Statement of Research
Marta Ortega-Llebaria
https://martaortegallebaria.com

I am a phonetician with a background in Hispanic linguistics and laboratory phonology who works on prosody. Prosody refers to the suprasegmental dimensions of speech, such as pitch, duration and intensity that convey melody and meaning to linguistic units of different sizes such as syllables, words, and sentences (thereby making them sound natural, unlike robot speech). Phoneticians have traditionally studied speech based on segmental rather than suprasegmental data. In recent decades, however, seminal work by Beckman (e.g., 1986, 2010) and Ladd (1996, 2008), among others, has provided both a theoretical framework and the analytical tools (e.g., the ToBi transcription system, Beckman & Hirschberg 1994) needed to bring research on prosody to the forefront of the phonetic sciences. It is in this context that I conduct experimental research to explore how the suprasegmental dimensions of speech cue prosodic units such as tone and intonation, stress and accent, and how these prosodic units interact in different populations (e.g., native speakers, second-language learners), languages (e.g., Chinese, English, and Romanian with special emphasis on Catalan and Spanish due to my interest in Hispanic linguistics), and social and non-linguistic variables (e.g., linguistic stereotypes, emotions). The ultimate goal of my research program is to contribute to our understanding of how prosody works, and in doing so, to refine and to extend our knowledge of speech perception into suprasegmental data. This endeavor is particularly important and impactful at the moment because the field of speech perception is currently going through a paradigm change (e.g., Dahan & Magnuson 2006, Heald & Nusbaum 2014, Magnuson et al. 2018) and suprasegmental data may play a key role in defining the new paradigms. Although I addressed these issues exclusively from the field of Hispanic Linguistics in my past research, during my time in Pittsburgh I have developed new lines of inquiry by including tonal languages, different populations, social variables, and new methods expanding the breath of my research and making it more interdisciplinary.

Past research

My research in Pittsburgh emerges from my longstanding focus on understanding the prosodic systems of Catalan and Spanish, in particular, the production and perception of stress and accent in those languages. Stress and accent are expressed via overlapping suprasegmental cues, and accent (or sentence stress) has traditionally been described as a more prominent type of word stress. However, I showed that there is a certain degree of independence between these two units of prominence. For instance, Spanish and Catalan speakers were able to perceive stress in de-accented contexts [e.g., publications **10, 11, 20, 22** as numbered in my CV][1], and words like the preposition 'de' that are intrinsically unstressed can receive a sentence accent in the appropriate contexts **[21]**. Moreover, I showed that stress in Spanish modulates the spectral cues of tautosyllabic consonants **[23]**, and I examined the expression of stress and accent in code-switched words, i.e., Spanish words in an English sentence such as "My daughter likes this *carro* **[19]**. I was also the main person in organizing the fourth iteration of the Laboratory Approaches to Spanish Phonology conference and then edited a volume that published selected contributions from this conference **[27]**.

---

[1] Following my CV, I refer to my published articles by number, e.g., [1] Ortega-Llebaria, Olson & Tuninetti (2018), and to my articles under review by a letter, i.e., [i] Ortega-Llebaria and Wu (under review)

Research directions published at University of Pittsburgh

(1) Tone and intonation in Mandarin-English bilinguals [Articles: 2, 3, i]

In this new research line started at University of Pittsburgh, I investigated the relation of tone and intonation. In Mandarin Chinese, the pitch variation present in the speech signal is used to express both lexical meanings by means of tones (e.g., [ma] spoken with the falling pitch of tone 4 means "to scold" and with the rising pitch of tone 2 means "to bother") and sentence-level meanings by means of intonation (e.g., the last tone in questions has an expanded pitch range in comparison to statements). In contrast, in non-tonal languages like English, the pitch variation present in the speech signal is recruited exclusively to express sentence-level meanings (e.g., "Rose" with a falling pitch is interpreted as a statement and "Rose?" with a rising pitch is interpreted as a question). These cross-language differences in the mappings of pitch forms (e.g., rising pitch, falling pitch) into meanings (e.g., word-level meanings as in Mandarin [ma] and sentence-level meanings as in English "Rose") lead to the two research questions I addressed in this line of research.

