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Facultad de Humanidades y Arte  
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**PERCEPTION AND PRODUCTION OF ENGLISH  
NUCLEAR ACCENT PLACEMENT BY L2 LEARNERS:  
THE ROLE OF WORKING MEMORY AND PROFICIENCY.**

POR

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## ABSTRACT

Prosody is widely recognized as one of the most challenging aspects of second language (L2) speech acquisition (del Saz & Grau, 2022). This study seeks to determine the role of proficiency and working memory (WM) in the perception and production of English nuclear accent (NA) by L1 Spanish learners. Specifically, the study examines both the default patterns of NA placement and exceptions to these rules. To this end, participants completed perception and production tests, together with a proficiency test and a reading span test to measure WM. The study employed 24 university participants from the English teacher education programme from a university based in Concepción-Chile, all of whom had previously completed an English intonation course. Results indicated that learners perceived default patterns more accurately, while their production of non-default patterns showed better performance. This suggests an asymmetry between perception and production, as no direct relationship between these two skills was observed. Proficiency showed weak positive correlations with most variables. WM, however, exhibited weak negative correlations across several measures of perception and production of NA. While subtle, these trends suggest that higher working memory capacity may not necessarily facilitate perception and production performance in this context, although further research is required.

**Key words:** prosody, accentuation, nuclear accent, working memory.

## 1. INTRODUCTION

Suprasegmental features, viz. intonation, accentuation, and rhythm, play a significant role in oral communication, often gaining greater importance in comparison with segmental elements (individual sounds) for effective interaction. This is supported by recent research studies that highlight the surge of interest in suprasegmentals in second language (L2) acquisition, emphasizing their contribution to intelligibility and comprehensibility (Gordon, Darcy, & Ewert, 2013; Thomson & Derwing, 2015; Melnik-Leroy et al., 2022). Unlike segments, which involve discrete and isolated sounds, suprasegmental features operate on a broader scale, shaping, for instance, aspects such as prominence in utterances, as well as the melody and rhythm of speech. These features significantly influence how messages are perceived and understood. For example, intonation - the rise and fall of pitch across utterances- guides listeners in interpreting sentence meaning and emotional tone (Wells, 2006). However, L2 learners often struggle with these features, particularly when their first language (L1) intonational patterns greatly differ from those of the target language, leading to subsequent communication breakdowns (Van Maastricht et al., 2016). One other illustrative example corresponds to nuclear accent (NA) placement in English – i.e. where the most important pitch accent is placed in an utterance – is a key suprasegmental aspect, which is closely linked to discourse focus. In Spanish, for instance, NA placement typically adheres to a default pattern, wherein the NA is typically placed at the end of an utterance, very often on the last lexical item (LLI).

Although English conforms to this rule, several exceptional NA patterns deviate from the LLI pattern (or rule). This discrepancy can result in negative transfer, where L1 Spanish learners misapply their native patterns to English (Melnik-Leroy et al., 2022). As research on suprasegmentals advances, their role in enhancing L2 communication and reducing misunderstandings becomes increasingly evident.

Research into the relationship between L2 speech perception and production reveals methodological variability and, at times, conflicting results. While early models, like Flege's Speech Language Model (SLM for short), indicated that accurate perception was a prerequisite for production, recent investigations suggest production may sometimes precede perception, influenced by proficiency or task design (Kim, Han & Chung, 2024). The scant research done into the relationship of between perception and production of suprasegments highlights prosodic training's role in enhancing perception and production, particularly with visual cues (Yenkimaleki & van Heuven, 2023). For nuclear accent (NA), research emphasizes its salience for L2 learners, though further studies are needed, especially with Chilean Spanish L1 learners (Bøhn & Hansen, 2017).

Working memory (WM) appears to play a role in L2 perception and production of both segments and suprasegmentals. Learners with higher WM capacity demonstrate advantages in speech fluency, accuracy, and complexity, as well as reduced L1 interference (Trude & Tokowics, 2011). WM also facilitates real-time auditory processing in L2 listening, such as parsing word sequences and making inferences

(Sakai, 2018). While WM positively correlates with L2 listening in some studies (Brunfaut & Révész, 2015; Masrai, 2020), there is very little research on the relationship between WM and perception and production of NA.

Thus, the aim of this study is to determine L2 learners' ability to perceive and produce default patterns and exceptions of nuclear accent, and whether there is a relationship between WM and the perception and production of default and non-default English nuclear accent placement patterns in Chilean L2 learners of English, considering the potential influence of their L1.

## 2. LITERATURE REVIEW

### 2.1. English intonation and nuclear accent placement

Intonation can be defined as the melody of speech. It is concerned with the rhythm of speech, the pitch of the voice and how the variation of the pitch (i.e., rises and falls) is used to convey different meanings in the areas of linguistics and pragmatics (Allen, 1971; Ladd, 1996; Wells, 2006). Suprasegmental features of stress and the correct production of intonation patterns are important to communicate effectively since they can help draw attention to relevant aspects of the discourse and are essential to convey attitudes, moods, and emotions (Boyle, 1997; Mirzaei et al., 2012). Tonality has to do with the division of the utterance into chunks or intonation phrases. Each intonation phrase has its own intonation pattern. Tonicity is the use of intonation to emphasize the most relevant words. To execute this emphasis the stressed syllable of the word is accented. This translates into adding pitch prominence to the rhythmic prominence a stressed syllable already carries. The most important accent within an intonation phrase is the nucleus. Tone is the type of pitch movement that is associated with the tonicity and the main options available in English are a fall, a rise and a fall-rise. A falling tone points at the information being complete and it is the default tone for statements, commands, wh questions and exclamations. A rising or fall-rise tone indicates more information is about to come. A rising tone is used for yes-no questions (Wells, 2006).

To analyse intonation, a unit bigger than a syllable is required -the tone-unit. The most important and mandatory component of the tone-unit is the tonic syllable or nuclear accent (NA). It is the only part of the utterance that carries both tone and stress, and the place where major pitch movement begins, marking the focal point of a message (Halliday, 1967; Roach, 1983; Bradford, 1988; Wells, 2006). In English, NA placement is one of the principal means of focusing (Cruttenden, 1986). Focus is the concentration of attention on a particular part of the message and can be used to explain the correlation between NA and material of different lengths that has been characterized as the most relevant. In an utterance, either everything can be brought into focus (broad focus), or one part can be selected (narrow focus) (Ladd, 1996; Ortiz-Lira, 1998; Wells, 2006).

The most frequent place for the NA is the last lexical item of unmarked (broad focus) utterances (Wells, 2006). The term lexical item usually includes nouns, verbs, adjectives, and adverbs, and excludes closed system items. These structural items are also referred to as function words, which comprise articles, pronouns, prepositions, and conjunctions. Halliday (1967) proposed the last lexical item rule (LLI) in which “the tonic falls on the (accented syllable of the) final lexical item in the tone group” (p. 207). Marked tonicity (narrow focus), on the other hand, can occur when a non-final component is contrastive and when a final component is present in the context or has already been mentioned (i.e., is a given). Traditionally, placing the nucleus on a non-final lexical item means that narrow focus or some sort of contrast is present.

However, there are exceptions to this rule for broad focus that may pose a challenge for L2 learners. Some researchers have suggested that the LLI rule does not apply to adverbials of time and place, events and Wh-adjectival in final position of an utterance (Cruttenden, 1986). A different group of words not following the LLI rule was also presented by Wells (2006). The author provides a vast number of examples but alongside adverbials of time and place, the categories that tend to be more troublesome for L2 learners with Spanish as L1 are phrasal verbs, prepositional verbs, final verbs and final adjectives, since these groups of words do not place the NA on the last function word of the utterance.

## **2.2. Spanish intonation and L2 learners of English**

Both English and Spanish are intonational languages and tone is used with a discursive and pragmatic purpose. Different intonational patterns allow us to distinguish a declarative sentence from an interrogative one, express politeness, affective states, belief status, and classify information according to its degree of relevance (Prieto & Rosano, 2019). In Spanish, there are two major focal points where tone is executed: the tonic syllable and the end of the utterance. Generally speaking, the last accent in the intonational phrase carries the prominence and it is where the NA is placed. This pattern occurs since native speakers of Spanish rely considerably on duration, thus, the last syllable that carries the NA has a prolonged duration and this contributes to its prominence (Hualde, 2005; Prieto & Rosano, 2019).

One of the main differences between the intonation system of English and Spanish is the degree of flexibility in the placement of NA. In English, in broad focus, a variety of exceptions can be found in the LLI rule, thus NA can be placed on different elements. In Spanish, however, NA placement is virtually fixed, usually falling on the last content word of the intonational phrase. Regarding focus, it has been stated that in English, it is realized prosodically through NA movement. Unlike English, Spanish uses syntactic means to realize it. Provided that there are no syntactic restrictions, native speakers will use word order in a way that favours placing the most informative items in final position and the very last of the items will carry the NA (Ortiz-Lira, 1998; Klassen, 2013). Nevertheless, experimental studies have exhibited that Spanish may be prosodically flexible to an extent. Veliz (2001) compared the post-nuclear patterns of both English and Chilean Spanish to establish similarities and differences. When producing utterances in their L1, Spanish speakers did prefer to place the NA on the last lexical item, but there were situations in which they decided to deaccent the tails of the utterance, fitting with the patterns usually found in English.

Hualde (2005) provided several examples to differentiate the intonational patterns of English and Spanish. One difference is that in English, it is preferred to place the NA on an argument (subject, object) rather than the verb as it occurs in Spanish, especially when the verb is located at the end of the utterance (I have a lot of **work** to do; Tengo mucho trabajo que **hacer**). In the case of indefinite object pronouns, they are deaccented in English and the NA is placed on the verb. In Spanish, the nucleus stays

on the pronoun which happens to be the final content word (I **know** someone; Conozco a **alguien**). As for repeated information at the end of an utterance, the nucleus is placed at the end in Spanish. In English, it is deaccented with the nucleus falling on an earlier word (¿El café lo quieres con **azúcar** o sin **azúcar**?; Do you want your coffee **with** sugar or with**out** sugar?)

Intonation is one of the earliest features a child acquires in their L1 (Berkovits, 1980). From a very early-stage intonation is used to comprehend and learn information and children rely heavily on prosodic prompts until they acquire syntactic, pragmatic and semantic competence in later stages of language development. Once this happens, intonation becomes a more automatic and subconscious process. Unlike, L2 learners, native speakers have the capacity to automatically select the most appropriate prosodic pattern to express what they wish to convey on a given situation (Flege & Liu, 2001).

Younger learners tend to outperform older learners in the acquisition of L2 phoneme contrasts, however, besides age and learning ability, factors like how late learners start using the L2 need to be taken into consideration. Shinohara and Iverson (2021) studied the case of Japanese speakers who were perceptually trained on the English segments /r/ - /l/; results demonstrated that they can improve perception and production of the segments being trained, and age did affect the improvement of their perception after training sessions. Younger learners improved their perception more than older subjects which suggests that L2 phoneme learning could decline as one ages.

Nevertheless, compared to adolescents, children did not obtain good results in their identification, perceptual sensitivity to the acoustic cue (F3) and category discrimination. Immature cognition and phonemic awareness being possible explanations (Shinohara & Iverson, 2021).

An aspect that should be addressed in L2 learning is individual differences and the impact they can have on a learner's process and success when learning a new language (Tan, 2023). Individual differences can be defined as personal traits that discern one learner from another in the process of learning a new skill. In every learning situation these unique characteristics can bring several variables that function as indicators of learners' potential, previous achievements and future performance. These variables can also be quite influential in the L2 classroom and the pace of a lesson (Duff, 2019; Tseng & Gao, 2021).

