PART I

Language acquisition

The development of intonation in L2 Spanish

A perceptual study

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This study explores the perceptual development of intonation in questions and statements in L2 Spanish. It presents cross-sectional data from 189 L2 learners from five different proficiency levels and 10 Spanish native controls. Participants performed an intonation matching task consisting of deciding whether sentences presented aurally and visually matched. Perception accuracy and reaction time results are consistent with the gradual acquisition of intonational cues, particularly for statements and yes-no questions. Statements are identified faster and more accurately than yes-no questions, suggesting that the latter are harder to process and acquire. Consistent with Trimble (2013) and Nibert (2005, 2006), our findings suggest that intermediate II learners are beginning to acquire the intonational cues that distinguish statements from yes-no questions in Spanish.

Keywords: intonation, perception, cross-sectional study, acquisition of L2 Spanish, statements, yes-no questions, L1 transfer, processing

1. Introduction

The goal of the present study is to contribute to our understanding of how intonation develops in second language (L2) learners. Intonation (i.e., the melodic pattern of a sentence) is used in languages to demarcate syntactic constituents, indicate focus, and distinguish between sentence types. An example is given in (1); in Spanish (and usually in English), statements are realized with falling final intonation, whereas yes-no questions are typically rising (see for example Navarro Tomás, 1944; Pierrehumbert, 1980). Intonation can also convey attitude, emotion and a range of other affective meanings (Levis, 2002).

https://doi.org/10.1075/ihll.26.01bra

(1) Intonation in statements and yes-no questions
(adapted from Zsiga, 2013, p. 392)

a. Statements: *Eres* *un hombre lobo* L%
(You) are a werewolf.

b. Yes-no questions: *¿Eres* *un hombre lobo?* (H)H%
Are (you) a werewolf?

From an acquisition perspective, intonation is essential to understand and detect foreign accent (Munro, 1995). Language learners frequently interpret native intonation incorrectly, which leads to comprehension and communication problems, particularly at beginning proficiency levels (Anderson-Hsieh, Johnson, & Koehler 1992; Mennen, 2004; Munro & Derwing, 1995; Trofimovich & Baker, 2006). In addition, intonation is seldom taught in the classroom and is one of the last areas of pronunciation mastered by L2 learners (Kvavik, 1976; Kvavik & Olsen, 1974; Mantini, 1980).

Despite its relevance, the acquisition of intonation is scarcely explored, especially for adult L2 learners (Simonet, 2012; Henriksen, 2014; Mennen, 2014). For L2 Spanish, a handful of studies provide us with a preliminary view of the development of intonation from a production point of view. Specifically, Henriksen, Geeslin, and Willis (2010), Thornberry (2014) and Craft (2015) compare L2 Spanish intonation in statements and questions at the beginning and end of study-abroad programs lasting either one semester or a few weeks. Results are mixed: Henriksen et al. (2010) and Thornberry (2014) find more native-like intonation at the end of the immersion program for some of the L2 participants, but Craft (2015) does not. As Craft (2015) states, motivation and degree of immersion and language contact during study abroad programs are important factors in the acquisition of L2 intonation and need to be explored further.

Perceptual studies are even scanter. Nibert (2005, 2006) explores whether L2 Spanish learners from different proficiency levels perceive intonational phrasing patterns (phrase accents) in English and Spanish. Participants were presented with a perception task consisting of sentences such as 'lilas y lirios amarillos', which can be interpreted as 'yellow lilacs and yellow irises', or 'lilacs and yellow irises'. In order to correctly disambiguate them, participants had to pay attention to intonational phrasing patterns. Nibert found that all L2 learners could perceive and interpret phrase accents in syntactically simple sentences, but only intermediate and advanced learners were able to do so in more complex sentences. Her results show a gradual development in the perception of L2 intonation patterns (beginner responses were more limited than intermediate learners'), and that native-like

perception and interpretation is possible for L2 learners, since advanced learners could interpret sentences nearly as well as native speakers.

A more recent perceptual study is Trimble (2013), who focuses on the intonational differences between statements and yes-no questions. Participants were presented with a gating listening task in which they were asked to indicate whether they heard a statement or a yes-no question. Participants listened to each token sentence, which they simultaneously read (without punctuation) on a computer screen. On average, L2 learners identified statements more accurately than yes-no questions. Accuracy greatly improved when participants heard the whole sentence rather than only part of it. In general, intermediate/advanced learners were more accurate than beginning learners. Additionally, the identification of yes-no questions was easier if the input was Northern Peninsular Spanish rather than Venezuelan Spanish, unless L2 learners had spent a semester or longer studying abroad in Venezuela.

Trimble (2013) suggests that similarities in intonational characteristics between American English and Northern Peninsular Spanish was conducive to the correct identification of yes-no questions in this dialect; on the other hand, the different intonational pattern exhibited by yes-no questions in Venezuelan Spanish (usually involving final circumflex or 'rising-falling' contours) made identification harder. Trimble's results also provide evidence that prolonged exposure to a second language (via study abroad programs) positively impacts the perception of L2 intonation.

