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# Editors' introduction

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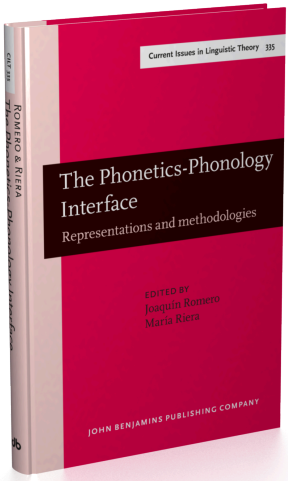


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**Edited by Joaquín Romero and María Riera**
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# Editors' introduction

A recurring question in research that challenges the traditional boundaries between phonetics and phonology is how to match the continuous, gradient nature of speech with the discrete units of phonological representation. Giving physical shape to phonetic implementation rules (Keating 1988, 1990) was an attempt to bridge the gap between the two levels of representation while still maintaining them as separate. The work on Articulatory Phonology (Browman & Goldstein 1989, 1990, 1992) took the challenge one step further by claiming that articulatory gestures can be the continuous units of phonetic description as well as the discrete building blocks of phonological representation, thus effectively doing away with the traditional division between phonetics and phonology. More recent work along the same lines (Gafos 2002, 2006, Gafos & Benus 2006) has used mathematical models from the theory of non-linear dynamics to show that discrete phonological units can result from continuous, task-defined coordinative structures such as articulatory gestures. Still, much work remains to be done in this area before we can have a clear grasp of how the abstract and the physical aspects of speech interact. The work presented in this volume is a contribution towards this goal.

One aspect of phonology that has received relatively little attention within the dynamics-based gestural approach is prosody and its impact on the segmental level (but see Byrd & Saltzman 2003 for an attempt to define prosodic gestures). In fact, a characteristic of research in the phonetics-phonology interface field in general has been the tendency to keep segmental and suprasegmental work separate. While it is true that both the type of data and analyses, on the one hand, and the underlying phonological theories, on the other, are to a great extent different, there are quite a few areas where investigating the overlap between prosody and segments can be very fruitful (Byrd et al. 2000, Kohler 2012). Some of those areas, such as tonogenesis and the relationship between prosody and nasalization, are investigated here (Cibelli, this volume). The results obtained will hopefully encourage researchers to continue exploring this line of work in the future.

Another area that continues to generate a significant amount of research on the phonetics-phonology interface has to do with the acquisition of first and/or second languages. How infants learning a first language can successfully develop phonological categories from the myriad phonetic cues that they are exposed to in the first months of their lives has been a central question in this line of research for years (Kuhl 1979, 1983, Kuhl et al. 1997) and still continues to generate an

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intense debate (Werker, Yeung & Yoshida 2012). Similarly, the acquisition of segmental categories by learners of second or foreign languages has been studied from a wide range of perspectives and experimental approaches. Amount of exposure, age, motivation, experience and type of instruction among other factors have been considered in numerous studies within a variety of theoretical frameworks (Flege 1995). A particularly interesting line of study in this area has to do with bilingual or multilingual speakers (Sebastián-Gallés & Soto-Faraco 1999, Costa & Sebastián-Gallés 2014) and how they may differ from monolinguals in terms of the potential modularity of each language and also how these speakers approach the acquisition of a third or fourth language. The papers included in this volume deal with these fundamental issues and provide novel and relevant data on the acquisition of phonological systems by bilingual and monolingual speakers.

As shown by the title of this collection, many of the contributions that are included here involve advances in experimental methodology. All too often work on the phonetics-phonology interface has relied rather heavily on theoretical assumptions provided by phonological models which have been tested using fairly basic experimental designs and data analysis tools. This approach is indicative of a predominant 'transducer' view of the relationship between phonetics and phonology (Fodor & Pylyshyn 1981, Ladd 2006) in which the phonetic component is conceived as a mere testing ground for higher level phonological assumptions. While the nature of the field does logically entail a preoccupation with phonological models and their assumptions and predictions, a lack of sophisticated experimental techniques, including data collection protocols and statistical analyses, can to some degree undermine the results and conclusions obtained. This volume shows how awareness of this crucial issue is increasing in the field by presenting work with highly innovative experimental designs, data acquisition techniques such as functional magnetic resonance imaging and electroglottography, or advanced statistical tests such as principal component analyses and modeling using Gaussian mixture models. We strongly believe that this is an important approach to follow and develop in work on the phonetics-phonology interface if it is to achieve its goal of bridging the gap between the two disciplines and doing it in such a way that it provides significant advancement not just in theoretical issues but also in experimental protocols.

