

From Cues to Features: Bridging Psycho- and Sociolinguistics in the Development of Non-Native English Stimuli

Marina Ivanova*

Chemnitz University of Technology, Germany

(Corresponding author. Email: marina.ivanova@phil.tu-chemnitz.de)

Josef Schmied

Chemnitz University of Technology, Germany

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Abstract

Developing credible stimuli for language experiments unites psycholinguistics and sociolinguistics – the stimuli need to reduce confounds while mirroring the investigated variety. Perceptual cues can be used to signal prototypical linguistic features which can be employed as variety markers and increase the experiment's ecological validity. This has implications for the scarce research on the perception of non-native English speakers of the variety they encounter daily – their own. Representing regional and foreign Englishes raises issues of avoiding stereotypes while introducing natural variability in the stimuli. We propose using credibly weighted cues to represent features of non-native Englishes on a small (phonology) and a large scale (syntax). Utilizing these stimuli in behavioral and psychophysiological studies has great potential to advance the understanding on non-native in-group variety perception. Moreover, the careful construction of experimental stimuli helps increase the experiment's credibility and validity, which are core quality criteria in language acquisition and TESOL research.

Keywords

Cue, feature, experimental stimuli, language variation, credibility

Introduction

Cue and feature are complex concepts, but they are often assumed to be common sense in the fields of psycho- and sociolinguistics. The term cue is more prominent in perception studies whereas feature mostly figures in production and sociolinguistic classification studies. There can be multiple perceptual cues to a feature and multiple features of the signal can serve as a cue. In speech perception, phonological features are revealed through the weighted encoding of acoustic cues – specific acoustic properties are attributed to the target sound or to elements of the context (see McMurray et al., 2011, p. 199).

In psycho- and neurolinguistics, perception is related to the processing of sensory linguistic information. In speech perception, for instance, the focus is on the way variable phonetic forms from the speech signal are mapped on invariant phonological representations in the mind (Ingram, 2007, p. 106). In sociolinguistics, perception is related to “beliefs or ideologies that people hold on a given topic” (Campbell-Kibler, 2010, p. 378) in the context of language variation. The focus is on both linguistic and social cues (Campbell-Kibler, 2010, p. 382). The overlapping foci of the two fields prompt the need for collaboration in the study of psychological processes in language variation. There are few reviews on the intersections between psycholinguistics and sociolinguistics (e.g., neurodialectology (Grimaldi, 2018;

Schmidt, 2016)). This paper aims at addressing this gap by focusing on the use of cues and features in the development of credible stimuli for experiments that reflect real-world variational distribution.

When it comes to the perception of varieties, studies have mostly exposed native speakers to regional and non-native accents (e.g., Bradlow & Bent, 2008; Cristia et al., 2012; Honbolygó et al., 2020; Scharinger et al., 2011). Some have exposed non-native speakers to native and regional varieties or to other non-native speakers from different backgrounds (e.g., Hu & Lindemann, 2009; Hamada & Suzuki, 2020). It is also common to present deviations, for instance in terms of grammar, which may be prototypical of the participants' variety (e.g., determiners for Chinese English, Schmied & Hofmann, 2017). Yet, the focus rarely falls specifically on how non-native speakers process cues and features that signal their own variety, and the evidence has so far been mixed (e.g., Major et al., 2002; Ludwig & Mora, 2017).

In addition to a rigorous research design, there is a need for credible stimuli representing the non-native variety. The most obvious solution is to record a speaker of the variety, but this raises some issues from both the psycho- and the sociolinguistic perspectives. From the psycholinguistic point of view, for instance, the physical variation of the stimuli may serve as a confounding variable in more fine-grained phonological perception studies. From a sociolinguistic point of view, it is difficult to determine if the designed stimulus has the prototypical form and distribution as it is naturally represented in the variety. In this contribution, we look at how to operationalize non-native varieties in the creation of experimental stimuli considering issues of credibility and validity.

The Concepts of Cue and Feature in Psycho- and Sociolinguistics

Cue: Definition

In perception, a cue is a clue to something. The concept is used in psychology for “[a]ny sensory stimulus that serves as a signal to guide memory, thought, or behavior.” (Matsumoto, 2009, p. 144). More broadly, a cue is “any source of information that allows the perceiver to distinguish between different responses” (Toscano & McMurray, 2010, p. 434). In linguistics, a cue is “a specific feature seen as an aid to the perception e.g. of some larger structure.” (Matthews, 2007, p. 89) Sensory information can serve as a cue to one or more components – vowel duration, for instance, can be used as a cue to the vowel and to the voicing feature of a following obstruent (Boersma, 2009, p. 59).