The present project contributes to the perceptual investigation of L2 Spanish acquisition pioneered by Nibert (2005, 2006) and Trimble (2013). Specifically, it examines how L1 English speakers learning Spanish in a classroom setting perceive the intonation of two types of statements (broad-focus and narrow-focus) and two types of questions (*wh* and yes-no) at varied proficiency levels. The study is based on an intonation matching task in which participants have to decide whether sentences presented aurally match sentences presented visually. It includes a larger number of participants (189) than previous perceptual studies on L2 Spanish, and a higher number of proficiency levels (beginner I, beginner II, intermediate I, intermediate II, and advanced). It also includes a control group of 10 native Spanish speakers (henceforth NS) for comparison. The input included in the intonation-matching task comes from eight different Spanish dialectal areas, reflecting the varied input that L2 learners in classroom settings in North America are exposed to in institutions of higher learning.

The structure of this paper is as follows. Section 2 presents the methodology and hypotheses of our perceptual study. Sections 3, 4 outline and discuss the main results obtained, and Section 5 offers concluding remarks and avenues for further investigation.

2. Methodology

2.1 Participants

A total of 194 L2 participants were recruited from Spanish classes at Florida State University (FSU) in Fall 2015 and Spring 2016. All were L1 English/L2 Spanish late learners who reported first exposure to Spanish language learning at 12.2 years on average.[1] Data from five participants was thrown out because of outlier values. Additionally, 10 native Spanish speakers also participated in the study. Table 1 displays more details about the participants.[2]

Table 1. Participant characteristics by group

		Gender		Age	
Group	**Number**	**Male**	**Female**	**Mean**	**Range**
Beginner I	38	20	18	20.2	19–23
Beginner II	35	12	23	19.9	18–21
Intermediate I	41	8	33	20.9	19–36
Intermediate II	22	7	15	20	18–22
Advanced	53	14	39	19.9	18–21
L1 Spanish	10	7	2	31.1	21–51
Total	**199**	**68**	**130**	**22**	**18–51**

Proficiency level was based on the Spanish course(s) in which students were enrolled.[3] Beginner I through intermediate I participants were enrolled in semesters one through three of Spanish language study. Half of this participant group attended classes with non-native instructors, and half with native Spanish instructors from Honduras, Mexico, or Spain. Intermediate II learners were enrolled in third-year Spanish grammar and conversation classes taught by instructors from

1. Although geographical background information was not collected, based on FSU student statistics <https://www.fsu.edu/about/students.html> and our experience with students taking Spanish in our institution, we are certain that most of them were from Florida.

2. L2 participants were compensated with extra credit for their participation; NS participants with $10.

3. Placement in Spanish courses is determined by a written exam and/or completion of previous required courses in the Spanish language sequence. Because these procedures are rigorous, it is reasonable to assume that Spanish course level is an appropriate reflection of proficiency.

Colombia or Spain. The advanced learner group was recruited from upper-level Spanish literature courses taught by near-native speakers of Spanish.[4] Finally, L1 Spanish participants were graduate students attending our institution from a variety of Spanish-speaking countries; they were not teaching any of the L2 participants at the time.

2.2 Materials

Target stimuli were designed for four different sentence types: (i) narrow focus statements, (ii) broad focus statements, (iii) absolute interrogatives (yes-no questions), and (iv) partial interrogatives (wh-questions). As shown in Table 2, for each of these conditions, 16 target sentences were presented; half displayed matching intonation between aural and written stimuli, and half were mismatched in both modalities. There were a total of 64 target items interspersed with 64 filler sentences, half statements and half interrogatives. All fillers matched on intonation between aural and visual stimuli, but varied in terms of content. Half of the statement and interrogative fillers were complete mismatches (i.e., all of the words in the sentence were different in the visual and aural stimuli). The remaining fillers differed only on the content of the one determiner phrase (DP), either sentence-initial (subject) or final (object).

Table 2. Experimental stimuli

Type	Condition	Number and match type	
Targets (64)	Broad focus statements	8 Match	8 Mismatch
	Narrow focus statements	8 Match	8 Mismatch
	Yes-no questions	8 Match	8 Mismatch
	Wh-questions	8 Match	8 Mismatch
Fillers (64)	Distractors	32 Complete semantic mismatch 16 First DP mismatch 16 Last DP mismatch	

Wh-questions differ intonationally from yes-no questions and statements in both English and Spanish, and serve as a baseline measurement of participants' perception of intonation when complemented by morphosyntactic variation. Their

4. Due to the limited number of instructors teaching levels beyond Intermediate I, recruiting from courses taught by both native and non-native instructors was not possible at the time of data collection. However, statistical analysis shows no effect for instructor type; see Section 3.3.

inclusion also provided variety in the stimuli presented, reduced redundancy, and provided a control to ensure participants remained on task. In contrast, fillers relied exclusively on lexical and syntactic mismatching.

Voiceovers for the perceptual study were recorded by 8 NS representing a variety of Spanish dialects, in order to ensure that our aural stimuli closely represented the L1 input that the learner groups receive in Spanish language classrooms (Table 3). In order to promote semantic comprehension of the materials, the vocabulary selected for targets and fillers came from the textbook used in our institution for Beginning Spanish I and II.