In recent years, eight individual differences have been identified to contribute to learners' individuality the most: Age, sex, motivation, beliefs, personality, culture, cognitive or learning style and autonomy (Griffiths & Soruç, 2021). Age, sex and cognitive style are hard to change and could show several differences in learning outcomes (Tan, 2023). Motivation could be one of the most important factors in L2 learning since individuals who are highly motivated to learn the target language may be more successful, however, motivational levels could easily fluctuate and be affected by changes in learners' goals, lifestyle or interactions with others. Beliefs and personality could also have an impact on the L2 learning process. Beliefs are thought

to be an assumed personal trait, but they tend to be dynamic. Having a positive belief towards a new language can make the learning experience easier, however, new beliefs may be adopted along the way and results in the target language may be negatively impacted. Personality provides a person's behaviour with both individuality and consistency and learners who are more outgoing may exhibit a stronger will to communicate. Nevertheless, more evidence is needed to account for the relationship between personality and an effective language learning (Valle et al., 2021).

### **2.3. L2 perception and production of NA and training studies**

Most communication issues between native speakers and L2 learners stem from a lack of experience and knowledge in how to use intonation patterns and its functions (Ranalli, 2002). Many L2 learners either fail to segment speech meaningfully or stress most words, which leads to difficulties when placing NA in English (Jenkins, 2000). Hahn (2004) conducted a study that examined the reaction of native speakers of English to non-native learners' NA placement in English discourse. The study provided evidence that NA placement plays a role in intelligibility since native speakers were able to remember more content and evaluate the L2 speaker better when the NA was placed correctly.

Del Saz and Grau (2022) explored the effect of L1 transfer from Spanish to English on the production of vowels and nuclear accent. The participants were two groups of Chilean Spanish speakers, 21 first-year students of an English teaching university

program (elementary), 12 students who finished said program (advanced) and 12 L1 English speakers. To analyse nuclear accent placement, 14 English sentences were adapted from Ortiz (2000). The sentences were divided into two groups: focus on the last noun and focus on another lexical item prior to the last lexical item. Their 14 Spanish counterparts were considered in the analysis as well. Once learners had been recorded, their sentences were evaluated with *Praat* to obtain pitch range of each utterance, pitch range from the NA to the last point of the utterance and duration and intensity of each NA. The goal of the procedure was to determine L1 influence and L2 proficiency. Results reflect the problem L1 speakers of Spanish face when placing NA in English since the focus of the utterance tends to be placed on the last lexical item. Learners also relied on duration rather than pitch to accent the nucleus. Finally, the results of the advanced learners of English points at the possibility that as L2 competence improves, production starts to become more accurate.

Traoré Reig (2014) conducted a study on the perception and interpretation of English tonicity by native speakers of Catalan, and the possible prosodic interference of their L1. 20 university students met the requirements and took three experimental tests in order to discriminate, interpret and identify different tonicity patterns. Audios to complement the tasks were created and provided as well. Results revealed a lack of correlation since learners had more issues when interpreting the meaning conveyed by tonicity patterns with a corrective or contrastive function and did better in the discrimination and identification tests. This could be seen as an indicator that

intermediate and advanced learners can perceive and identify different pitch accents but struggle when interpreting the information found in these pitch patterns. Findings also suggest a positive transfer since Catalan learners used phonological focus to perceive the suprasegmental features of English. Although further research is needed in this area, it can be implied that Catalan learners could be able to discriminate different pitch accents independently from their placement and meaning and may also identify the tonic syllable in an utterance independently from the meaning of the pitch accent.

Passarella and Silveira (2016) conducted a pilot study to investigate how four Brazilian Portuguese (BP) intermediate learners of English used the nuclear stress when interacting with others since in BP the nuclear accent tends to go at the end, whether it is a content or a function word. In pairs, students had to perform an oral task and produce 160 utterances that were recorded and analyzed with *Praat*. The utterances tested speakers' intention based on NA placement in initial position (36), medial position (100) and final position (24). The task was divided into two parts. First, the speaker read a question in silence and provided the answer to their partner. Then, based on where the speaker placed the nuclear stress, the listener had to choose among three questions for that answer. The purpose of this part was to assess if learners were able to indicate information obtained in a statement. In the second part, the speaker read a context in silence and proceeded to correct a piece of information in the context aloud. According to what the speaker read; the listener chose a

contrasting idea. The main goal of this task was to evaluate whether learners were able to highlight relevant contrasting information. The results displayed that it was a challenge for learners to signal through the placement of nuclear stress when information was being elicited and when corrective information was being provided. Furthermore, it was also troublesome for learners to place the nuclear stress in all positions. The presence of words that were hard to pronounce could have been the culprit of the challenges learners faced, since these words contributed to a greater number of pauses, rising intonation and syllable lengthening when producing the utterances.

Kivistö-de Souza (2017) examined Brazilian Portuguese speakers' sensitivity to English NA placement and whether this was affected by the type of utterance, unaccusative or deaccented. Participants were 69 Brazilian Portuguese learners of English and 16 native speakers of English who were used as a guideline to compare learners' task behaviour. To assess learners' awareness of NA implicit testing methods were applied. The author decided to use this method instead of asking learners to verbally describe their awareness because most language users are not able to elaborate on phonology rules in the L1 and L2. In the task, learners had to listen to question-answer dialogues and select if the intonation in the answer was suitable for the context. For this, two types of trials were designed, one which presented the right intonation patterns of English but if transferred to Brazilian Portuguese became

inaccurate, and a trial with incorrect English patterns that turned into an appropriate pattern when transferred to Brazilian Portuguese. In addition to this, unaccusative and deaccented structures were also tested. Half of the items found in the deaccented group were function words, the other half, given information. The task was created and implemented with *DmDx* software.

Results showed that NA awareness in English was higher when learners were presented utterances with deaccented information. Within this category, learners had higher awareness when NA was placed on a final function word. A possible explanation as to why NA placement seemed to be easier in deaccented utterances was that this structure is quite frequent (SVO pattern), whereas unaccusative items can be formed with a limited number of verbs and their structure is less frequent (SV pattern). The fact that awareness was higher when NA was placed in utterances finishing in function words and not in given information, encourages the idea that learners may have acquired real awareness about English NA placement in that context since function words in Portuguese are not deaccented. However, for the most part, L1 Brazilian Portuguese EFL learners' sensitivity to English NA placement was rather poor. The only category in which they showed satisfactory results was deaccented sentences that end in function words (76%). Performance was at or below chance level in unaccusative (40%) and deaccented utterances that end with given information (52%). The author finally suggests that even advanced learners with higher levels of proficiency could benefit from explicit prosodic instruction.

French and English do not realize intonation and stress in the same manner. French speakers tend to transfer their native model *groupe rythmique* (rhythmic group) to the target language. A *groupe rythmique* is a prosodic unit whose main characteristic is that the stress is put on the last syllable, this has an effect on the intonation of the whole sentence or discourse (Post, 2000). This may pose a problem for French learners since stress in English is distributed more freely, thus it is necessary to learn the different rules to place it properly. Otruba (2016) assessed the speech of six French speakers of English and the issues they face both in producing segments and suprasegmentals. In this study, it was predicted that older learners (three participants), who started studying English at 15 years old, would make more segmental and suprasegmental mistakes and would be more imprecise than younger learners (three participants), who started at the age of five. The participants were given a short article in English to discuss it with no preparation. They were then asked to answer questions regarding personal information, their language skills, and the skills of French people in general. Regarding suprasegmentals, results showed that learners under 30 were able to imitate English intonation patterns with no major obstacles. However, learners over 30 were unable to place the stress correctly in most exercises since they mostly relied on their native model. Consequently, foreign accent was more noticeable in this group.

Bu and Zhou (2021) studied the problems Chinese learners of English have with the acquisition of English stress. 25 participants took part in three recording tests designed by the authors. The first test contained a word list with no phonetic symbols or stress placement cues. The second instrument, a word list with indicators, and lastly, three sentences with intonation boundary marks. Findings indicate that the main issues that contribute to having a foreign accent are placing the stress incorrectly in polysyllabic words, making unstressed and stressed syllables just as prominent in both words and sentences, and showing no information focus on the nuclear stressed syllable.

At the sentence level, participants were asked to read three sentences which contained rising, falling nuclear tones, and a number of placements of nuclear syllables. Most Chinese learners made the mistake of giving prominence to unstressed, stressed and nuclear syllables by using a higher pitch. Nonetheless, when compared to native speakers, Chinese learners' production of nuclear accent was not prominent enough. Authors suggest that stress should be the main aspect to consider in the learning of English intonation since the correct pitch patterns of intonation can be acquired through proper word and sentence stress perception and production. This is particularly important for native Chinese speakers because their language is tone-oriented which may be the culprit of 'stress-deafness' (Peperkamp & Dupoux, 2002).

Regarding training studies, Thomson and Derwing (2015) state that helping learners become more intelligible, should be the aim of pronunciation research and instruction.

The authors conducted a review on the efficacy of second language pronunciation instruction by analysing the methods and results of 75 different studies. These studies contained a mix of traditional classroom instruction (61%) and Computer Assisted Pronunciation Teaching (CAPT) (39%). Studies that investigated CAPT provided students with more detail and more practice; this approach can promote autonomy and individualized instruction, but it is not really popular amongst language teachers. Additionally, most authors failed to describe the methodology used in the classroom. This lack of detail in the description of studies limits teachers' capacity to use the information in the classroom, hence, it is advisable to provide more evidence for the sake of teachers and other researchers willing to replicate experiments.

Lessons in the classroom lasted between 30 and 70 minutes while CAPT lasted 20. It was difficult for authors to determine the amount of input students received during those lessons but they believed it is related to the scope of training. This suggests that making progress in intelligibility and comprehensibility may take a considerable amount of time. Regarding scope of training, some studies covered a few features while others dealt with several aspects; 53% focused on segments only, 23% on suprasegmentals and 24% on both. Furthermore, when assessing students' production, teachers tend to rely heavily on reading-aloud, a task that does not represent natural and spontaneous speech. From the analysis, it was concluded that 82% of the studies showed that pronunciation teaching helps to improve target forms. Seven out of the 75 studies presented an improvement in intelligibility and comprehensibility.

As for production training and whether it can enhance perception of problematic L2 sounds for Arabic learners of English positive evidence was found. 46 participants were assigned to either a focused exposure condition or an articulatory training to improve their perception of three troublesome English contrasts: /æ/ vs. /ʌ/, /ɜ/ vs. /ɔ/ and /g/ vs. /dʒ/. Performance on pre, post and post-post condition perceptual discrimination tests was used to evaluate subjects' ability to perceptually distinguish sounds after production training. The articulatory training proved to be successful in that production can inform perception and facilitated L2 acquisition (Linebaugh & Roche, 2015).

Saito (2013) examined the role of explicit phonetic information in second language learning. 20 Japanese learners of English participated in the study and were divided into a control and an experimental group. Both groups received four-hour instruction on segments of English, more specifically the sounds /æ/, /f/, /v/, /θ/, /ð/, /w/ and /l/. The perceived foreign accent and comprehensibility of learners' oral production was then assessed by four native English listeners using an accentedness and comprehensibility rubric. Results suggest that explicit instruction has a positive impact of comprehensibility when it comes to sentence-reading tasks. Nonetheless, neither group was able to reduce their accent.

Gordon, Darcy and Ewert (2013), also explored the effects of explicit phonetic instruction in the L2 classroom and discovered that it helps students notice the

different features of the target language and develop a more intelligible speech. 30 students were divided into three groups. Two of them received explicit instruction in segmental and suprasegmental features while the third group did not. All of them participated in a pre and a post-test where they recorded a set of sentences.

The study highlights the fact that teachers in the experimental groups consistently remarked how mispronunciation creates miscommunication in all kinds of contexts. Teachers in these groups reinforced content through comprehension check, feedback and by providing students with individual assistance. Consequently, the results showed that the explicit phonetic information and directed feedback upgraded intelligibility ratings in the experimental groups. The control group that just repeated words and sentences and practiced their fluency without major guidance did not improve; proving that a lack of focus on form might help with fluency but does not help with the development of accuracy in production (Lyster & Ranta, 1997). Moreover, the results indicate that by dedicating a little amount of time to pronunciation in a communicative classroom, students can enhance their production abilities.

