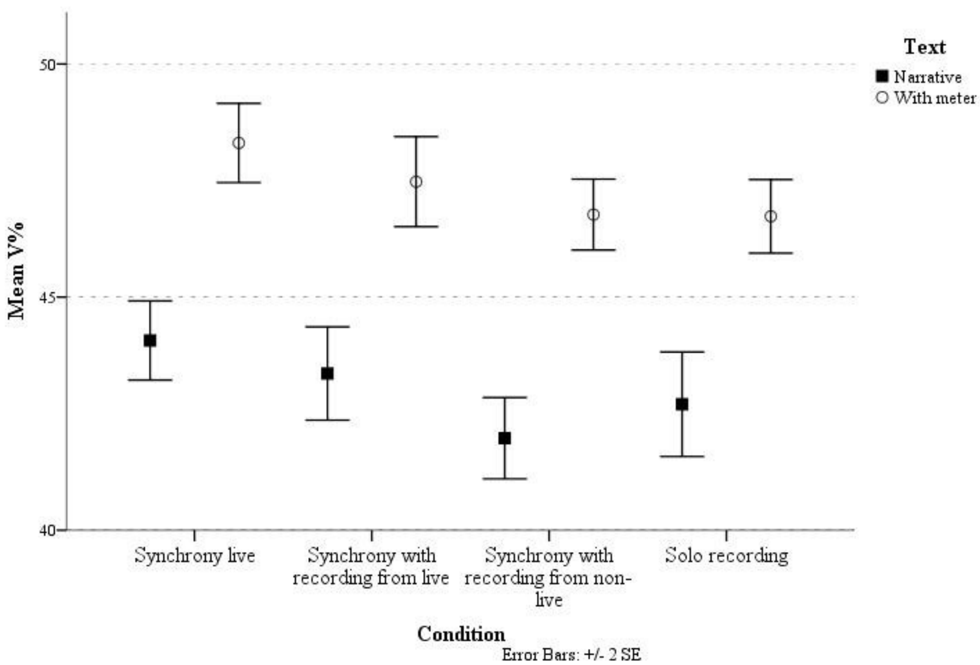

Figure 7. Results for V% for native participants

Figure 7 displays the significant differences found for the factors Condition and Text. The effect of the Synchrony-live condition (1) in the production of V%, together with the significant differences between the Synchrony with a recording from the live condition (2) and Synchrony with the recording from non-live condition (3) can be appreciated. Likewise, the effect of Text in the production of V% can be observed. These results indicate that participants produced the highest percentage of vocalic intervals in the condition with the highest degree of synchrony, the Synchrony-live condition (1). Also, they display that vocalic intervals were more productive when the participants read the text with meter (2), showing that the text 2 increased the percentage of vocalic intervals in the speech of participants, which is an indication of the modulation produced by meter in the production of syllable-timed speech.

4.1.3. Comparison of the results for V% for non-native and native participants

In the following figure, a comparison of vowel percentage production for non-native and native participants is presented.

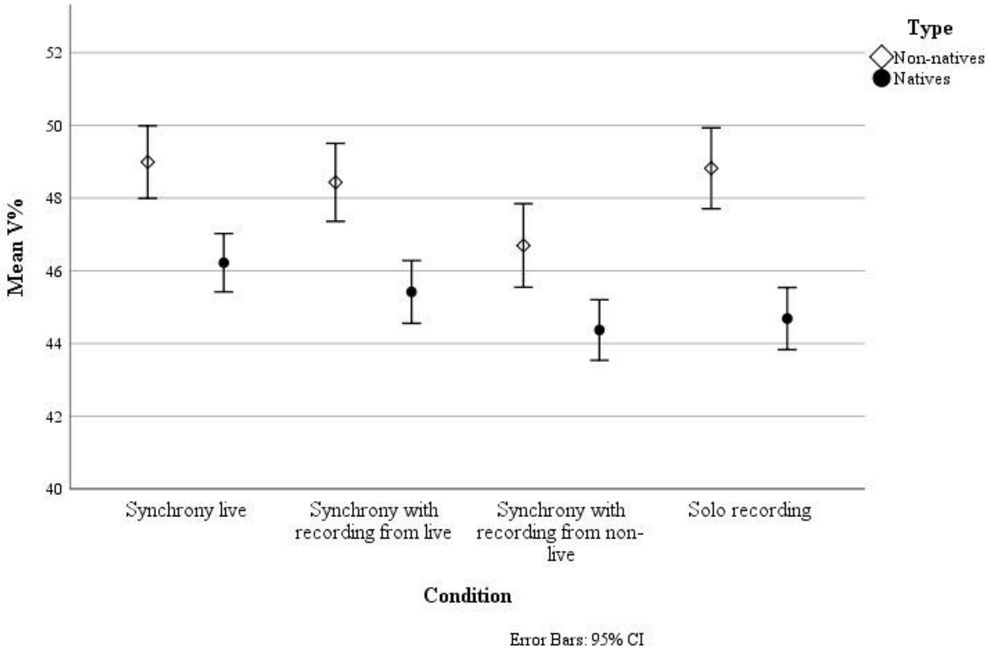

Figure 8. Comparison of the results for V% for non-native and native participants

In Figure 8, it can be noted that vowel percentages were higher for non-natives participants across the three synchrony conditions (1, 2, & 3) and the asynchrony condition (4). When looking at the Between-Subjects effects and Pairwise Comparisons between both groups across conditions, statistically significant differences were found between the two groups across conditions ($F (1, 57) = 36. 577$, $p = p<0.0005$). These results indicate that non-native participants produced a higher percentage of vocalic intervals than native participants across conditions, irrespective of the degree of synchrony of the four conditions.

4.1.4. VarcoV in non-native participants

Intra-subject effect tests showed a significant effect for Condition ($F (3, 81) = 2.959$; $p =0.037$) and Text ($F (1, 27) = 9.693$; $p = 0.004$); also, an interaction was found between the factors Condition and Text ($F (3, 81) = 3.141$; $p = 0.03$). Despite this, the Pairwise Contrasts with Bonferroni correction did not show any significant differences between the four experimental conditions. For the factor Text, Pairwise Contrasts with Bonferroni correction confirmed significant differences between the narrative text (1) and the text with meter (2) (p = 0.004).

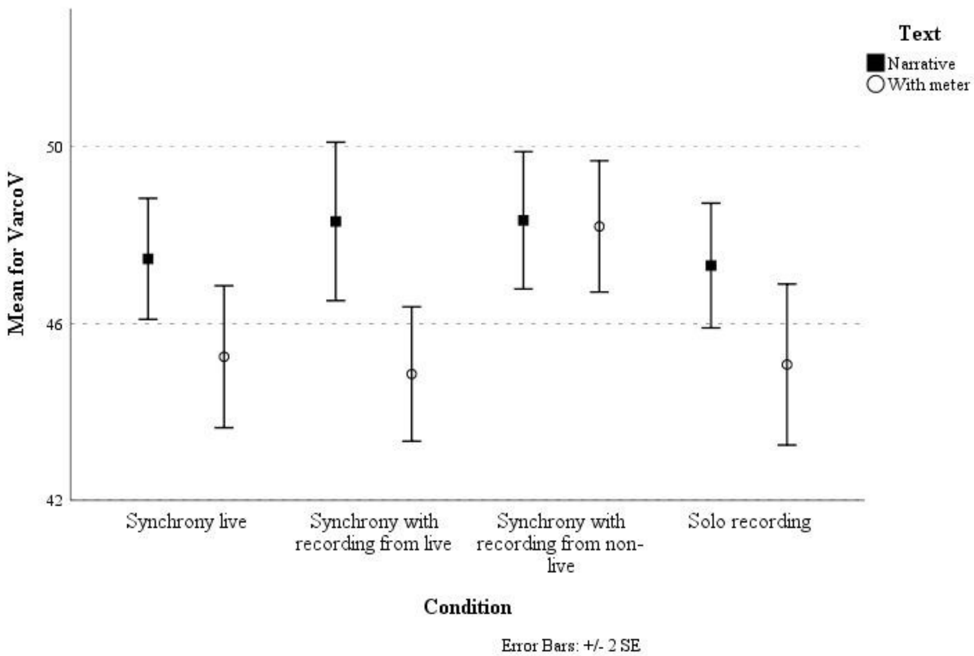

Figure 9. Results for VarcoV for non-native participants

Figure 9 displays the significant differences found for Condition and Text and the interaction between these two factors. In this figure, which exhibits the measure of the normalized standard deviation of the duration of vocalic intervals, the differences between the narrative text (1) and the text with meter (2) can be observed. These results indicate that the non-native participants displayed lower variability in the duration of vocalic intervals in both the Synchrony-live condition (1) and the Solo-recording condition (4). This finding of lower variability for condition (1) was not surprising but was unexpected in the case of condition (4). Initially, it was predicted that non-native participants would show a higher degree of variability in the Solo-recording (4) condition because their native language is English, which is a language that tends to reduce unstressed vowels, which is correlated with higher variability in the duration of vocalic intervals. Also, this figure shows that there was also a lower degree of variability in the normalized standard deviation of vocalic intervals across conditions when reading the text with meter (2), which is an indication of the modulation produced by meter in the duration of vocalic intervals.

4.1.5. VarcoV in native participants

Intra-subject effect tests showed a significant effect for Condition (F (3, 75) = 18.076; p<0.0005) and Text (F (1, 25) = 84.173; p<0.0005). The Pairwise Contrasts with Bonferroni correction showed that the Synchrony-live (1) & the Synchrony with recording from non-live conditions (3)(p<0.0005);

the Synchrony with recording from live (2) & the Synchrony with recording from non-live conditions (3) ($p<0.0005$); and the Synchrony with recording from non-live (3) & the Solo-recording conditions (4) ($p=.002$) were significantly different. For the factor Text, Pairwise Contrasts with Bonferroni correction also confirmed significant differences between the narrative text (1) and the text with meter (2) ($p<0.0005$).

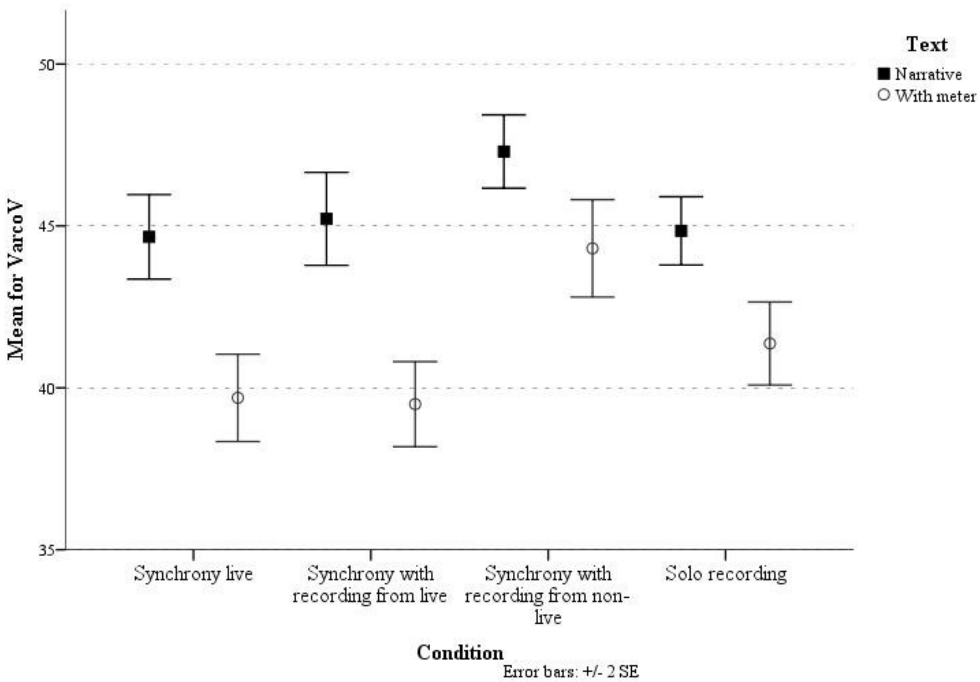

Figure 10. Results for VarcoV for native participants

Figure 10 displays the significant differences found for the factors Condition and Text. This figure displays the effect of the Synchrony-live condition (1) in the normalized standard deviation of mean duration values for vocalic intervals, along with the significant differences between the conditions of Synchrony with a recording from the live condition (2) and Synchrony with the recording from non-live condition (3). Likewise, the differences between the Synchrony with the recording from non-live condition (3) relative to the Solo-recording condition (4) can be observed. Also, it can be noted that no significant differences were found between the Synchrony-live condition (1) and the Synchrony with recording from live condition (2).