Table 3. Dialect and gender of 8 voiceover speakers

Country of origin	Gender
Argentina	Male
Bolivia	Female
Colombia	Male
Cuba	Female
Mexico	Female
Spain	Male
Peru	Male
Puerto Rico	Female

Informants were presented with a list of broad focus statements, yes-no questions and wh-questions, and were asked to read them as naturally as possible. For narrow focus statements, informants were instructed to read each target sentence after the interviewer asked the relevant corresponding question, as in (2):

(2) Example of narrow-focus prompting[5]
   a. Interviewer: *¿Adónde iba Daniel?*
      Where was Daniel going?
   b. Informant: *Daniel iba a **Bolivia**.*
      Daniel was going to Bolivia.

5. The focus of our investigation was pragmatically neutral information-seeking questions. Therefore, we elicited non-contrastive narrow-focus rather than contrastive focus (such as in '*¿Daniel iba a Perú?*' Daniel was going to Peru? '*(No), Daniel iba a **Bolivia**.*' No, Daniel was going to Bolivia). Both contrastive and information-seeking narrow focus statements can show intonational differences compared to broad-focus statements; see for example Chung (2012) and references therein.

2.3 Procedure

Participants were recruited in person by the investigators and provided informed consent prior to the experimental session, which were completed with entire Spanish classes in the laboratory, with each participant working on their own computer using headphones. After a brief orientation to the lab, participants completed an 8-item practice after which they could ask clarification questions to the investigator. The practice session was immediately followed by the experimental task; both involved SuperLab 5.0.

In the experimental task, participants were directed to listen to a sentence in Spanish and read a related sentence. The prompt *¿Son iguales?* (Are they the same?) appeared on the computer screen below each written sentence; participants responded 'Sí' (Yes) or 'No' using the left/right buttons on Cedrus RB-540 response pads. Table 4 provides sample target stimuli. The session, which lasted 25–50 minutes, concluded with completion of the Bilingual Language Profile online (Birdsong, Gertken, & Amengual, 2012).

Table 4. Sample target stimuli for all conditions

Condition	Aural stimuli	Visual stimuli
Broad focus match	Daniel iba a Bolivia.	Daniel iba a Bolivia.
Broad focus mismatch	Daniel iba a Bolivia.	¿Daniel iba a Bolivia?
Narrow focus match	Daniel iba a **Bolivia**.	Daniel iba a Bolivia.
Narrow focus mismatch	Daniel iba a **Bolivia**.	¿Daniel iba a Bolivia?
Yes-no question match	¿Daniel iba a Bolivia?	¿Daniel iba a Bolivia?
Yes-no question mismatch	¿Daniel iba a Bolivia?	Daniel iba a Bolivia.
Wh-question match	¿Por qué iba Daniel a Bolivia?	¿Por qué iba Daniel a Bolivia?
Wh-question mismatch	¿Por qué iba Daniel a Bolivia?	Daniel iba a Bolivia.

2.4 Analysis

Participants were presented with the aural and written sentences simultaneously. This mitigated any potential confounding effects of variation in participants' working memory, which may have been taxed by the retention required if stimuli were presented separately. For this reason, RTs were measured starting at the onset of presentation of the stimuli. Participants were instructed to read all sentences carefully and respond as quickly and accurately as possible.

Outlier analyses were performed for the reaction time data using the statistical program SPSS 23 (IBM Corp., 2014). Responses were excluded if they were

± 2 standard deviations from a participants' mean or outside the cut-off of 3000 milliseconds (ms.). This affected 2.8% of the data.

The dependent measures were (i) perception accuracy percentage and (ii) reaction times. Unless otherwise noted, participants' responses were analyzed with a 6 × 4 × 2 repeated-measures ANOVA, with *level* (beginner I, beginner II, intermediate I, intermediate II, advanced, L1 Spanish) as the between-subjects variable, and *sentence type* (broad focus, narrow focus, yes-no questions, wh-questions) and *matching condition* (match, mismatch) as within-subjects variables. We also conducted post-hoc analysis of simple main effects with Bonferroni adjustment for multiple-comparisons to further explore any significant main effects or interactions. An alpha level of .05 was used for all statistical analyses.

2.5 Hypotheses

In both Spanish and English, statements, wh-questions and yes-no questions can be considered to have similar final contours (falling for statements and wh-questions, and rising for yes-no questions; see for example Navarro Tomás, 1944; Pierrehumbert, 1980). However, there are clear differences in peak alignment, scaling, pitch accents and (de)accenting in both languages (Estebas-Vilaplana, 2008; García Lecumberri, 1995, 1996; Gutiérrez-Bravo, 2002; Gutiérrez Díez, 2008). As Mennen (2014) points out, it is not only categorical differences in intonation (such as final contours) that can result in acquisition difficulties; their phonetic implementation and relative frequency of occurrence can also contribute to acquisition problems. Therefore, we hypothesize that L2 learners will have lower perceptual accuracy overall than NS, and a different pattern in their reaction times.

From the sentence types investigated, we hypothesize that accuracy and reaction times in L2 learners will differ from NS the most for yes-no questions. The main reason is that while in Spanish they are primarily characterized by final rising intonation, in English they are typically realized with verb or auxiliary fronting (cf. 1a, 1b) or do-support. On the other hand, accuracy and reaction times for L2 learners will be closer to NS for wh-questions, since their salient word-order will probably make them easier to perceive and process than other sentence types.