When comparing explicit and non-explicit training of segmental and suprasegmentals to study the development of comprehensible speech in L2 learners, results suggest that when suprasegmental features are included learners' comprehensibility levels tend to improve more and faster (Gordon & Darcy, 2016). Zhang and Yuan (2020)

also focused on the effects of explicit and non-explicit segmental and suprasegmental pronunciation instruction. 90 second-year Chinese undergraduate students were divided into three groups. One received specific pronunciation instruction on segments, the second one on suprasegments, while the third group received non-specific pronunciation instruction. After 18 weeks of training, both segmental and suprasegmental groups improved their pronunciation, specifically their comprehensibility when performing a reading sentence task. Nonetheless, only the group who received specific instruction on suprasegments showed significant progress in their comprehensibility at a spontaneous level and maintained their results on the post tests. These results contribute to the idea that explicit phonetic instruction should have a bigger role in ESL classrooms, and to the notion that paying attention to suprasegmental features can have a deeper effect on comprehensibility levels when time is limited.

Luchini and Paz (2022) evaluated the effectiveness of two pronunciation instruction strategies using comprehensibility and nuclear accent placement as ways of measurement. 50 L1 Spanish learners of English were evenly divided into two groups (A and B). Using a teacher-centered approach, both groups received suprasegmental instruction over the course of 16 weeks. Sessions were mostly theoretical and covered intonation, stress and rhythm of English. Dictations in which learners had to recognize and transcribe segmental and suprasegmental features, were the only form of practice since student-teacher and student-student interactions were not encouraged. In

addition to the described treatment, group B's instruction included a communicative awareness-building component, which focused on the teaching of suprasegmentals. The communicative tasks completed during these sessions required students to work together and aimed at raising the awareness of specific phonological target forms. This was followed by a period where learners had to reflect and analyse the different phonological target forms and self-assess their own production.

To obtain the speech samples, an oral achievement test was administered in the form of pre and post tests before and after instruction (at week 1 and 16, respectively). To assess nuclear accent placement, two experienced English pronunciation teachers and researchers listened to, transcribed and segmented students' recordings into tone units. The teachers then identified and placed NA in each tone unit taking into consideration the rules of English intonation and the context provided by the audio-files. *InfoStat* was used to run statistical analysis. Between pre and post-tests, group B was the only group that showed a significant improvement in both NA placement and comprehensibility. These results suggest that instruction using dictation and transcription combined with a communicative approach can help improve students' production of NA placement and comprehensibility.

There is also evidence that explicit phonetic instruction facilitates various dimension of L2 pronunciation development, however, it is still open to debate what kind of instruction can help learners acquire new sounds in the most effective manner. Lee,

Plonsky and Saito (2020) explored the effects of perception and production methods of pronunciation instruction in Japanese students of English. Flege's speech learning model (SLM) was directly relevant to this study since it was used to predict which instruction method would be more helpful when learning segmental and suprasegmental aspects of the target language. The SLM states that perception is necessary for production to happen, and in order to produce an L2 sound the learner needs to be able to detect the novel sound first and then create a phonetic category in their brain. As this model claims that L2 pronunciation acquisition takes place when learners are able to hear new sounds, it was predicted that perception-based training would be more effective than production-based training.

Participants received two weeks of instruction on either segmental or suprasegmental features of English, using either a perception or a production-based method. The progress was assessed in a pre, post, and a delayed post-test. Results highlighted that all groups improved their pronunciation accuracy, nevertheless, performance did vary across groups and over time. From pre to post-test and then delayed post-test, perception groups showed larger gains that were maintained over time. In comparison, production groups' improvement was less significant, and results could not be maintained in time.

The overall accurate detection and subsequent replication of suprasegmental stress patterns most likely played a major role in the increased ratings for the syllabic perception group. This finding is significant since it lends support to the SLM that this

study based its work on, which states that accurate perception precedes accurate production in the L2. It is important to note that even if results could not be maintained as time passed by, all groups did show gains and improved their pronunciation accuracy to an extent. This aligns with findings regarding the positive effects of pronunciation instruction, and keeps testing the nature, directionality, and transferability of the link between perception and production in L2 instruction.

These studies support the idea of NA placement being troublesome for L2 learners. There are structures that are easier to perceive and produce, especially the ones that are similar between the L1 and L2, nonetheless, L2 learners' sensitivity to NA placement still seems to be problematic. An advanced knowledge in the language may be required to learn prosodic features, thus, as proficiency develops, significant improvement can be achieved. Even so, and as most studies presented suggest, all learners could benefit from explicit prosodic instruction.

#### **2.4. Perception and production link**

L2 speech learning models are designed to explain phonological acquisition in the L2. The two most popular models that account for how the L1 influences L2 speech are the Speech Learning Model (SLM; Flege, 2003) and the Perceptual Assimilation Model (PAM; Best & Tyler, 2007). SLM applies to both L2 perception and production and was created to predict the acquisition of new phonetic categories in the L2. PAM

deals with perception only. Although these models were designed to be used in learners with no L2 knowledge and who were acquiring the language in an L2 environment, they have been applied in more educational contexts successfully (Tyler, 2019).

The SLM started as a model that accounted for age-related limitations on the necessary skills to produce segments in a native-like manner. The main focus was on L2 pronunciation learning by bilinguals who had spoken the L2 for a number of years. It claimed that the lack of accurate perceptual targets to guide the sensorimotor learning of foreign sounds, causes an inaccurate production of sounds, in other words, that all production errors are perceptually motivated (Flege, 2003). The revised version proposes that the L1 mechanisms to acquire the language are accessible in the L2 learning process. The theory is that the ability to form a new phonetic category for L2 sounds depends on how precise L1 categories are at the time L2 learning starts, the quality and quantity of L2 input, and the perceived difference between an L2 sound from the closest L1 sound (Flege & Bohn, 2021).

PAM uses perceptual assimilations to make predictions on L2 category acquisition. To achieve optimal L2 perception, students need to be able to detect a phonological contrast between each and all other L2 phonemes. This can be done through the use of existing L1 phonological categories that can then become common L1/L2 categories, or by setting up new L2 only phonological categories. Learners need to

have enough chances for perceptual learning in the early stages of learning acquisition and before the establishment of a large L2 vocabulary to attain new L2 phonological categories (Best & Tyler, 2007).

As previously stated, these models were created considering an immersion context and there were no predictions when applied to the foreign language classroom. Nevertheless, it was hypothesized that acquiring new categories would be more difficult in the classroom due to less opportunities for perceptual learning of L2 phonological contrast. Piske (2007) summarized how the SLM principles could be applied in the classroom and concluded that formal instruction should start as early as possible, with intensive foreign language use over time. The input and output provided should be of high quality, and training should focus mostly on perception and production. To these suggestions Tyler (2019) added the PAM principles to further improve category acquisition in the classroom. These principles could guarantee that learners are familiar with clear phonological differences for all L2 contrasts, provide learners with perceptual learning of all category assimilations since the beginning, introduce new vocabulary considering perceptual assimilation, and manage the introduction of written forms of words.

Including research and practice it in the classroom is a known challenge usually left to teachers to figure out. The lack of a systematic framework for integrating pronunciation only adds to the problem. McGregor and Marnie (2018) worked on a

framework over the course of a 10-year period and it was tested in pre-post classroom-based research. Results showed that the improvements made in pronunciation were quite significant.

The framework consists of five stages to guide instructors in the integration of pronunciation. Each stage is conformed of guiding questions, research, and possible outcomes. These are provided through examples from a curriculum designed for international teaching assistants. The stages developed, while effective, need to be used considering learners' pronunciation needs and gains as well as repeated in time to develop a pronunciation-inclusive curriculum. Teachers are highly encouraged to work through the stages, but also take risks, experiment and reevaluate as they see fit.

In stages one and two teachers should take into account institutional parameters and students' learning goals so that they align with the models, tasks, and intelligibility levels present in the curriculum. Stage three is to help instructors with their awareness and prioritization to improve their ability to assess needs and features. In stage four, teachers are encouraged to use their knowledge and explicitly provide information on pronunciation elements. This is to help learners with the development of their skills as it can be useful in increasing their knowledge and by using a common language, precise feedback can be established. Finally, stage five is for teachers to promote self-regulation and autonomy in the learners.

Research has supported the idea that it is difficult to establish a direct relation between perception and production. This could be due to, as previously stated, the lack of a proper curriculum to teach pronunciation, an existence of a range of methods and foci, together with different tasks and instruments to assess these variables. As a result, it has not been possible to reach an agreement since most studies address the L1-L2 issues that specific learners face, thus, conclusions are open to interpretation and can not be used to explain how perception and production truly interact. It has recently been suggested a change of focus to include other factors such as task difficulty, function of time, linguistic properties of the L2 and learners' cognitive abilities instead of asking whether these two variables are related (Peperkamp & Bouchon, 2011; Nagle & Baese-Berk, 2022. Baese-Berk; Kapnoula & Samuel, 2024).

Kartushina, Soto and Martin (2023) studied metacognition in the perception and production of the French vowel contrast /ø/-/œ/ by Spanish novice learners. Participants had to rate how confident they felt in their responses since it was expected it would help them predict their accuracy. Based on the results and considering subjects' confidence, metacognitive skills in nonnative speech perception are efficient in the language learning process. Nonetheless, the opposite happened in production, indicating that metacognition in nonnative sounds is not as fruitful in beginners. Nagle (2018) studied the relationship between perception and production using the Spanish stops /d/, /p/, and /b/ in English native speakers. A positive relation was established when determining how /d/ and /p/ were perceived and produced, but no significant

relationship was found for /b/. Overall results suggest that production improved before learners could achieve a nativelike level in perception, which goes against the general idea that the formation of a category is obtained through nativelike perception that in turn promotes production accuracy.

Baese-Berk (2019) conducted a study to examine the relationship between perception and production during learning. The main objective was to assess whether learning in one modality is related to learning in the other. Subjects were able to learn in the modality they were trained, nevertheless, learning across modalities presents a more intricate pattern. This is because learners who trained in perception demonstrated a robust learning in production, but individuals with production training did not show significant learning in perception, that is, production during training disrupted perceptual training. Consequently, the outcome of the experiments did not show a strong correlation between perception and production, which suggests that it is possible but not a given for learning to transfer between modalities and that learning in production does not depend on learning in perception happening first.

It is relevant to highlight the different neural mechanisms involved in L2 perception and production. Few studies have covered auditory perception, a crucial skill in the decoding of speech sounds to understand meaning and integrate different features of a language in the speech comprehension process. These studies suggest that structural changes of the brain in the auditory perceptual area, the left superior temporal gyrus

and inferior frontal gyrus, could be the culprit for native and non-native sound processing when learning new L2 vocabulary. Further analyses showed an activation of the temporal and frontal regions during new lexical retrieval. The collaboration of a ventral stream for speech perception and a dorsal stream for sensory motor mapping in the left hemisphere are responsible for L2 learning. The ventral pathway in the frontal-temporal regions becomes stronger as L2 proficiency increases. These ventral pathways can be stronger in individuals with better pitch and tone perception abilities. Overall, having better auditory perception abilities prior to learning a new language could predict L2 proficiency and lead to higher engagement of the ventral pathways in the retrieval of learned lexicon (Wong, Perrachione & Parrish, 2007; Mårtensson et al., 2012; Yang & Li, 2019).

Speech production, on the other hand, is a highly complex motor act. Even a phoneme involves the coordination of several articulators. Underlying this complex act is the speech motor control system represented in the temporal, parietal, and frontal cortex, together with associated sub-cortical structures, to produce a more intelligible and fluent speech. A simple way to understand this system was the idea that each phoneme is associated with an articulatory target or a muscle length target, so as to the production of a phoneme can be done by moving the articulators to that muscle configuration. The task dynamic model challenged this simple view, indicating that depending on the phonetic context, individual articulator positions often vary for the same phoneme. This model focuses on the treatment of vocal tract shape targets. The

main targets of speech are the degree and location of key constrictions of the vocal tract (Petersen et al., 1988; Saltzman & Munhall, 1989; Sörös et al., 2006; Kearney & Guenther, 2019).

