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INTRODUCTION

Transdisciplinary Intersections in Second Language Pronunciation Learning and Teaching

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Abstract: As we work to advance the field of second language (L2) pronunciation teaching and learning, we look to other fields that have guided advancements in the teaching of other aspects of language learning. Fields such as corpus linguistics, pragmatics, instructed second language acquisition (SLA), psycholinguistics, technology, and assessment have served to inform and shape major changes in applied linguistics, and their impacts have been eminent in the field of L2 pronunciation teaching and learning as well. In fact, the current popularity of artificial intelligence (AI) and automated speech recognition (ASR) development have been particularly facilitative in this collaborative movement, as they offer vast opportunities in applications and practices in L2 pronunciation.

In order for this work to be transdisciplinary (i.e., involve true collaboration between researchers in multiple fields), we see the need for bidirectional engagement. Applied linguists working in the field of L2 pronunciation teaching and learning need to be more familiarized with the new literature and techniques in other strands of applied linguistics. Likewise, experts in those strands need to be aware of distinctive issues within L2 pronunciation teaching and learning. Only then will researchers be able to produce new research in a collaborative and innovative manner. To these ends, the current

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special issue brings together core research areas in various disciplines of applied linguistics from the perspective of L2 pronunciation, with the hope of advancing transdisciplinarity by informing expert and novice researchers and teachers across fields, encouraging them to be inclusive of each other's work through recognition, practice, and research.

Overview of Second Language Pronunciation Research over the Last 30 Years

In the past 30 years, L2 pronunciation research seems to have had three major foci: a) theory-oriented investigations into construct conceptualization, such as that of accentedness, comprehensibility, and intelligibility; b) pedagogy-oriented investigations into L2 pronunciation learning, teaching, and assessment; and c) social-justice-oriented investigations on the effect of L2 pronunciation or accents on listeners' social perception of speakers. Therefore, these lines of research have been included either as empirical or review papers in the current special issue, or as future directions and discussion in this article.

Theory-Oriented Investigations

In terms of theory-oriented investigations, most studies in the past 30 years have attempted to explore the constructs of accentedness, comprehensibility, and intelligibility. These studies have examined the linguistic variables associated with these constructs (e.g., Isaacs & Trofimovich, 2016; Kang, 2010). More recently, speakers-related behavioral and affective variables, such as anxiety and collaborativeness, have been explored in relation to comprehensibility (Nagle et al., 2022). Besides speaker-based variables, scholars have also investigated listener background in relation to these speech constructs, including one's familiarity with semantic contexts (Kennedy & Trofimovich, 2008), multilingual background (Saito & Shintani, 2016), linguistic training (Saito & Saito, 2017), and general language learning experience (Kang & Rubin, 2009). In addition to speaker and listener variables, studies have investigated contextual effects, including the use of different elicitation tasks (Crowther et al., 2015) as well as the level of visual cues revealed to the listeners (e.g., static or dynamic images of the speaker; Tsunemoto et al., 2022). It can be said that taken together, accentedness, comprehensibility, and intelligibility are co-constructed by both listeners and speakers (Rajadurai, 2007) and are sensitive to a range of contextual variables. It is important to note, however, that much of this research has largely focused on L2 English rather than other languages.

Besides these constructs, scholars have also become interested in related constructs such as acceptability (Crowther et al., 2023; Thomson, 2017),

appropriateness (Taguchi et al., 2022), and accent familiarity (Miao & Kang, 2023). This conceptual expansion has been accompanied by increasing emphasis on methodology, especially measurement (e.g., Kang et al., 2018). For instance, researchers have begun to make use of more sophisticated statistical models, including mixed-effects modeling (Nagle et al., 2022), nonlinear regression modeling (Kang et al., 2023a), and the use of G-theory to determine sample size (Hirschi & Kang, 2023).