Finally, following results from the perceptual studies in Nibert (2005, 2006) and Trimble (2013), we expect a gradual increase in perception accuracy across proficiency groups, with the highest expected accuracy in advanced L2 learners and NS. We also expect that reaction times of more advanced L2 learners will be closer to those of the NS than in lower proficiency groups. These three hypotheses are summarized in (3) below:

(3) Hypotheses
   a. H1: L2 learners will have lower accuracy and reaction times than NS
   b. H2: L2 learners will have lowest accuracy for yes-no questions, and highest for wh-questions. Reaction times will be closer to those of NS for the latter.
   c. H3: Intermediate learners will have higher accuracy than beginning learners, and advanced learners will approach or reach NS accuracy. RT will be closer to NS in more advanced proficiency levels.

3. Results

3.1 Perception accuracy

Results for accuracy are given in Tables 5, 6.[6] Overall, there was a significant effect for level, $F(5, 193) = 28.9$, $p < .001$, $\eta^2_{partial} = .429$. The analysis of simple main effects indicated no significant difference on accuracy among the three lowest proficiency levels (beginner I, II and intermediate I) ($p = 1.000$). These levels had the lowest percentage of perception accuracy, which was higher in the intermediate II ($p < .001$), and advanced level ($p < .001$). Spanish NS had the highest perception accuracy percentage overall ($p < .001$). These results provide support for H1 and H3.

Table 5. Perception accuracy for statements

		Broad focus statements				Narrow focus statements			
		Match		Mismatch		Match		Mismatch	
Level	***N***	***%***	***SD***	***%***	***SD***	***%***	***SD***	***%***	***SD***
Beginner I	38	93.6	8.4	7.1	10.1	94.1	9.2	9.3	12.2
Beginner II	35	95.3	6.9	12.4	22.9	95.6	9.1	12.1	21.7
Interm. I	41	92.7	10.1	8.9	18.1	94.7	9.1	7.2	17.8
Interm. II	22	94.2	6.5	30.1	34.6	96.1	5.9	33.2	34.9
Advanced	53	94.1	7.7	34.4	36.9	95.9	6.8	30.4	35.1
L1 Span.	10	100	0	76.3	35.1	100	0	81.4	31.9

6. Accuracy for fillers was 98.8% for NS, and 93.9% for all L2 groups combined.

Table 6. Perception accuracy for questions

		Yes-no questions				Wh-questions			
		Match		Mismatch		Match		Mismatch	
Level	*N*	*%*	*SD*	*%*	*SD*	*%*	*SD*	*%*	*SD*
Beginner I	38	94.3	8.6	6.5	9.5	91.3	14.8	65.7	29.7
Beginner II	35	94.9	9.7	6.1	10.7	91.8	12.7	74.4	26.7
Interm. I	41	96.6	8.3	5.1	12.3	94.2	7.8	82.5	21.4
Interm. II	22	98.3	4.4	11.9	14.5	96.4	8.4	96.9	9.6
Advanced	53	97.4	5.7	13.7	21.5	96.2	8.4	92.1	13.2
L1 Spanish	10	97.3	5.7	61.1	35.9	98.8	3.9	97.5	7.9

Accuracy was very high (>91%) in match conditions but not in all mismatch conditions, where it is below chance for all L2 levels for all sentence types except wh-questions. This difference is significant, $F(1, 193) = 1281.3$, $p < .001$, $\eta^2_{partial} = .869$. Pairwise comparisons indicated higher accuracy in match sentences compared to mismatch ones in all proficiency levels ($p < .001$; see Figure 1). This shows that mismatch conditions were harder than match conditions.

In addition, there was a significant effect for sentence type, $F(3, 579) = 311.4$, $p < .001$, $\eta^2_{partial} = .617$. The analysis of simple main effects indicated that wh-questions had the highest accuracy percentage in all proficiency levels ($p < .001$). This provides partial support for H2. The analysis also revealed no significant differences between the accuracy of broad focus and narrow focus statements at any proficiency levels ($p > .05$; Figure 2).