<u>*Research question 1:*</u> Does the long-term experience that Chinese-English bilinguals have with tone affect their perception of English intonation? In other words, do Chinese-English bilinguals process pitch in English (i.e., "Rose?" with rising pitch and "Rose" with falling pitch) differently from non-tonal speakers of English, e.g., Spanish speakers of English? We showed that Chinese-English bilinguals processed pitch variation in English words differently from non-tonal speakers and in a manner that was reminiscent of tone **[2]**. According to one of the journal's reviewers, the implications of this finding are important: "This work fills an important gap in the field of bilingualism; mainly how tonal and non-tonal languages interact in bilingual speakers. A very considerable portion of the world's bilinguals fall into this group of speakers who have a tonal L1 and non-tonal L2; however, as the authors correctly note, current models of speech perception in bilinguals fail to adequately incorporate pitch processing mechanisms. This study seeks to remedy this problem. […] It is my view that this study makes a timely and much-needed contribution to the study of bilingualism."

Currently, I am expanding the above results by comparing Mandarin speakers' perception of pitch in English words with similar pitch variations in Mandarin words and non-words in order to control for possible effects of L1 and phonetic salience **[i]**. While results on English words faithfully replicated the effects of tone found in the previous study confirming that Chinese-English bilinguals perceived pitch in English differently from monolinguals, results in Mandarin words and non-words ruled out that these differences were due to L1 transfer and phonetic salience respectively

<u>*Research question 2:*</u> When native Mandarin speakers listening to their native language encounter a pitch contour mapped into both tone and intonation meanings, which meaning do they process first and why? What is the time-course of tone and intonation processing, and what kind of constraints guide it? Previous literature found an overall advantage of tone over intonation processing (e.g., Li et al. 2008). This suggests a sequential processing of pitch in which lexical meanings were mapped before sentence-level meanings into pitch contours. Our findings, however, showed that although the tone processing advantage was present in tones with a dynamic shape (e.g., tone 2 and tone 4), the static shape of tone 1 favored simultaneous processing of tone and intonation **[3]**. Consequently, these results revealed that tonal shape mediated the time-course of tone and intonation processing challenging the linear model of pitch perception and supporting instead a highly interactive model. Reviewers judged these results to be "new and theoretically relevant." In their view, the manuscript was "original" and "of excellent scientific quality."

(2) Lexical stress and sentence pitch-accent in a second language [Articles: 4, 7, 8]

In this second new line of research, I investigated how adult learners of a second language (L2) perceived L2 prosody. More specifically, I addressed the phenomenon of "stress deafness" [8], the effect of context in the perception of L2 sentence intonation [7], and the stress typicality effect [4].

<u>*Stress Deafness*</u> refers to the great difficulty that some speakers experience in perceiving stress in an L2. Previous research showed that this perceptual difficulty was present in speakers of languages with fixed, predictable stress such as Hungarian and French and it was related to the lack of detail in their lexical representations (e.g., Perperkamp et al. 2010). The rationale was that, due to its predictability in their L1, speakers of these languages did not encode stress in their mental lexicons and that, consequently, lexical entries did not contain information on stress causing "stress deafness" in L2. Complementing this explanation, we showed that speakers of languages with unpredictable stress like English and Spanish also experienced "stress deafness" and that this difficulty was related to the encoding of phonetic detail [8]. Proficient English learners of Spanish experienced difficulty perceiving Spanish stress in contexts where phonetic detail represented context-appropriate realizations of stress in Spanish but not in English (see also Domhas et al. 2012, 2013 for the role of phonetic detail in the perception predictable stress). Taken together, these studies provide a more comprehensive view of the "stress deafness" phenomenon and show that L2 stress perception difficulties encompass different causes and levels of processing.