Pedagogy-Oriented Investigations

With regard to pedagogy-oriented research, many researchers and practitioners have been influenced by Celce-Murcia et al.'s (2010) communicative framework. Scholars have used different speech constructs (e.g., accentedness, intelligibility, and comprehensibility) as global perceptual judgements or acoustic analyses as anchors to investigate L2 speakers' pronunciation development and learning progression. Studies have examined a range of target features, including specific segmental features (i.e., vowels and consonants) known to be difficult for particular learner groups (Saito & Lyster, 2012). There has also been sustained interest in evaluating and comparing the impact of segmental or suprasegmental instruction in general (Derwing et al., 1998; Saito & Saito, 2017). Moreover, studies have focused on different instruction types utilizing concepts and theories in SLA, such as form-focused instruction and corrective feedback (Saito & Lyster, 2012), as well as the role of corrective feedback alone (Saito, 2013). With the popularity of technology-enhanced language learning, scholars have also been interested in L2 pronunciation courses via different delivery formats, including traditional in-person classroom settings, online platforms (Dalman, 2022), and mobile applications (Hirschi et al., 2022). More recently, scholars have also developed data-driven pronunciation learning targets with insights from corpus linguistics (Hirschi & Kang, 2024; Staples, 2019).

Besides pronunciation learning and teaching as a standalone endeavor, scholars are also interested in L2 pronunciation in relation to L2 speaking and listening assessment. In L2 speaking assessment, scholars have examined the pronunciation features that distinguish different proficiency levels (Ginther et al., 2010; Iwashita et al., 2008; also Yan et al., this special issue), rater and assessor biases, which may be driven by familiarity with certain linguistic backgrounds (Winke & Gass, 2013), the generalizability of test scores to real-life performance (Ginther & Yan, 2018), and automated scoring (Cardwell et al., 2022). In L2 listening assessment, especially in English, scholars have argued for the inclusion of diverse accent varieties (beyond the British and American

models) to reflect the sociolinguistic reality of English use (Harding, 2012). Recently, scholars have also been interested in how to enact this proposal by investigating issues surrounding fairness (Kang et al., 2023b), construct validity (Nishizawa, 2023), and stakeholders' attitudes (Isbell et al., 2023).

Social-Justice-Oriented Investigations

English is used as a lingua franca, spoken by people of different linguistic and cultural backgrounds for communication purposes (Eberhard et al., 2022). Thus, many scholars are interested in the social dimension of L2 pronunciation and people's evaluations of and reactions to different spoken varieties of languages (predominantly English). As one of the first attempts to investigate people's evaluations of different English spoken varieties, Lambert et al. (1960) found that people generally have positive or negative bias against different varieties across different dimensions (e.g., social attractiveness and superiority). Scholars have found that English speakers with a nonstandard accent are oftentimes negatively evaluated. For example, people tend to believe that they are less intelligent (Ryan & Bulik, 1982), less credible (Hanzlikova & Skarnitzl, 2017; Lev-Ari & Keysar, 2010), and less engaging (Wennerstrom, 1994). More importantly, both first language (L1) and L2 listeners demonstrate this negative bias against different accent varieties (Kang & Rubin, 2009; Lindemann et al., 2014; Xu et al., 2010). Beyond these laboratory-based findings, scholars also found that speakers with a nonstandard accent experience real-life discrimination in contexts such as employment (Hansen & Dovidio, 2016) and criminal investigations (Lippi-Green, 1994).

Although many studies have provided support for listener bias, a growing number of studies have explored ways of changing listener perceptions. We have listed several studies below to emphasize the dynamiccharacteristics of perceptual ratings and listeners themselves. For example, Lindemann et al. (2016) studied explicit phonological instruction on different accent features as well as implicit exposure and found that both approaches contributed to short-term word recognition skills when participants were listening to Korean-accented English (similar to Derwing et al.'s, 2002, findings). Subtirelu et al. (2022) included a perspective-taking technique, providing the opportunity for listeners to reflect upon the difficulties experienced by English speakers with a nonstandard accent, and found that this type of intervention affected students' willingness to communicate with speakers of different English varieties. Kang et al. (2015) developed a structured opportunity for L1 English students to interact with and be meaningfully engaged with English speakers with diverse accents. They found that such a structured program improved L1 English

students' perception and evaluation of international teaching assistants. In a similar vein, Miao et al. (2023) designed a 1-week intervention based on cognitive dissonance theory, which focused on making interlocutors aware of their behaviors or thoughts, including the fact that certain behaviors or thoughts can be harmful. This awareness can lead interlocutors to reduce cognitive dissonance by changing their thoughts or behaviors. The intervention was shown to positively change American undergraduate students' perception of English speakers of diverse varieties. Boduch-Grabka and Lev-Ari's (2021) research has also demonstrated that a short exposure to foreign accent can reduce listeners' bias, leading to improvement in the processing of accented speech. Indeed, social-justice-oriented line of research within L2 pronunciation is pushing the field toward a more diverse, equitable, and inclusive future, including researching languages other than L2 English.