The papers in this volume reflect the natural evolution of the Phonetics and Phonology in Iberia (PaPI) conferences. While keeping a strong core of work on Romance languages, it has expanded to encompass a broader language range and thus aims at presenting a more theoretically and methodologically relevant and diverse body of work intended for an equally more diverse audience. The contributions have been organized into four sections. Section I brings together papers on language acquisition, whether as an L1 or an L2. Section II explores a variety of

prosodic aspects — stress, rhythm and intonation — while also examining some relevant areas of the overlap between segments and prosody. While Section III concentrates more on the description of segmental aspects, it also gives us interesting glimpses into how intricately related the segmental and suprasegmental levels of phonetic and phonological analyses truly are. Finally, Section IV presents some state-of-the-art data collection and analysis techniques that reflect fundamental concerns with and for experimental soundness and analytical reliability.

The four papers included in Section I, "First and Second Language Acquisition", address a variety of theoretical and experimental issues that have been at the forefront of research in the acquisition of segments and phonological systems, be it in infants vs. adults or in monolinguals vs. bilinguals. As mentioned above, unraveling the intricate relationship between phonetic variation and phonological invariance lies at the heart of much current work in laboratory phonology. The contribution by Best explores precisely how intertwined the two levels of linguistic representation truly are to the extent that, according to the evidence presented by the author, phonetic detail is not only relevant in determining underlying phonological structure, but may also be crucial in improving perceivers' ability to handle unfamiliar or non-optimal input. The paper reviews a wealth of recent findings within the L1, L2 and dialectal variation acquisition literature that argue against the view that listeners systematically need to weed out phonetic detail from the signal in order to be able to access the discrete phonological units of which a particular word or message is ultimately composed. Compelling evidence from native adult perception, infant first-language learners and adult second-language learners instead points to the notion that phonetic detail is central in speech perception. For example, cross-linguistic studies of non-native adult perception show how speakers of languages with front rounded vowels in their inventory — French, German, Danish — can outperform native speakers of English in discriminating a /w-j/ continuum (Hallé, Best & Levitt 1999, Bohn & Best 2012). Similarly, in a discrimination task where speakers were asked to distinguish a familiar contrastive feature (i.e., voicing) within unfamiliar pairs of consonants, (i.e., Zulu lateral fricatives or Tlingit lateral affricates) experience with similar phonetic detail in the native language seemed to play a significant role in their ability to perceive the unfamiliar distinctions. Also, infants develop the ability to distinguish between words and non-words even when spoken in an unfamiliar variety of their native language, and this developmental landmark seems to be achieved at about the same time that their vocabularies reach a 100+ size. It is concluded that familiarity with natural phonetic variability actually helps improve listeners' ability to develop and exploit phonological distinctions, which is indicative of the inherent interdependence between the phonetic and the phonological levels of linguistic representation.

Following up on a very fruitful line of work regarding second language acquisition (Flege 1995, 2007), the study described in Mora, Keidel & Flege deals with the issue of how exposure to a second language can influence the production of categorical vowel distinctions in the L1 in bilinguals who have had early exposure to the L2. They set out to explore this hypothesis by analyzing the production of Catalan mid-vowel contrasts, i.e., /e/-/ɛ/ and /o/-/ɔ/ by four groups of Spanish-Catalan bilinguals from Barcelona. One interesting characteristic of this population is that they are life-long users of the two languages, which is in contrast to the populations of many studies on bilingualism in which participants were first exposed to the L2 as a consequence of migration. The participants in the study were divided into four groups based on how they reported using the two languages in their everyday interactions, from mostly Catalan to mostly Spanish. It is worth remarking that, as the authors observe, bilingualism is so widespread and pervasive in Barcelona that it is not possible to find true monolingual speakers of either language in a population that was schooled in the area. The acoustic data obtained were analyzed first in terms of spectral distance scores. The results corroborated that the Catalan-dominant bilinguals were clearly better at producing the mid-vowel distinction than the other groups. However, an analysis of the individual data showed that some Spanish-dominant participants performed similarly to the Catalan-dominant group. In order to investigate these individual differences, spectral effect scores were calculated and participants were assigned to different groups based on how they had performed in the /e/-/ɛ/ distinction perceptually in an earlier study by the same authors. These results showed a correlation between the performance in perception and production, so that bilinguals who were capable of hearing the /e/-/ɛ/ distinction were also able to produce it more robustly even if they were in the Spanish-dominant group. This is further evidence of how intricately L1 and L2 are intertwined in life-long bilinguals, and how easily categorical distinctions in one language can influence either the development or the decline of similar distinctions in the other.