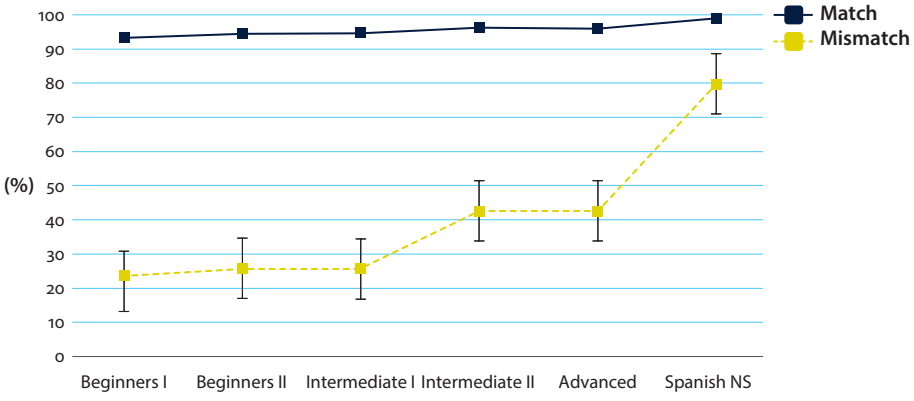

Figure 1. Perception accuracy in match and mismatch conditions for all levels

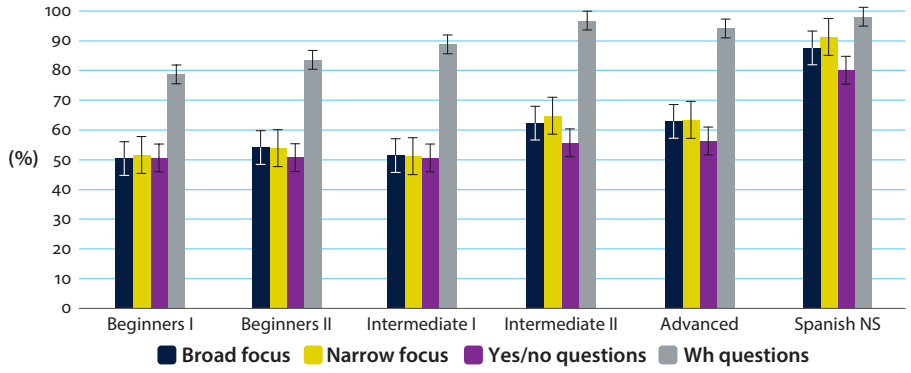

Figure 2. Perception accuracy by sentence type and level

There was a significant interaction between level × sentence type, $F(5, 193) = 3.58$, $p = .004$, $\eta^2_{partial} = .085$. Pairwise comparisons between both statement types and yes-no questions reveal no significant differences between beginner I, II, and intermediate I groups ($p > .05$). The intermediate II group was significantly different from these three levels in all mismatched conditions ($p < .05$). In addition, the advanced group was significantly different from intermediate II, and beginner I and II in mismatch statements and yes-no questions ($p < .05$). The NS group was significantly different from all others in mismatch statements and yes-no questions ($p < .001$; see Figure 3). This provides further support for H3.

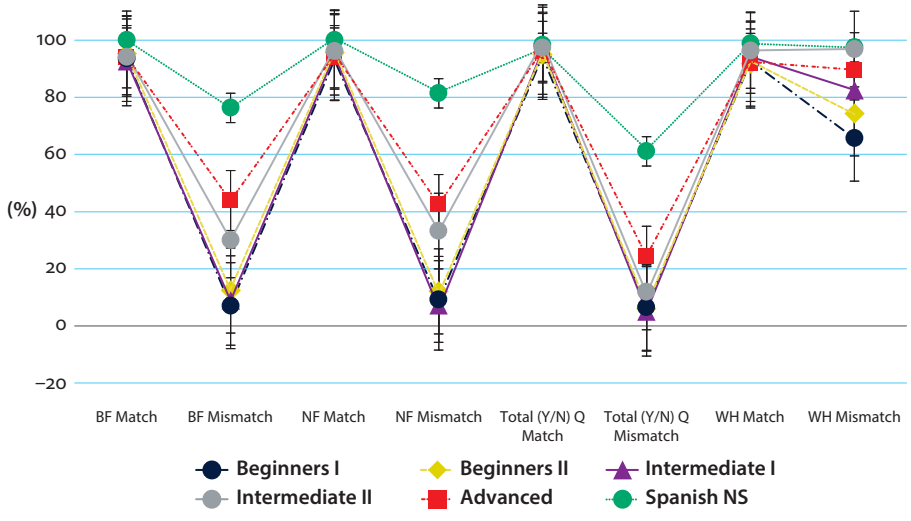

Figure 3. Level and sentence type interaction for perception accuracy.

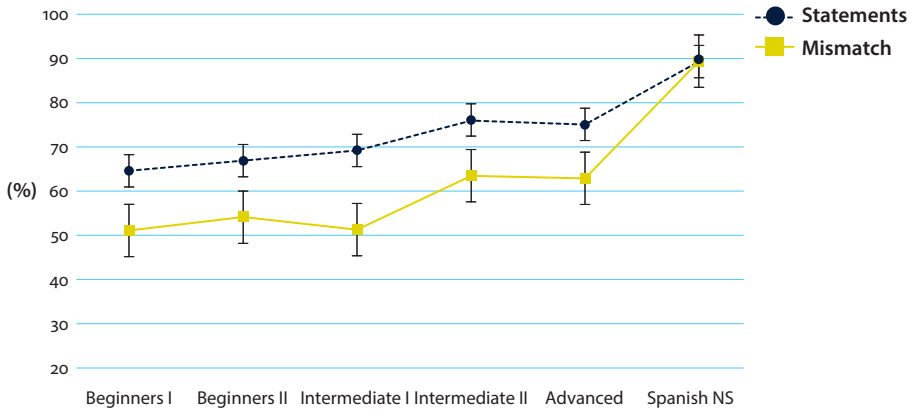

Figure 4. Perception accuracy for statements and questions for all levels

A 6 × 2 × 2 repeated measures ANOVA showed a significant effect for statements (broad and narrow focus) versus questions (yes-no and *wh*), $F(1, 193) = 113.4$, $p < .001$, $\eta^2_{partial} = .370$. Pairwise comparisons indicated that statements had a lower perception accuracy rate compared to questions at all proficiency levels ($p < .001$). The exception was the NS, who had similar accuracy rates in both ($p = .973$; see Figure 4). However, these results could be misleading, since wh-questions have the highest accuracy and yes-no questions the lowest. A comparison between statements and yes-no questions show that the three lowest proficiency levels performed similarly; i.e., they had high perception accuracy in the match condition, but low accuracy in the mismatch condition (Tables 5, 6), with no statistical difference between statements and yes-no questions ($p > .05$). On the other hand, the intermediate II and advanced groups display a similar pattern in the match condition, but significantly higher accuracy in the mismatch condition for statements than for yes-no questions (intermediate II group: $p < .016$; advanced group: $p < .001$).