In the research that supports a positive link between perception and production, Akahane-Yamada, Tohkura, Bradlow and Pisoni (1997), conducted a study in which native speakers of Japanese had to identify English minimal pairs. For the experiment, 12 of the subjects were assigned to a control group and 11 to a trained group where they received 45 sessions of perception training over the course of 15 days. Both groups took a perceptual pre and post-test; recordings to assess subjects' production were made during these phases as well. The experts noticed that the trained subjects improved from pre-test to post-test in perception while the control subjects did not, demonstrating that the improvements were due to the perceptual training. The trained group improved their production abilities as well. After three months, all the subjects were recorded to assess the retention of their productive skills . Six months later, the trained group was evaluated once again. The results from the follow-up tests indicate that perceptual training caused significant improvement in both perception and production, and it was maintained overtime.

Kim and Clayards (2019) investigated this link in a direct and controlled way using explicit phonetic imitation. A manipulated natural vowel stimulus varying in duration and quality was used in both perception and production tasks. Results showed that

having better perceptual abilities were related to a better performance in vowel imitation. Vowel duration was easier to imitate despite not being a perceptually important cue. This outcome hints at the possibility that speech perception and production are linked at the individual level. Jaiprasong (2019) studied L1 Thai learners' English word stress perception and production of suffixes and compound words. 30 beginners and 30 intermediate learners completed two tasks of marking and reading the stress of English words. Results revealed that intermediate subjects outperformed novice learners in both perception and production, however, a positive relation between the two forms was observed from both groups.

## **2.5. Working memory and second language acquisition**

Working memory (WM) can be understood as a system of limited capacity that is responsible for temporarily storing and manipulating the information people need to carry out tasks such as comprehending, reasoning, and learning (Baddeley & Hitch, 1974). The current version of the WM model comprises four main components. The central executive is the system responsible for managing WM, through attentional control (Baddeley, 2010). Attention control abilities are necessary to maintain relevant information and task goals in an active state and avoid focusing on internal and external distracting stimuli (Engle & Kane, 2004). The sketchpad, which holds visuospatial information that can be divided into separate spatial visual and kinaesthetic components. The episodic buffer, the most recent component added to

the model, can be understood as a temporary storage system that incorporates information coming from different sources. This system is controlled by the central executive which can retake information from the storage in the form of conscious awareness, reflect on said information, manipulate and modify it (Baddeley, 2000). The fourth component, the phonological loop, uses a temporary store and an articulatory rehearsal system to keep verbal and acoustic information. The principal purpose of the phonological loop is “to store sound patterns while more permanent memory records are being constructed” (Baddeley, Gathercole & Papagno, 1998, p. 158). There is evidence that this loop has evolved to enhance language acquisition in children since it is crucial when learning new phonological forms found in unfamiliar words. Children who possess a poor phonological loop struggle in acquiring novel vocabulary.

WM not only plays a role in the process of first language acquisition but it has also been found to contribute to second language acquisition and learning. Wen (2012) introduced an approach to integrate the concept of WM into second language acquisition (SLA). The author proposed a framework of WM for SLA based on WM studies in cognitive psychology and research that supports the link between the two.

The framework consists of three main parts: the definition of WM for SLA, the structure of WM for SLA, and the measure of WM for SLA. Regarding the definition, Wen uses the one provided by Skehan (1998) which states that WM for SLA is a system of limited capacity used to carry out complex tasks. As for the structure of

WM for SLA, it is suggested that all WM components should be considered, but it would be best to focus mostly on the components that are directly involved in the SLA process. Based on previous research that studied the effects on L1 and L2 learning, the phonological and executive WM are the most relevant components. Lastly, in order to measure said WM elements, a nonword repetition span task could be used to assess phonological WM, and a complex memory span task, such as a reading span task, to measure the executive WM component.

The information to obtain this framework was obtained through an empirical study with the help of 40 participants. The principal objective of the study was to analyse the effects of WM. As previously stated, the author measured the executive and the phonological component of WM on L2 speech production and task-based planning through a complex memory span task and a nonword repetition task respectively. One of the variables considered was pre-task planning, thus, 30 of the 40 participants were able to prepare their speech for 10 minutes after watching the video prompt. The remaining 10 had to start talking as soon as the video finished. Reformulation, replacement, words per minute, false start, accuracy, lexical diversity, and syntactic complexity, were some of the variables included to measure L2 speech.

Findings indicate that executive WM had an impact on the length of accurately produced speech and repair fluency measures such as false start and reformulation. Phonological WM influenced measures like words per minute and replacement. Syntactic complexity and lexical density of learners' speech played a role in both WM

elements. These results support the idea that because of the effects on different areas of second language task-based speech planning and performance, the phonological and the executive WM should be regarded in WM/SLA research. Understanding the link between these WM constructs and L2 speech, together with its limitations, could help in predicting L2 learners' performance independently of the planning conditions and tasks features.

It has been suggested that WM capacity can also influence the cognitive processes that surround the perception and production of a target language, the problem-solving tasks and comprehension that occurs when learning (Skehan, 2015). More specifically, WM capacities emerge in the performance of tasks that are more challenging. Tasks that are more demanding lead learners' WM to focus on relevant linguistic resources, and consequently, linguistic production tends to be more accurate and complex (Li, 2022). Some studies have proposed that WM can have a higher engagement in L2 acquisition and use than in L1 production and development (Harrington, 1992; Finardi & Weissheimer, 2008). One possible reason for this could be the lack of access to Universal Grammar, since L2 learners will not be able to access this information to the same degree as native speakers. WM may also be directly linked to the degree of proficiency a person has in any specific language. In general, learners with higher WM capacity outperform those with a lower one in aspects of language performance and acquisition.

Among the components present in the WM model, the role of the phonological loop in L1 acquisition has been found to be related to L2 learning when dealing with foreign language vocabulary. The capacity of this loop influences the rate of vocabulary acquisition; a larger vocabulary inventory is linked to better verbal memory capacity (Baddeley, 2015). Additionally, WM can contribute to L2 reading comprehension; however, this contribution is not always independent. It has been reported that in order for WM to play a role in reading comprehension, L2 learners need to know the target language syntax and vocabulary, or the topic vocabulary of the text (Joh & Plakans, 2017).

Choi (2013) conducted a study and concluded that WMC (working memory capacity) was more effective than vocabulary to analyse literal reading comprehension performance, while knowing specific vocabulary related to the text proved to be more useful in both explaining inferential reading comprehension and literal reading comprehension as well. Findings also show that a wider vocabulary range can facilitate reading comprehension for L2 learners with a low processing ability. In three separate sessions, 46 university students from South Korea performed a Reading Span Task to measure WMC, the Nelson-Denny Comprehension test and a Vocabulary test. Results aligned with the predictions made and with past studies that reported vocabulary knowledge is more relevant than WM when accessing lexicon and overall learners' retrieval capacity, especially in inferential reading comprehension (Mizera, 2006). Nonetheless, there is no agreement on this area and other studies speculate that

WMC does influence inferential reading comprehension since it requires higher cognitive abilities than literal reading comprehension (Apltekin & Ercetin, 2011). Furthermore, having higher WM abilities could be useful for L2 learners to efficiently retrieve more words in a new message because it is easier to have access to the word stock in their minds and select the most suitable option for the situation they are in (Gilabert & Muñoz, 2010).

Research on the area of L2 speech production suggests the importance of WM to understand productive abilities. Findings suggest that WM is present in all stages, especially when L2 learners are beginners and the retrieval, selection and articulation of different linguistic terms to produce a message require more effort (Fu & Li, 2019). A strong relation has been found in some studies between individuals' WM capacity and their L2 fluency, accuracy and complexity (Fortkamp, 2000; Juffs & Harrington, 2011). The central executive and the phonological loop components are thought to play important roles in this area while L2 learners' grammatical encoding processes become more automatic (Baddeley, 2015). The central executive is linked to linguistic complexity and fluency when conceptualizing a message. This component also monitors linguistic accuracy in the formulation stage of the message. The phonological loop is involved in the stages of formulating and articulating the message. One of its main purposes is to make the process of retrieving and activating linguistic knowledge faster, thus, it is crucial for the fluency aspects of speech production. (Fortkamp, 2000; Finardi & Weissheimer, 2008; Li, 2022). Individuals

with higher WM capacity can also be more successful in avoiding L1 interference which leads to overall ability to produce L2 structures more accurately and stay focused on the task during the procedures (Trude & Tokowicz, 2011).

Despite theory supporting the importance of WMC in L2 production, there have been studies in which no relation was found. WM contributes to the planning and articulation stage of language production; the process of storing parts of the speech before producing an utterance, it is helpful for L2 learners when planning and encoding their message, which can enhance their speech quality. However, this very same process could be an issue for learners when they have to speak, since in the planning process of the whole message, students also have to address all the vocabulary available in their minds. This translates into a cognitive load that can weaken L2 speech and make it less fluent (Kormos & Safar, 2006; Segalowitz, 2010).

Nergis (2020) investigated L2 speaking capacity of advanced learners with low and high WM and the role of this variable. The participants were a group of 52 students of English for Academic Purposes who took a course that focused on academic speaking skills. Data was collected through an oral argumentation task using Daneman's speaking span test (1991) and was then analysed in terms of acoustic measures of accuracy, fluency, structural and lexical complexity. The analysis revealed that L2 WM capacity explained the variations in lexical complexity but not in syntactic, fluency and oral complexity. This means that participants' capacity to hold long stretches of words in short term memory did not help them to produce

utterances faster or more. Nevertheless, participants who possessed the ability to store and process long stretches of speech were able to produce lexically enhanced utterances. Back in 2008, Kormos and Safar reported similar results. The authors studied the relationship between WM and phonological short-term performance and capacity. 121 students from a bilingual program at a Hungarian secondary school, aged 15-16, participated in an English test that measured reading, listening, writing and speaking skills, as well as a backward digit span test to measure WMC. Results show that phonological short-term memory capacity plays a role in proficiency, but ultimately, there was no relationship between L2 speaking and WM, but a higher one between WMC and lexical complexity.

Based on the discussion, although studies on NA and WMC could not be found since most of the literature deals with vocabulary and reading comprehension, it can be understood that an agreement on the relation between WM and SLA has not been reached. A combination of theoretical account and empirical data are needed to comprehend the multifaceted nature of WM and its relation to the complex cognitive skills that are involved in the acquisition of a foreign language.

## **2.6. Proficiency in the L2**

Proficiency is generally understood as the overall L2 competence. It deals with pragmatic knowledge, which refers to being able to use sentences and texts in an appropriate manner in different contexts, and organizational knowledge, the ability to

organize utterances, sentences and texts according to lexical and grammatical knowledge (Bachman & Palmer, 2010). Proficiency is also linked to the competency of the L2 speaker in real-life language situations (Hosseini, 1983). To measure L2 proficiency, three components need to be taken into consideration: complexity, accuracy, and fluency. Complexity refers to the varied and elaborated use of the L2. Accuracy has to do with the ability of the L2 learner of producing error-free speech. Fluency refers to the capacity of processing language in a native-like manner (Skehan, 1998).

In the L2 speech field, proficiency has been addressed in several studies. Regarding segments, research suggests that high L2 proficiency or experience with the language can result in increased production accuracy of consonants compared to learners with a low proficiency level or who started learning later in life (Chakraborty, Domsch & Gonzales, 2011). Nevertheless, in a study that measured the impact of L2 proficiency on vowel training, Wong (2015) concluded that the performance of both high and low proficiency learners was not significantly different. Both groups benefited from being exposed to natural stimuli, which successfully trained their perception of non-native phonetic contrasts.