Additionally, this figure exhibits the findings of the effect of the narrative text (1) and the text with meter (2) in the normalized standard deviation of mean duration values for vocalic interval. The results indicate that native participants showed the highest levels of variability in the duration of vocalic intervals in the Synchrony with recording from non-live condition (3). Before carrying out this research, it was expected that both groups of participants would show a higher degree of variability in the Synchrony with recording from non-live condition (3) relative to the other two synchrony conditions (1 & 2) because they would be provided with less acoustic cues.

Even so, the initial prediction was that the group of Spanish speakers would show less variation than the group of native speakers of English, because of their linguistic background. Notably, English is a language that tends to reduce unstressed vowels, which is correlated with higher variability in the duration of vocalic intervals. Additionally, Figure 10 shows that there was also a lower degree of variability in the normalized standard deviation of vocalic intervals across conditions when reading the Text with meter (2), which is an indication of the modulation produced by meter in the duration of vocalic intervals.

4.1.6. Comparison of the results for VarcoV for non-native and native participants

In the following figure, a comparison of the measure of the normalized standard deviation of the duration of vocalic intervals for non-native and native participants is introduced.

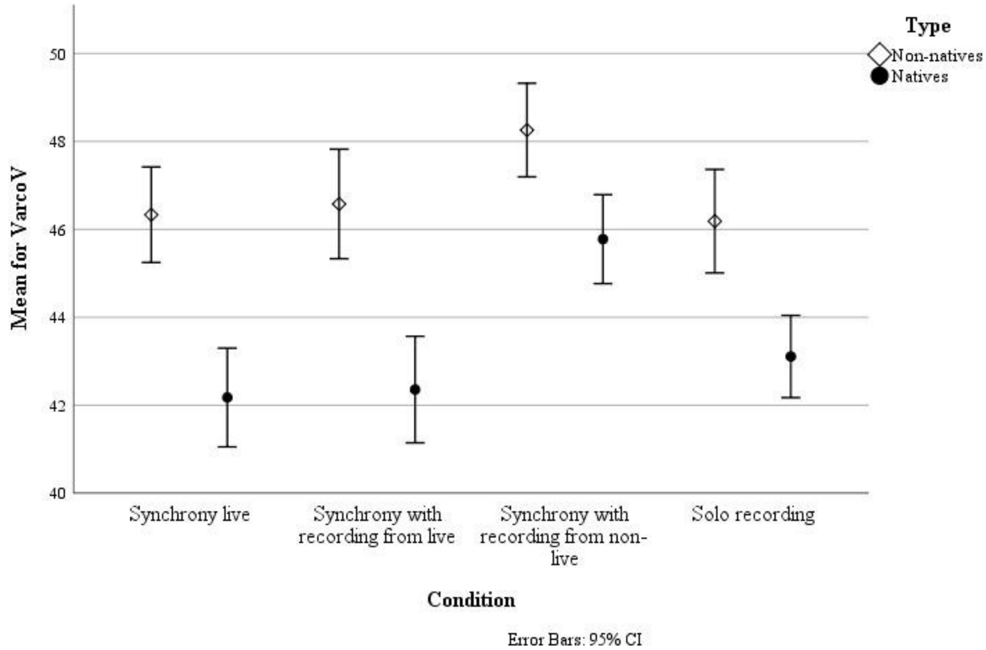

Figure 11. Comparison of the results for VarcoV for non-native and native participants

In Figure 11, it can be noted that for VarcoV, non-native participants showed higher values of standard deviation than native participants. When looking at Between-Subjects effects and Pairwise Comparisons between both groups across conditions, statistically significant differences were found across conditions between the two groups ($F (1, 55) = 54.859$, $p = p<0.0005$). These results show an effect that was expected from the beginning of the design of this experimental paradigm, which was that non-native participants would produce higher values of normalized standard deviation for vocalic intervals because they are native English speakers.

4.1.7. VnPVI in non- native participants

Intra-subject effect tests showed a significant effect for Text (F (1, 22) = 8.222; p=0.009); the Pairwise Contrasts with Bonferroni correction also corroborated this finding (p = 0.009).

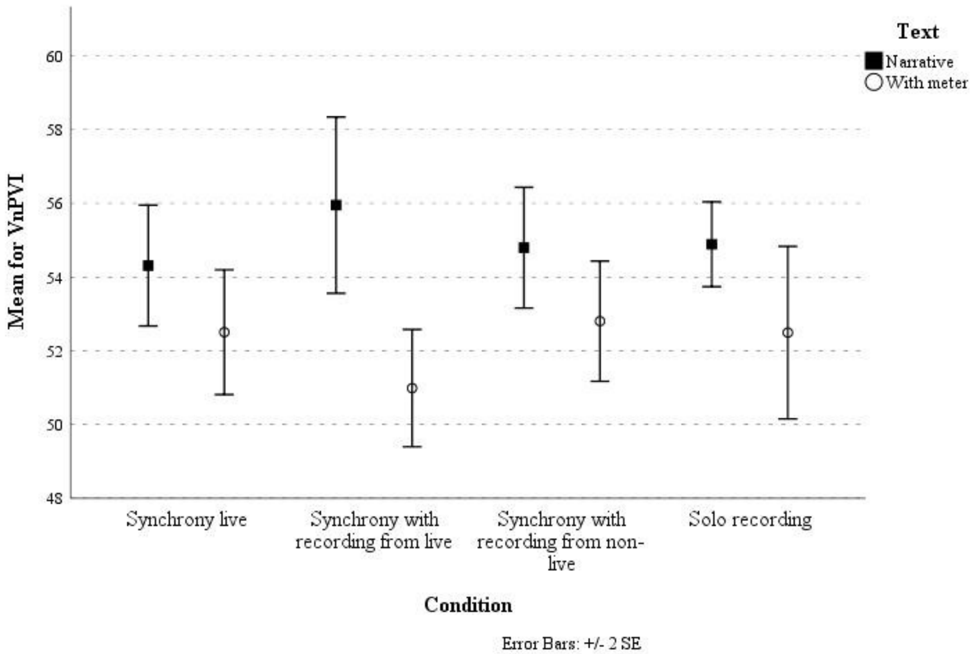

Figure 12. Results for VnPVI for non-native participants

Figure 12 displays the significant differences found for the narrative text (1) and the text with meter (2) in the duration of pairwise vocalic intervals. In Figure 12, the reader can appreciate a lack of significant differences between the four conditions, although there is some variability in the results for the Synchrony-live (1), the Synchrony with recording from live (2), and the Solo-recording (4) conditions. It is believed that the absence of significant differences indicates that participants did not drastically modify the duration of their vocalic intervals in terms of subsequent vocalic intervals, but instead, they did it at a higher-order level. Also, it is hypothesized that this finding is related to the overall effect of the task. Let us note that VnPVI measures the duration of two subsequent intervals normalized by speech rate in an interpausal stretch of speech.

Concerning the differences found for the duration of subsequent vocalic intervals for the narrative text (1) and the text with meter (2), it also can be observed that the text with meter produced a decrease in the duration of vocalic intervals, with values more similar to the durational values of the native participants in Figure 13.

4.1.8. VnPVI in native participants

Intra-subject effect tests showed a significant effect for Condition (F (3, 66) =4.355; p = 0.007) and Text (F (1, 22) = 176.295; p<0.0005). The Pairwise Contrasts with Bonferroni correction showed that the Synchrony with the recording from non-live (3) & the Solo-recording conditions (4) (p =0.004) were significantly different. For the factor Text, Pairwise Contrasts with Bonferroni correction also confirmed significant differences between the narrative text (1) and the text with meter (2) (p<0.0005).

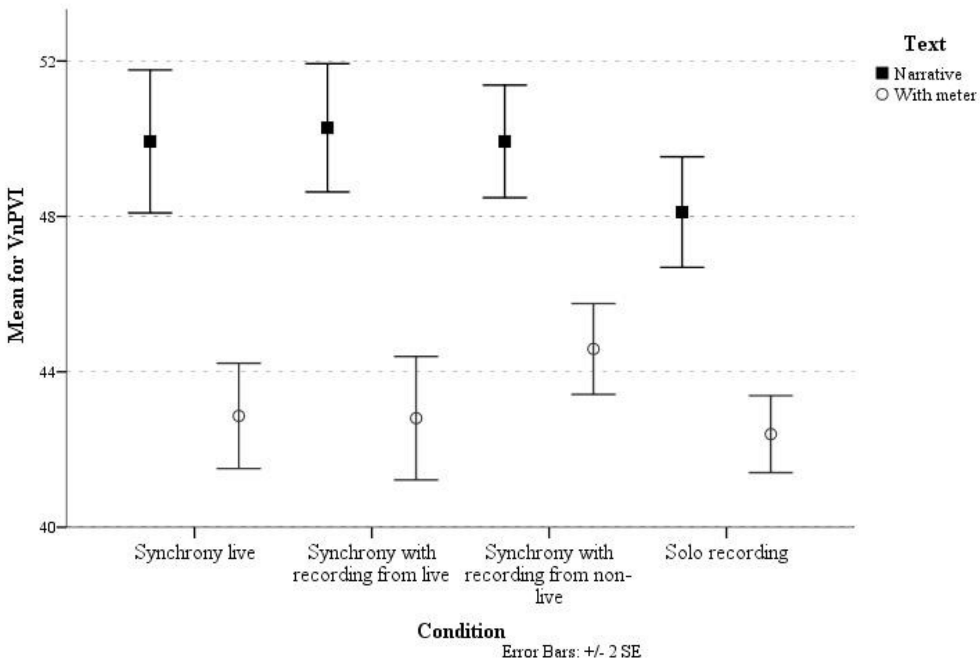

Figure 13. Results for VnPVI for native participants

Figure 13 exhibits the significant differences found for the factor Condition and Text. It shows the differences between the Synchrony with the recording from non-live condition (3) and the Solo-recording condition (4). Also, it depicts that no significant differences were found for the Synchrony-live (1), the Synchrony with recording from live (2), and the Synchrony with the recording from non-live conditions (3).

Additionally, the effect of both texts in mean duration values for vocalic intervals can be seen. This effect points to the modulating effect of the synchronic conditions in the duration of vocalic intervals because it can be noted that during the Solo-recording condition (4), participants decreased the duration of their subsequent vocalic intervals, which made their speech less syllable-timed than in the other three conditions. Concerning the differences found for the duration of subsequent vocalic intervals for the narrative text (1) and the text with meter (2), a metronome effect of the text with meter can be observed. Mainly, it is displayed that meter guided native participants to procure the maintenance of the metric structure of the text at the level of adjacent pairs.

4.1.9. Comparison of the results for VnPVI for non-native and native participants

In the following figure, a comparison of the normalized pairwise duration of vocalic intervals for non-native and native participants is presented.

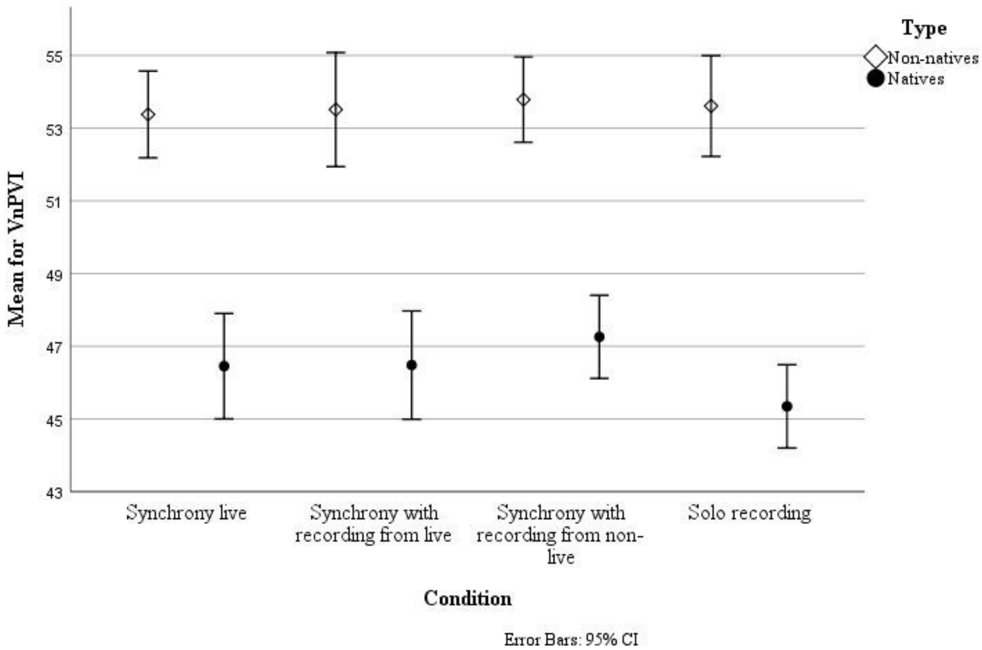

Figure 14. Comparison of the results for VnPVI for non-native and native participants

Figure 14 exhibits that the duration of vocalic intervals was longer in non-native participants across conditions, including the three synchrony conditions and the asynchrony condition. When looking at Between-Subjects effects and Pairwise Comparisons between both groups across conditions, statistically significant differences were found between the two groups across conditions ($F (1, 50) = 96.436$, $p = p<0.0005$). These comparative results indicate a tendency that has already been seen in the previous results vowel related results; notably, non-native participants tended to increase the duration of their vocalic intervals, which seems to indicate that the experimental paradigm had an overall effect in the production of vocalic intervals in this group of participants.