Summarizing this section, overall accuracy results support H1 and H3, and partially support H2 (for wh-questions). In addition, although accuracy in mismatch conditions is below chance for L2 learners in all sentences except wh-questions, intermediate II and advanced L2 learners show significant differences between statements and yes-no questions in this context, unlike the three lowest proficiency levels. This finding suggests that yes-no questions are the hardest type of sentence to perceive/process, supporting H2, and also provides additional evidence for the gradual development of intonation, supporting H3. Results from the NS group, which shows lower accuracy in mismatch yes-no questions than in statements, also suggest that the intonational properties of the former are more difficult to perceive/process than the latter.

3.2 Reaction times

Tables 7 and 8 provide reaction time (RT) means and standard deviations for statements and questions, respectively. A significant effect obtained for level, $F(5, 193) = 4.94$, $p < .001$, $\eta^2_{partial} = .113$. The analysis of simple main effects revealed that the intermediate II group is the fastest of all groups for all sentence types. On the other hand, NS had the longest RTs. These results are consistent with the NS realizing at an early point of the study that the intonation of questions and statements was being tested. Their longer RTs reflect that they were taking longer to process sentences to make sure they were attending to the intonational cues in the stimuli.

There was a significant effect of matching condition, $F(1, 193) = 43.42$, $p < .001$, $\eta^2_{partial} = .184$; matched sentences were processed faster than mismatched sentences in all groups ($p < .05$) except for the intermediate II group ($p = .19$) and the NS ($p = .09$). As with accuracy, this confirms that mismatched conditions were harder.

Table 7. Reaction times: Statements

	Broad Focus					**Narrow Focus**				
	Match		**Mismatch**			**Match**		**Mismatch**		
Level	***M***	***SD***	***M***	***SD***	***Diff.***	***M***	***SD***	***M***	***SD***	***Diff.***
Begin. I	1600	441	1875	516	275	1572	417	1781	478	209
Begin. II	1593	321	1838	447	245	1659	378	1801	375	142
Interm. I	1727	491	1971	522	244	1841	428	1946	467	105
Interm. II	1333	356	1713	398	380	1393	368	1606	399	213
Advanced	1482	403	1827	471	345	1532	355	1853	493	321
L1 Span.	1511	243	2005	460	494	1664	269	1902	461	238

Table 8. Reaction times: Questions

	Yes-no questions					**Wh-questions**				
	Match		**Mismatch**			**Match**		**Mismatch**		
Level	***M***	***SD***	***M***	***SD***	***Diff.***	***M***	***SD***	***M***	***SD***	***Diff.***
Begin. I	1651	482	1676	471	25	2009	588	1942	568	−67
Begin. II	1655	377	1733	365	78	2094	509	2120	523	26
Interm. I	1827	477	1875	436	48	2278	458	2094	575	−184
Interm. II	1325	314	1597	378	272	1617	395	1602	658	−15
Advanced	1521	406	1824	500	303	1938	478	1655	457	−283
L1 Span.	1882	410	2199	620	317	2176	378	1670	504	−506

There was also a significant effect for sentence type, $F(3, 579) = 33.13$, $p < .001$, $\eta^2_{partial} = .147$, with statements and yes-no questions being processed faster than wh-questions in all groups ($p < .001$) except in the intermediate II group ($p > .05$) and the Spanish NS ($p > .05$).

A significant interaction of level x sentence type was found, $F(35, 1351) = 2.82$, $p < .001$, $\eta^2_{partial} = .068$. Pairwise comparisons showed that beginner and intermediate I levels performed similarly, with longer RTs in mismatch sentences in all conditions ($p < .05$). The exception was yes-no questions, where RTs were comparable in both matching conditions ($p > .05$; see also Figure 5). On the other hand, the intermediate II group had longer RTs in mismatch sentences in all conditions ($p < .01$) except in wh-questions ($p = .900$) while the advanced group had longer RTs in mismatch sentences in all conditions ($p < .001$). The Spanish NS also had longer RTs in mismatch sentences in all conditions ($p < .001$) except in wh-questions ($p = .004$; see Figure 5). The fact that the three lowest proficiency levels had comparable RTs in both matching conditions for yes-no question contexts suggests that they are not perceiving/processing the intonational cues for this sentence type, providing further evidence for H3.

A 6 × 2 × 2 ANOVA was performed to compare statements versus questions. There was a significant main effect for sentence type, $F(1, 193) = 43.75$, $p < .001$, $\eta^2_{partial} = .185$. Pairwise comparisons showed that all L2 learners processed statements faster than questions ($p < .01$) except for the intermediate II group ($p > .05$) and the advanced group ($p = .08$; see Figure 5).