<u>*Context and L2 Sentence Intonation*</u>. In [7], we explored the complex form-meaning mappings in L2 English contrastive-focus (CF) sentences and the effects of enhancing the meaning of CF via contextualized tasks. In other words, we explored whether providing a story (in contrast to random sentences presented in isolation) aided L2 speakers in perceiving and producing the intonation of English CF. Results showed that Chinese and Spanish advanced learners of English successfully imitated the tune of English CF in sentences presented in isolation. Their performance, however, deteriorated in contextualized tasks (especially in Spanish speakers) where the CF meaning was made more obvious by means of a story. These results revealed the complexity of L2 intonation form-meaning mappings. We proposed an L2 intonation model that captured these complex relations and accounted for the difficulty that speakers experienced in learning L2 contrastive-focus.

<u>*Stress typicality effect*</u> is the association between stress position and word categories. In English disyllabic words, for example, nouns tend to be stressed in the first syllable and verbs in the second, i.e., <u>sub</u>ject (noun) vs. sub<u>ject</u> (verb). Previous research found that native English speakers are sensitive to the stress typicality effect during word processing and that their sensitivity develops with age via statistical learning of lexicons (e.g., Arciuli et al. 2012). In [4], my colleagues and I examined whether a similar development takes place in Chinese speakers of English. Results revealed that adults, but not adolescents, showed stress typicality effects reinforcing statistical learning theories of L2 vocabulary acquisition and suggesting good practices for vocabulary teaching.

(3) Understanding the prosodic systems of Catalan, Spanish, and English [Articles: 1, 6, 9]

For me, studying the prosodic systems of Catalan, Spanish and English constitutes a long-standing line of inquiry and one that is related to my interest in Hispanic Linguistics. In the section of this document on *Past Research*, I describe the earlier work that I have done on this subject. Here, I describe three articles on this topic written in Pittsburgh. These articles build a more precise understanding of how prosody works by examining the perception and the production of prosodic cues by adults and infants in their own L1.

<u>Article [9]</u> is a production study in which we examined the acoustic correlates of lexical stress in Catalan and Spanish across two sentence intonations [9]. One of the article's main findings is related to spectral tilt (which is a measurement of amplitude that captures why syllable "win" in the word "window" sounds louder

than "dow") and its role as a cue to lexical stress. Previous literature proposed that spectral tilt was the main correlate of lexical stress across languages (e.g., Sluijter et al. 1997, but see Beckman 1986b for alternative intensity measurements). However, these experiments did not strictly control for vowel reduction. In our experiment, we did control for vowel reduction, and we demonstrated that changes in spectral tilt were a direct consequence of vowel reduction rather than stress. This finding was particularly relevant in the context of Hispanic Linguistics because lexical stress was traditionally considered a loudness-related phenomenon – e.g., Navarro-Tomás' "acento de intensidad" (1990).

Article [6] was the outcome of a collaboration with Professor Laura Bosch from the APAL infant lab at the University of Barcelona [6]. We compared the effects of segmental and prosodic cues in the discrimination of Western and Eastern Catalan dialects by 5 month-old infants raised in Catalan-speaking families. An acoustic analysis of the speech samples showed that vowel spectral information (or the energy distribution in a vowel spectrum) constituted a more reliable cue to dialectal classification than duration-based rhythm metrics, and this suggested that infants' discrimination between Catalan dialects may rely on gross vowel spectral information in addition to prosodic patterns.

In article [1], we give an explanation to a puzzling result, namely Cutler and colleagues found out that during lexical access, Dutch speakers were more adept at perceiving suprasegmental cues to stress in English than native English speakers themselves (Cutler et al., 2005). Similar results were found for Spanish speakers triggering the observation that due to the consistent correlation in English between stress and vowel reduction, English speakers were more attuned to segmental than suprasegmental cues during lexical access. As a result, attention to vowel reduction prevented English speakers, but not Dutch and Spanish speakers, from focusing in suprasegmental cues like duration or pitch. In this third article, we proposed a perception mechanism, the Cue-Driven Window Length Hypothesis, to account for these cross-language processing asymmetries at the word and the sentence level. By means of three perception experiments in English and Spanish, we showed how the acoustic detail present in the speech signal, i.e., duration and vowel quality cues to stress, interacted with predictions based on the subjects' knowledge of sentence intonation in order to facilitate lexical access [1]. More specifically, we showed that speakers adjusted the length of the processing window to perceive the acoustic detail that facilitated lexical access, which in turn, determined their effectiveness in processing cues to sentence-level prosody, and that these interactions were, to some extent, language independent.