Spoken language perception depends on the interaction of sensory cues (acoustic) and knowledge-based cues (morphosyntactic, lexical, pragmatic) (Kaufeld, Naumann, et al., 2020, p. 934). An acoustic cue is “[a]n acoustic property of a speech sound ... used to identify the sound and to distinguish it from other speech sounds.” (Colman, 2015, p. 7). For example, among the acoustic cues that differentiate vowels are formant frequency and duration. The acoustic-phonetic cues of the signal are processed through a top-down mechanism and matched to a bottom-up phonological representation. This is achieved by the knowledge-based cues such as phonotactic, syntactic, and semantic constraints (Kaufeld, Ravenschlag, et al., 2020, p. 549). Cues can also combine across modalities such as auditory (speech) and visual (lip movement) cues to spoken language.

The physically measurable properties of cues are what differentiates them from abstract categories like distinctive features. Huilgol et al. (2019, p. 1) understand acoustic cues more generally as “physically observable patterns in the speech signal that can be extracted and interpreted to provide information about the speaker, or about the underlying message.”

McMurray and Jongman (2011, p. 221) look at cues in the context of speech perception as well as phoneme normalization and categorization as “a specific measurable property of the speech signal that can potentially be used to identify a useful characteristic like the phoneme category or the talker”. Thus, cues can be used as a measure for phonemes and their distinctive features.

Cues can also be represented on a larger scale, e.g., cues signaling the end of turns in Conversation Analysis (Matthews, 2007, p. 89). Similarly, in Interactional Linguistics (e.g., Couper-Kuhlen & Selting, 2018), cues determine how speakers signal and interpret meaning in social interaction.

Variation in cue perception

The numerous sensory cues in the environment are not given equal value in perception but are weighted. Each cue has a strength of association with a particular memory item but also simultaneously with other memory items, which is taken into account during processing (Parker, 2019, p. 3). When we take a retrieval probe from a target, the association strengths of cues are combined, thus, “items that match more cues will have a higher probability of retrieval and integration into the processing stream” (Parker, 2019, p. 3). This is fundamental for language perception processes like the discrimination between speech and non-speech stimuli.

From birth we are able to identify phonetically relevant acoustic properties of speech (Strange & Shafer, 2008, p. 157). Infants learn to selectively attend to phonologically relevant phonetic differences and to weigh cues so that they can handle the inevitable variability of speakers around them (Strange & Shafer, 2008, p. 157). The listener determines which cues are relevant for a given contrast and their relative importance, and thus manages to understand the input despite the large speaker and dialect variation (Schertz & Clare, 2020, p. 2).

Cues can combine in a linear manner, independent of each other, and in a non-linear manner, dependent on the match with other cues (Parker, 2019, p. 3). A good example of an independent cue is Voice Onset Time, which can determine the perception of a stop consonant as voiced or unvoiced. Still, it can be influenced by external or contextualizing cues like speech rate (see Schertz & Claire, 2020, p. 3). After cues are summed, they are normalized, i.e., integrated with their reliability, which is their representational strength (Martin, 2016, p. 8, 10). Cue weight can be updated, allowing the system to handle uncertainty, noise, and variation (Kaufeld, Ravenschlag, et al., 2020, p. 550). The combination of cues can thus “overcome variability in any one cue” (McMurray & Jongman, 2011, p. 231).

Martin (2016)’s theory of cue integration explains the function of cues as signals of linguistic hierarchy components and links between the components themselves. Perceptual cues such as speech rate, phoneme, morpheme, etc. integrate with more abstract cues such as syntactic structure and contextual factors in a cascading manner (see Martin, 2016, p. 7). Follow-up eye tracking experiments showed that cues are combined dynamically on a group and individual level (Kaufeld, Ravenschlag, et al., 2020). Contrary to the original logical integration order, the acoustic cue was used after the morphosyntactic cue, indicating that processing is flexible and does not necessarily occur stepwise based on a hierarchy (Kaufeld, Ravenschlag, et al., 2020, p. 561).

Numerous studies have found language-dependent cue processing (e.g., Chrabaszcz et al., 2014; Meng et al., 2020). For instance, in the case of word stress cues, Russian learners of English rely on vowel quality, intensity, and duration but not that much on pitch (Chrabaszcz et al., 2014, p. 10). Meanwhile, Cantonese learners of English are more sensitive to information

on the variation of pitch and less sensitive to information on the variation of duration compared to Mandarin English learners (Meng et al., 2020, p. 1496).