Historical Overview of Second Language Pronunciation Teaching

The history of language teaching and learning has undergone major changes, similar to the general attitudes and approaches to L2 pronunciation learning. One of the earliest approaches was characterized by *grammar translation*, in which little time was spent focusing on pronunciation or communication. Rather, students were expected to view languages analytically and parse complex sentences grammatically (Richards & Rodgers, 2001). This was followed by the *direct approach*, which sought to address the fact that the grammar translation method did not focus on language use. The direct approach featured native-speaking instructors and emphasized the ability to use, not analyze, language (Celce-Murcia et al., 2010). Because the direct approach relied heavily on instructors with nativelike proficiency, which was often not realistic or sustainable in many educational contexts, a shift occurred toward the *reading approach*. Here, the classes were focused on the development of reading proficiency because people did not travel widely then to actually use the language verbally. General interest in pronunciation teaching seemed to decline during this period, from approximately 1920 to 1950, due to primary interest in reading and vocabulary (Murphy & Baker, 2015). Later, with the development of the behaviorist view of teaching and learning (Skinner, 1957), *audiolingualism* developed. According to this approach, language learning was believed to happen due to repeated drills. Here, pronunciation was stressed because the ability to mimic was prioritized.

In the 1960s, a *cognitive approach* to language learning diverted attention from pronunciation to grammar and vocabulary acquisition. From a cognitive standpoint, language learning was viewed as the systematic acquisition of a

set of rules. Although some learning theories at the time were concerned with communication and interaction (Long, 1985), these theories did not emphasize pronunciation. Then, pronunciation teaching received some attention through the Silent Way and Community Language Learning teaching methods of the 1970s (Celce-Murcia et al., 2010). Soon after this period, the *communicative approach* developed, which sought to emphasize the meaningful exchange of information through the target language while deemphasizing the formal aspects of language learning. The emergence of communicative language teaching in the 1980s had consequences for L2 pronunciation teaching and learning. Although Celce-Murcia (1987) developed her well-known communicative framework for teaching pronunciation, other scholars (e.g., Pennington, 2021) argued that this meaning-based approach meant that pronunciation instruction was mostly ignored. Yet, around this time period, the intelligibility principle emerged, which argued that language learners' speech needed to be understandable rather than nativelike (Murphy & Baker, 2015).

More recently, scholars have actively argued for the significance of pronunciation teaching. Levis (2005) commented on a paradigm shift in pronunciation instruction by reiterating the importance of the *intelligibility-based approach*. In fact, L2 pronunciation teaching and learning can be broadly categorized by two competing approaches: a) the *nativeness approach*, in which the goal of learning is to achieve nativelike proficiency and b) the intelligibility approach, where the goal is to be able to speak intelligibly and comprehensibly but not necessarily with nativelike pronunciation. Within the intelligibility-oriented approach to language learning and teaching, many scholars have sought to identify what linguistic variables contribute to intelligibility in order to provide insights into teaching priorities. For example, scholars have sought to identify what sounds carry more weight in meaning, in other words, what sounds have higher functional load and thus should be prioritized (Brown, 1988; Catford, 1987; Sewell, 2021). This line of research provides valuable insights into what segmental features influence understanding.

Beyond segmental features, scholars have also noted the contributions of suprasegmental features, such as word stress (Field, 2008), rhythm (Pickering, 2018), intonation (Wennerstrom, 2000), and temporal aspects of language (Kang, 2010) to intelligibility. This body of research into the features that promote intelligibility has contributed greatly to classroom practice. In fact, Thomson and Derwing (2015) in a research synthesis found that although most of the pronunciation learning studies were still nativeness-oriented, around 25% of their reviewed studies adopted an intelligibility-oriented approach, which shows a gradual paradigm shift in terms of the approaches to

pronunciation teaching and learning. Overall, approaches in pronunciation teaching and learning have vacillated over time (Celce-Murcia et al., 2010), but it is very promising to see a growing interest in L2 pronunciation instruction as well as research-based pedagogy practices.