(4) Documenting the prosody of understudied languages [Articles: 5, ii]

This line of research has the objective of documenting understudied languages, in particular their prosody and infrequent contrasts. It has yielded exciting collaborations with students of Hispanic Linguistics on understudied dialects of Argentinian Spanish (such as Tucumán Spanish sentence intonation and the Tonadilla Cordobesa), and Quechua (i.e., documenting the undergoing changes in the stop and ejective sounds). With doctoral student Adeetee Bhide from LRDC, we examined the effect of orthography in the perception of the retroflex-alveolar contrasts in Marathi by English speakers. Outcomes from this research appeared in peer-reviewed journals (e.g., [5, ii], were presented in well-established conferences in phonetics and Hispanic Linguistics (e.g., Meeting of the Acoustical Society of America, Hispanic Linguistics Symposium), and the Quechua project was selected by the Provost's Office to represent the University of Pittsburgh in the Meeting of the Minds this March 2019.

Research in progress and future research

Currently, I have five articles in progress: two continue research lines 4 and 2, the third article is the result of my collaboration with Brainlab at University of Barcelona (http://www.ub.edu/brainlab/team/lab-visitors/), and fourth and fifth articles focus in my future line of research which explores the effects of prosodic cues to

linguistic and social variables in comprehension.

(1) In the Quechua project (research line 4), we examine the acoustic characteristics of the 15 voiceless stops of the understudied Cuzco dialect, which exhibits an unusual three-way contrast between plain stops, aspirated stops, and ejectives. With a team of 4 undergraduate students, we are analyzing sound recordings that come from language corpora (elicited speech), Bolivian radio (natural speech), and a crowd sourced database, Siminchikunarayku (repeated speech). Joseph Jaros, the leading undergraduate student, will present our analysis of the elicited speech dataset in the Meeting of the Minds (see section 4 above). This analysis will be compared with those obtained from natural and repeated speech revealing how this three-way contrast is expressed across speech styles. An article will be submitted in Summer 2019 to a peer review journal.

(2) Previous research showed that foreign accented speech may become more intelligible to non-native speakers (e.g., Xie & Fowler 2013). Much of this research, however, has been based on segmental traits from isolated words. In collaboration with my former Brackenridge undergraduate student Claire Chu, and Assistant Professor Carrie Epp Demmans from University of Alberta, we are examining how suprasegmental variables in addition to segmental ones modulate this perception advantage in words and sentences in Chinese-accented English (research line 2). Results will be submitted in July to the Cambridge University Press volume *Second language speech learning: Theoretical and empirical progress*.

(3) Fast Frequency Responses (FFR) are the only brainwaves that faithfully reproduce the acoustic waveform of sound stimuli making them ideal for the study of speech perception. However, the large amount of repetitions required to obtain this wave (at least 1000 per condition) impose strict constraints on the duration of the stimuli, i.e., very short tones or beeps. We overcame these limitations by designing a lexical decision task that obtained FFR on the last vowels of words and pseudo-words. This design opens a door for the exploration of meaningful linguistic stimuli with FFR. Crucially, results provided the first neurophysiological signature for lexical to sublexical feedback. The article is to be submitted for publication this summer.

(4) Information about who we are (e.g., where we grew up, education, socio-economic status), is encoded in our speech. While we easily interpret these social variables in our native language by imposing on the speech signal the social knowledge shared by our communities of practice (Eckert 2018), we still do not know how we learn these social variables in a second language. My graduate student Angela Krak and I are designing an experiment that explores this question in a group of L2 advanced students of Spanish during a three week immersion program in Seville, Spain. This city is ideal because students will have access to the regional standard, the prestige national standard, and the low-prestige variety. Each variety has well-defined segmental and suprasegmental speech traits.