In bilinguals, cue weighting in the case of Russian English speakers was influenced by the dominant language and they performed like native English speakers in the perception of English-specific cues to voicing, i.e., vowel duration (Dmitrieva, 2019, pp. 141–142). The bilinguals performed differently from Russian native speakers in the perception of glottal pulsing, a typical Russian cue to voicing (Dmitrieva, 2019, p. 142).

In the case of foreign language learners, experiments on the perception of primary and secondary cues to the r/l distinction in Japanese English show that the expected cue reliability from acoustic measurements may not correspond to the actual weighting by the learners (Iverson et al., 2005, p. 3275). The measured natural distributions of F2 transition duration would predict that a long transition is a more reliable cue for /r/ than a short transition for /l/, yet the listeners weighted this asymmetry differently – they used short transitions as a cue to /l/ more than they used long transitions as a cue for /r/ (Iverson et al., 2005, p. 3275). Therefore, correlates of acoustic properties of produced speech do not fully correspond to correlates of perceived speech. Bent and Bradlow (2003, p. 1607) also suspected that the higher performance of their non-native listeners in non-native speech listening in comparison to native listeners may be because they are attending to different cues.

Finally, cue weighting of relevant L2 cues can be trained. Ylinen et al. (2010) trained Finnish learners of English to rely more on L2-typical cues by increasing the variance of their preferred L1-typical cue, vowel duration, and engaging them in minimal pair identification tasks. The results from the electroencephalography (EEG) experiment showed potential development of long-term memory representation of /l/, yet the authors also appeal for more exposure to the L2, so that the phoneme representation lasts (Ylinen et al., 2010, p. 1329). Holt and Lotto (2006) propose that “adding variance to an over-utilized cue ... may be an effective strategy to change listeners’ weighting functions.” (Holt & Lotto, 2006, p. 3069). Thus, in line with the ideas of the High-Variability Phonetic Training (HVPT) approach, a useful strategy in training cue perception could be to make less relevant cues more variable and thus support their learning. Still, the effectivity of the HVPT approach has been shown to vary with the different individual aptitudes and with the acquisition of more challenging non-native speech categories (Sadakata & McQueen, 2014).

To summarize, in perception, sensory external cues activate internal neural representations about the environment, which we have learned with experience (Martin, 2020, p. 1409). Cues are perceived differently based on the native language of the listener, but this can be influenced through learning.

Feature: Definition

A feature is a distinctive characteristic. In psychology, a feature is “[a]ny attribute of a sensory stimulus” (Colman, 2015, p. 276). Linguistics goes beyond the sensory aspect and describes it as “any property assigned to a unit” (Matthews, 2007, p. 137). Distinctive features classify sounds via a set of characteristics through articulator-bound features such as the place of the tongue body (e.g., ±high, ±back), or through articulator-free features (e.g., ±sonorant) (e.g., Chomsky & Halle, 1968, p. 68; Stevens, 2005, p. 128). Each speech sound can be described through a set of these features, a feature bundle.

In sociolinguistics, a feature often relates to a larger feature complex typical of the language produced in a regional or social variety – a “regular and widely, informally accepted feature” (Mesthrie & Bhatt, 2008, p. 47). It is close to the concept of the linguistic variable – a varying feature of language (Tagliamonte, 2006, p. 235) that is authentic, correlates with linguistic and/or sociolinguistic reality, and meets the criteria of functional equivalence, distribution, and structural embedding (Tagliamonte, 2006, pp. 97-98). Labov (1994, p. 78) distinguishes three types of sociolinguistic variables: stereotypes, which “are the overt topics of social comment and show both correction and hypercorrection”, markers, which “show consistent stylistic and social stratification”, and indicators, which “are never commented on or even recognized by native speakers, but are differentiated only in their relative degrees of advancement among the initiating social groups”. Even only few usages of indicators trigger sociolinguistic connotations.

The descriptive scope of a linguistic feature can vary on a large range – e.g., a variety like Chinese English can be described through phonological features like the replacement of /θ/ with [s] (He & Li, 2009, p. 72), syntactic features like the topicalization of adjuncts (p. 73), and pragmatic features like inductive logical structure of texts (p. 74). Compiling the prototypical features of a variety is difficult since it requires numerous large-scale quantitative studies to capture the complex linguistic landscape (Albrecht, 2021). As Albrecht (2021)’s review shows, this is especially true for Chinese English given the variable language backgrounds of its speakers, which may even require further stratification into subnational varieties.