Towards a Transdisciplinary Approach to Second Language Pronunciation

As discussed above, within L2 pronunciation research, particularly in the global and listener-based perception studies, three prominent speech constructs have been widely researched: *accentedness*, the degree to which a speaker's accent is different from a target variety (usually a prestigious L1 variety), emphasizing phonological differences (Munro & Derwing, 1995a); *comprehensibility*, listeners' perception of how easy or difficult a speaker is to understand, emphasizing perceptual and processing efforts (Munro & Derwing, 1995a); and *intelligibility*, listeners' actual understanding of speech utterances (Munro & Derwing, 1995a).

Nearly 30 years ago, Munro and Derwing (1995a) demonstrated that comprehensibility and accentedness are distinct listener-based constructs whose relationship to intelligibility varies across listeners. In their study, comprehensibility, or listeners' impressionistic perception of how easy speech is to understand, was strongly aligned with intelligibility, or listeners' actual understanding of the speech utterance. Within-listener correlations for these two constructs ranged from medium to large. Conversely, within-listener correlations between accentedness and the other two constructs were often not significant, and the range of coefficients was relatively large. In other words, their study demonstrated that speech can be heavily accented but completely intelligible. The independence of these constructs has also been observed in recent studies (Kang et al., 2023a), including studies across different languages (Huensch & Nagle, 2021).

Since Derwing and Munro's work (1995a, 1995b, 1997), L2 speech research has experienced a theoretical and methodological renaissance centered on the speech constructs of comprehensibility, intelligibility, and accentedness. For instance, a significant body of scholarship has emerged on the linguistic correlates of comprehensibility and accentedness across multiple speaking tasks (Crowther et al., 2015), target languages (Bergeron & Trofimovich, 2017; O'Brien et al., 2014; Saito & Saito, 2017), and speech features, such as intonation and prominence (Kang, 2010; Kang et al., 2010: Trofimovich & Isaacs, 2012). Studies have further investigated the pronunciation features that affect intelligibility across different target varieties (Kang et al., 2020) as well as how

intelligibility can be defined and measured (Kang et al., 2018), which supports an intelligibility-based approach to pronunciation learning (Dalman, 2022; Levis, 2005). In another vein, scholars have started to view these constructs as dynamic, changing in real time (Nagle et al., 2019; Trofimovich et al., 2020) and influenced by social-affective variables beyond linguistic features (Nagle et al., 2022). Much research continues to happen with regards to these speech constructs and listeners' perception as well as efforts of characterizing them.

The interconnection of L2 pronunciation and other disciplines is also important to consider from the teaching perspective. L2 pronunciation instruction was once called the "Cinderella of language teaching" (Celce-Murcia et al., 2010, p. 2), and pronunciation teaching remains on the margins in many L2 classrooms (Foote et al., 2011). Teachers cite not only lack of training in pronunciation teaching but also competing demands in the classroom as reasons why pronunciation teaching is deprioritized. Furthermore, learners' perceptions of English pronunciation teaching do not necessarily match teachers' practices (Burri, 2021). It remains the case that novice instructors may see pronunciation teaching as disconnected from other important areas of second language learning and teaching, such as pragmatics, instructed SLA, and assessment. In addition, they may find new methods, such as those found in natural language processing (NLP), ASR, or AI, challenging to integrate into existing classroom practices. Finally, they may be less familiar with perspectives on pronunciation from other fields (e.g., corpus linguistics), which may be applied in important language for specific purposes settings, such as call center discourse. A transdisciplinary approach can bridge the gap between these important research areas and pronunciation learning and teaching in a practical sense.

Indeed, L2 speech research increasingly operates within a multidimensional framework that integrates speaker and listener differences with various contextual variables. Other disciplines have started to incorporate various aspects of L2 speech research, recognizing its interconnectivity with their subdisciplines (e.g., intelligibility in speech science and perceptual training for accented professional speech in social psychology). Furthermore, the speech constructs of intelligibility, comprehensibility, and accentedness have been used as a bridge connecting pronunciation to other branches of knowledge. However, there is still no systematic resource that demonstrates how topics of L2 pronunciation can be applied or practiced with other areas of research.

The current special issue specifically focuses on the following disciplines of applied linguistics, with the aim of illuminating how such areas intersect with L2 pronunciation: instructed SLA, pragmatics, psycholinguistics,

corpus linguistics, NLP and AI, and assessment. We intentionally chose these disciplines due to their strong impact on and applicability to L2 classroom teaching and learning. In the following sections, we highlight each of these areas.