The production of suprasegmentals can also be influenced by L2 proficiency. Trofimovich and Baker (2006) studied the production of a variety of suprasegmental aspects in learners with different levels of experience (3 months, 3 years, and 10 years). Results revealed that the ability to produce suprasegmentals that characterize

speech melody, such as stress timing, was directly related to L2 proficiency. Other aspects like speech rate, pause frequency and pause duration, that describe speech fluency, were related to the age of first extensive exposure to the L2. Moreover, authors found that suprasegmentals contributed to foreign accent at all levels of proficiency, which suggests that native or near native-like production of suprasegmentals may require many years of practice and exposure, and all learners could benefit from perceptual and production training.

Puga et al. (2017) studied the perception of intonation patterns of German L2 speakers of English. The main focus of their study was investigating whether advanced German learners of English possessed enough knowledge of the intonation patterns of different sentence types. Some of the categories selected were statements, yes/no questions, open and closed tag questions, and sarcasm. Results indicated that learners performed similar to native speakers for sentence types like statements and yes/no questions; however, their performance was not as good when perceiving open and closed tag questions and sarcasm. A possible explanation presented by these researchers is that sarcasm in German is not realized at the syntactic level, and tag questions do not exist in their L1. This outcome suggests that L1 can interfere and make the perception of some L2 intonation patterns more challenging than others. Thus, in order to successfully learn L2 intonation, it is important to present these patterns in context rather than in isolation.

The authors also highlighted that proficiency was a variable that influenced learners' positive results. Learners who had a better knowledge of intonational patterns had had access to a better quality and a higher quantity of input. Participants who performed better in the tasks were more advanced in their studies since all of them were part of a master's programme, had spent a considerable amount of time in an English-speaking country and were able to speak more than three languages

Concerning proficiency and WMC a positive association was found. Prebianca, Finardi and Weissheimer (2014) conducted a study that measured L1 Portuguese and L2 English across three proficiency levels: elementary, intermediate and advanced. Two speaking span WM tests created by the authors were used, one in Portuguese and the other in English. 60 adult students of English as a foreign language were part of the study; 19 elementary, 19 intermediate and 22 advanced learners. Advanced learners outperformed elementary and intermediate learners in both the L1 and L2 WMC test, and the elementary group got better results than the intermediate one. For the mean ranks of the L1 WMC test, differences were not as significant between the elementary and the advanced learners as they were in the L2 WMC test. Authors suggest that this may be evidence that WM relies on different abilities when using the L1 or the L2. This further supports the idea that proficiency in the L2 is an important variable that has to be considered in WM.

Nevertheless, proficiency levels could negatively interfere with the quality of the processes that are involved in L2 speaking. One of the main mechanisms behind speech production is lexical access and proficiency plays a role in the lexical retrieval and sentence formulation, specifically in the stages of defining the correct vocabulary for the intended message and monitoring the selection outcome. The sub-processes mentioned may be too complex for learners who are not proficient enough, and this could overload their WMC since they would have to use more attentional resources to retrieve the right vocabulary which could make them lose focus on producing a speech that's fluent and free of errors (Albergi & Tavakoli, 2023).

### **3. RESEARCH QUESTIONS AND OBJECTIVES**

#### **Research questions**

1. To what extent is the perception of nuclear accent in English challenging for L2 learners?
2. How is the production of nuclear accent in English affected by the learners' L1 pattern?
3. What is the relation between working memory capacity and the perception and production of NA placement in English as L2?
4. What is the relation between proficiency and the perception and production of NA placement in English as L2?

#### **General objective**

To determine L2 learners' capacity to perceive and produce the nuclear accent placement in English.

#### **Specific objectives**

1. To assess learners' ability to perceive and produce the placing of NA in English as an L2.
2. To establish whether there is any relation between the perception and production of the four patterns under study: Last lexical item (LLI), LLI + tail, Adverbials of place (adv\_place), Adverbials of time (adv\_time).

3. To establish the degree of difficulty in the perception and production of the four patterns under study: LLI, LLI+tail, adv\_place, adv\_time.
4. To determine the relation of working memory and the perception and production of NA placement in English as an L2.
5. To determine the role of proficiency in the perception and production of NA placement in English as an L2.

## **4. METHODOLOGY**

### **4.1. Participants**

24 university students of the English teaching programme at Universidad de Concepción took part in this study. Participants have an intermediate to advanced level of English (B1, B2, and C1 according to the Common European Framework for languages (CEFR). All of them had taken an intonation course the previous year or semester. The limited sample size of this study needs to be taken into account to consider the results with caution, given that generalisation of findings to a larger population is not possible.

The sample originally consisted of 25 subjects, however, one of the students failed one of the tasks of the working memory test. It was mandatory for all subjects to obtain 80% in the processing task and this particular student only got 70%. Participants age was asked during this test; it ranged from 20 to 25 years old. The mean was 22.

### **4.2. Instruments**

This was a quantitative correlational study. There were five instruments in total. A perception and production tests that aimed at assessing learners' ability to perceive and produce the correct intonation patterns and determine whether they could recognise some of the exceptions of the NA rule. To help with the selection of the

most troublesome categories for L2 learners, a pilot test was implemented. Based on the results, the categories of adverbials of time and adverbials of place proved to be more problematic than the rest and were selected to create the final version of the perception and productions tests because of how frequently they can be found in spoken language.

It was decided then that in the perception and production tests these well-known exceptions of the default patterns, as well as default patterns of NA would be included. Each test is comprised of 48 different sentences in total, divided as follows:

- Sentences for the exceptions: 12 sentences that include adverbials of time (adv\_time) in final position and do not carry the NA, and 12 sentences that include adverbials of place (adv\_place) in final position and do not carry the NA.
- Sentences for the default pattern: 12 sentences that conform to the pattern of the last lexical item (LLI), meaning the last syllable carries the NA, and 12 sentences that follow the pattern of the last lexical item and a tail (LLI\_tail), meaning the syllable that carries the NA can be followed by one or more syllables.

#### **4.2.1. Perception test**

To assess L2 learner's ability to perceive NA placement in four groups of utterances (adverbials of time, adverbials of place, last lexical item, and last lexical item + tail),

12 sentences per group were taken and adapted from phonetics and phonology textbooks (Cruttenden, 1983; Brazil, 1994; Wells, 2006). Some sentences were also created using the patterns found in the textbooks as reference. A total of 48 sentences were obtained for the perception test to be used in a recorded version. A British English native speaker, a male in his late 50s from Leeds, in the north of England was part of the process. He was provided with the key and was requested to record the sentences twice to guarantee the right intonation patterns were being produced. NA placement was checked using *Praat* to make sure the accent was placed on the expected word. The list of sentences was judged by the native speaker and he confirmed the emphasis was natural.

The recordings were made using a laptop and a headset with a microphone included. The files were created using an MP4 format and converted to WAV format to analyse them in *Praat*. It was recorded in mono sound, and the sampling rate was 48 kHz. The audios were edited using *Audacity* to delete background noise.

The test was provided to participants in the Phonetics Lab at Universidad de Concepción. It consisted of a multiple-choice test presented using Google Forms. The 48 sentences were presented in a one-track audio with a three-second pause between stimuli, time to provide the answer. A total of 6 sentences for practice were provided before starting the actual test. Participants listened to an audio stimulus containing a sentence as they were presented with a multiple-choice with five options to choose

from. The options showed different syllables of words belonging to the sentence they had listened to, they had to select the most prominent one.

The test took around 6 minutes to complete. Answers were entered into a spreadsheet; correct answers were assigned a “1”, incorrect a “0”. Overall results were computed in percentages. Participants did not receive feedback on their answers.

#### **4.2.2. Oral production test**

To assess L2 learner’s accuracy in the production of NA in four groups of utterances (adverbials of time, adverbials of place, last lexical item, last lexical item + tail), 12 sentences per group were taken and adapted from phonetics and phonology textbooks (Cruttenden, 1983; Brazil, 1994; Wells, 2006). Some sentences were also created using the patterns found in the textbooks as reference. A total of 48 sentences were obtained for the production test. These sentences were randomized to create a list of stimuli for the test.

The test was given to participants in the Phonetics Lab at Universidad de Concepción. The list of 48 sentences was presented to participants individually on a MS power point presentation and were recorded with the Audacity software (version: 3.3.2). Before starting the test, instructions were presented, and it was made clear that they were allowed to record the utterances once only. 5 minutes were given to participants so that they could familiarize themselves with the sentences. Once the MS power point

presentation started, they had 8 seconds per slide to read and record the sentence. The test took around 6 minutes.

#### **4.2.3. Production test: Pilot**

To decide on the types of sentences to use in the perception and production test, eight categories of utterances were selected based on groups of sentences suggested in the literature. These categories of words do not follow the LLI rule, thus, they do not receive the NA even if they are the last lexical item of an utterance. The suggested categories by Cruttenden (1983) and Wells (2006) were used to create a randomized list of 28 sentences. The categories included: empty words, adverbials of time, adverbials of place, prepositional verbs, phrasal verbs, final adjectives, final verbs and event sentences. Each group contained four sentences.

Empty words refer to nouns that have very little meaning on their own, particularly general nouns such as ‘things’, ‘people’, ‘places’, etc. Adverbs in general carry the NA, however, adverbs and adverbial phrases of time and place are often not accented when in final position, even if they contain new information. The general rule for phrasal verbs is that the NA is placed on the particle. As for prepositional verbs, the NA falls on the verb. There is a general tendency of placing the NA on a noun where possible, in preference to other word classes. Thus, if an utterance ends with a verb or an adjective, the NA should go on the preceding noun. In event sentences the NA is

also placed on the noun, which is the subject, rather than the verb which happens to be intransitive.

Participants who were given the pilot test were 21 second-year students of the English Teaching Programme at Universidad de Concepción. Participants were given 5 minutes to familiarize with the sentences; after that, they were asked to record them using the headsets available in the laboratory. Participants sent their recordings by email. The recordings were analyzed with *Praat* software (version 6.3.10) to accurately assess their pitch movement, intensity and confirm the placement of the nuclear accent (NA). Finally, students received written feedback on NA placement and segmental errors.

The result of the analysis of about 569 recordings (three participants missed three recordings and one participant missed ten recordings) revealed that there were no major issues in the placement of NA in “event sentences” and “empty words”. The remaining categories were all troublesome, being “final verbs”, “adverbials of time” and “adverbial of place” the groups with the lowest scores in the accuracy of NA placement. From this analysis, it was decided that the creation of a perception and production test would include utterances with adverbials of time and place, since they are more frequent in spoken English.

#### 4.2.4. Working memory test

A reading span test (RST) was created using the English version by Biedroń & Szczepaniak (2012). Some of the English sentences were translated and adapted to Spanish, while others were completely new. The test comprised seven sentences for the trial sets and 52 sentences for the test itself. The 52 sentences were divided into eight sets. The number of sentences in each set gradually increased from three to ten (e.g., set one contains three sentences, set two contains four sentences, etc.). The test sentences were divided into sensible and nonsensical in even numbers (26/26). For instance, the sentence: *Nadie sabe lo que pasará en el futuro respecto al trabajo* made sense. On the other hand, the sentence: *El elefante postuló a un puesto de dentista en el hospital* did not since elephants cannot apply for a job. The average number of words per sentence was approximately nine and twelve words. Each sentence was followed by an unrelated word, which was a two-syllable noun presented in capital letters.

The preliminary set of 52 sentences was submitted to a N° of Chilean Spanish native speakers, who judged the sentences according to their naturalness and whether they make sense or not.

This was a dual task since participants had to simultaneously process and determine whether each sentence made sense and remember the unrelated word for subsequent recollection. The test was provided in the Phonetics Lab at Universidad de

Concepción. Participants had to read one sentence and remember the last word in capital letters. Then, they had to decide if the sentence fit easily into everyday communication. After the last sentence in each set, a few minutes were provided for them to write down the unrelated words.

The scoring to participants' answers was assigned by giving 1 point per correct answer. The final score of the RST of each participant was the total number of words they were able to remember correctly. The seven sentences for the trail were not computed for the final score, thus the maximal score was 52. The processing task (i.e., judging the sentences as sensical or nonsensical) served as a distractor, therefore, results were not considered when calculating the final score. Nonetheless, if a subject got a score below 80% in this task, it meant they were not paying attention and were excluded from the sample.