(5) Previous research showed that words spoken in fear are more intelligible than words spoken in other emotions such as happiness, sadness, or anger (Dupuis & Pichora-Fuller 2014). An evolution based explanation accounts for these results: fear is linked to a life-and-death situation and it requires an immediate response. As a result, words with fear need to be maximally intelligible. For this evolution-based argument to hold, it should yield similar results across languages. With the help of a Brackendridge Fellowship, my undergraduate student Catherine Coates and I are testing this hypothesis by exploring the intelligibility of English and Korean words spoken in 5 different emotions and listened by L1 and L2 speakers.

In the future, I will continue with my already established lines of research described in the above section *Research directions published at University of Pittsburgh* and add a new research line by including social variables to the study of prosody. More specifically, this new research line will explore how the interaction of social with linguistic variables affect listeners' comprehension. It combines ideas and methods from psycholinguistic research on speech perception (e.g., Sumner 2015) with sociolinguistics theories on the creation of speech communities and linguistic stereotypes (e.g. Eckert 2018). I started working with my current

graduate and undergraduate students on these new ideas by applying them to different populations as shown by the articles in progress 4 and 5 described above. Moreover, this new research line attracted my three incoming graduate students, namely Mr. Joseph Rose, who was awarded a Mellon Fellowship to work on the growing Hispanic population of Pittsburgh, Irene Soto Lucena, who wants to work in L2 prosody and linguistic profiling, and Mr. Sebastián Leal Arenas, who is interested in *flaite*, the non-standard sociolect of the Spanish spoken in Santiago de Chile. Furthermore, I started an interdisciplinary collaboration with Assistant Professor Scott Fraundorf from Psychology and LRDC and Ms. Tahirah Walker from the Center for Teaching and Learning to apply this new line of research to the international TA population at University of Pittsburgh. Our goal is to combine our expertise in phonetics, sentence processing, and pedagogy to (1) enhance our theoretical understanding of speech perception by determining which social variables moderate the intelligibility, comprehension, and retention of non-standard and foreign-accented English varieties by undergraduate students, and (2) create research-informed materials that help undergraduate students become better listeners of global English. We have a research plan and recently we submitted our first proposals to request funding.

Broader contributions

As explained above, I continued my research in prosody upon my arrival at Pitt. However, I moved away from strictly Hispanic Linguistics (research lines 3 and 4) and developed new lines of inquiry by including tonal languages (research line 1), L2 learners (research line 2), social and indexical variables (my future research), and learned to use new techniques, e.g., EEG, making my research more interdisciplinary. My contribution to research in prosody from this interdisciplinary perspective has been recognized by my field in several contexts. For example, my articles in the new research lines 1 & 2 were published in 2 of the top-five journals in Linguistics, representing the top 4% (i.e., *Bilingualism: Language and Cognition* ranked 7th out of 181 linguistic journals and *Studies in Second Language Acquisition* ranked 8th) and they received strongly positive reviews. As detailed above, reviewers described my work as "a timely and much-needed contribution to the study of bilingualism", "new and theoretically relevant" and "of excellent scientific quality". Articles in my other research lines 3 & 4 have been published in the top 11.5% of linguistics and language journals according to SCImago, 2015 (e.g., *Journal of Phonetics*, *Language & Speech*). In 2012 I was awarded a prestigious Canadian SSHRC grant, and in 2014 I was invited to join the Perfetti Lab of which I am an active member. In 2016 I was invited to resubmit my NSF research proposal, which I declined due to my father passing away. I regularly contribute as an ad hoc reviewer for the main journals of linguistics, phonetics, acoustics, bilingualism and L2, and Hispanic Linguistics. These journals include *Bilingualism: Language and Cognition, Cognition, Language Learning, Journal of the Acoustical Society of America, Journal of Phonetics, Laboratory Phonology, Lingua, Language and Speech, Speech Communication, Journal of Hispanic and Lusophone Linguistic*s. I also review grant proposals for the NSF. From 2011-2018, I served on the editorial board of *Catalan Review*, a journal that disseminates Catalan culture in North America (http://nacs.espais.iec.cat/catalan-review-2/)