The Electronic World Atlas of Varieties of English (eWAVE) (Kortmann et al., 2020) is the main resource for morphosyntactic features of English varieties which have been coded in terms of attestation and pervasiveness. A widespread feature like the different count noun/mass noun distinction (attestation in 55% and pervasiveness in 68% of all varieties) can thus be observed in national varieties (e.g., in Tanzania, Kenya, and Uganda) and generalized to the East African Englishes and the New Englishes (Schmied, 2017, p. 483).

Features are part of the indexicality of language (see e.g., Chevrot et al., 2018) – the information they carry points to social characteristics of the speaker which we have learned throughout our sociolinguistic experience (e.g., Kleinschmidt et al., 2018, p. 821). Thus, we can use features as cues and indicators (Labov, 1994, p. 78) of a speaker’s characteristics like gender, age, and social network, as well as other social stereotypes associated with them.

Although phonological features are abstract properties of speech sounds, we use them in perception and prediction (Monahan, 2018, p. 22). Scharinger et al. (2011) found that adult listeners extract dialectal information from speech fast and without attention. They presented listeners in a magnetoencephalographic (MEG) experiment with different variants of “Hello” in the realization of [ɛ] and [o], corresponding to Standard American English and African American English. The differences in the perception of the features were interpreted as a possible in-group/out-group effect (Scharinger et al., 2011, p. 2336). This account thus aims to connect distinctive features, which characterize phonemes, and sociolinguistic features, which signify a particular social background. However, the experiment is not enough to conclude that the listeners have recognized an African American pronunciation – the results only infer that they have recognized a different accent. The focus on the recognition of the variety or some of its salient features would require a different paradigm.

Overall, a feature is used for distinctive characterization and it can index linguistic properties on a different scale.

Features and varieties of English

In the context of language variation, features and deviations have been distinguished from mistakes based on their origin and systematicity (Mesthrie & Bhatt, 2008, pp. 45-46; Kachru, 1992, p. 62). Still, features can be stigmatized like mistakes or errors, for instance as in the different merger pronunciation of /r/ and /l/ in the sub-national varieties in Kenya (Schmied, 1991, p. 426). In this context, the Gikuyu tend towards /r/ and the neighboring Embu towards /l/ (Schmied, 2017, p. 476). The /r/-/l/ distinction (and /l/-/n/ distinction in some Chinese dialects, see Koffi, 2019) in perception and production is given high priority for Chinese and Japanese learners in Cruttenden/Gimson's pronunciation book even for the less restrictive 'international English' (Cruttenden, 2014, p. 344). The degree of stigmatization can vary, e.g., in Polish English, a feature like word stress shift is more stigmatized than lack of vowel reduction and is considered an error rather than a "regular feature of a Polish accent" (Zajac, 2015, p. 164).

There have been efforts to eliminate the negative connotations of dialect or accent and to neutrally discuss systematic differences across varieties by defining accent based on the listener's perspective:

... a talker may be described as accented if his/her speech diverges from that of the listener's systematically at the suprasegmental and/or segmental level. Consequently, if the listener speaks a "non-standard" regional variety, and the talker a standard variety, the latter would still be described as *accented*, because his/her speech deviates from that of the listener. (Cristia et al., 2012, p. 1)

Based on this account, a "standard" English speaker from a listening exercise would be perceived as accented by a learner of English, whereas their classmates, who speak the same non-native variety, would not be described as accented. This idea intuitively comes across as unusual because accent is often viewed in terms of norm and attitude. It would be expected that learners aim to follow the norm and have a more positive attitude towards the standard variety and would therefore not view it as "accented English". Yet, from a researcher perspective, viewing accent in terms of an in-group/out-group dynamics provides many opportunities in exploring the perception of non-native speakers of their own varieties.

The main subject of research in the past has been how native speakers perceive non-native speakers and vice versa, or how non-native speakers perceive other regional and non-native varieties. However, there is a scarcity of research on how non-native speakers perceive the variety they are likely to encounter daily, e.g., while learning the language at school. The available findings are mixed, e.g. only the beginner and not the advanced Catalan and German learners of English profited from L1-accented English in an animacy judgement task (Ludwig & Mora, 2017). Meanwhile, in a listening task, the Spanish listeners profited from Spanish-accented English, but the Chinese did not profit from Chinese English (Major et al., 2002). More performance-focused studies show the impact of non-native accent in listening comprehension, such as stimulated perceptual adaptation in learner script-assisted shadowing of Global Englishes (Hamada & Suzuki, 2020). Moreover, student performance is shown to be affected both positively and negatively by familiar and unfamiliar regional and foreign accents in TOEFL listening tasks (Kang et al., 2018; Ockey & French, 2014). This overall mixed evidence shows the need for more research on how non-native speakers from different backgrounds perceive features of in-group and out-group varieties.