#### **4.2.5. Language Proficiency test**

This test was given in the language laboratory at Universidad de Concepción. They took it in one session, all together, but there was an empty seat in between each participant.

Participants' proficiency level was assessed with an online test. The online proficiency level test consisted of 50 multiple questions that increased in difficulty as they answered. This test measured vocabulary use, as well as grammatical and pragmatic knowledge. It took from 15 to 20 minutes to complete. After participants

completed the test, they received their score and proficiency level according to the CEFR. The website also allows reviewing the answers to further analyse their strengths and weaknesses.

**Table 3.1** *Subjects' proficiency level*

<b>Level</b>	<b>Number of participants</b>
<b>B1</b>	<b>3</b>
<b>B2</b>	<b>6</b>
<b>B2+ -C1</b>	<b>15</b>

#### **4.3. Data analysis**

The data collected from the four tests was analysed to compute the overall accuracy percentage of NA placement in the perception and the production of NA. Descriptives of Means and Standard Deviations were obtained and used to compare means. To establish relations between variables, bivariate correlations were run for all the variables in this study, variables associated with perception and production of NA patterns, proficiency and WM capacity.

#### **4.4 Sessions**

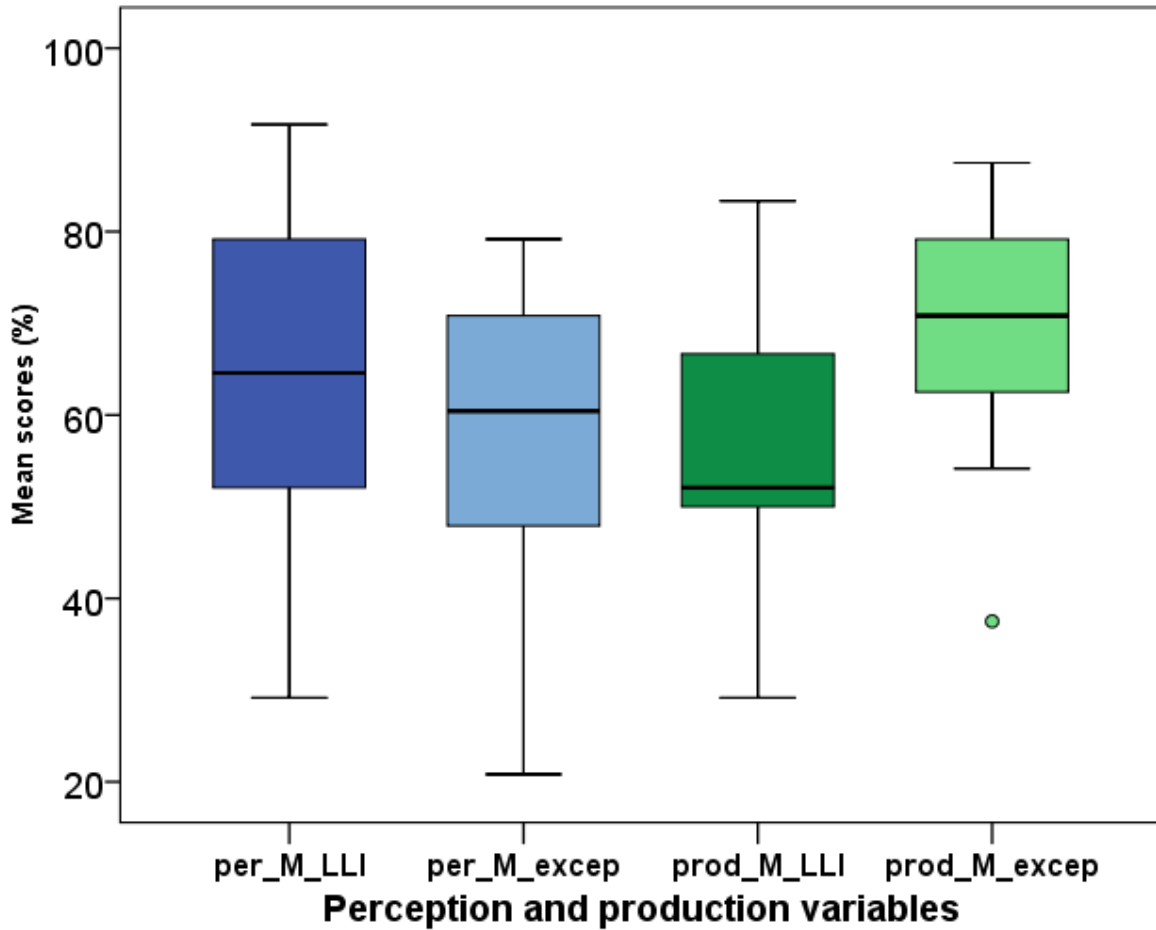
Subjects took all tests in one session. It was expected that the four tasks would take a little more than an hour, but most students finished in 40 to 45 minutes. Half of the subjects took the tests as a group in the phonetics laboratory, nine of them in groups of three in said laboratory, and three students, who joined later, took the tests individually in the supervisors' office. The tests were given in the following order: proficiency test, perception test, production test, working memory test.

## 5. RESULTS

Scores across participants for the overall mean (M) of the perception of default patterns of Nuclear Accent ( $\text{per\_M\_LLI}$ ;  $M = 65.11$ ,  $SD = 17.63$ ) and the mean of the perception of exceptions ( $\text{per\_M\_excep}$ ;  $M = 57.99$ ,  $SD = 16.44$ ), were compared and no significant differences were found  $t(23) = 1.48$ ,  $p = .152$ ,  $d = .30$ . Scores were significantly higher on the mean of the production of exceptions ( $\text{prod\_M\_excep}$ ;  $M = 68.75$ ,  $SD = 11.06$ ) rather than the mean of the production of default patterns ( $\text{prod\_M\_LLI}$ ;  $M = 55.56$ ,  $SD = 14.15$ ),  $t(23) = -3.39$ ,  $p = .003$ ,  $d = .69$ . Scores were significantly higher on the mean of the perception of default patterns ( $\text{per\_M\_LLI}$ ) ( $M = 65.11$ ,  $SD = 17.63$ ) rather than the mean of the production of default patterns ( $\text{prod\_M\_LLI}$ ) ( $M = 55.56$ ,  $SD = 14.15$ ),  $t(23) = 2.19$ ,  $p = .039$ ,  $d = .45$ . as well. Finally, for this section, results on the mean of the production of exceptions ( $\text{prod\_M\_excep}$ ) ( $M = 68.75$ ,  $SD = 11.06$ ) significantly surpassed the results of the mean of the perception of exceptions ( $\text{per\_M\_excep}$ ) ( $M = 57.99$ ,  $SD = 16.44$ ),  $t(23) = -2.71$ ,  $p = .013$ ,  $d = .55$ . (Fig. 5.1, Table 5.1).

### **Figure 5.1**

*Mean of perception and production variables of NA default patterns (LLI, LLI\_tail) and exceptions (adv\_place, adv\_time).*



**Table 5.1**

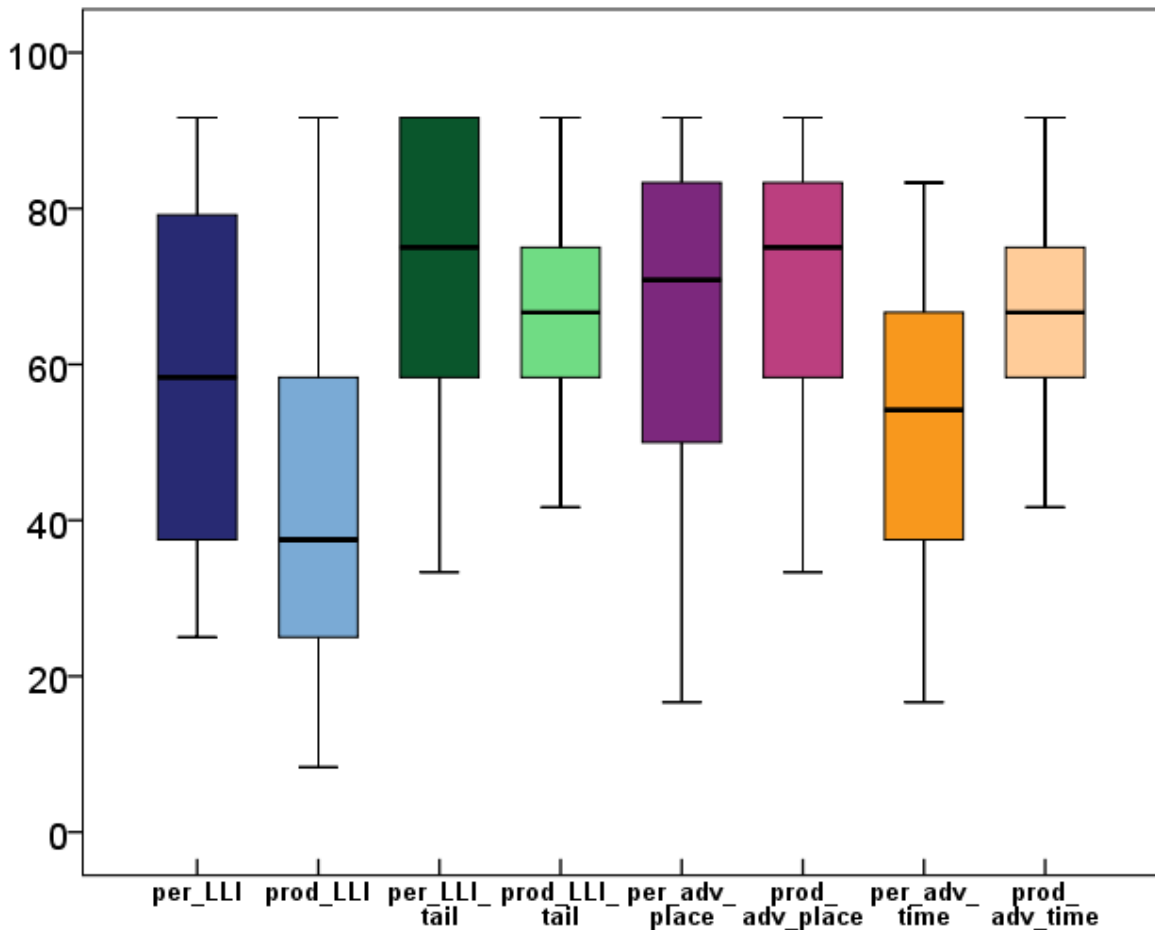
*Descriptive statistics of variables and NA patterns.*

	M	SD
1. Prof	72.58	13.46
2. PerceptionNA	61.37	12.33
3. ProductionNA	61.98	8.18
4. WM	69.23	14.72
5. Per_M_LLI	65.11	17.63
6. Per_M_excep	57.99	16.44
7. Prod_M_LLI	55.56	14.15
8. Prod_M_excep	68.75	11.06

Regarding the perception and production of the default patterns of NA and some of its exceptions, several scores were compared across subjects in more detail. Two variables were used for the default pattern of LLI for perception and production and the overall mean included perception of the last lexical item (per\_LLI), perception of the last lexical item with a tail (per\_LLI\_tail), production of the last lexical item (prod\_LLI) and production of the last lexical item with a tail (prod\_LLI\_tail). In the case of the exceptions, two variables were created for perception and production, one for adverbs of place (per\_adv\_place), (prod\_adv\_place), another for adverbs of time (per\_adv\_time) and (prod\_adv\_time). It was discovered that participants' performance was significantly better on the perception of the last lexical item with a tail (per\_LLI\_tail;  $M = 72.57$ ,  $SD = 19.73$ ) than on the perception of the last lexical item (per\_LLI;  $M = 57.64$ ,  $SD = 23.17$ ),  $t(23) = -2.96$ ,  $p = .007$ ,  $d = 0.61$ . It was also found that the perception of adverbials of place (per\_adv\_place;  $M = 63.54$ ,  $SD = 22.63$ ) was significantly higher than the perception of adverbials of time (per\_adv\_time;  $M = 52.43$ ,  $SD = 18.63$ ),  $t(23) = 2.15$ ,  $p = .042$ ,  $d = .44$ . Furthermore, scores on the production of the last lexical item with a tail (prod\_LLI\_tail;  $M = 66.67$ ,  $SD = 13.00$ ) were significantly higher than scores on production of the last lexical item (prod\_LLI;  $M = 44.44$ ,  $SD = 22.75$ ),  $t(23) = -4.55$ ,  $p < .001$ ,  $d = 0.93$ . However, no substantial differences between scores on the production of adverbials of place (prod\_adv\_place;  $M = 69.79$ ,  $SD = 15.89$ ) and production of adverbials of time (prod\_adv\_time;  $M = 67.71$ ,  $SD = 14.18$ ),  $t(23) = 0.50$ ,  $p = .623$ ,  $d = 0.10$ . were found (Fig 5.2).