It is known that very young infants are capable of discriminating between different languages even before they have been able to fully develop a phonological system for their native language (Werker & Tees, 1984). This has led researchers to investigate which components of linguistic structure infants might be relying on in the discrimination process. Prior work (Mehler et al. 1996) has argued for segment-independent rhythmic aspects as being key in this process, so that infants rely on the rhythmic relationship between vowel sounds in an utterance rather than on the existence or absence of specific vowels and consonants. However, the question remains as to how infants are able to distinguish between two varieties of the same language with very similar rhythmic characteristics. The study by Ortega-Llebaria and Bosch explores precisely this issue by comparing two varieties

of Catalan — Eastern or Central vs. Western — as produced by female speakers of the two dialects who were all mothers of young infants and who were instructed to speak to them using infant-directed speech. They analyzed the production of all four speakers in terms of rhythmic parameters as well as vowel category (formant frequencies) parameters. It was found that, in general, vowel counts (how often a key vowel such as /ə/ appeared in one variety vs. the other) seemed to have a much more robust effect on discrimination between the two varieties than rhythmic measurements. This is taken as evidence that, in those cases in which the languages or varieties compared are similar in terms of rhythmic patterns, infants may still be able to resort to other parameters, such as the presence vs. absence of specific vowel sounds, in order to correctly discriminate between them. Thus, the study is an important contribution to our understanding of how language develops in infancy and how the prosodic and the segmental levels interact in the acquisition of a first language.

Even though the acquisition of an L2 sound system has been the object of countless studies and of some well-established theories of second language adaptation (Best 1994, Flege 1995), the inherent complexity of how the phonological categories — as well as the phonetic details of particular segments in a language — are assimilated by a speaker of a different language continues to generate a wealth of relevant research. The contribution by Peperkamp falls within this category. Her study sets out to determine whether the adaptation of loanwords from English into French is based on phonological rather than phonetic proximity. Following up on previous research by the same author which suggests that, at least under on-line adaptation conditions, it is the phonetic proximity (in acoustic space) that prevails, the study explores the perception of American English monophthongs by a group of monolingual French speakers. One of the key aspects of the methodology is the inclusion of tokens both within a consonantal context and excised from it. Results indicate that, overall, loanword adaptation relies more on phonetic proximity, especially when the vowels are presented without the flanking consonants. It is the case, however, that speakers seem to be able to compensate, at a phonological level, for phonetic differences caused by coarticulation when the context is available. Some interesting theoretical as well as methodological reflections are presented in the paper, such as the relationship between perception and production in the adaptation of loanwords, and the appropriateness of using isolated formant values instead of distributional data when comparing adaptation of cross-linguistic categories. As some of the most recent research in this field shows (see the paper by Best, this volume), speakers may be able to use knowledge about the distribution of certain phonetic and phonological parameters in their own language when adapting sounds from a foreign language.