Instructed Second Language Acquisition and Second Language Pronunciation

Pronunciation instruction has gone through various changes. Although models of communicative competence have evolved throughout the years (Bachman & Palmer, 1996; Canale & Swain, 1980; Celce-Murcia et al., 1995, to name a few), researchers now believe that L2 competence is the product of the dynamic interaction of simultaneously responsible language skills, including pronunciation. Since approximately 2005, the time when the Educational Testing Service incorporated speaking as a part of the regular Test of English as a Foreign Language (TOEFL) test set, the speaking skill has received more attention. Researchers and practitioners have stressed both the importance of pronunciation in instructed SLA (ISLA; Celce-Murcia et al., 2010; Derwing, 2017; Lee et al., 2015) and the training of teachers for pronunciation in ISLA (Murphy, 2017). In fact, empirical research has provided evidence of the effectiveness of ISLA for pronunciation learning. An important meta-analysis by Lee et al. (2015) reviewed 86 studies related to pronunciation in ISLA, and their results showed positive results for learners' pronunciation accuracy in both within-group comparisons (0.89 standard deviation units of improvement) and between-group comparisons (0.80 standard deviation units of improvement as compared to control groups).

Crowther and Loewen in their conceptual review, "Instructed Second Language Acquisition and Second Language Pronunciation," add to our understanding of ISLA research on pronunciation and include findings that show benefits of ISLA on perception as well as production. In addition, although global measures of production (accentedness, comprehensibility, and intelligibility) are still underrepresented in the literature when compared with improvement on the production of specific pronunciation features (as represented by Lee et al. 2015), more recent meta-analyses by Saito and Plonsky (2019) showed that, at least for English, more gains were found for comprehensibility than for accentedness after instruction. This both underscores the importance of a focus on instruction outside of accuracy and suggests that more research is needed to understand gains on global measures, particularly for languages other than English. In addition, as mentioned above, focus on form instruction with corrective feedback has emerged as the most effective

type of instruction, but as Crowther and Loewen highlight, more research is needed in this area as well, given that most studies employed highly controlled tasks that do not reflect the real-world demands of language learners. The authors find promise in newer technological developments in pronunciation instruction, including high variability phonetic training, ASR, and AI. They close with practical implications for teachers.

Pragmatics and Pronunciation Teaching and Learning

The intricate relationship between pragmatics and prosody was established in early 1950s (see Pike, 1945; Ladd, 1996). Ladd (1996), for example, described the nuanced contextual cues of intonation (one of the most important prosodic features) as belonging to a system "with rich interpretive pragmatics" (p. 39). Overall, then, pragmatics and pronunciation seem to be inseparable. L2 learners are constantly exposed to speaking opportunities that require the negotiation of pragmatic meaning. Some recent L2 research in this area has found that study abroad and proficiency impact English L2 learners' patterns of prosody (Taguchi et al., 2022), making them more nativelike for select speech acts (Kang et al., 2021). Kostromitina and Miao (2024) found that listener perception of appropriateness in L2 speech acts was influenced by both suprasegmental features, such as rhythm, and lexicogrammatical features, such as hedges, that perform pragmatic strategies. This research provided empirical evidence to further support the pronunciation–pragmatics link.

Chen et al. in "Prosody in Pragmatic Competence: Proficiency Impact on Pitch and Fluency Features in Request-Making in L2 Chinese" provided an important example of this line of research on languages other than English. Their study examined L2 Chinese/L1 Japanese in a widely used but notoriously difficult speech act—requests. The analysis focused on L2 Chinese speakers' use of prosodic features (speech rate, pausing, and pitch range) in comparison with L1 Chinese speakers' prosody in the same speech situations. They also investigated differences across two types of request role plays, one that elicited a high power differential and high social distance for the interlocutor (e.g., professor or boss) and high imposition (e.g., extending a deadline) and one representing speakers of an equal level of power and low social distance (e.g., friend or roommate) and low social imposition (e.g., taking one's picture). Their results show that although both high and low proficiency learners modulated speech rate and pauses across pragmatic situations, only high proficiency learners varied their use of pitch range but not to the level of the L1 Chinese group. In addition, neither L2 group modified pitch values based on situation, in contrast to the L1 group. These findings suggest that

both L2 groups would still benefit from training in the use of prosody for sociopragmatic purposes but on specific features.