4.1.10. Summary for vocalic intervals for native and non-native participants

The following table introduces a summary of the statistically significant findings for vocalic intervals in both groups of participants.

Table 10

Summary of the statistically significant results for vocalic intervals for native and non-native participants

Group	Metric	Factor	Intra-subject effect test (1)	Pairwise Contrasts (2)
Non-native speakers	V%	Conditions (4)	F (2.357, 66.007) =11.375; p<0.0005; ηp2 = 0.289	Conditions 1 & 3 (p<0.0005) Conditions 2 & 3 (p<0.0005) Conditions 3 & 4 (p<0.0005)
		Text (2)	F (1, 28) = 156.893; p<0.0005; ηp2 = 0.849	Text 1 & Text 2 (p<0.0005)
Native speakers	V%	Conditions (4)	F (2.375, 64.116) = 14,556; p<0.0005; ηp2 = 0.350	Conditions 1 & 2 (p = 0.027) Conditions 1 & 3 (p<0.0005) Conditions 1 & 4 (p = 0.001) Conditions 2 & 3 (p = 0.001)
		Text (2)	F (1, 27) = 281.132; p<0.0005; ηp2 = 0.912	Text 1 & Text 2 (p<0.0005)
Non-native speakers	VarcoV	Conditions (4)	F (3, 81) = 2.959; p =0.037; ηp2 = 0.099	_
		Text (2)	F (1, 27) = 9.693; p = 0.004; ηp2 = 0.264	Text 1 & Text 2 (p = 0.004)
Native speakers	VarcoV	Conditions (4)	F (3, 75) = 18.076; p<0.0005; ηp2 = 0.420	Conditions 1 & 3 (p<0.0005) Conditions 2 & 3 (p<0.0005) Conditions 3 & 4 (p = 0.002)
		Text (2)	F (1, 25) = 84.173; p<0.0005; ηp2 = 0.771	Text 1 & Text 2 (p<0.0005)
Non-native speakers	VnPVI	Conditions (4)	_	_
		Text (2)	F (1, 22) = 8.222; p=0.009; ηp2 = 0.272	Text 1 & Text 2 (p = 0.009)
Native speakers	VnPVI	Conditions (4)	F (3, 66) =4.355; p = 0.007; ηp2 = 0.165	Conditions 3 & 4 (p = 0.004)
		Text (2)	F (1, 22) = 176.295; p<0.0005; ηp2 = 0.889	Text 1 & Text 2 (p<0.0005)

Notes. (1) A Greenhouse-Geisser correction was applied to all Repeated-measures ANOVAs in this study when the assumption of sphericity was violated; (2) a Bonferroni correction was applied to all pairwise contrasts throughout the study.

4.1.10.1. Summary of vocalic intervals results for non-native participants

For non-native participants, the factor Text had a significant effect on the production of vocalic intervals, while the factor Condition had a significant effect only in two of the three rhythm metrics used (V% and VarcoV). Also, the Pairwise contrasts reported that the Synchrony with the recording from non-live condition (3) was significantly different from the Synchrony-live (1), the Synchrony with recording from live (2), and the Synchrony with the recording from non-live (3) conditions in the case of V%. As we have discussed before, these results display that the conditions did modulate the speech of participants. The specific phenomena relative to this modulation will be discussed in Chapter 5.

4.1.10.2. Summary of vocalic intervals results for native participants

As shown in Table 10, all metrics exhibited significant differences for the factors Condition and Text. Also, Pairwise contrasts reported significant differences in all metrics for the Synchrony-live condition (1), expect for VnPVI, and a significant difference across metrics for both texts. These results exhibit that native participants also modulated their speech according to the different conditions and materials. The specific phenomena concerning this modulation will be explored in Chapter 5.

4.1.10.3. Summary of results of vocalic intervals for non-natives and natives

The following table introduces a summary of the comparison of the findings for vocalic intervals for both groups of participants.

Table 11

Summary of the comparisons of vocalic intervals between native and non-native participants

Metric	**Between-Subjects Effects Test**
V%	F (1, 57) = 36. 577, p = p<0.0005, ηp2 = 0.391
VarcoV	F (1,55) =54.859, p = p<0.0005, ηp2 = 0.499
VnPVI	F (1,50) =96.436, p = p<0.0005, ηp2 = 0.659

When contrasting the results for both groups, it can be noted that vowel percentages were higher for non-natives participants across the three synchrony conditions and the asynchrony condition; these findings proved to be significantly different from the vowel percentages of the native group, indicating a tendency in the non-native group to produce speech that was more syllable-timed in respect to duration and percentage of vocalic intervals than the speech of the native group. This trend was also seen in the metrics of the normalized pairwise duration of vocalic intervals metrics, VnPVI, which showed that the duration of vocalic intervals was significantly longer in the case of non-native participants across conditions. The implications concerning these differences will be discussed in Chapter 5.

4.2. Consonants

4.2.1. Varco C in non-native participants

Intra-subject effect tests showed a significant effect for Text (F (1, 25) = 62.582; p<0.0005). The Pairwise Contrasts with Bonferroni correction confirmed significant differences between the narrative text (1) and the text with meter (2)(p<0.0005).

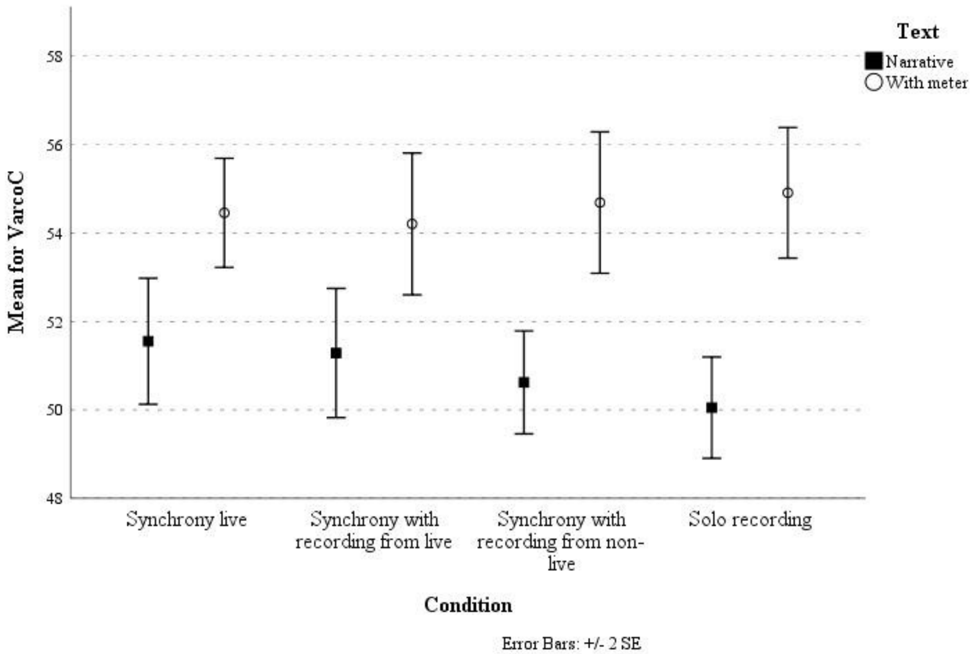

Figure 15. Results for VarcoC for non-native participants

In Figure 15, the effect of both texts, the narrative text (1) and the text with meter (2), can be appreciated in the mean duration values for consonantal intervals. These results exhibit the modulating effect of the text with meter in the production of consonantal intervals; notably, the normalized standard deviation of consonantal intervals increased when reading the materials with meter (2), which is something that we will delve into in Chapter 5.

4.2.2. VarcoC in native participants

Intra-subject effect tests showed a significant effect for Text (F (1, 26) = 23.102; p<0.0005). The Pairwise Contrasts with Bonferroni correction confirmed significant differences between the narrative text (1) and the text with meter (2) (p<0.0005).

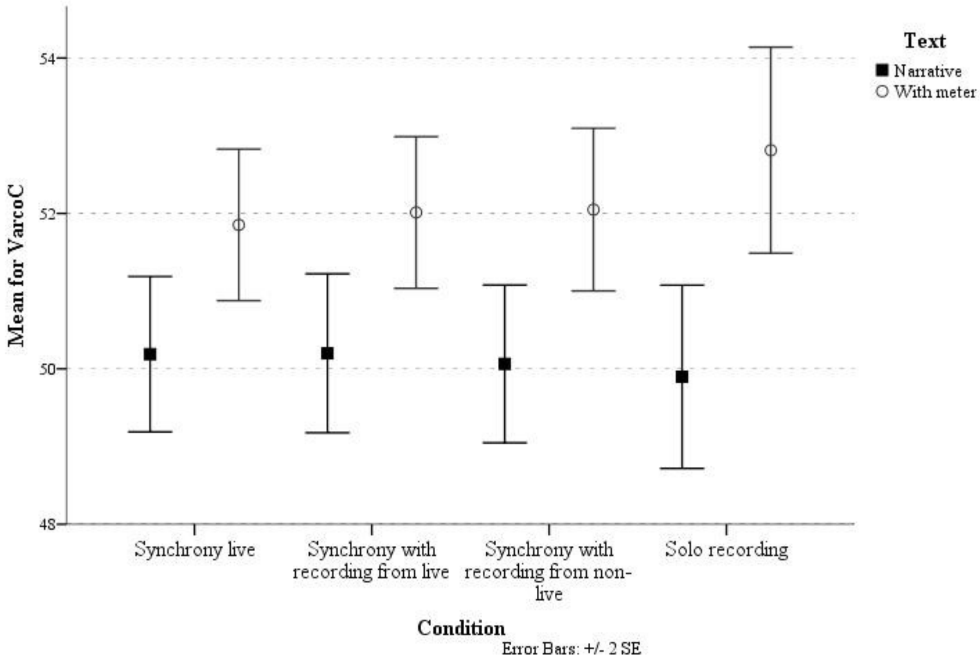

Figure 16. Results for VarcoC for native participants

In Figure 16, the effect of the narrative text (1) and the text with meter (2) in consonantal interval mean duration values can be appreciated. Just like exhibited in the findings for non-native participants, these results exhibit the modulating effect of the text with meter (2) in the production of consonantal intervals; specifically, the normalized standard deviation of consonantal intervals increased when reading the materials with meter.

4.2.3. Comparison of the results for VarcoC for non-native and native participants

In the following figure, a comparison of the normalized standard deviation of the duration of consonantal intervals for non-native and native participants is presented.

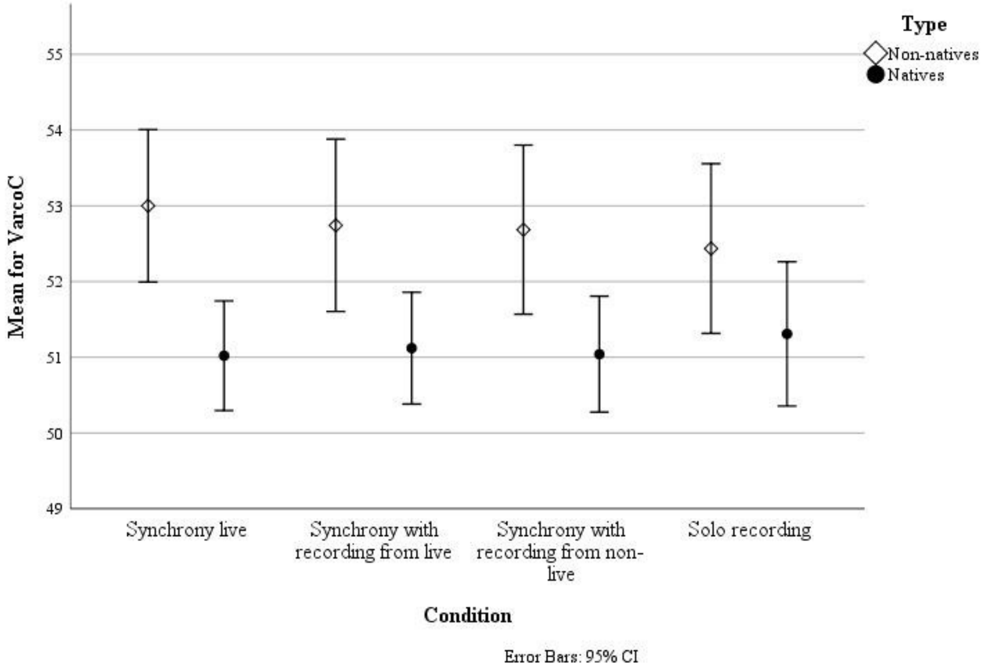

Figure 17. Comparison of the results for VarcoC for non-native and native participants

In Figure 17, it can be noted that for VarcoC, non-native participants showed higher values of normalized standard deviation than native participants. When looking at Between-Subjects effects and Pairwise Comparisons between both groups across conditions, statistically significant differences were found between the two groups across conditions ($F(1, 53) = 33.771$, $p = p < 0.0005$). These results exhibit the greater modulating effect of the text with meter (2) in the production of consonantal intervals for non-native participants; this effect will be discussed in Chapter 5.