To conclude, I believe that the positive reception of my new research lines by colleagues in the field of prosody, the continuous support I receive from the Perfetti lab at LRDC, my new interdepartmental collaboration with Professor Fraundorf from Psychology and Ms. Tahirah Walker from the Center for Teaching and Learning, my international collaborations with Prof. Demmans Epp from University of Alberta, Canada, with Profs. Bosch and Escera from University of Barcelona, Spain, with Prof. Juan Zhang from University of Macau, China, and Prof. Nagao from Shotoku University, Japan, my long-term expertise in prosody and my new knowledge on EEG, and importantly, the conjoined interest in Spanish, prosody, and non-standard varieties I share with my current and incoming students, altogether put me in a position in which I have the knowledge, network, and manpower to tackle research in prosody from a new and exciting interdisciplinary perspective. In

the next five years, while deepening into my established research lines, my goal is to explore the effect of social and non-linguistic aspects of prosody in the comprehension and retention of non-standard language varieties. This research has the potential to make important theoretical contributions in speech perception, and at the same time, it has practical implications for improving communication in contexts of linguistic diversity such as undergraduate classrooms with Teaching Assistants (TAs) that speak regional- and foreign-accented varieties of English, the context of our new interdepartmental collaboration. Finally, this research aligns well with the Chancellor's and Provost's Plan for Pitt by engaging in theoretically innovative research (Goal 2) that advances educational excellence (Goal 1) while promoting a climate of diversity and inclusion in campus (Goal 4) (https://www.pitt.edu/sites/default/files/Plan%20for%20Pitt_11032016.pdf)

Work cited not included in my CV

Arciuli, J., & Simpson, I. C. (2012). Statistical learning is related to reading ability in children and adults. Cognitive science, 36(2), 286-304.

Beckman, M. E. (1986). Stress and non-stress accent (Vol. 7). Walter de Gruyter.

Beckman, M. E., & Hirschberg, J. (1994). The ToBI annotation conventions. Ohio State University.

Cutler, A., Wales, R., Cooper, N., & Janssen, J. (2007). Dutch listeners' use of suprasegmental cues to English stress. In Proceedings XVI ICPhS, p1913-1916.

Dahan, D., & Magnuson, J. S. (2006). Spoken word recognition. Handbook of psycholinguistics, 2, 249-284.

Domahs, U., Knaus, J., Orzechowska, P., & Wiese, R. (2012). Stress "deafness" in a language with fixed word stress: an ERP study on Polish. Frontiers in psychology, 3, 439.

Domahs, U., Genc, S., Knaus, J., Wiese, R., & Kabak, B. (2013). Processing (un-) predictable word stress: ERP evidence from Turkish. Language and Cognitive Processes, 28(3), 335-354.

Dupuis, K., & Pichora-Fuller, M. K. (2014). Intelligibility of emotional speech in younger and older adults. Ear and hearing, 35(6), 69.

Eckert, Penelope (2018). Meaning and Linguistic Variation: Third Wave in Sociolinguistics. New York: Cambridge University Press.

Heald, S. L., & Nusbaum, H. C. (2014). Speech perception as an active cognitive process. Frontiers in psychology, 5.

Ladd, D. R. (1996, 2008). Intonational phonology. Cambridge University Press.

Li, X., Yang, Y & Hagoort, P. (2008). Pitch accent and lexical tone processing in Chinese discourse comprehension: an ERP study. Brain Research, 1222, 192-200.

Peperkamp, S., Vendelin, I., & Dupoux, E. (2010). Perception of predictable stress: A cross-linguistic investigation. Journal of Phonetics, 38(3), 422-430.

Sluijter, A. M., Van Heuven, V. J., & Pacilly, J. (1997). Spectral balance as a cue in the perception of linguistic stress. JASA, 101(1), 503-513

Magnuson, J. S., Mirman, D., Luthra, S., Strauss, T., & Harris, H. D. (2018). Interaction in spoken word recognition models: Feedback helps. Frontiers in psychology, 9, 369.

Tomás, T. N. (1935). El acento castellano. Hispania, 18(4), 375-380.

Tomás, T. N. (1990). Manual de pronunciación española (No. 3). Editorial CSIC-CSIC Press.

Xie, X., & Fowler, C. A. (2013). Listening with a foreign-accent: The interlanguage speech intelligibility benefit in Mandarin speakers of English. Journal of phonetics, 41(5), 369-378.