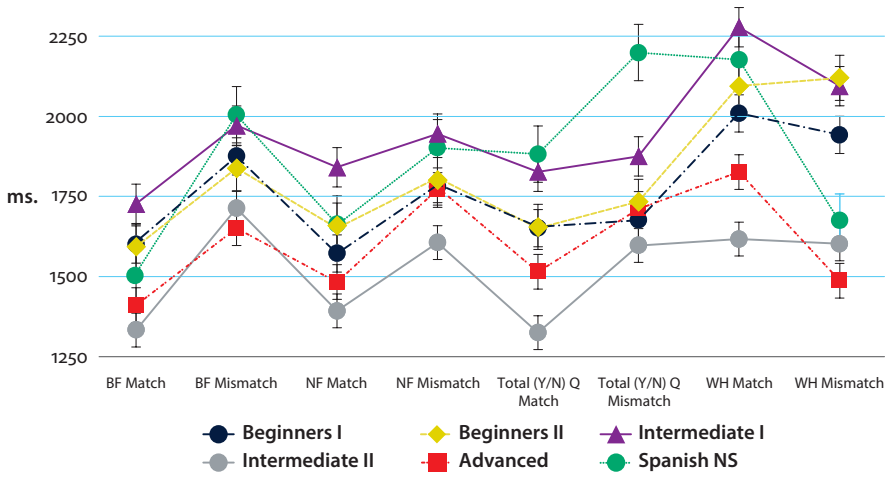

Figure 5. Reaction times (ms.) for all levels

3.3 Instructor type

A separate 6 × 4 × 2 × 2 repeated measures ANOVA with the between-subjects variable 'instructor type' (native vs non-native), was conducted to explore if instructor type was a factor in the perceptual results obtained. No significant effect obtained for accuracy, $F(1, 144) = .648$, $p = .422$, $\eta^2_{partial} = .004$, or RTs, $F(1, 144) = .554$, $p = .458$, $\eta^2_{partial} = .004$. We conclude that instructor type did not affect the perceptual results in the intonation matching task.

3.4 D-prime analysis

To test for a possible bias in participants' responses, we conducted two d-prime sensitivity analyses. The first one was performed using the formula $d' = z(H) - z(F)$ where H = hit rate = 0.236, and F = false alarm rate = 0.194. The d score was $d' = .02$. We also conducted a sensitivity analysis using the formula $1 - \{[4\,h(1 - f) - 2(h - f)\,(1 + h - f)] / [4\,h\,(1 - f) - (h - f)(1 + h - f)]\}$, where: h = the proportion of correct YES responses (i.e., hit rate) = 0.236, and f = the proportion of incorrect YES responses (i.e., false alarm rate) = 0.194.[7] The score obtained was .061 (out of a maximum possible score of 1.00). D-prime values obtained were positive, meaning that participants tended to respond affirmatively to YES trials as opposed to NO trials. We conclude that there is no evidence for bias in their responses.

4. Discussion

The accuracy results described in Section 3.1 provide support for our three hypotheses. Perception accuracy for all sentences investigated is significantly lower for L2 learners than NS overall, supporting H1. Accuracy is higher for wh-questions, which are perceptually salient because of their word-order characteristics, partially supporting H2. More interestingly, we observe significant differences in how accurately statements vs. yes-no questions were perceived in intermediate II and advanced L2 groups in mismatch conditions, but not in lower proficiency levels. This suggests that yes-no questions are the hardest sentence type to process, and that it is only at the intermediate II level that learners are beginning to perceive their intonation cues. This, and the fact that RTs in lower proficiency groups is similar for yes-no questions in matched and mismatched conditions-but significantly different in all other groups-provides further support for H2 and H3.

Thus, accuracy and reaction times results suggests that learners at the intermediate II proficiency level are beginning to acquire the perceptual cues that

7. See Huibregtse et al. (2002) for a justification of this measure.

distinguish statements and yes-no questions in Spanish. Our results coincide in part with those of Trimble (2013) and Nibert (2005, 2006), who found that intermediate learners were more accurate than beginners in perceiving intonational differences between statements and yes-no questions, and better at disambiguating complex sentences via intonation, respectively. However, unlike these studies, we find that the advanced learners in our study are only trending towards the NS ability to use Spanish intonational cues for the sentence types investigated – their RTs are close to those of NS, but their accuracy in mismatch conditions is still below chance for statements and yes-no questions.

Our findings reveal a more gradual pattern of perception development for statements but not for yes-no questions, suggesting that the intonation of statements emerges earlier. Wh-questions are identified more accurately and swiftly overall for all groups, but this is to be expected because of their salient word-order. In addition, no accuracy or RT differences obtained between broad-focus and narrow-focus statements. To the best of our knowledge, the latter perceptual difference has not been tested in L2 Spanish learners before.

In all likelihood, the difficulty of distinguishing yes-no questions from statements in Spanish primarily stems from the fact that English typically uses verb/auxiliary movement to the front of the sentence (or 'do' support) in yes-no questions, but Spanish does not. Thus, although in both languages the most common final contours for statements and yes-no questions are similar, L2 Spanish learners are not paying close attention to these cues. Our results show, however, that higher proficiency levels are able to be significantly more accurate and have reaction times closer to NS. We expect that at even more advanced proficiency levels (such as after significant time spent abroad, or higher exposure to L2 Spanish), perceptual accuracy will continue to improve.