Psycholinguistics

Psycholinguists' interests include how people process and comprehend languages. When listeners process speech, they quickly adapt to the auditory idiosyncrasies of the speakers (e.g., Field, 2008), including speakers' accents (e.g., different accent varieties; Munro & Derwing, 1995b). For example, reaction-time-based studies have shown that it takes less than a minute for people to adapt to unfamiliar accents in listening (Clarke & Garrett, 2004). Moreover, relevant exposure and training can further reduce processing burdens when listening to unfamiliar accents (Witteman et al., 2015), and the effect of such training and exposure can extend to novel speakers and novel accent varieties, such that they develop the ability to comprehend different accents better (Baese-Berk et al., 2013). Psycholinguists are also interested in the individual differences of listeners, such as listeners' familiarity (Kennedy & Trofimovich, 2008), multilingual background (Saito & Shintani, 2016), linguistic training (Saito & Saito, 2017), and general language learning experience (Kang & Rubin, 2009).

Saito and Tierney add to this body of research in "Roles of Domain-General Auditory Processing in Second Language Speech Learning Revisited: What Degree of Precision Makes a Difference?". They investigate a relatively underresearched individual difference that may affect the impact of interventions on learners' development of pronunciation accuracy: auditory processing. Results show that learners that reach a particular threshold for auditory processing (14 out of 100) can compensate for lower levels of auditory processing over time and with higher use of the L2. However, those not reaching this threshold may benefit from additional instruction in phonetic and/or auditory training. Their findings have important implications for differentiating instruction among individuals with various ranges of auditory processing.

Corpus Linguistics and Pronunciation Teaching and Learning

Whereas corpus linguistics has revolutionized the understanding of language learning and teaching in the areas of vocabulary and grammar, the same cannot be said for pronunciation learning and teaching. Due to the more labor-intensive process of gathering spoken corpora and also the time-consuming nature of pronunciation analysis, there have been fewer spoken corpora produced, and most of the focus within spoken corpora has been on lexico-grammatical features. There are some notable exceptions, including the

massive study of discourse-based intonation using the Hong Kong Corpus of Spoken English (HKCSE; Cheng et al., 2008) and the LeaP, Learning Prosody in a Foreign Language (Gut, 2009), which contains prosodically transcribed speech for learners of English and German (21 different L1s), and The Louvain International Database of Spoken English Interlanguage (LINDSEI; Gilquin et al., 2010) corpus. In addition, there are a few studies focused on pronunciation analysis for the training of specialized professionals (see Pickering, 2001, for an early example of this in an analysis of international teaching assistants). In her investigation of internationally educated nurses (IENs) working in the American health care context, Staples (2015) compared the prosodic patterns of IENs with those of United States-educated nurses whose first language was English. Key differences were found in the use of particular prosodic patterns, including pitch range and tone choice on empathetic statements and the proportion of stressed syllables on informational content. These findings were then used to create corpus-informed materials for use in a pronunciation course for nurses (see Staples, 2019).

Pickering et al. in "The Role of Prosody in International Communication in English in Call Center Interactions" add to this growing body of corpus research with implications for pronunciation teaching. Their study used a small sample from a corpus of outsourced call center interactions between customers in the United States and Filipino agents. Unlike previous reports on conflicts in call-center interactions, Pickering et al. are able to pinpoint the specific prosodic elements contributing to the conflict, including unexpected intonation from the agent, but also overlapping speech from the customer. They also report that the conflicts are rarely caused by segmental issues from the agent. These findings have important implications for the training of agents, and the corpus provides a rich resource for illustrating examples of these conflicts and the prosodic patterns that lead to them during training.

Natural Language Processing and Automated Scoring

L2 pronunciation has served as a robust locus of research for linguists interested in the development of oral communicative competence. Recent advances in machine learning (ML), AI, and ASR have made significant improvements in identifying words in noisy, variable, and imperfect acoustic signals (Kinoshita et al., 2020). New developments in deep neural networks (DNNs) in ML have also revolutionized the possibilities of training ASR models with minimally labeled or unlabeled audio data (meaning they do not require extensive manual annotation) for speech recognition tasks, resulting in very large training datasets that substantially improve accuracy with speaker

variability, including accents (Narayanan & Wang., 2015). In fact, L2 speech researchers have used various ASR systems with positive effects by employing prebuilt speech-to-text systems (e.g., Liakin et al., 2015) and specialized systems for L2 pronunciation training (e.g., Cucchiarini et al., 2007). These models mirror human perception notably better in that they use more of the acoustic signal and more closely represent the millions of neural connections within the human perceptual system (Gad & Jarmouni, 2021). They have been adopted across industries and are already a part of our interactions with technology through various websites and conversation agents.