Section II, "Prosody", brings together contributions that illustrate some of the variety and complexity in this area of the phonetics-phonology interface, from stress to rhythm to the relationship between prosodic conditions and segmental phenomena. Avanzi, Schwab & Racine investigate penultimate stress in the standard Parisian and Swiss (Neuchâtel) varieties of French. Their paper throws new light on a well-known aspect of French prosody, i.e., the occurrence of penultimate stress in non-standard varieties, which has not been experimentally studied in depth before. The study uses the PFC spontaneous speech database (Durand, Laks & Lyche 2009) from an older segment of the population (60- to 86-year-old speakers) to investigate whether penultimate stress is more common in non-standard than in standard varieties of the language. Previous work hypothesized that penultimate stress might be an archaic feature that has been retained in regional varieties, perhaps due to a different linguistic substratum, and is progressively disappearing in the standard language. The authors segmented the speech materials into accentual phrases following Jun & Fougeron (2002) and obtained duration, mean F0 and F0 rise values. The results show that there is indeed a difference in the perceived prominence status of penultimate syllables between the two varieties, with Neuchâtel showing significantly more prominent penultimate syllables than Parisian. Additionally, a difference is observed in the acoustic parameters used to mark penultimate syllable prominence: speakers of the Swiss regional variety (Neuchâtel) tend to rely more on duration as a cue to signal penultimate prominence, while standard speakers (Paris) make more use of F0 mean values. Thus, the results seem to confirm the trend that standard varieties of the language are progressively abandoning the use of penultimate stress as a prosodic marker. The use of standard notation and analysis techniques offers a promising path for the study of penultimate stress in other varieties of French.

The contribution by Cangemi and D'Imperio explores the interaction of sentence modality and tempo in the distinction between statements and questions in Neapolitan Italian. An interesting observation is made regarding the fact that too often the role of duration is ignored when investigating intonational patterns related to sentence modality, assumed to be distinguished mostly by specific F0 contours. The authors set out to test the relevance of duration both in terms of absolute sentential duration and as localized effects by developing an orthogonal design that strictly controls for possible confounding factors such as lexical frequency effects, phonotactics or syntax, while testing for the possible relevance of focus (subject vs. object). The results of a discrete analysis of whole utterance duration and phone duration with respect to its position in the utterance showed nearly identical values in overall utterance duration between statements and questions but some potential differences when phone position in the utterance was taken into account. Further, a continuous analysis was performed using a modified

version of Pfitzinger's formula (2001). The results confirmed the findings of the discrete analysis while shedding some light on the role of focus and its interaction with sentence modality. Despite the preliminary nature of the findings reported here, the authors provide interesting results that justify the need for a representation of intonational patterns that is richer in phonetic detail and that does not rely exclusively on the role of fundamental frequency.

One very promising area of research in the study of the phonetics-phonology interface is the interaction between segmental and suprasegmental or prosodic factors. The paper by Di Napoli deals with this issue by studying the presence of glottalization in central Italian as a marker of prosodic constituency (phrase or word boundary). Existing accounts of glottalization in Italian differ as to the interpretation of what the linguistic function of this process is in the language, ranging from Vayra's (1994) segmental account in terms of empty codas to more recent work by Stevens, Hajek & Absalom (2002) proposing a more prosody-based explanation. Di Napoli sets out to test these different hypotheses by designing a series of production (acoustic and EGG) experiments testing segmental factors (vowel vs. consonant-initial words), lexical factors (stressed vs. unstressed final syllables) and prosodic factors (presence vs. absence of word and/or phrase boundary). Her results show a complex picture in which all the factors included in the analysis seem to have an influence on the presence of glottalization. However, in line with more recent research, it appears that the marking of a prosodic boundary is by far the most favorable environment for glottalization to occur. Additionally, glottalization is also found to act as a hiatus-preserving mechanism, thus preventing the potential coalescence of vowels across word boundaries. These results seem to fit well with findings for many other languages in which non-modal voice (glottalization or creak) is used to mark boundaries between prosodic constituents.

The papers in Section III, "Segments", though centered primarily on the analysis of specific phones or 'segments', exemplify the intricate relationships between segmental and suprasegmental phenomena as well as the influence of sociolinguistic and dialectal factors in the realization of particular phonological/phonetic categories. The experimental study of geographically or socioculturally conditioned variation, as dealt with partially also in the Avanzi et al. paper, is the main motivation in the contribution by Barbero and González. Their investigation of interdentalization of coda /k/ in Northern Peninsular Spanish (as in the pronunciation of 'actor' as /aθtoɾ/) is preliminary but it provides previously non-existent experimental evidence of a phonetic phenomenon that has traditionally been neglected because of its stigmatization as non-standard (coda /k/ is usually pronounced as a velar stop in peninsular Spanish) and socioculturally marked (common mostly in speakers of low sociocultural extraction). Earlier work on the topic is purely descriptive and does not provide any phonetic detail of the exact nature