4.2.4. CnPVI in non-native participants

Intra-subject effect tests showed a marginal effect for Text ($F(1, 25) = 4.176$; $p = 0.052$), which was corroborated by the Pairwise Contrasts ($p = 0.052$).

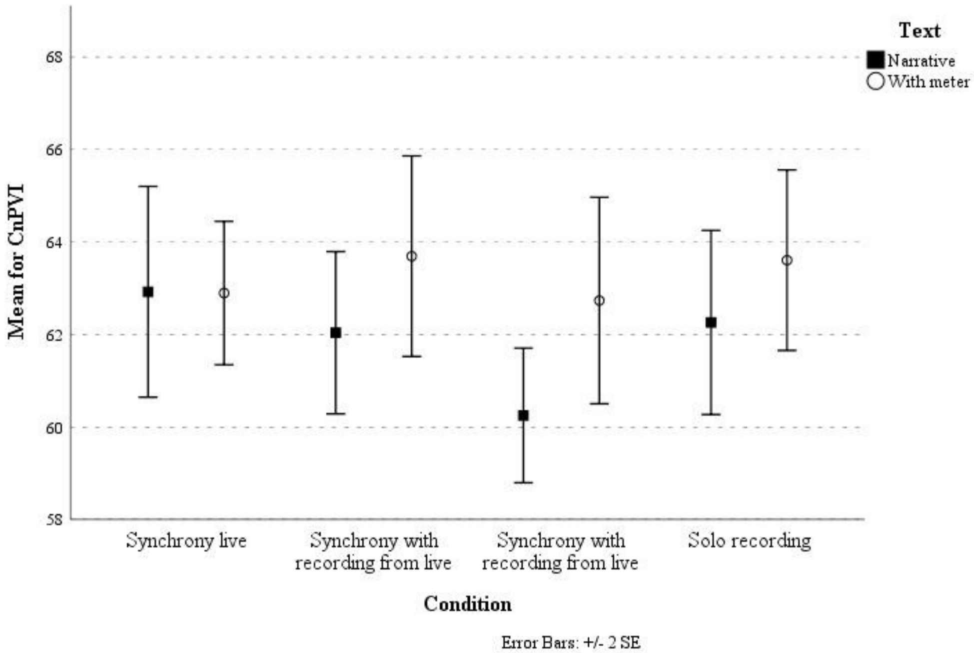

Figure 18. Results for CnPVI for non-native participants

Figure 18 displays the marginal effect for the factor Text in the duration of the consonantal intervals. These results display the marginal effect of the text with meter (2) in the duration of pairwise consonantal intervals for non-native participants, which can be observed for the Synchrony with recording from live (2), and the Synchrony with the recording from non-live (3), and the Solo-recording (4) conditions.

4.2.5. CnPVI in native participants

Intra-subject effect tests showed a significant effect for Text ($F(1, 26) = 0.792$; $p = 0.025$). The Pairwise Contrasts with Bonferroni correction also confirmed significant differences between the narrative text (1) and the text with meter (2) ($p = 0.025$).

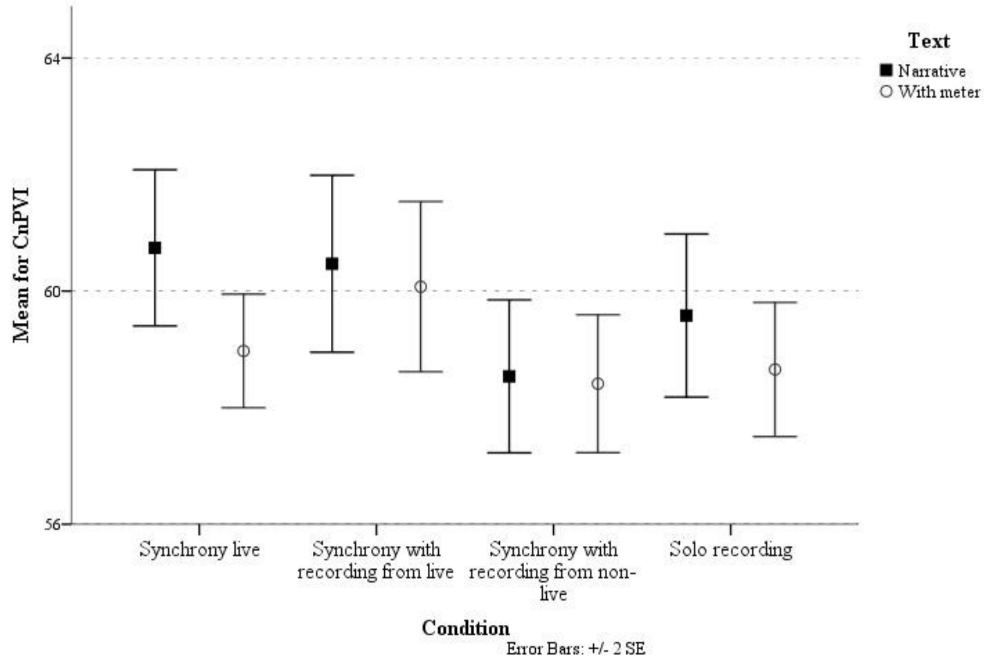

Figure 19. Results for CnPVI for native participants

Figure 19 exhibits the effect of both texts, narrative (1), and with meter (2), in the mean duration of consonantal interval values. These results exhibit the significant effect of the text with meter (2) in the duration of pairwise consonantal intervals for native participants, which unlike for non-native participants, caused a decrease in the duration of pairwise consonantal intervals in the speech of native participants.

4.2.6. Comparison of the results for CnPVI for non-native and native participants

In the following figure, a comparison of the values for the normalized pairwise duration of consonantal intervals for non-native and native participants is introduced.

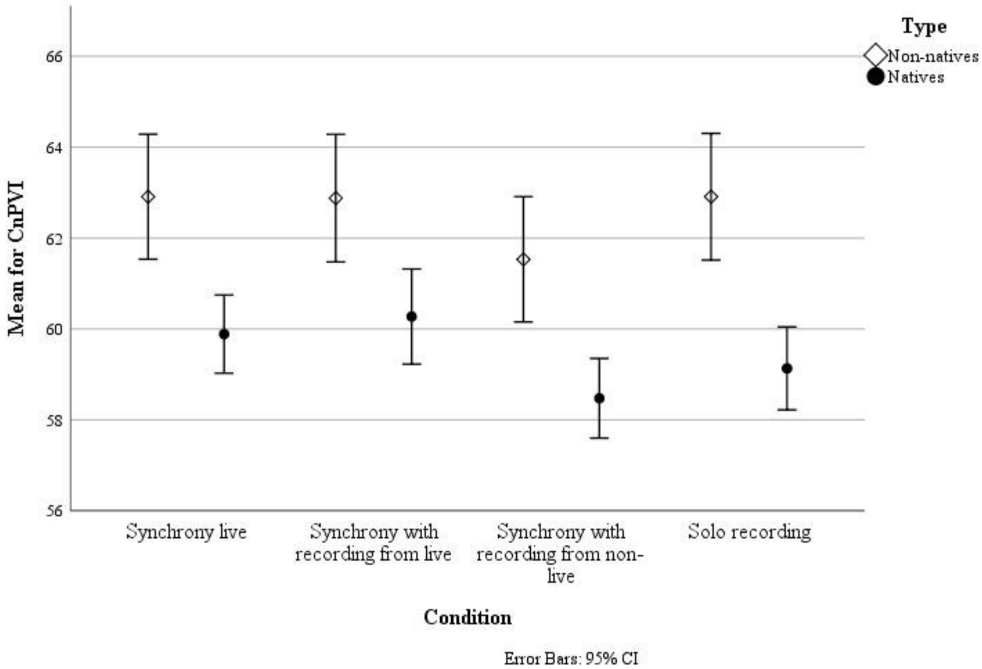

Figure 20. Comparison of the results for CnPVI for non-native and native participants

In Figure 20, it can be seen that the duration of consonantal intervals was longer in non-native participants across conditions, including the three synchrony conditions and the asynchrony condition. When looking at Between-Subjects effects and Pairwise Comparisons between both groups across conditions, statistically significant differences between the two groups were found across conditions (F (1, 53) =36.3, p = p<0.0005). These results exhibit the modulating effect of the four conditions in the group of non-native participants, displaying longer consonantal pairwise durations than the group of native participants. The implications of this effect will be discussed in Chapter 5.

4.2.7. Summary of statistically significant results for consonant measurements

The following table introduces a summary of the significant findings for consonantal intervals in both groups of participants.

Table 12

Summary of the statistically significant results found for consonantal intervals for native and non-native participants

Group	Metric	Factor	Intra-subject effect test (1)	Pairwise Contrasts (2)
Non-native speakers	VarcoC	Conditions (4)	_	_
		Text (2)	F (1, 25) = 62.582; p<0.0005; ηp2= 0.706	Text 1 & Text 2 (p<0.0005)

Native speakers	VarcoC	Conditions (4)	_	_
		Text (2)	F (1, 26) = 23.102; p<0.0005; ηp2= 0.470	Text 1 & Text 2 (p<0.0005)
Non-native speakers	CnPVI	Conditions (4)	_	_
		Text (2)	F (1, 25) = 4.176; p = 0.052; ηp2 = 0.143	Text 1 & Text 2 (p =0.0052)
Native speakers	CnPVI	Conditions (4)	_	_
		Text (2)	F (1, 26) = 0.792; p =0.025; ηp2 =0.030	Text 1 & Text 2 (p =0.025)

Notes. (1) Greenhouse- Geisser correction was applied to all Repeated-measures ANOVAs in this study when the assumption of sphericity was violated; (2) a Bonferroni correction was applied to all pairwise contrasts throughout the study.

4.2.7.1. Summary of the results of consonantal intervals for non-native participants

In Table 12, it can be observed that no significant effects were found for the factor Condition for consonantal intervals. For the factor Text, significant differences were found for VarcoC, which is a measurement that provides the normalized average of the standard deviation of the duration of vocalic intervals. For CnPVI, only a marginal effect was found. These findings indicate that the type of text modulated the production of consonantal intervals in the speech of non-native participants.

4.2.7.2. Summary of the results of consonantal intervals for native participants

In Table 12, it can be noted that no significant effects were found for the factor Condition for consonantal intervals. For the factor Text, the table shows significant differences were found for VarcoC and CnPVI across conditions. These findings display that the type of text modulated the production of consonantal intervals in the speech of native-participants, although, as previously discussed, the effect was different for the groups of non-native and native participants. The implications for this will be discussed in Chapter 5.

4.2.7.3. Summary of the comparisons for non-native and native participants for consonantal intervals

The following table introduces a summary of the comparison of the findings for consonantal intervals for both groups of participants.

Table 13

Summary of the comparisons of consonantal intervals between native and non-native participants

Metric	Between-Subjects Effects Test
VarcoC	$F(1,53) = 33.771$, $p = p<0.0005$, $\eta p2 = 0.389$
CnPVI	$F(1,53) = 36.3$, $p = p<0.0005$, $\eta p2 = 0.406$

When contrasting the results for both groups, it can be observed that for VarcoC, non-native participants showed higher values of standard deviation than native participants; the differences between both groups were statistically significant, as well the differences for CnPVI, which were also found to be significant. Relative to these findings, we can note that the non-native group showed both longer duration in consonantal intervals as well as more variability in the duration of these types of intervals. These findings will be discussed in Chapter 5.