However, much is yet unknown about how ASR models can be employed for the measurement of L2 pronunciation, despite a large body of research on the linguistic correlates of constructs such as comprehensibility (Kang, 2010) and proficiency (Iwashita et al., 2008). Also, improving accuracy in speech detection and learner feedback is a recurring challenge (Kang & Johnson, 2018). More research is still needed to investigate how AI or ASR models are aligned with human perception and how they can be used for learners' pronunciation learning.

In response to this need, Cai et al., in "Developing an Automatic Pronunciation Scorer: Aligning Speech Evaluation Models and Applied Linguistics Constructs" discuss how pronunciation features are used in an automated speech scoring system in development by Duolingo. They compared their proposed automated scorer with human raters as well as five other baseline automated scoring models. The proposed scorer outperformed all other automated scoring models, establishing a Spearman's rho of .82 compared with .86 for the human raters. All other models were below .78. The proposed model suggests that integrating neural network algorithms into existing models can significantly improve automated scoring, which has important implications for research and practice in this area.

Artificial Intelligence-Based Technology for Pronunciation Learning

Following recent advancements in AI, the field of education, including language learning and teaching, is undergoing a substantial reform to include AI models. For example, Wang et al. (2022) found that learners who perceived higher cognitive (e.g., "the AI coach allows me to improve my English competence") and social (e.g., "I feel like I am communicating with a real teacher") presence when interacting with AI as a humanized agent performed higher on a mid-term test that included pronunciation, along with listening comprehension, vocabulary, and spelling. Similarly, Zou et al. (2023) found positive effects for AI in L2 speaking improvement. However, such a

fast-moving approach comes with serious concerns for many scholars and practitioners. For instance, Wang et al. (2023) showed that students benefited differentially from AI, leading them to caution teachers about sole reliance on AI. Similarly, Ju (2023) conducted an experiment on the impact of generative AI on students' learning. Results suggested that complete reliance on AI could lead to reduced language skills. At the same time, the findings suggested that students who already have strong skills can benefit from AI. Overall, this line of research provides preliminary evidence supporting the potential usefulness of technology and AI in pronunciation learning.

Building on this body of research, Hirschi et al. in "Artificial Intelligence-Generated Feedback for Second Language Intelligibility: An Exploratory Intervention Study on Effects and Perceptions" share an empirical study focusing on how AI-assisted pronunciation feedback can be generated for learners and how Chat-GPT can assist in pronunciation improvement. The study focused on three groups: visual only feedback, visual plus narrative feedback from Chat-GPT, and no feedback. Both feedback groups improved significantly in their production of prominence after feedback, but the visual + narrative group also showed a significant difference in their use of thought groups after feedback as well as improved intelligibility ratings. Interestingly, though, participants perceived a significant decline in the helpfulness of the visual + narrative feedback across four lessons. The findings suggest that feedback from Chat-GPT may be helpful for learners but that it may benefit from pairing with human feedback to increase user satisfaction.

Pronunciation Assessment

The assessment of L2 speaking proficiency has been of central interest to researchers in applied linguistics since the first discussions of communicative competence (Canale & Swain, 1980). In fact, pronunciation is an essential aspect of the assessment of oral skills as it helps us understand the fundamental processes of the construction of spoken discourse in L2 performance. That is, listeners begin by processing individual sounds constructed by L2 speakers to arrive at an interpretation for a stream of speech. The discrete sounds of pronunciation can be a critical area of investigation as listeners tend to evaluate speaking ability on the basis of pronunciation (Luoma, 2004), often after listening to a brief speech sample. Pronunciation is a key aspect of language proficiency, and most L2 learners have strong opinions and clear motivations related to it (Leather, 1999).