We propose that the combination of intonation/syntactic L1 transfer and the high cognitive demands that beginning learners experience when processing meaning and intonation in the L2 impacts perception accuracy and reaction times. Language processing is cognitively very demanding at the beginning stages of L2 acquisition (VanPatten, 2007), which would explain that beginning and intermediate learners are not able to effectively use intonation as a cue for L2 comprehension due to the heavy cognitive load that L2 language processing imposes on them at this stage.

5. Conclusion

This study contributes to the ongoing investigation of how intonation perception develops in L2 Spanish. Specifically, it provides evidence that L2 perception of

intonation lags behind that of NS – particularly in lower proficiency levels. In addition, it shows that statements are perceived/processed earlier than yes-no questions by L2 learners, and that, consistent with Trimble (2013) and Nibert (2005, 2006), L2 intonation perception appears to undergo a gradual development.

One possible limitation of the study reported here is task-related. Participants were asked if aural and visual stimuli matched, but it is unclear how many of them realized at some point of the experiment whether intonational differences between statements and questions were being tested. Future research should continue to implement innovative experimental designs in order to explore how perception of intonation develops in L2 Spanish. For example, an auditory discrimination task could be conducted in which participants are provided with binary choices and asked to match sentences and questions with auditory input. This might serve as a more explicit test of the perception of intonational cues; its results would also complement the findings from the present study.

Another possible limitation concerns the elicitation and incorporation of broad-focus and narrow-focus statements. Accuracy and reaction times for both statement types were not significantly different; but as noted earlier in the paper, both were elicited differently for the experimental voiceovers. In addition, it is unclear if the task employed was effective in testing for both types of statements, since unlike questions, nothing in the written stimuli signaled focus.

It is unclear to what extent dialectal and/or sociolectal variation could have influenced participants' responses in our experiment. For example, English statements can be realized with final rising intonation ('uptalk') in some dialects and sociolinguistic groups (Warren, 2016 and references therein). In addition, Spanish yes-no questions are 'circumflex' (i.e., display rising-falling final contours) in several dialects, including Venezuelan, Caribbean, and some Northern Peninsular varieties (Hualde, 2005; Robles-Puente, 2011; Sosa, 1999). Trimble (2013) shows that dialectal differences in the realization of yes-no questions results in perceptual difficulties for L2 Spanish learners, especially if they have not been exposed to them before. We have noted that 'uptalk' is common in the L1 of many students at our institution; and we are aware that our participants might differ in their degree of attunement to Spanish intonation variation. Our study did not include yes-no question stimuli from 'circumflex' dialects. Even so, there might be dialectal or sociolectal differences in pitch alignment, pitch ranges and other intonational characteristics that could have impacted perceptual results. The inclusion of voiceovers from NS from different dialects (and genders) is one way to take into account the variation of Spanish intonation that learners in a typical classroom environment encounter. Future research should include dialects not studied here and/or examine the relationship between exposure to specific Spanish varieties in the L2 classroom and intonational perception for these varieties. Trimble (2013)

finds that the intonation of some Spanish dialects is easier than others; there is motivation to explore both the effects of dialect and input type on the development of intonation perception in L2 Spanish, and in L2 more generally.

There is not, to date, a theoretical model available for the acquisition of intonation in L2. Research is also scarce on whether intonation is transferred from the L1 to the L2 (but see Nibert, 2005, 2006) and whether developmental or universal strategies occur at any proficiency level (one exception is Henriksen et al., 2010). Mennen (2014) proposes the *L2 Intonation Learning Theory (LILt)* as a working model for L2 intonation production, based on the investigation of four intonation dimensions that contribute to cross-linguistic differences and difficulties in L2 acquisition: (i) the inventory and distribution of phonological elements in intonation; (ii) its phonetic implementation, (iii) the semantic dimension, involving the function/meaning of intonation, and (iv) the frequency of use of intonation elements. As our understanding of L2 intonation increases, it is hoped that an adequate theoretical framework for L2 intonation perception begins to develop. We also hope that future studies will examine the relationship between L2 intonation production and perception. One follow-up study, currently underway, considers longitudinal data from selected participants from the perception study reported here. It is expected that the detailed acoustic analysis of their intonation, both in L2 Spanish and L1 English, will shed further light on the impact of L1 English transfer and/or developmental strategies in the development of L2 intonation.

Funding

This project was funded in 2015–2016 by a Planning Grant from the Council on Research and Creativity (CRC) and the Undergraduate Research Opportunity Program at Florida State University.

Acknowledgment

We thank our undergraduate research assistants Kelly Bagwell and Mercedes Puig for their help designing and testing material. Thanks also to the Department of Modern Languages and Linguistics for making lab space and technical assistance available. The following instructors were kind enough to give us permission to obtain data collection in their classes: Brenda Cappuccio, Sarah Fluker, Perla Garcia Frutis, Juan Carlos Galeano, Tyler King, Sergio Leiva, Maria Morado Vazquez, Lara Reglero, and Tiffany Robayna. We thank all participants and voice-over informants, without whom we would not have been able to conduct this study. Last but not least, we thank the two anonymous reviewers of this paper for their insightful comments and questions.

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