of the /k/ to /θ/ change, its phonotactic or prosodic conditionings or its possible phonological underpinnings. Barbero and González provide acoustic data from four speakers of Spanish from the Basque Country, in Northern Spain. In addition to being qualitatively interesting, because they exemplify the actual complexity of the phenomenon in terms of the variety of possible outcomes, the results provide interesting quantitative data that partly support the observations made in previous work. Thus, it is shown that interdentalization is quite general in the variety studied but that its realization is not categorical, ranging from stops to fricatives to approximants to complete deletion, which is clearly indicative of the gradient nature of the phenomenon. Interestingly, none of the phonotactic or prosodic conditionings (flanking consonants or vowels, number of syllables or presence vs. absence of stress) appear to have any effect on the realization of /k/ as /θ/. Age, however, is a significant factor, which corroborates the fact that interdentalization in Northern Spanish is a change in progress. The results also give support to a phonological interpretation of interdentalization as involving place assimilation and manner dissimilation.

The paper by Cibelli is another example of the potential of studying how segmental and suprasegmental factors interact and influence each other in a language's phonology. The author explores the depressor effects of prenasalized consonants on tone. Consonant type — mostly in terms of laryngeal configuration — is known to correlate with historical development of specific tone patterns (tonogenesis) in a range of languages (Abramson 2004). Cibelli's paper further investigates this line of work by analyzing data from one speaker of Chichewa, a language with a rich consonant inventory, especially occlusives. The study analyzes a wide range of phonetic factors and their effect on F0 as a function of consonant type, specifically in relation to the presence of prenasalization. Even though the results are inconclusive as to the real effect of prenasalization on tonal height in Chichewa, the study reports many novel results regarding the multidimensional nature of the interaction between tone and consonant duration, VOT and voicing. It also introduces some relevant discussion as to the need to reconsider our understanding of the role of voicing in prenasalization.

One fundamental goal of research in the phonetics-phonology interface is to provide novel experimental data that can test commonly held assumptions about phonological structure in languages. All too often theoretical proposals are made based on data that are exclusively descriptive and consequently are skewed toward a categorical viewpoint. The study by Weissglass contributes to our understanding of how rhotic sounds are produced in different parts of the Spanish-speaking world. Previously available impressionistic reports claim that C2 rhotics in tautosyllabic clusters (in words such as *brisa*, *trama* or *gruta*) tend to appear as trills in the Spanish of Basque-Spanish bilinguals, in contrast to the common tap/flap

pronunciation of Spanish monolinguals. The present study investigates this claim by comparing rhotics in a variety of contexts for monolingual Spanish speakers from La Rioja and Spanish-Basque bilingual speakers from the Basque Country and Navarre. The acoustic study yields some important results. First, despite prior descriptions, only one of the Spanish-Basque bilinguals produced trills at all, while the other bilinguals never did. Furthermore, the study found that, among monolingual speakers, approximants were the most common realization of the rhotic in Cr clusters, which also goes against previous descriptions that claim taps/flaps as the standard pronunciation of rhotics in these contexts. The author examines a series of possible explanations, phonological and phonetic, as well as dialectal, for these unexpected findings. One interesting claim is that the presence of approximant rhotics might be caused by lenited (spirantized) voiced stops in the C position, so that the continuant nature of the stop would somehow spread to the rhotic. While this is a theoretically enticing hypothesis given what is known about stop lenition in the language, clearly more of the type of basic experimental work reported in this paper is needed to corroborate these claims.

Finally, Section IV, "Methodology", presents a selection of papers that are strongly marked by the novelty and singularity of the methodology employed. It was mentioned earlier that, in the past, work on the phonetics-phonology interface has been criticized for lacking a certain experimental or methodological depth. The contributions included here demonstrate that it is certainly possible to do research in this field using solid, cutting-edge methods and technologies (whether in the collection or the analysis of the data) that will in turn generate new and exciting opportunities of investigation for future researchers.