The assessment of pronunciation has experienced historical changes of perspectives as well. In some cases, pronunciation assessment has focused

on the accuracy of segmental features, and in others, on the approximation or the mastery of suprasegmentals. Since 2005, when a speaking section was introduced as a part of the TOEFL test by the Educational Testing Service, more attention has been paid to production skills and construct validity issues, including pronunciation assessment. Consequently, pronunciation has been integrated into assessment topics and criteria, including the pronunciation features distinguishing speaking proficiency levels (Kang & Moran, 2014), rating scale development (Isaacs et al., 2018), shared-L1 accent effects in listening tests (Shin et al., 2021), or accent fairness in listening comprehension (Kang et al., 2023b). In fact, pronunciation can be more than just another subskill of speaking, as it can distinctively and independently contribute to proficiency scores.

In "Incorporating Cooccurrence into the Operationalization of Speech Disfluency for Second Language Pronunciation and Oral Proficiency Assessment," Yan and Pan focus on one element key to pronunciation assessment: disfluency. Instead of operationalizing this construct with individual variables, they examine the cooccurrence of 15 different disfluency variables. Importantly, they show that some features (e.g., lots of partial utterances followed by quick repairs related to recall) are meaningfully associated with proficiency, whereas others (e.g., hesitation and hesitation repair) are not. These results were somewhat mediated by task type as well, indicating that some tasks, for example, those that are more constrained by time and the need for accuracy, may distinguish between proficiency levels more than those that require more planning time and content formulation. The findings have important implications for our understanding of disfluency as a multifaceted construct and its relationship with pronunciation assessment.

Future Directions

As can be seen from the review above, the field of pronunciation teaching and learning has changed dramatically in the last 20 years and has increasingly incorporated concepts and methods from various disciplines. The daily use of English in an international context is on the rise, especially with the recent effect of social media venues that include audio and video components (e.g., TikTok, Stories). Therefore, the number of English language users is only going to grow, and more variety in linguistic productions will be created. Exploring these modes of communication can only expand our knowledge of English as an international language and its real-time use by a large number of speakers. Also, with the recent incorporation of corpus-based data-driven teaching strategies in the L2 classroom, more practical pedagogical approaches

can be developed for listening and speaking instruction in the classroom. However, only a few studies have evaluated the effectiveness of these approaches, and much more work is needed to make these approaches more accessible to classroom teachers, who are not experts in corpus linguistics, pronunciation research, or either.

In addition, such developments, although centered on English, have clear implications for other second and foreign languages. As global communication becomes increasingly multimodal and multilingual, languages including Spanish, French, Mandarin, and Arabic are also being shaped by digital and transnational interactions. The insights from this special issue—such as the role of pragmatic speech data, intelligibility-oriented instruction, and L2 speaking assessment—can inform research and teaching practices in these additional language contexts. Moreover, the pedagogical potential of corpus-based, data-driven approaches can be extended to a variety of L2s, encouraging comparative work across languages and instructional settings. By engaging with these broader applications, researchers and educators in multidisciplinary fields can build more inclusive, transferable frameworks for pronunciation and oral communication instruction that reflect the diversity of today's learners and learning environments.

Most recently, of course, there has been a heightened focus on the use of new technologies such as ASR, NLP, and AI. We are delighted to have these technologies represented in our special issue, but we realize that these innovative research and teaching methods are only just beginning to be implemented in pronunciation teaching, learning, and assessment. One area that continues to be troublesome is the reliance on "native speaker" models for ASR and AI development of chatbots, meaning that speakers of less well represented varieties continue to experience more difficulties communicating with such technologies. The focus on a native speaker model for such advances in technology means that speech is evaluated not on intelligibility, which is a more important consideration for effective communication, but accentedness. We hope that researchers using these advanced technologies will work towards a more equitable approach to speech recognition that includes a greater diversity of language varieties.

Along these lines, we know that, in this increasingly fractured world, there is an even greater need for the type of social justice research that has been a part of the field of pronunciation, as discussed above (e.g., Kang et al., 2015). This research has benefited from its transdisciplinary engagement with concepts developed by intercultural communication scholars. Along with continued work in this area, we also see opportunities for pronunciation

researchers to draw on other asset-oriented instructional models, such as critical language awareness (Fairclough, 1992/2014) and culturally and linguistically responsive pedagogies (Haan & Gallagher, 2022) in a more explicit way. The tenets of these pedagogies are compatible with the work of Kang, Rubin, Lindemann, and others, but engagement with these approaches has the potential for this important work to move beyond the field of pronunciation to align with work in this same vein from scholars across the field of applied linguistics.

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