The evaluations of variety perceptions have often been measured directly through methods like map drawing, attitude judgments, and the matched-guise technique (Clopper & Pisoni, 2005, pp. 315–317). For example, Mandarin English learners were presented Cantonese and American English excerpts in a matched guise experiment where participants reported perceiving word-final consonant deletion only in the case of the Cantonese (Hu & Lindemann, 2009). The matched-guise technique has, however, experienced some criticism (Clopper & Pisoni, 2005, p. 317).

Some studies focus on the features that make accent be perceived as more or less strong, as in the Czech English study by Skarnitzl & Rumlová (2019). The evaluation is usually performed on an attitude scale, which makes this measure of perception rather subjective. The participants can be biased by stereotypes and prescriptivist norms taught at school (Clopper & Pisoni, 2005, p. 317). It is also difficult to connect the produced phonetic features of the English learners with the perceived cues that have led to the evaluators' ratings. Finding an objective measure for such correlations requires using suitable experimental designs and awareness of confounding variables and biases.

Psychophysiological methods (e.g., EEG, pupillometry) provide an opportunity to indirectly measure (i.e., independent of attention) how certain isolated features are perceived. Still, their data analysis and interpretation can be complicated. Moreover, when exploring feature salience, it is important to consider initial salience, which is marked by surprisal, and later salience of a reencountered variant in a new lect (Jaeger & Weatherholtz, 2016, p. 3). In applied language testing scenarios, comprehension of an unfamiliar accent may increase as the subject advances in the test (Ockey & French, 2016, p. 710). Such priming effects, similar to sensory adaptation confounds, are important to consider in popular EEG paradigms like the oddball paradigm (Luck, 2014, pp. 134–136). Isolating confounding variables is one of the most challenging aspects of psycholinguistic experiments, but the inquiries gained from them are worth the careful planning.

From features to cues, from cues to features

The paradox of the concepts of cue and feature is that a cue has certain features through which it can be described, but cues also constitute perceived features.

Acoustic cues are extracted from the signal by sampling parameters (Stevens, 2002, p. 1885). Then, the features or feature bundles that define phonemes are derived from these cues (Gow, 2003, p. 575; Stevens, 2002, p. 1872). The listener can determine which feature cues are temporally associated with the same segment and thus integrate them (Gow, 2003, p. 576). This process also considers the context of other features (Stevens, 2005, p. 150). The identification of the features can then lead to the identification of the word they constitute (Stevens, 2002, p. 1881). So, the simplified sequence is cue – distinctive feature – phoneme – word.

The idea of representing features through cues is also inspired by the C-Cure model (Computing CUEs Relative to Expectations), according to which similar acoustic cues are associated with features and are thereby grouped (McMurray et al., 2011, p. 204). It puts more emphasis on the context and the expectations of the listener to account for the processing of variation.

It can additionally be argued that the perceived cues also infer about the articulatory traces in the acoustic signal. As Stevens points out, “the acoustic cues that are used to identify the underlying distinctive features are cues that provide evidence for the gestures that produced the

acoustic pattern” (Stevens, 2005, p. 142). Cues thus inform how something has been pronounced and what it signals in perception.

The Need for Non-Native Experimental Stimuli in Psycholinguistics

The fields of language perception and variation have been combined in perceptual dialectology which investigates the perception of dialects in terms of geographical spread and attitude. However, it deals with a different idea of “perception” in comparison to psycholinguistics, as its methods (e.g., Preston, Ed., 1999) are based on direct inquiry. In contrast, behavioral and psychophysiological measures predominate in psycholinguistics. Sociolinguistic perception is a promising and underexplored field which can bring more insights on open questions like the lack of invariance problem created by coarticulation (Fowler & Magnuson, 2012, p. 4). Integrating sociolinguistically plausible variation in psycholinguistic studies can demonstrate how listeners adapt to variability and process “the joint distribution of social variables, linguistic categories, and acoustic cues” (Kleinschmidt et al., 2018, p. 819). The responses of non-native speakers to the native normative English variety they are taught (e.g., British English) and to their social English variety are two different topics, both interesting on its own. Yet, if the aim is to study real-world language variation outside of exonormative standards, non-native stimuli have great potential in controlled psycholinguistic experiments.