4.3. Synchrony data

4.3.1. Onset synchrony in non-native participants

Intra-subject effect tests with Greenhouse-Geisser correction showed a significant effect only for Condition ($F(2, 20) = 9.258$; $p = 0.001$). The Synchrony-live condition (1) & Synchrony with the recording from non-live conditions (3) were significantly different ($p = 0.001$). A marginal significance effect between the conditions Synchrony-live condition (1) & the Synchrony with the recording from live conditions (2) was also found ($p = 0.063$). No significant differences were found between the narrative text (1) and the text with meter (2).

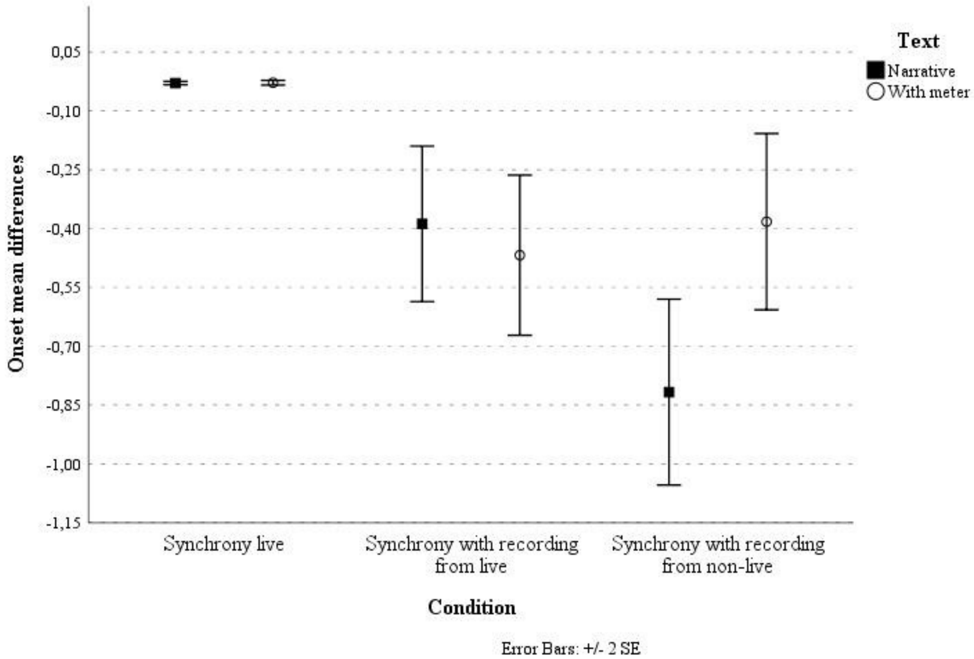

Figure 21. Results for onset synchrony in non-native participants

Figure 21 displays the significant differences found across Conditions; specifically, the significant differences between conditions Synchrony-live condition (1) and Synchrony with the recording from non-live (3) conditions can be observed. Figure 21 exhibits the different modulations produced by the different degrees of synchrony in the task. Notably, the figure displays that the Synchrony-live condition (1) showed the lowest degree of onset differences between the model speaker and the participants, while the Synchrony with the recording from non-live condition (3) showed the highest value of differences for the narrative text (1). We also appreciate the modulating effect of the text with meter (2), which reduced onset differences in the case of the condition with the lowest degree of synchrony, Synchrony with the recording from non-live conditions (3).

4.3.2. Onset synchrony in native participants

Intra-subject effect tests with Greenhouse-Geisser correction showed a significant effect for Condition ($F(1.415, 28.302) = 21.933$; $p<0.0005$). The Pairwise contrasts with Bonferroni correction showed that the Synchrony-live condition (1) & the Synchrony with the recording from live conditions (2) ($p<0.0005$), and the Synchrony-live condition (1) & Synchrony with the recording from non-live conditions (3) were significantly different ($p<0.0005$). No significant differences were found for Text.

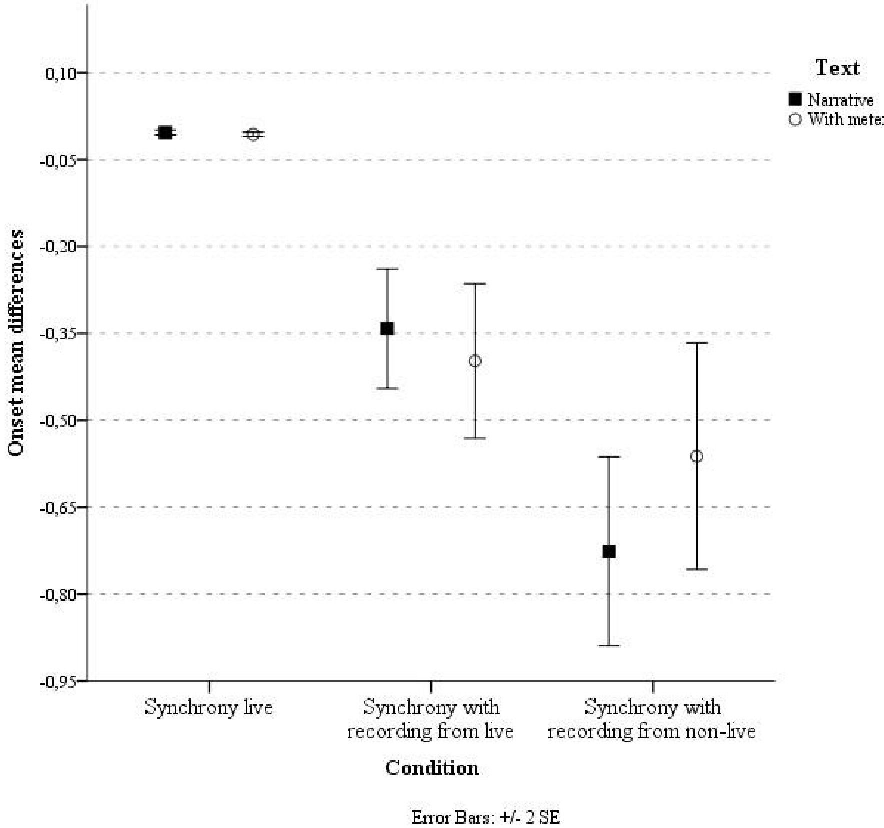

Figure 22. Results for onset synchrony in native participants

Figure 22 displays the significant differences found across Conditions. The differences between the Synchrony-live condition (1) and the Synchrony with the recording from live (3) and Synchrony with the recording from non-live (3) conditions can be distinguished. Also, it can be noted that the effect of text was not significant for synchrony measurements. Notably, Figure 22 exhibits the different modulations produced by the different degrees of synchrony in the task; outstandingly, we observe that the Synchrony-live condition (1) showed the lowest degree of onset differences between the model speaker and the participant, while the Synchrony with the recording from non-live conditions (3) showed the highest value of differences for the narrative text. We also appreciate the modulating effect of the text with meter, which lowered the differences in the case of the condition with the lowest degree of synchrony, Synchrony with the recording from non-live conditions (3).

4.3.3. Comparison of the results for onset synchrony for non-native and native participants

In the following figure, a comparison onset mean differences for the three synchrony conditions (1, 2, and 3) for non-native and native participants is presented.

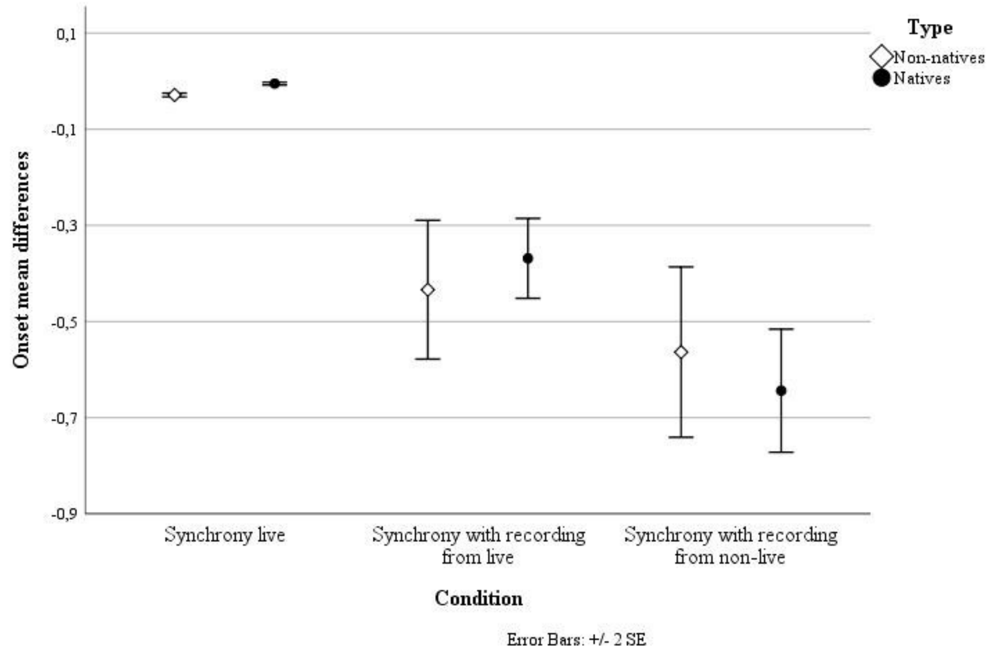

Figure 23. Comparison of the results for onset synchrony for non-native and native participants

In Figure 23, it can be seen the Synchrony live condition (1) had a similar effect in both groups of participants, while the other conditions showed different patterns for each group. Namely, non-native participants reached lower levels of onset synchrony in the Synchrony with recording from live condition (2) and higher levels of onset synchrony in the Synchrony with recording from non-live condition (3) than native participants, indicating a different effect according to the type of condition for both groups.

4.3.4. Summary for onset synchrony measurements

Table 14 below depicts the effect on onset synchrony for speakers of both groups according to the factors Condition and Text. Specifically, a pattern in both groups was found, which was that the Synchrony-live condition (1) showed significant differences in respect to the Synchrony with the recording from live conditions (2) and the Synchrony with the recording from non-live (3) conditions. Also, let us note to the reader that significant differences were found between conditions 2 and 3 for both groups of participants, although the trajectories of these differences were different. Particularly, non-native participants reached lower levels of onset synchrony in the Synchrony with recording from live condition (2) and higher levels of onset synchrony in the Synchrony with recording from non-live condition (3) in comparison to native participants.

Table 14

Summary of the statistically significant results found for onset synchrony for native and non-native participants

Group	Metric	Factor	Intra-subject effect test (1)	Pairwise Contrasts (2)
Non-native speakers	Onset synchrony	Conditions (3)	F (2, 20) = 9.258; p = 0.001; ηp2 = 0.481	Conditions 1 & 2 (p = 0.063) Conditions 1 & 3(p = 0.001)
		Text (2)	_	_
Native speakers	Onset synchrony	Conditions (3)	F (1.415, 28.302) = 21.933; p<0.0005; ηp2 = 0.523	Conditions 1 & 2 (p<0.0005) Conditions 1 & 3(p<0.0005)
		Text (2)	_	_

Notes. (1) A Greenhouse-Geisser correction was applied to all Repeated-measures ANOVAs in this study when the assumption of sphericity was violated; (2) a Bonferroni correction was applied to all pairwise contrasts throughout the study.

4.3.4.1. Summary for non-natives and natives for onset synchrony

The following table introduces a summary of the comparison of the findings for onset synchrony for both groups of participants.

Table 15

Summary of the comparisons of onset synchrony between native and non-native participants

Metric	Between-Subjects Effects Test
Onset synchrony	F (1,31) =0.403, p = 0.53; ηp2 = 0.013

As exhibited in Table 15, in the case of onset synchrony, no significant differences were found between both groups. In other words, the two groups performed similarly across all synchrony conditions. Even so, as we have previously indicated, even when they both performed similarly across conditions, there were still some differences, which will be discussed in Chapter 5.

5. Discussion of the results

5.1. The effect of synchrony and asynchrony conditions in the speech rhythm production of non-native and native participants

5.1.1. Rhythm measurements and synchrony conditions

In the previous section, the effects of the different experimental conditions in the speech rhythm of both groups of participants were revealed. However, the impact of the conditions was different according to the type of condition, the group, and each specific measurement. In respect to conditions, let us note that three out of the four conditions were synchrony conditions, and one of the conditions was an asynchrony condition. Namely, the synchrony conditions were the Synchrony-live condition (1), Synchrony with the recording from live conditions (2), and Synchrony with the recording from non-live condition (3); the asynchrony condition was the Solo-recording condition (4).

For V%, which measures the percentage of vocalic intervals in a segment of speech, no significant differences were found in the non-native group between the Synchrony-live condition (1) and the Synchrony with the recording from live conditions (2), although significant differences between these two conditions were found for the native participants. Relative to this, it is thought that the non-native participants made more use of the acoustic cues provided by the recording in the Synchrony with the recording from live condition (2), which was the recording of the model speaker reading in synchrony with them during the Synchrony-live condition (1); in contrast, the Spanish speaking participants, due to their native competence in Spanish, did not make use of these acoustic cues, and, therefore, they did not adjust their speech rhythm production in the same way that the non-native speakers did.