The contribution by Nicholas Henriksen seeks to expand on our knowledge of how the basic statement vs. question distinction can be signaled by secondary prosodic correlates in addition to or instead of the well-known overall fall vs. rise F0 contour. Henriksen uses acoustic data from the Manchego variety of Castilian Spanish to test the relevance of these secondary phonetic cues, namely, baseline slope, speech rate, prenuclear syllable duration and nuclear syllable duration. Precisely because these are often considered secondary cues, the study includes a principal components analysis in order to tease apart how these different cues group in determining the general fall vs. rise contour in the distinction between declarative questions, wh-questions and declarative statements. The results of the acoustic analyses suggest that baseline slope correlates positively with questions but not in the expected rising slope pattern; rather, it seems to be the case that it is the extent of the rise or fall that might determine whether the utterance is meant as a question or a statement. As for the results of the principal components analysis, one of the most relevant observations is that there seems to be no evidence of the use of lexico-semantic devices in the signaling of questions, which runs counter to

previous findings (Van Heuven & Haan 2000, 2002). This paper constitutes a novel contribution to our understanding of how intricately intertwined phonetic and phonological cues can be in carrying such a basic distinction between prosodic patterns as in statements vs. questions. It is also a fine example of how sophisticated statistical techniques can be useful to make sense of this complexity and shed light on how the phonological and the phonetic components interact.

Differences in rhythmic organization between languages are the focus of the study by Nava & Goldstein. Their work builds on existing evidence that the classical distinction between stressed-timed vs. syllable-timed languages is too broad to capture subtle variation in rhythm across languages (see the paper by Ortega-Llebaria & Bosch, this volume). Furthermore, they test how bilingual speakers show the influence of L1 rhythmic patterns in their L2. The authors perform a series of experiments comparing acoustic productions by native English speakers and bilingual L1Spanish/L2English speakers. Experiment 1 shows a clear difference in how the two groups place prominence in wide focus sentence with non-accusative verbs, object-verb compounds, and regular verb-object transitive verbs: the bilingual speakers consistently fail to place prominence anywhere but finally. Experiment 2 tested differences in vowel duration in a reading task. The results showed that the bilingual participants tended to produce most vowels with a similar duration, in sharp contrast to the native English speakers, who showed a wide range of durations. Further, Gaussian mixture models were fitted into the different distributions, which confirmed a correlation between the flexibility of prominence placement observed in Experiment 1 and the variability in vowel duration. In Experiment 3 subjects were asked to complete a rhythm repetition task intended to test whether L2 speakers distinguished between syllable-based rhythm and foot-based rhythm. Again the results showed a significant difference between the two groups of speakers, with the native English ones performing clearly differently for the two rhythmic units, while the bilingual L2 speakers persistently relied on syllable timing exclusively. The overall results corroborate how the temporal organization of prosodic units at the phrasal level parallels the organization of rhythmic events. They also demonstrate that modeling using Gaussian mixture models can uncover subtle patterns of temporal organization that go beyond the simple stress vs. syllable timing categories.

The relevance of methodological innovation in the study of the phonetics-phonology interface is perfectly illustrated in the last paper in this collection. The study by Post, Stamatakis, Bohr, Nolan & Cummins examines patterns of neurological activation using functional Magnetic Resonance Imaging (fMRI) techniques to disentangle the linguistic and paralinguistic functions of intonation. It is well known that prosody, more specifically intonation, can

be used as both a marker of linguistic contrast — as in distinguishing questions from statements — and as an indicator of emotional and/or attitudinal conditions on the part of the speakers. These two functions often overlap, which makes it difficult to extricate which part of the signal is linguistically relevant and how much is simply paralinguistic and thus not essential in determining meaningful contrasts. The study by Post et al. observes significant differences in the activation of specific cortical areas in the left and right brain hemispheres that correlate with these two functions of intonation. The results partly corroborate previously existing data that suggest that the linguistic function of intonation is indicated by activation of the supramarginal gyrus, while paralinguistic information, though also indicated partly by activation in the same cortical area, is only right dominant and restricted to the right inferior frontal gyrus. This is taken as evidence that linguistic and paralinguistic information in intonation is processed differently at the neural level. The authors also propose that this distinction could in fact be interpreted as supporting the traditional theoretical separation between phonetics and phonology as two distinct though intricately intertwined levels of linguistic processing.

Taken together, the papers that make up this volume represent a multifaceted cross section of current work on the phonetics-phonology interface. The variety of topics, theoretical approaches and methodological techniques shown in these studies are at the forefront of research in laboratory phonology today. They are thus excellent contributions to our goal of deepening our understanding of the phonetics-phonology interface. We anticipate that they in turn will open up numerous venues for further investigation that will continue to push the boundaries of what we know about how the abstract and the physical aspects of speech interact.

Tarragona, February 2015
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