It is particularly rewarding to apply mixed psycholinguistic methods because they may show systematic differences between attitudinal, behavioral, and psychophysiological responses. Zaharchuk et al. (2021) tested the responses to the prototypical Southern dialect feature of double modals (*might could*) by American English speakers who are familiar and unfamiliar with the feature. They found a discrepancy between the attitude and the behavioral and EEG responses – although the Southern subjects found double modals more acceptable and intelligible in their questionnaire responses (Zaharchuk et al., 2021, p. 8), their behavioral measures and ERP responses were not significantly different from those of the unfamiliar participants. Both groups showed a similar level of comprehension accuracy and reaction times (Zaharchuk et al., 2021, p. 6) as well as an Early Anterior Negativity and a P600 signaling the detection of a semantic deviation and the re-analysis of the sentence (p. 10). In an experiment on the perception of German stress by Hungarian L2 speakers, Kóbor et al. (2018, p. 105) also show a 30.3% error rate in their behavioral lexical decision task in contrast to the elicited ERP responses to the prime-target stress mismatch. Thus, introducing an indirect measure of cognitive processes can give us additional insight on the processing of foreign language features.

The validity of stimuli representing language cues/features in experimental designs

Operationalizing a concept in an experiment requires attention to construct, external, internal, and ecological validity. External validity expects that results can be generalized to a larger population (Abbuhl et al., 2013, p. 117; also see Speed et al., 2018, p. 191). Internal validity requires that the stimulus was responsible for the observed effect (Abbuhl et al., 2013, pp. 116–117). Ecological validity means that the results can be applied to the real world. This is especially difficult to recreate for language in its fully embedded multimodal context (Speed et al., 2018, p. 200).

Studies aiming at ecological validity can recreate real-world situations (Speed et al., 2018, p. 201). Nevertheless, it is recommended that the stimuli are prepared before the experiment “to avoid contaminations from linguistic elements other than those of interest” (Verga & Kotz, 2019, p. 537). The recreation of spontaneous real-world situations risks the reliability and reproducibility of the study.

As an alternative, Verga and Kotz (2019, p. 537) suggest designs using stories, moving “from individual to social interaction” or game-like experiments (Verga & Kotz, 2019, p. 539). Kandylaki and Bornkessel-Schlesewsky (2019) also summarize the advantages and challenges of using natural rich-context stimuli for the exploration of multiple language modalities, new research questions, populations, and varieties, and argue for a synergy between natural and controlled approaches. This is a big topic in neurolinguistics because it is difficult to find a compromise between controlled stimuli, which are easy to interpret but far from real life, and natural stimuli, which are challenging to interpret because of the many psychophysiological processes taking place at the same time.

Overall, it is important to find a suitable trade-off between physically controlled stimuli and natural stimuli for the particular research question.

Mirroring features of non-native English

Language stimuli can be produced by recording a speaker of the variety and using the recording as is, re-synthesizing it to adjust features of interest, or synthesizing the stimuli altogether. Presenting the original recording can be useful if we want to study the impact of accented English as a whole and can tolerate that some features are more prominent than others. If this natural variability raises confounding variables, we can ensure the operability and authenticity of the stimuli by recording a speaker and then adjusting certain variables through re-synthesis (Verga & Kotz, 2019, p. 537). Meanwhile, synthesis is useful for achieving full control over the physical properties of stimuli, but still compensates with their naturalness. Synthetic stimuli may allow researchers to isolate and manipulate certain cues better (Toscano & McMurray, 2012, p. 1298). However, “varying synthetic stimuli along a single dimension, while holding other cues constant, may not reflect the way that speech sounds vary naturally” (Toscano & McMurray, 2012, p. 1298).

There are other more specific issues of recreating non-native varieties. Finding speakers who represent the average speaker of the variety may be difficult without knowing which features constitute it and to what extent the speakers represent it. It is also challenging to determine the foreign language status of the participants or the recorders in the first place, though a well-structured sociolinguistic background questionnaire, a read-aloud task, and a language test could be useful (as in Kóbor et al., 2018, pp. 103–104).

The recreated feature should have a clear goal and role in the variety, as evident from the Labovian classification discussed above. Is the feature part of a stereotype, i.e., recognized and imitated by outsiders, or is it a marker that shifts between styles, or is it an indicator of a sociolinguistic variable like gender or ethnicity (see Labov, 2010, p. 250)? In addition, the mode in which it is presented is decisive since the gap between written and spoken language is relatively large for dialect speakers (Treiman & Kessler, 2007, p. 657). Recreating oral features in written form where they are not attested may be considered an offensive and inaccurate representation of the variety.