**Figure 5.2**

*Perception and production of NA default patterns (LLI, LLI\_tail) and exceptions (adv\_place, adv\_time).*



The correlations between a series of variables were computed as shown in Table 5.2. The variables included were proficiency, Working Memory (WM), the overall mean of perception of NA in default patterns which merges the scores for the last lexical item and the last lexical item with a tail (Per\_M\_LLI), the overall mean of production of NA in default patterns which merges the scores for the last lexical item and the last

lexical item with a tail (Prod\_M\_LLI), the overall mean of perception of exceptions which merges the scores of adverbials of place and adverbials of time (Per\_M\_excep), and the overall mean of production of exceptions which merges the scores of adverbials of place and adverbials of time (Prod\_M\_excep). The results indicate that there were no significant correlations among these variables.

**Table 5.2**

*Correlations of variables and NA patterns*

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	1	2	3	4	5	6
1. Proficiency	-					
2. WM	-.19	-				
3. Per_M_LLI	.06	.05	-			
4. Per_M_excep	.12	-.33	.11	-		
5. Prod_M_LLI	.07	-.02	.04	.09	-	
6. Prod_M_excep	.29	-.22	.06	.14	-.16	-

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

## 6. DISCUSSION

The main goal of this research was to determine L2 learners' ability to perceive and produce the default patterns of English nuclear accent and some of its exceptions. To assess this, 24 students of the English Teaching programme at Universidad de Concepción took a perception and production test containing 48 sentences. Tests to explore whether learners' proficiency level and working memory capacity would be related to their perception and production of English nuclear accent were also used.

Despite general results not being statistically significant, when analysing the perception and production of the specific default patterns of English NA and some of its exceptions, results worth reporting were found in the current study. The default patterns assessed were the last lexical item (LLI) and the last lexical item with a tail (LLI\_tail). The exceptions considered for this research were adverbials of time (adv\_time) and adverbials of place (adv\_place).

Results showed that the perception of the default pattern (LLI, LLI\_tail) was significantly higher than the production of the same patterns for L2 learners. Regarding production of the default patterns, learners found it easier to produce the LLI\_tail form (LLI: 44% vs LLI\_tail: 67%. Mean: 55% ), in a similar way as what happened with the perception of this pattern. Within these patterns, learners struggled less when perceiving the LLI\_tail pattern (LLI: 58% vs LLI\_tail: 73%. Mean: 65%). The examples selected and adapted to create the instruments to assess these two

variables only included function words in the tail of the last lexical item. Learners probably used the rules they have learned and know that function words tend to have little to no meaningful content, thus, they have become better at disregarding them and placing the nucleus on content words.

Another possible explanation for this ability to perceive NA patterns better could be that subjects had previous training since they had already taken an intonation course. This training was not part of the current study but its effect needs to be taken into consideration. The results in training studies for segments show a pattern of higher results in perception than production. The difference between these variables may be explained by the development of these two capacities in a second language which, generally speaking, happen to be stronger in perception (Kartushina et al., 2023).

Despite the higher results in perception, the average of both patterns was 65% which means that perceiving these forms was still a challenge. It was expected that subjects' L1 would cause a high degree of interference, this could serve as an explanation of the 65% accuracy. This outcome may also suggest that participants are at a developmental stage concerning the automatization of perception and production and there is room for improvement.

The opposite was discovered in the analysis of the exceptions. Learners performed significantly better when producing these exceptions and were not able to perceive them as accurately (perception: 58%, production: 69%). A possible explanation could

be that all subjects had taken an intonation course, thus, knew about the NA placement rules. Although it was easier for learners to produce these patterns, the production of NA is still a problem for learners of English with Spanish as L1 since they tend to follow their L1 pattern and place focus of the utterance on the last lexical item, relying on duration rather than pitch to accent the nucleus (Del Saz & Grau, 2022).

One possible reason for these findings may be that intonation is one of the earliest features a child acquires in their L1 and participants in this study were late learners of English. From a very early-stage intonation is used to understand and process information and children rely heavily on prosodic prompts until they acquire syntactic, pragmatic and semantic competence in later stages of language development. Once this happens, intonation becomes a more automatic and subconscious process (Wichmann, 2015). Native speakers can process information related to context and lexicon because they have prior experience and have dealt with specific linguistic messages in a wide range of contexts. This allows them to automatically choose the prosodic pattern that will best convey the intended communicative purpose (Flege & Liu 2001). Since non-native speakers may lack the experience and exposure, it is expected that they select patterns of their L1 to conjecture on L2 intonation.

On the perception and interpretation of English tonicity by native speakers of Catalan, and the possible prosodic interference of their L1, a lack of correlation was found (Traoré Reig, 2014). This means that intermediate and advanced learners could

perceive and identify different pitch accents but struggled when interpreting the information found in the pitch patterns. Although further research is needed in this area, it can be implied that a Catalan learner could be able to discriminate different pitch accents independently from their placement and meaning and may also identify the tonic syllable in an utterance independently from the meaning of the pitch accent (Traoré Reig, 2014). In the case of Portuguese, it was a challenge for learners to signal through the placement of nuclear stress and to place this stress in all positions (Passarella and Silveira, 2016). As for Mandarin Chinese, the main issue that lead learners to having a foreign accent is the incorrect placement of stress in polysyllabic words, which makes unstressed and stressed syllables just as prominent, hence, there is no information about the focus of the nuclear stressed syllable (Bu & Zhou, 2021).

From these results it can be understood that there is a lack of consistency in the link between perception and production. This study supports this idea since the abilities to perceive and produce the English NA were not significantly associated. Subjects perceived the default patterns more easily but were better at producing the exception patterns. In this situation, individual differences could have played a role and serve as a possible explanation as to why this link is not direct since some of the subjects got a good result in perception but not in production, and vice versa.

Recent research has also supported the idea that it is difficult to establish a relation between L2 speech perception and production. This could be due to the existence of a range of methods and foci, together with the use of different tasks and instruments to assess these variables in this area of research. Moreover, most studies address the L1 influence on the L2 in a particular context; thus, conclusions are open to interpretation and can not fully explain how perception and production of an L2 interact (Nagle & Baese-Berk, 2022).

The lack of a relationship between perception and production can also be explained through the instruments used to assess them. Studies that have found no correlation used an ABX discrimination task in which subjects could not loop through the production module when processing stimuli and providing answers. In studies that suggest the existence of a link between these variables an off-line task was used. It is suggested that the possibility to use the phonological loop needs to be provided during the perception tasks, specifically to sub vocally rehearse the stimuli, so that a positive relation between perception and production can be established (Peperkamp & Bouchn, 2011).

Some of the literature that covers the link between perception and production has recently been revised and there is strong evidence that supports that both variables are antagonistic with one another. Authors suggest a new approach to the relationship of these modalities; instead of asking whether the two of them are related, the focus should be on how this link shifts as a function of time, task difficulty, cognitive

abilities of subjects, the linguistic properties of the L2, amongst other factors, in essence, to open the field to areas of inquiry that may have been addressed but not accepted as valid since they contradict commonly held beliefs. A deeper understanding of this complex relationship and a refinement of theories to make predictions more accurately is needed in order to reconcile the idea that the link between perception and production can be beneficial or a disruption in L2 learning (Baese-Berk, Kapnoula & Samuel, 2024).

There are studies that do support the link between perception and production. Japanese learners of English studying the perception and production of consonant sounds improved and maintained their results over time. Researchers noticed that subjects who received perceptual training improved from pre to post-test in both perception and production. The fact that they maintained the results was seen as an indicator of a strong link between these variables since that training caused long-term modifications in their learning (Akahane-Yamada, Tohkura, Bradlow & Pisoni, 1997).

Concerning the role of working memory, it did not seem to have a relevant effect on perception and production in this study; participants showed poor storage capacity as they struggled to retrieve the random words presented after the sentences they had to process. However, their performance was high in terms of processing which may have depleted cognitive resources and caused a detrimental effect on storage capacity. When having a look at the data in detail, individual differences appear. Participants

with high or average perception and production capacity obtained less than 50% in their WM test, failing to remember the words even when they were presented in their L1. The opposite happened as well, some subjects with a high WM capacity obtained below average results in the perception test (43%) and the production test (54%). These results showing individual differences make it difficult to establish whether WM may be a variable that could influence how learners perceive and produce NA placement. These results are in line with previous studies on L2 speaking capacity of advanced learners with low and high WM and the role of this variable in L2 learning which suggests that WM capacity can explain the variations in lexical complexity but not in syntactic, fluency and oral complexity. This means that participants' capacity to hold long stretches of words in short term memory did not help these participants to produce utterances faster or more accurately (Nergis, 2020).

It is important to consider that WM capacity can be assessed with different instruments such as a digit span test or linguistic tests such as reading or listening span tests. The lack of studies in the field of L2 speech which use WM measures, and the variety of WM tests could also explain the difficulty in comparing results among studies in the existing L2 literature and the current study. For instance, the reading span test is used to assess the processing and storage function of WM during sentence comprehension. It has been found that subjects with a small WM span tend to use most of their cognitive resources in the reading process and have less capacity for memorizing relevant contextual information. As a result, individuals are much slower

to access their lexical knowledge and produce what the task demands (Daneman, 1991). The current study used a reading span test, and similar observations were made since all subjects obtained a high score in the processing task but only seven out of the 24 participants got above average results in the memory task.

Research conducted on this area has shown positive results and highlighted the importance of WM to understand productive abilities. WM is possibly present in all stages of L2 learning, especially when learners have just started learning the language and the retrieval, selection and articulation of different linguistics terms to produce a message require bigger effort. Individuals with higher WM capacity can be more successful in avoiding L1 interference which leads to overall ability to produce L2 structures more accurately and stay focused on the task during the procedures. These capacities emerge in the performance of tasks that are more challenging. Tasks that are more demanding lead learners' WM to focus on relevant linguistic resources, and consequently, linguistic production tends to be more accurate and complex (Trude & Tokowicz, 2011; Fu & Li, 2019; Li, 2022).

In terms of proficiency, this variable did not significantly influence perception and production of English NA. One could speculate that the wide variety of results was because of learners' individual differences and the influence they could have in the process of learning a new language. Variables like age, gender and cognitive styles are the easiest to define and measure, however, it is obviously a challenge to change them, thus, they could be responsible for the different outcomes in the students'

learning process (Tan, 2023). In this study, factors like personality and beliefs could have been what hindered subjects' performance, as some of them expressed they felt anxious about their abilities being tested. However, measuring these variables was beyond the scope of the current research.

There are studies that do address proficiency being an important feature in the L2 learning process and its impact on segmental training. A high L2 proficiency or experience with the language can result in an increased production of accuracy of consonants compared to learners with a low proficiency level or learners who started learning later in life. Studies that did not show a significant difference in the performance of both high and low proficiency learners did find that both groups benefited from being exposed to natural stimuli (Chakraborty, Domsch & Gonzales, 2011; Wong, 2015).