In the case of the measures concerning the duration of intervals, for VarcoV, it was interesting to see that even when there was a significant effect according to Condition in both groups, no significant differences were found in the Pairwise Contrasts analysis for non-native speakers. Regarding this, it is posited that non-native speakers modified their speech rhythm patterns across conditions due to the experimental nature of the task. These findings are congruent with the fact that the asynchrony condition (4) did not show any significant differences from the other three synchrony conditions (1, 2, and 3).

For VarcoC, no significant differences across Conditions in neither group were found. In the case of the native group, these results are not surprising, because, as far as we have observed, Spanish tends to maintain syllabic structure through the duration of the nucleus, which is always a vocalic interval in Spanish; thus, speech rhythm is mainly reflected in the metrics for vocalic intervals. In the case of the non-native speakers, the fact that the type of condition did not show any effect on the normalized standard deviation of the duration of consonantal intervals seems again to be linked to an overall effect of the experimental conditions in the production of speech rhythm. It is believed that the experimental conditions facilitated the L2 speech rhythm production of participants, making it more similar to the speech rhythm production of native participants, in the sense that both groups showed no durational variability effects according to Condition for consonantal intervals. Even so, let us remind the reader that the non-native group did show overall greater variability in the production of consonantal intervals than the native group, which could be a sign of L1 transference.

Concerning VnPVI, in principle, significant differences were expected for the non-native group between the Synchrony-live condition (1) and the Solo-recording condition (4) due to the native language of participants and its tendency to debilitate vocalic intervals. However, no significant differences were found according to Condition for the group of non-native speakers. For the group of native speakers, the results did yield significant differences. The differences were observed between the Synchrony with the recording from non-live condition (3) and the Solo-recording condition (4). Again, it is thought that these differences were due to the fact that the experimental task had a pervasive effect in the production of speech rhythm of the non-native speakers, which was not the case for the native speakers, who did vary their speech rhythm production in the Synchrony with the recording from non-live (3) and the Solo-recording conditions (4), which were the two conditions with the lowest degree of synchrony.

In respect to CnPVI, no significant differences were observed across conditions in neither group of participants. Again, this is not remarkable, since this pattern was also found for the VarcoC metrics. Both the results for VarcoC and CnPVI seem to indicate that what is crucial to the production of speech rhythm in Spanish, whether participants are native or non-native, is the production of vocalic intervals.

5.1.1. Text type and synchrony conditions

The results indicate that the metric structure of the text with meter (2) made a significant contribution to the regularity of beat distribution in the speech signal, as reflected by higher values of %V and lower durational variability of vowels, both pairwise (VnPVI) and as measured across the whole utterances (VarcoV) in both groups. In the case of consonantal intervals, all metrics, VarcoC and CnPVI, showed that the type of text had a significant effect on the speech rhythm production of speakers of both groups. In this sense, it is believed that the internal meter of Text 2 acted as a metronome, which helped participants achieve lower durational variability in the production of vocalic and consonantal intervals.

5.2. The effect of live human interaction

The results displayed that vowel and consonant onset time differences were modulated by Condition. Inter-speaker alignment of vowel and consonant onsets was the highest in the Synchrony-live condition (1) for both groups. Importantly, in the Synchrony-live condition (1), the deviation of values for onset timing differences was minimal for both groups (Figure 23). This finding proves the boosting effect of live human interaction on rhythmic synchronization with the speech signal.

The boosting effect of live interaction on the degree of speech synchronization can be explained by mutual efforts of both interactants, who dynamically modify their rhythmic patterns online and adjust their speech onsets. It is posited that during live face-to-face interaction, participants modify their prosodic timing patterns online and that this mutual effort yields a beneficial effect on the performance of the task.

Importantly, it has been shown that inter-speaker synchrony is achieved in live synchronous reading and reading with the recording obtained from live reading conditions with no difference between narrative and poetic texts. In the Synchrony with recording from the non-live condition (3), better synchronization with the recording for the poetic text, which exhibits a stronger meter, was observed (Figure 23). This result is congruent with the hypothesis that meter acts as a text-internal metronome and provides additional expectancy cues that people recourse to in a more challenging condition when the timing regularity at the level of the beat is not sufficient to enable synchronization.

An alternative hypothesis would be that people were able to synchronize better to the text with meter (2) in this experiment because it exhibits higher regularity in prosodic timing patterns, e.g., lower durational variability of vowels, more isochronous distribution of vowel onsets. Should that be the case, however, the higher degree of regularity at the level of the beat in a poetic text should lead to a better inter-speaker or speaker-to-recording synchronization, and the effect of the Text would have been found across all conditions. However, the improvement in task performance was only found in the most challenging condition, in which the speaker had to synchronize with the recording obtained from a non-live condition. The model speaker, who was recorded in solo reading, did not have to regularize his prosodic timing to facilitate the other speaker's entrainment to her speech signal. Therefore, the more plausible hypothesis is that the meter in Text 2 provided additional expectancy cues, beyond those provided at the beat level, and that these additional cues are more rarely exploited to synchronize inter-speaker verbal behavior.

These results show that both internal and external factors play a role in the achievement of synchrony between two speakers during a dyadic reading task, irrespective of their native or non-native competence in the language. Text 2, a poetic text, has a strong inherent meter, which provides strong metrical expectancy cues at a hierarchical level higher than the beat and thus facilitates achieving synchrony. As for external factors, it can be noted that speakers, when reading together with a different speaker or with a recording, regularize durations of vocalic and consonantal intervals, thus making the distribution of the vowel and consonant onsets more isochronous and thus more predictable. Enhanced expectancy cues at the beat level, in turn, allow better inter-speaker synchronization on vowel and consonantal onsets, which is reflected in higher synchrony measures in this study.

5.3. The link between perception and production in L2 speech rhythm

In Table 1 a list of previous studies about the perception and production of L2 speech that explored the production of segmental features in the L2 was introduced, such as the link between perception and production in the acquisition of the /r/ and /l/ contrast in English for Japanese speakers (Aoyama et al., 2004; Bradlow et al., 1999; Kim & Park, 1995; Sheldon & Strange, 1982) as well as the acquisition of other problematic segments for Chinese speakers of English (Chan, 2014; Jia et al., 2006) and Korean speakers of English (Kim & Park, 1995; Tsukada et al., 2005), among others. Many of these studies found that improvement in L2 speech production was correlated to improvement in L2 speech perception.

In the case of this study, even when specific segmental features were not explored like these authors did and perception was not tested either, the production of speech rhythm was tested through a task that involved both the perception and production of L2 speech through synchronic aloud reading. Needless to say, the production of speech rhythm involves segmental production of consonantal and vocalic intervals, which is one of the measurements that was used to assess the production of speech rhythm in learners according to the different conditions from the task.

It was also previously mentioned that English and Spanish differ in terms of vowel reduction (Table 2), which is also linked to segmental and suprasegmental production. When looking at the results, it was observed that English speakers produced a higher percentage of vocalic intervals (V %) and longer durations of vocalic intervals than the group of native speakers of Spanish across all conditions (VnPVI). In other words, an overall effect in the variation of vocalic intervals production took place when learners participated in the experimental task, even when reading alone. In respect to this, it is thought that two factors intervened in these results. First, as it has been mentioned before, it is believed that since the experimental task involved both perception and production there was a pervasive effect in the production of vocalic intervals, which led to English speakers producing a higher percentage of vocalic intervals and longer vocalic intervals than Spanish native speakers, which would seem unlikely otherwise since English tends to vowel reduction and lower vowel percentages (White &Mattys, 2007; Galaczi et al., 2016).

Secondly, it is posited that these findings are related to the fact that stress-timed languages are marked in comparison to syllable-timed languages (Ordin & Polyanskaya, 2015). Outstandingly, Ordin & Polyanskaya posited that interlanguages show a tendency to be syllabled-timed and that in the case of speech rhythm, stress-timed speech rhythm would the marked type of speech rhythm. White & Mattys (2007) found that English speakers produce higher vowel percentages (V %) than native Spanish speakers. Likewise, Van Maastricht, Krahmer, Swerts, & Prieto (2018) observed that Dutch speakers of Spanish, a Germanic language that is typically considered to be stress-timed, showed less transfer of their L1 speech rhythm speech patterns than Spanish speakers of Dutch. In this sense, it seems that being a speaker of a stress-timed language, with a marked type of speech rhythm, benefits learners when producing syllable-timed L2 speech because speakers tend to do parameter resetting (Archibald, 1994). These findings are also congruent with the findings of Cummins (2002b), who was not able to induce stress-timed rhythm in native speakers of Spanish and Italian when training them with a metronome.

5.4. Discussion in light of different acquisition models

5.4.1. Major's model (2001)

It was mentioned before that the results of this study would be discussed in light of the OPM model (Major, 2001), because even when this research did not explore time and style, which are some of the variables introduced in Major's model, it did look into the acquisition of different prosodic structures and markedness. Specifically, the non-native participants produced the speech rhythm of Spanish, which is a language with a tendency to be syllable-timed, unlike English.

In this sense, it was found that the conditions in the experimental task did yield an effect on the production of L2 speech rhythm. Firstly, as mentioned before, the duration of vocalic intervals was longer in the group of non-native speakers than in the group of native speakers, and the percentage of vocalic intervals was also higher in the group of non-native speakers in comparison to the group of native speakers of Spanish. It is believed that this occurred because non-native speakers reset their parameters for marked phenomena associated with speech rhythm, namely stress-timed rhythm, which led the group of non-native speakers to produce longer vocalic intervals and higher vowel percentages than the native speakers. In other words, the group of native speakers produced L2 speech rhythm in Spanish that was more syllable-timed than the actual speech of native speakers, which is congruent with the proposal from Ordin & Polyanskaya (2015), who indicate that interlanguages exhibit a syllable-timed speech rhythm.

5.4.2. Archibald's model (1994)

Since the learners of this study were native speakers of American English, a language that tends to be a stress-timed, it was expected that the speech rhythm from their L1 would transfer to the production of speech rhythm in Spanish, which is a language that tends to be syllable-timed. However, although higher values of standard deviation for the normalized duration of vocalic and consonantal intervals were found for the group of non-natives participants, which could be a sign of transference from the stress-timed tendency of English, it was also found that non-native speakers exhibited a tendency to produce longer vocalic and consonantal intervals, along with higher vowel percentages across conditions. In other words, their interlanguage showed a stronger tendency to be syllable-timed than stress-timed.

It is believed that this effect can be linked to the positive evidence provided by the experimental task. Principally, it is thought that the experimental task influenced the production of L2 speech because learners used the positive and well-formed cues provided by the different synchronic conditions (1, 2, & 3), which included a model speaker reading aloud and along with them as input. This hypothesis would also explain why the learners reset their parameters of stress-timed speech rhythm even in the case of the solo reading condition, which also exhibited longer durations for vocalic and consonantal intervals in conjunction with higher V% percentages in comparison to native speakers.

5.4.3. MacWhinney's model (2005)

As it has been mentioned before, it is posited that the synchrony conditions of the task could be regarded as high states of resonance for learners, because of their nature involving both perception and production. Likewise, it was initially suggested that the experimental task included both linguistic forms and linguistic functions because it implicated both the perception and the production of speech. In this sense, it was hypothesized that the production of L2 Spanish rhythm should drastically improve in synchronic conditions because participants would perceive speech in addition to producing speech.

Relative to the previous statements, the results show that the conditions, which included linguistic forms and functions, served as a high state of resonance for learners because non-native participants produced longer durations of vocalic and consonantal intervals across conditions. In other words, it seems that the high state of resonance was pervasive during the experimental task and that speakers were benefited from the synchronous conditions even when synchrony was not involved in the task, as in the case of the Solo-reading condition (4).

Concerning synchrony, it was found that native and non-native participants did not show any significant differences in terms of the levels of achieved onset synchrony values across conditions. Both groups significantly benefited from the Synchrony live condition (1), which caused both groups to achieve the highest levels of onset synchrony in this condition. This finding also points out that the high state of resonance is valid for both native and non-native speakers and that L1 transference does not interfere with this effect.

5.5.Pedagogical implications of the findings of this study

One of the objectives of this research was to introduce some pedagogical implications for the findings of this study. As the reader may have already noticed, the results regarding synchrony, L2 acquisition, and perception and production of L2 speech can be of relevance for the creation of methods and materials to teach L2 speech rhythm for adult late learners. First, it has been found that human interaction is, in fact, an excellent resource to improve the production of speech rhythm in learners, because the results display that both groups of speakers highly benefited from the Synchrony live condition (1), irrespective of their native language.