These goals speak of a certain intentionality of the stimuli. Intentionality “denotes the fact that conscious experience always implies the experience of a particular kind of access to a particular kind of content” (Prinz, 2017, p. 348); for instance, we cannot hear without hearing a sound. Applied to our context, intentionality implies that the stimuli are consciously created with a purpose; they aim to establish a connection between the physical sound and the mental phonological representations and to evoke an authentic reaction. In the frame of human-agent interaction, Schmied (2020, pp. 109–111) proposed integrating intentionality in the

development of the discourse of credible conversational pedagogical agents. Similarly, in the stimulus-participant ‘interaction’, experimental materials tailored to the variety of the participants can open new research perspectives on foreign language acquisition. Cues offer an opportunity to signal which features are intended to be perceived and establish the reference between the sound file and the mental language representations of the variety the participants encounter daily.

Considerations in the Design of Non-Native Experimental Stimuli in Psycholinguistics **Methodological challenges**

Each stimulus is marked by variables, including the contrasts under investigation and the salience of the cues for these contrasts (Strange & Shafer, 2008, p. 182). Stimuli can vary based on their form, tokens, and speakers (Strange & Shafer, 2008, p. 182). For example, in the study of word stress shifts, to exclude the confound of vowel quality and prosody, Friedrich (2003, p. 48) presents only words with full vowels. While this is easy in German and Dutch due to the abundance of unstressed reduced syllables in frequent words (Cooper et al., 2002, p. 208), in English many unstressed syllables feature vowel reduction. This makes it difficult to find frequent words which change only suprasegmentally. The stimuli also often need to be embedded in suitable carrier sentences to eliminate confounding prosodic effects (e.g., Broś et al., 2021, p. 7). The variation and order of the stimuli (random, semi-random or set sequence) can also impact anticipation (Strange & Shafer, 2008, p. 183).

There are many other influential factors of the methodological design, e.g., the number of speakers and the perceived strength and intelligibility of the out-group accent (for a detailed list, see Strauber et al., 2021, p. 3). Based on the guidelines by Lewendon et al. (2020, p. 7) and Broś et al. (2021, p. 6), we can summarize several relevant variables. For the stimulus design, it may be necessary to control for general physical properties like fundamental frequency, phonotactics (especially for pseudowords), coarticulation effects, familiarity, lexical frequency, and word type. For the group design, it is important to control for the participants’ age, age of acquisition, language distance between L1 and L2, exposure to L2, and time spent abroad (in a general and native context).

In the interpretation, it is difficult to determine whether the observed reaction prompted by the cues and features is language-specific or based on sensory properties (Scharinger et al., 2011). To solve this, Scharinger et al. (2011, p. 2331) used a passive oddball paradigm with two types of deviants that follow variable standards from both dialects. Thus, inducing internal variation can be useful to eliminate sensory confounds and draw conclusions on abstract properties like features.

Another challenging distinction is between the listener’s familiarity with the presented accent versus their interlanguage speech intelligibility benefit (Bent & Bradlow, 2003), i.e., the benefit non-native speakers and listeners of the text may have because they share a common L1. To determine accent familiarity, the subjects would need to do a questionnaire on the heard accent (see Ockey & French, 2016, p. 709), best presented after the experiment to avoid bias. However, accent familiarity is prone to become a rater effect and requires detailed documentation of the language background of the raters and the test takers (Winke & Gass, 2012, pp. 766, 785).

Using cues to represent features

Cues can be used as measurable characteristics of linguistic features, which can then function as markers of a language variety. There are few available resources that align cues and features,

for instance, McMurray and Jongman (2011) have constructed a corpus of fricatives and their relative cue values, which can be used for acoustic analysis and modelling. Huilgol et al. (2019) have developed a system to annotate audio corpora with cues for more accurate analysis. In their framework, variability is not considered as noise, but a normal constituent of language – phoneme sequences are made up of “combinations of cues drawn from the set of relevant acoustic cues for each feature” (Huilgol et al., 2019, p. 2). This enables a focus on cues that are related to linguistic feature contrasts.

In addition to analysis, cues have the potential to be used to synthetically re-create features. Again, multiple cues would have to be combined to generate a perceived non-native accent (Boula de Mareüil & Vieru-Dimulescu, 2006, p. 248). Smaller-scale cues on the segmental and suprasegmental level can be used to recreate phonological variation like the length and quality differences in the basic five-vowel system in East African Englishes (Schmied, 2008, p. 161; 2017, p. 477), or differences in intonation patterns (Schmied, 2017, p. 478). Larger-scale cues can be used to recreate syntactic and pragmatic variation such as determiner usage patterns in Chinese English (Schmied & Hofmann, 2017) or empathy discourse cues like elaborate greetings in East African English (Schmied, 2017, p. 484f.). In the stimulus design, it is important to pay attention to stigmatized features, such as subnational consonant “problems” (Schmied 2008, p. 159), and to differentiate them from variety indicators like non-rhoticity (Schmied 2008, p. 159).