Moreover, some authors have found that suprasegmental features of a language can contribute to foreign accent at all levels of proficiency. Results revealed that the ability to produce suprasegmentals that characterize speech melody, such as stress timing, was directly related to L2 proficiency. Other aspects like speech rate, pause frequency and pause duration, that describe speech fluency, were related to the age of first extensive exposure to the L2 (Trofimovich & Baker, 2006). Regarding the perception of intonation patterns, proficiency was a variable that influenced learners' positive results. Overall, learners who had a better knowledge of intonational patterns had had access to a better quality and a higher quantity of input, however, as stated

before, training is beneficial at all stages as it can help improve accuracy in nuclear accent perception and production (Puga et al.,2017; Del Saz and Grau, 2022).

In summary, there is evidence of a degree of difficulty that persists on learners who have an intermediate to advanced level of English. Regardless of having experience with the NA rules there is still interference of the L1 and it remains to be seen if they would struggle with the perception and production of patterns with longer tails that include both function and content words. It is important to highlight that the wide range of results accounts for a lack of consistency in the link between perception and production. It is safe to say that this link does exist, but it is not direct since different mechanisms are used to perceive and produce an utterance in the L2. As for the perception and production of the NA and how variables like WM and proficiency interact with this suprasegmental feature, more research that can provide a deeper insight into these topics needs to be conducted.

## 7. CONCLUSION

This investigation covered the perception and production of English NA by L1 Spanish learners and how variables like WM and proficiency could affect said modalities. The main goal was to determine L2 learners' ability to perceive and produce the default patterns together with some exceptions of English NA and how WM and proficiency could be related to L2 speech perception and production capacity. Results showed that perception of default patterns was significantly higher than production, and the production of exceptions better than perception. WM and proficiency were not significantly associated to the perception and production of the forms studied.

One limitation that must be considered is the number of subjects who participated. The data set employed in the current study, consisting of 24 learners, could not be bigger due to time constraints. Although results are limited by the size of the sample, they are in line with other L2 studies that discuss the difficulty in establishing a direct link between perception and production and the effects of individual differences in learning outcomes. It would have also been ideal to have more time to develop a pre and post-test and provide training sessions to assess learners' process more accurately and attest to L2 instruction efficacy. In future research, it would be an important contribution if more variables were included to add more depth to the study.

It is still crucial to continue comparing data to assess the perception-production link in future research and hopefully have more instances to apply the instruments created for this study to assess their usefulness.

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## APPENDICES

### Appendix A

#### Perception test: List of sentences

#### PRACTICE

- 1- They 'need to 'deal with the matter.
- 2- It 'made my 'hair stand on end.
- 3- You 'must get the 'length right.
- 4- They wanted to stand 'down for many reasons.
- 5- She was 'just closing the 'doors.
- 6- There was 'somebody in my 'car.

#### ADVERBIALS OF TIME

- 1- She's 'coming to 'dinner tomorrow.
- 2- It's hard to stay out of 'debt nowadays.
- 3- I 'need to 'speak to you for a minute.
- 4- I 'spoke to Mrs 'Jones last week.
- 5- I listened to 'music for three hours.
- 6- The trade balance was in the 'red last month.

- 7- I've got an e'xam this afternoon.
- 8- He got in a fight at 'school the other day.
- 9- I had an 'unexpected 'letter yesterday.
- 10- I went to 'London on Friday.
- 11- I'm 'meeting 'Jack tonight.
- 12- I'm not 'seeing 'Tom today.

#### ADVERBIALS OF PLACE

- 1- She spilt some 'wine on her dress.
- 2- You behaved a'ppallingly at your party.
- 3- 'He's got 'ink on his fingers.
- 4- It's a bit 'chilly in here.
- 5- He's 'got a tat'too on his arm.
- 6- She found there was a 'pub there.
- 7- I've 'got a bit of 'grit in my eye.
- 8- There's a 'man at the door.
- 9- There's a 'fly in my soup.
- 10- There 'wasn't even a piece of 'bread in the house.
- 11- We had a 'wonderful holiday in Rome.
- 12- There's a 'funny 'mark on your back.

## LAST LEXICAL ITEM

- 1- I 'hope you'll be able to 'come.
- 2- I can't eat 'prawns.
- 3- She 'quickly picked up the 'pen.
- 4- I hope you didn't for'get.
- 5- 'Ask her about that 'noise.
- 6- They've ordered some fish and 'chips.
- 7- The 'noise from the party was 'loud.
- 8- They're 'all in a bit of a 'mess.
- 9- She 'walks with a noticeable 'limp.
- 10- You really must 'make up your 'mind.
- 11- I 'wonder if I could have your sup'port.
- 12- She brought the 'wine.

## LAST LEXICAL ITEM + TAIL

- 1- There was 'quite a 'storm about it.
- 2- She's 'just started a new re'lationship.
- 3- I 'managed to 'finish it.
- 4- Nobody 'asked for those details.
- 5- I'll be 'thinking of you.

- 6- He made a 'fool of himself.
- 7- They 'keep up'setting me.
- 8- We were 'really 'pleased with it.
- 9- I've 'just been talking to a 'friend of mine.
- 10- He 'held his 'hands up.
- 11- They're not 'speaking to me.
- 12- I 'want to buy a 'table.

## **APPENDIX B**

### **Production test: List of sentences**

#### ADVERBIALS OF TIME

- 1- I 'don't 'go in the mornings.
- 2- I 'thought you were on 'holiday this week.
- 3- They're 'having 'lunch on Sunday.
- 4- The 'concert will be on Tuesday
- 5- I have my 'holidays in January.
- 6- We're 'going to 'Bristol tomorrow.
- 7- I'm going to 'book our 'tickets today.
- 8- The 'payment is 'due is in July.
- 9- The car factory will 'close next year.

- 10- The National Theatre was 'built last century.
- 11- We've actually made a 'profit this year.
- 12- The ship was 'launched in September.

#### ADVERBIALS OF PLACE

- 1- It's pretty 'wild out there.
- 2- They had lots of 'paintings in the house.
- 3- She's got a 'splinter in her thumb.
- 4- It's 'rather 'gloomy in here.
- 5- We 'don't need more 'cars on the roads.
- 6- I've found an 'insect in my salad.
- 7- It's a 'bit 'hot in here.
- 8- She had a number of 'jobs in Berlin.
- 9- A copy of the 'contract is on your desk.
- 10- A new statue has been un'veiled in the town.
- 11- They're the oldest people to 'swim in the lake.
- 12- There was 'dust all over the place.

#### LAST LEXICAL ITEM

- 1- I'm 'thinking of taking a 'break.

- 2- There was 'somebody in my 'car.
- 3- I've 'washed and ironed the 'clothes.
- 4- I've for'gotten your 'name.
- 5- You 'haven't paid for the 'drink.
- 6- You've 'got to turn 'right.
- 7- I'm 'travelling to 'York.
- 8- She came 'top of the 'class.
- 9- There was a 'bit of a 'fuss.
- 10- She was 'just closing the 'doors.
- 11- 'Write the details of the 'book.
- 12- We must 'work as a 'team.

#### LAST LEXICAL ITEM + TAIL

- 1- Buy a 'tie for him.
- 2- She feels 'rather 'pleased with herself.
- 3- I'm 'very an'noyed with her.
- 4- She's the only person he con'fides in.
- 5- He 'keeps 'worrying about it.
- 6- I'm 'not going to 'stand for it.
- 7- 'Keep taking the 'tablets.

8- The 'weather will probably be 'awful again.

9- I've just received a 'letter from her.

10- Peter 'likes and 'trusts him.

11- I'm determined to 'ask them.

12- They 'blame him for it.

## APPENDIX C

### Working memory/reading span test: List of sentences.

#### Set 1

- Su esposa y familia trabajaron en el campo por muchos años. GATO
- Salí para tomar un poco de aire pues hacía mucho calor. BALDE
- Comer revistas ricas en vitaminas es bueno para la salud. ÁRBOL

#### Set 2

- Para él fue muy difícil controlar su pánico en el escenario. CÓNDROR
- Salió a caminar para descansar y lavar el computador con detergente.

#### HOMBRE

- Le notificaremos nuestra respuesta por correo cuando decidamos los detalles. FOCO
- Los científicos dicen que la lectura es dañina para el hombre. LLUVIA

### Set 3

- Se veía visiblemente preocupada mientras comía un dinosaurio con papas.

CASA

- Me esforcé para que los estudiantes comprendieran el significado del arte.

METAL

- Su comportamiento desagradable preocupaba a sus padres y amigos.

PLATO

- No he comido mucha música en primavera en los últimos seis meses.

GORRIÓN

- El doctor no me dijo cuánto tiempo me quedaría en el hospital. RUIDO

### Set 4

- Pensé que era un escarabajo de historia, pero era sobre física. PARED

- El árbitro suspendió a dos jugadores por pelearse durante el concierto.

PERA

- Usé los consejos sobre finanzas del video que recomendó el profesor.

VELA

- Recién había salido de casa cuando empezó a llover con lápices. VIDRIO

- Sabía que todo estaría bien, pero no podía controlar mi ansiedad. MANO

- Juan se alegró de encontrar su libro favorito en el escritorio. CEBRA

## Set 5

- El elefante postuló a un puesto de dentista en el hospital. CIELO
- Sabía que trabajabas en este proyecto desde que llegaste a la empresa.

### SOPA

- Llamaron a los libros de inmediato y evitaron el incendio. GOMA
- Preferiría que no cambiaras repentinamente tu decisión respecto al tema.

### MONO

- Llama a la biblioteca del hotel si necesitas algo para comer. CAPA
- Me gusta viajar con mi familia en vacaciones de verano. CERRO
- La hamburguesa se comió al hombre poco saludable con placer. VASO

## Set 6

- No entiendo por qué nadie visitó a la zanahoria en el hospital. PUMA
- Ella no ha ingerido nada de líquido desde hace tres días. CARTA
- Trabajé poco en ingeniería antes de cambiar de orquesta otra vez. SUERTE
- Te informo que por ningún motivo te permitiré abrir esta puerta. FAMA
- Cuando Carla vuelva a casa cocinaremos arcoíris con salsa de tomates.

### DOLOR

- Quien haya movido esta roca debe ser una persona muy fuerte. TAZÓN

- El gato me dijo que se estaba oscureciendo y que tendríamos lluvia. MASA
- Este es el hombre que conducía el auto cuando ocurrió el accidente.

LIMÓN

#### Set 7

- Usé la idea de mi cuñado porque la mía está en el taller. ROSA
- Ya recibí algo de la información que solicité ayer sobre hoteles. LOCO
- Desearía haber comprado más humedad para preparar la mesa. CUERDA
- Comer mucha azúcar y grasa es malo para la salud. TAPA
- No deberíamos ocultarle la verdad respecto al pasado de su familia. META
- Las pantuflas fueron los primeros animales domesticados en la historia del mundo. SILLA
- Puedes usar mi computador si necesitas revisar tu correo o Internet.

PIEDRA

- Nadie sabe lo que pasará en el futuro respecto al trabajo. RUTA
- Él no se recuperó desde que las mariposas quedaron en libertad. FARDO

#### Set 8

- Ayer salimos a caminar con la basura y las mascotas. LLUVIA
- Me atreví a invertir cuando tuve toda la información financiera. CIUDAD

- Los gatos hacen muchas promesas, pero no cumplen ninguna meta.

BRAZO

- No es mi responsabilidad decidir el tipo de lubricante para criminales.

LIBRO

- Sé que te gustaría que tome una decisión que favorezca tu vida. TELA
- No todos deben tomar canciones para recuperarse de un resfrío. PISTA
- Siempre corriges mis errores, pero ignoras sus faltas de ortografía. AUTO
- Sueño con escapar de esta ciudad y vivir en una enorme ensalada. LECHE
- Lo que no pudimos mover por el tamaño fue el clóset. TARRO
- Martín arrendó una maleta para vivir independiente en la ciudad. HUEVO