Cummins (2002a, 2003, 2007 & 2009) and Bowling et al. (2013) had previously shown that native speakers could entrain their speech rhythm when reading a text in synchrony. For L2 speakers, Banzina et al. (2014) had also found this effect in the production of English L2 speech rhythm, but so far, no studies had tested the effect of synchrony tasks for L2 Spanish speech rhythm. The positive results from this study for L2 speech rhythm entrainment in terms of vowel percentage and consonantal and vocalic interval duration indicate that this type of paradigm can be used to create pedagogical tasks for the acquisition and teaching of L2 speech rhythm.

Secondly, it seems that this experimental task had a general beneficial effect in the case of the production of the L2 speech rhythm for learners. Namely, it was found that the learners produced longer consonantal and vocalic intervals, with less variation than reported in other speech rhythm studies for English (White & Mattys, 2007). These findings show that participants do benefit from the experimental paradigm of synchronous speech and that this method is indeed a good option for the explicit instruction a of L2 speech rhythm in the foreign language classroom.

Thirdly, and relative to the tendency shown for the duration and percentage of vocalic intervals, the findings show that the use of different materials is especially relevant in the case of consonantal intervals and not necessarily significant in the case of vocalic interval duration. For vocalic intervals, an overall effect irrespective of text materials was observed. However, in the case of consonantal intervals, the findings revealed that while there were no significant differences according to condition in the production of consonantal intervals by the group of non-native speakers, there was an effect on the production of consonantal intervals according to the type of text, which was either a narrative text (1) or a text with meter (2). Notably, non-native produced longer vocalic intervals when reading the text with meter (2).

The findings concerning the type of text materials are highly pertinent for the use of this paradigm as an explicit instruction method for L2 speech rhythm acquisition because they indicate that if this method were applied as an explicit instruction method for the acquisition of L2 speech rhythm, the text materials would need to be chosen with care and with attention to the form or function that is being targeted. Relative to this, the take-home message is that for the practice of consonantal intervals, the method should always include texts with meter.

Finally, concerning the models of prosody acquisition proposed by Archibald (1994), Major (2001), MacWhinney (2005), the results of this study indicate a beneficial effect of synchrony conditions in the sense of a resetting of parameters in the overall production of L2 speech rhythm for English speakers of Spanish. This effect of parameter resetting is essential for the acquisition and teaching of L2 speech rhythm in Spanish, especially when working with native speakers of languages that show stress-timed rhythm features. We posit that the task provided a high state of resonance for learners, offering positive evidence, allowing them to entrain better to the speech rhythm of native speakers, together with allowing them to produce L2 Spanish speech rhythm with a tendency to be syllable-timed, diminishing the effects of L1 transference.

6. CONCLUSIONS

The initial research questions concerned the effect of synchronous speech tasks in the production of an experimental group of non-native speakers of Spanish relative to the speech production of a control group of native speakers of Spanish. First, the findings indicate that the synchronous speech tasks did yield an effect in terms of vocalic and consonantal duration, which made non-native speakers produce longer vocalic and consonantal intervals as well as a higher percentage of vocalic intervals than what is usually found for speakers of languages with a tendency to be stress-timed. It is posited that the synchronous experimental task brought speakers to a high resonance state, involving positive evidence and perceptual cues, which made them reset their stress-timed marked speech rhythm parameters and produce speech rhythm with a tendency to be syllable-timed.

So, the answer to the first research question is yes, the synchronous speech conditions did yield an entrainment effect in the production of the speech rhythm in the group of non-native speakers, which caused their speech rhythm to exhibit longer interval durations and higher vowel percentages than the speech rhythm of the native speakers.

As to the differences of the task in both groups of speakers, an effect in terms of interval duration, vowel percentages, and variability in the non-native group in comparison to the native group was found. For the beneficial effect of synchronous speech, it was found that both groups of speakers, irrespective of their native language, greatly benefited from the condition with the highest level of human interaction, which was the condition of Synchrony-live condition (1). In other words, the high levels of synchronization for condition (1) show that this condition was highly resonant for both groups of speakers.

Concerning the findings about speech synchrony, the data has exhibited that when it comes to interspeaker entrainment native speakers are not the only ones who benefit from synchrony conditions, as it had been previously shown for English native speakers by Cummins (2002a, 2003, 2007, & 2009), and German native speakers by Bowling et al. (2013). The results of this study show that the effect of synchrony conditions is pervasive to speakers regardless of their native or non-native status, which also agrees with the findings of Banzina et al. (2014) for L2 speakers of English. In addition to this, it was established that non-native speakers benefited more from the Synchrony with recording from non-live condition (2) than native speakers, indicating that during entrainment, non-native speakers make larger use of the perceptual cues provided during the task than native speakers.

Furthermore, the data also shows the overall beneficial effect of synchronous speech in the production of L2 speech rhythm for English speakers of Spanish, which is something that had not been shown to this date. Mainly, the group of non-native speakers produced longer vocalic intervals than the group of native speakers of Spanish and higher vowel percentages, making their L2 speech rhythm more syllable-timed in comparison to the speech rhythm of English. In other words, the effect of L1 speech rhythm transference was reduced by the experimental paradigm.

Relative to the methods used for this research project, three things are essential to mention. First, as it was previously explained in this manuscript, the paradigm of synchronic speech has been rarely applied to the study of L2 speech rhythm. The findings of this study, along with the results from Banzina et al. (2014), indicate that exploring the effect of synchronous speech in the speech rhythm of L2 speakers is indeed productive and offers results that are relevant for both the theory about L2 speech rhythm perception and production as well as for pedagogical methods to improve L2 speech rhythm acquisition in late adult learners.

Secondly, it is believed that a practical spin-off for this research project would be to introduce this method into the foreign language classroom as an explicit training method. Let us not note that using this experimental paradigm in the foreign language classroom as training method to improve the production of L2 speech rhythm would not be hard to implement, because the process of reading two short texts in synchrony does last more than three minutes, and any native language tutor could act as a model speaker for the learners in the classroom, if no other resources are available.

Thirdly, as the results have shown, non-native participants also benefit from synchrony conditions entailing a recording from a model speaker reading along with them. These findings imply the possibility of creating software in which the model speaker would only need to be recorded reading along with the non-native speaker once. After that, the language learner would be able to read along with the recording systematically. The software could also include the option of recording each session to assess speech rhythm progress by using rhythm metrics and onset synchrony measurements. Probably, the reader is thinking at this point that the model speaker could simply disappear from such a type of method, but, as stated before, it is believed that a key to the findings of this research is entrainment to live human interaction and that a machine cannot replace the human model speaker in a condition involving a recording from a model speaker reading along with the language participant.

Finally, it is fundamental to note that this research was conducted with several limitations that not only delayed the collection of the speech samples but also produced some changes to the original project. Originally this research project aimed to explore the L2 speech rhythm production of English speakers of Spanish according to their different competence levels, specifically, a group of B1 learners of Spanish and a group of C1 learners of Spanish (Council of Europe, 2011). However, the lack of language standards in most SFL teaching institutions in Chile, the scarce number of C1 learners receiving formal SFL instruction, and the insufficiency of monetary resources to pay participants for their participation soon made clear that it would not be possible to collect a significant amount of samples to be able to compare to statistically compare the differences of the non-native group according to different competence levels.

It is believed that with enough time, resources, and the proper support of a SFL language institution, the original research could be implemented and even expanded. It would be highly beneficial for the study of Spanish L2 speech rhythm production to explore the effect of synchronous speech in the speech rhythm of non-native speakers of Spanish with different competence levels and also with different native languages. Such a study would deliver more details about the different effects of synchrony conditions according to competence levels, along with more data about the tendency to reset speech rhythm parameters and L1 speech rhythm transference. Therefore, it is posited that possible future research could take place if the conditions are favorable and the findings in this piece of research provide enough support to continue this line of research.

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8. APPENDICES

8.1 Instrument 0: List of sentences

Lea por favor las 15 oraciones a continuación en sincronía con la persona que está al frente suyo o que usted está escuchando. Si bien es importante que su compañero/a y usted sincronicen su lectura, trate de leer de manera tranquila, haciendo pausas entre cada oración y tratando de evitar que suene como una lista de oraciones. Si lo prefieren, pueden mencionar el número de la oración con su compañero/a, hacer una pausa y luego leer la oración.

No se preocupe si no pronuncia algo "correctamente", la idea es que lea de la manera más fluida. Tenga en consideración que no es necesario que hable de ninguna manera particular, no se estará midiendo su español ni su dicción. Mientras más natural le salga, tanto mejor.

1. En el norte de Chile el sol brilla muy fuerte.
2. Mi amiga y su esposo nunca discuten.
3. Después de hacer ejercicio siempre me duele el cuerpo.
4. El regalo del viajero estaba envuelto en papel de colores.
5. Las personas que vivían ahí ya no están.
6. La fuerza bruta no sirve para nada.
7. El género de mi vestido se rompió.
8. Los logros son más bonitos cuando son compartidos.
9. Un transeúnte fue atropellado ayer por un bus.
10. El viento en Santiago casi nunca sopla fuerte.
11. La ropa ceñida no permite que la sangre circule bien.
12. Nunca hay que darse por vencido.
13. Durante el invierno alemán hay que andar muy abrigado.
14. Las personas diferentes siempre son vistas como personas extrañas.
15. Los habían despojado de todas sus riquezas materiales.

8.2 Instrument 1: Narrative text

Lea por favor el texto a continuación en sincronía con la persona que está al frente suyo o con la grabación que está escuchando. Si bien es importante que su compañero/a y usted sincronicen su lectura, trate de leerlo de manera tranquila, haciendo pausas entre cada oración o coma y tratando de evitar que el cuento suene como un solo bloque de texto.

No se preocupe si no pronuncia algo "correctamente", la idea es que lea de la manera más fluida. Tenga en consideración que no es necesario que hable de ninguna manera particular, no se estará midiendo su español ni su dicción. Mientras más natural le salga, tanto mejor ☺

El viento norte y el sol discutían sobre cuál de ellos era el más fuerte, cuando pasó un extraño viajero envuelto en unas ropas muy abrigadas. Convinieron en que quien antes lograra obligarlo al transeúnte a quitarse el abrigo sería considerado más poderoso. El viento (...) sopló con gran furia, pero cuanto más soplaba, más se ceñía el hombre su ropa al cuerpo. Entonces se dio por vencido, y el sol empezó a brillar con mucha fuerza. Inmediatamente el viajero se despojó de su abrigo; y así ya quedó claro que el sol tenía superioridad respecto del viento.

8.3 Instrument 2: Text with meter

Lea por favor el poema a continuación en sincronía con la persona que está al frente suyo o con la grabación que está escuchando. Si bien es importante que su compañero/a y usted sincronicen su lectura, trate de leerlo de manera tranquila, haciendo pausas entre cada verso y tratando de evitar que suene como una lista de oraciones.

No se preocupe si no pronuncia algo "correctamente", la idea es que lea de la manera más fluida. Tenga en consideración que no es necesario que hable de ninguna manera particular, no se estará midiendo su español ni su dicción. Mientras más natural le salga, mejor ☺

Ya no me clava la estrella,
ya no me amarga la luna;
la vida es una fortuna
vistosa, próspera y bella;
sus lluvias y sus centellas
nos engalanan los aires
nos brinda como una maire
su aliento renovadero,
yo siento qu'el mundo entero
está de canto y baile.

Nunca he subido al tribuno
jamás hablé con el juez,
solita me confesé
en mis terribles apuros,
miré más allá del muro
que me apartaba de todo,
y veo en su claro modo
que cada ser en su abismo
habita con egoísmo
bebiendo su propio yodo.

8.4 Consent form for non-native participants

INFORMED CONSENT LETTER

Testing the effect of synchronous speech tasks in the production of non-native speech rhythm in learners of Spanish as a Second Language

Karina Cerda Oñate
Doctoral researcher in Linguistics at PUC

You have been invited to participate in the study *"Testing the effect of synchronous speech tasks in the production of non-native speech rhythm in learners of Spanish as a Second Language"*, conducted by the researcher Karina Cerda Oñate, who is currently a Ph.D. researcher at the Ph.D. of Linguistics from Pontificia Universidad Católica de Chile. The purpose of this form is helping you assess if you would like to take part in this particular research.

What is the purpose of this research?
The main purpose of this research is to assess non-native speech skills in learners of Spanish as a Second Language.

What will my participation consist of?

You will participate in two different tasks that involve reading a text aloud. During the first task, your speech will be recorded while you read along a native speaker of Spanish. In addition, in this first task, you will be recorded reading along with two different recordings as well as reading alone. All of the texts you will read during the first task will be the same. The second task will consist of reading two sets of 32 short sentences: the first set will be in English, and the second set will be in Spanish. We estimate that the total experiment will last no longer than 50 minutes. Besides this, you will be requested to provide general information about the development of your skills in Spanish as a Second Language.

How long will my participation last?

Only 1 session, which will last 50 minutes approximately.

What are the risks involved if I participate?

There are no risks involved if you decide to participate in this research.

What benefits may you obtain from your participation?

You will obtain a ticket to the cinema as well as the opportunity to participate in a Spanish phonetics workshop. You will also test you oral skills in Spanish by reading along with native speakers of Spanish. Furthermore, your participation may help future learners of Spanish as a Second Language to develop their second language speech skills.

What will happen to the information and the data that you will provide?

The researcher will handle all the data you provide her with strict confidentiality. Speech samples will be labeled using specific codes and neither your name nor your personal information will be shared.

Am I obligated to participate? Can I withdraw my consent during the study?

Taking part in this study is voluntary. If you decide not to take part or to skip some of the tasks, it will not affect your current or future relationship with Pontificia Universidad Católica de Chile or the researcher.

Whom may I contact to know more about this study or if I have any doubts concerning this study?

If you have any questions regarding this study, you may contact Karina Cerda, PhD researcher at Facultad de Letras at Pontificia Universidad Católica de Chile. Her phone number is +56979574106 and her e-mail is karina.cerda.o@gmail.com. If you have any comments or concerns regarding your rights as a participant in this study, you can contact the Scientific Ethics Committee for Social Sciences, Arts and Humanities at UC. Namely, you can contact the Head of the Ethics Committee, María Elena Gronemeyer, at eticadeinvestigacion@uc.cl

I have read the above information, and I have been able to ask any further questions about the study. I consent to take part in the study.

____

Participants' signature Date

____

Participants' name

____

Researchers' signature Date

(You will be given a copy of this form to keep for your records)

8.5 Consent form for native participants

CARTA DE CONSENTIMIENTO INFORMADO

Evaluando el efecto de tareas de habla sincronizada en la producción del ritmo del español de Chile en aprendientes de Español como Lengua Extranjera

Karina Cerda Oñate

Programa de Doctorado en Lingüística, UC

Usted ha sido invitado a participar en el estudio "Evaluando el efecto de tareas de habla sincronizada en la producción del ritmo del español de Chile en aprendientes de Español como Lengua Extranjera" a cargo de la investigadora Karina Cerda Oñate, tesista del Programa de Doctorado en Lingüística de la Pontificia Universidad Católica de Chile. El objeto de esta carta es ayudarlo a tomar la decisión de participar en la presente investigación.

¿Cuál es el propósito de esta investigación?

Evaluar la producción de habla en aprendientes de español como lengua extranjera.

¿En qué consiste su participación?

Participará en una entrevista, que incluye una tarea de lectura en voz alta de textos breves. Durante esta tarea, usted será grabada/o mientras lee de cuatro formas distintas: a) De manea sincrónica con un hablante nativo de español de Chile, b) De manera individual; c) De manera sincrónica, con una grabación de un hablante nativo, d) De manera sincrónica, con una grabación de un hablante nativo. Además, se le solicitará rellenar un formulario sobre sus conocimientos de español y segundas lenguas.

¿Cuánto durará su participación?
1 sesión, 40 minutos

¿Qué riesgos corre al participar?
No existen riesgos al participar en esta investigación.

¿Qué beneficios puede tener su participación?
Además de obtener una entrada al cine por su participación, usted ayudará de manera indirecta a futuros aprendientes de español como lengua extranjera.

¿Qué pasa con la información y datos que usted entregue?
Los investigadores mantendrán CONFIDENCIALIDAD con respecto a cualquier información obtenida en este estudio. Las muestras de habla se rotularán sólo con códigos y ni su nombre ni su información personal serán divulgados.

¿Es obligación participar? ¿Puede arrepentirse después de participar?
Usted NO está obligado/a de ninguna manera a participar en este estudio. Si accede a participar, puede dejar de hacerlo en cualquier momento sin repercusión alguna.

¿A quién puede contactar para saber más de este estudio o si le surgen dudas?

Si tiene cualquier pregunta acerca de esta investigación, puede contactar a Karina Cerda, tesista doctoral de la Facultad de Letras de la Pontificia Universidad Católica de Chile. Su teléfono es el +56979574106 y su email es Karina.cerda.o@gmail.com. Si usted tiene alguna consulta o preocupación respecto a sus derechos como participante de este estudio, puede contactar al Comité Ético Científico de Ciencias Sociales, Artes y Humanidades. Presidenta: María Elena Gronemeyer. Contacto: eticadeinvestigacion@uc.cl

HE TENIDO LA OPORTUNIDAD DE LEER ESTA DECLARACIÓN DE CONSENTIMIENTO INFORMADO, HACER PREGUNTAS ACERCA DEL PROYECTO DE INVESTIGACIÓN, Y ACEPTO PARTICIPAR EN ESTE PROYECTO.

____

Firma del/la Participante Fecha

____

Nombre del/la Participante

____

Firma del/la Investigador/Investigadora Fecha

(Firmas en duplicado: una copia para el participante y otra para el investigador)

8.6 Questionnaire for non-native participants

Participante n°:_______

Set:

Ficha de información para participantes

Estimado estudiante: Les agradecemos contestar esta ficha con la mayor cantidad de información posible *¡Muchísimas gracias por su tiempo y colaboración!*

Nombre: ____

Sexo:

Femenino

Masculino

Edad: _______________

País de origen: ____

Lengua materna o nativa: ___________________________________

Lenguas que domina y su respectivo nivel:

	Alemán	**Francés**	**Inglés**	**Portugués**	**Otra**
A1 (Principiante)	☐	☐	☐	☐	☐
A2 (Pre-intermedio o elemental)	☐	☐	☐	☐	☐
B1 (Intermedio)	☐	☐	☐	☐	☐
B2 (Intermedio-alto)	☐	☐	☐	☐	☐
C1 (Avanzado)	☐	☐	☐	☐	☐
C2 (Muy avanzado)	☐	☐	☐	☐	☐
Nativo	☐	☐	☐	☐	☐

Por favor, si eligió otra lengua, especifique cuál:

____

¿Cuánto tiempo lleva estudiando español en Chile?

____
____
____

¿Cuánto tiempo lleva estudiando español?
____

¿Qué nivel de conocimientos de español tenía antes de llegar a Chile?

Ninguno

A1 (Principiante)

A2 (Pre-intermedio o elemental)

B1 (Intermedio)

B2 (Intermedio-alto)

C1 (Avanzado)

C2 (Muy avanzado)

¿Cómo aprendía español en su país de origen?

Clases particulares/individuales

Institución o centro de idioma

Curso en la universidad

En línea

Otro: ____

¿Cómo aprende español en Chile?

Clases particulares

Institución o centro de idioma

Curso en la universidad

En línea

Otro: ____

¿Con quién(es) vive en Santiago?

Familia chilena

Familia extranjera

Residencia de estudiantes o departamento compartido (mayoritariamente extranjeros)

Residencia de estudiantes o departamento compartido (mayoritariamente chilenos)

Departamento individual

Hostal, hotel, apart-hotel

Otro: ____

En caso de que no viva solo: ¿Cuál o cuáles son las lenguas maternas de quienes viven con usted?

	1 persona	2 personas	3 personas	4 personas	5 o más personas
Alemán	☐	☐	☐	☐	☐
Chino	☐	☐	☐	☐	☐
Español	☐	☐	☐	☐	☐
Francés	☐	☐	☐	☐	☐
Inglés	☐	☐	☐	☐	☐
Japonés	☐	☐	☐	☐	☐
Portugués	☐	☐	☐	☐	☐
Otra	☐	☐	☐	☐	☐

Por favor, si eligió otra lengua, especifique cuál.

____

¿Trabaja en Chile? (Prácticas, voluntariados, trabajo part-time, etc.)

Sí

No

Si su respuesta fue afirmativa: ¿En qué se desempeña?

____
____
____
____
____

Previamente a su estadía en Chile, ¿había vivido alguna vez en un país hispanohablante?

Sí

No

Si su respuesta fue afirmativa: ¿En qué país y por cuánto tiempo? ¿Cuáles fueron las razones de su estadía? ¿Vivía con una familia, con otros estudiantes o de manera independiente? Por favor, comente acerca de su experiencia.

____
____
____
____
____
____
____

8.7 Questionnaire for native participants

Participante n.:________

Set: _____________

Fichas de información de participantes

Estimado participante: Les agradecemos contestar esta ficha con la mayor cantidad de información posible *¡Muchísimas gracias por su tiempo y colaboración!*

Nombre: ____

Sexo:

Femenino

Masculino

Edad _____________

Ciudad y país de origen: ____

Lengua materna: ____

Lenguas que domina y su respectivo nivel:

	Alemán	**Francés**	**Inglés**	**Portugués**	**Otra**
A1 (Principiante)	☐	☐	☐	☐	☐
A2 (Pre-intermedio o elemental)	☐	☐	☐	☐	☐
B1 (Intermedio)	☐	☐	☐	☐	☐
B2 (Intermedio-alto)	☐	☐	☐	☐	☐
C1 (Avanzado)	☐	☐	☐	☐	☐
C2 (Muy avanzado)	☐	☐	☐	☐	☐
Nativo	☐	☐	☐	☐	☐

Por favor, si eligió otra lengua, especifique cuál:

____

En caso de que no viva solo: ¿Cuál o cuáles son las lenguas maternas de quienes viven con usted?

	1 persona	2 personas	3 personas	4 personas	5 o más personas
Alemán					
Chino					
Español					
Francés					
Inglés					
Japonés					
Portugués					
Otra					

¿Ha vivido alguna vez en otro el extranjero?

Sí

No

Si su respuesta fue afirmativa: ¿En qué país y por cuánto tiempo? ¿Cuáles fueron las razones de su estadía? ¿Vivía con una familia, con otros estudiantes o de manera independiente? Por favor, comente acerca de su experiencia.

8.8 Script to measure onset synchrony data

Inhouse 3.6 python script

```
import pandas as pd

name =" file.csv"
data = pd.read_csv(name)

data1 = data.iloc[:,1:3]
data2 = data.iloc[:,4:6]

data1_d = data1.dropna()
data2_d = data2.dropna()

data1_d = data1_d.astype(str, copy=False)
data2_d =data2_d.astype(str, copy= False)

data1_d_r = data1_d.reset_index(drop=True)
data2_d_r = data2_d.reset_index(drop=True)

#data1_d_r = data1_d_r.astype(str, copy=False)
#data2_d_r = data2_d_r.astype(str, copy=False)

i_lst = []
for i in range(len(data1_d_r.index)):
    if data1_d_r.iloc[i, 0] == "99.0" and data1_d_r.iloc[i,1] != "99.0":
        i_lst.append(i)
data1_d_r = data1_d_r.drop(data1_d_r.index[i_lst])
```

```
i_lst = []
for i in range(len(data2_d_r.index)):
    if data2_d_r.iloc[i, 0] == "99.0" and data2_d_r.iloc[i,1] != "99.0":
        i_lst.append(i)
data2_d_r = data2_d_r.drop(data2_d_r.index[i_lst])

data1_d_r = data1_d_r.reset_index(drop=True)
data2_d_r = data2_d_r.reset_index(drop=True)

data1_segments = []
c=0
for i in range(len(data1_d_r.index)):
    if data1_d_r.iloc[i,0] == "99":
        data1_segments.append(data1_d_r.iloc[c:i,:])
        c=i+1

data2_segments = []
c=0
for i in range(len(data2_d_r.index)):
    if data2_d_r.iloc[i,0] == "99":
        data2_segments.append(data2_d_r.iloc[c:i,:])
        c=i+1

data_full = pd.concat([data1_d_r,data2_d_r], ignore_index=True, axis=1)

diff_series  = []

for elem1, elem2 in zip(data1_segments, data2_segments):
    if(len(elem1.index)==len(elem2.index)):
```

```
        for i in range(len(elem1.index)):
            if elem1.iloc[i]['S'] == elem2.iloc[i]['S.1']:
                diff_series.append(float(elem1.iloc[i]['model_speaker_COND_text_start point']) -
float(elem2.iloc[i]['experimental_speaker_COND_text_start point']))
            else:
                diff_series.append("")
    else:
        for _ in range(len(elem1.index)):
            diff_series.append("")
    diff_series.append("")

#for elem in diff_series:
#    print(elem)

data1_d_r['diff'] = diff_series
data1_d_r.to_csv('{}_processed.csv'.format(name), index=False, sep=',')
print('Done!')
```