The non-native stimuli could then be used to inspect different psycho- and sociolinguistic topics, such as the “cues to linguistic origin” (Kolly & Dellwo, 2014), i.e., what kind of information on dialect variation is used to link a speaker to their variety (Clopper & Pisoni, 2005, p. 320). For example, students who are presented with listening exercises with different varieties as in Kang (2018) can report what variety they have heard and why they categorize it as such. Another point of interest would be to compare the reaction to conflicting cues which may not be identified as social markers versus cues which indicate the same linguistic and social features – for example, combining the grammatical features of one variety with the pronunciation features of another. A further interesting study design could take the insights on the grammaticality judgements on relative clauses by Chinese learners of English as a Foreign Language (EFL) from Zhang (2021) and investigate how Chinese EFL learners perceive these clauses in an eye-tracking experiment (similar to Schmied & Hofmann, 2017). The scale could even be increased on the level of cohesion, e.g., looking at English learners’ perception of native and non-native theme structures (e.g., based on the results of Martinez-Insua, 2021 for Spanish or Dontcheva-Navratilova et al., 2020 for Czech). Overall, non-native stimuli can be used to test cue and feature salience and thus gain a better understanding of the variety. Eventually, these efforts have the potential to evoke acceptance of language variation.

Implications for TESOL

This paper has argued for the need of more diversified English input in terms of language variation and has provided suggestions for the creation of language experimental stimuli mirroring non-native varieties. The insights from these experiments can be used to develop teaching materials and methodologies. However, the tight language curriculum often does not leave space for exposing learners to different varieties of English. It is important to prioritize variation training, as the English most foreign learners will encounter is likely to vary in different parameters. TESOL materials have successfully incorporated such noise though the use of more authentic materials (Field, 1998) – for instance, more general noise like unknown vocabulary (Ur, 2013 [1984], p. 85), internal noise like speech rate, and external noise like background traffic noise. Still, there is a need for more research on the benefits of introducing

the natural ‘noise’ of language varieties, as this would mirror authentic sociolinguistic environments.

Boduch-Grabka and Lev-Ari (2021) have shown that after being exposed to Polish English, native English speakers process the non-native variety easier and perceive it as more trustworthy. Exposure does not need to be active, i.e., through conversation, but can also take place passively through media, or in combination (Bradlow & Bent, 2008; Cristia et al., 2012, p. 3). Müller and Mair (2022) found that German processing of Nigerian English may have been influenced by the participants’ exposure to different varieties, as those who were able to identify the speaker’s origin (Africa) performed better in a transcription task than those who were not (p. 13). Still, research on the effectiveness and application of perceptual training methods is not conclusive (Sadakata & McQueen, 2014). Bradlow and Bent (2008) found that exposure of native English speakers to Chinese English helps improve their perception of Chinese English but does not necessarily help them in the recognition of a novel accent like Slovakian English. Interdisciplinary research in TESOL and language acquisition with methods from psycholinguistics and sociolinguistics can make English learners more sensible to language variation and support them in their encounters of natural variation in the real world.

Conclusion and Outlook

Interdisciplinary studies in psycholinguistics, sociolinguistics, language acquisition and TESOL have great potential to provide insights on open questions like the perception of language variation and its impact on teaching and learning EFL. Developing credible experimental stimuli that evoke a life-like response to the variety in controlled experimental conditions is one of the main challenges in combining these paradigms. The stimuli should be designed with consideration of how they will be perceived. As controlled synthetic stimuli are likely to have weak ecological validity, there is a need to introduce variability in linguistic stimuli both in terms of speaker variability and language variation.

Studies on the perception of non-native varieties by speakers of these varieties are surprisingly scarce. Variation complicates study designs in terms of participant sample and language stimuli, and researchers are still working on designing paradigms that eliminate known confounds. One way to enhance the credibility of non-native linguistic stimuli is through the cues to the features of the variety. These cues (and their weights) could then be implemented to inform the experimental stimuli both in terms of tokens and their (re-)synthesis. They can be used on a small scale to represent phonological and suprasegmental features, and on a large scale to represent syntactic and pragmatic features. These features can also be applied in learning and testing scenarios which reflect authentic English variation outside of the simulated study scenario. The combination of psycholinguistically- and sociolinguistically-informed stimuli and experimental paradigms in an applied linguistics context can show how variation affects the validity of constructs such as listening (Abeywickrama, 2013, p. 70) and provide implications for the teaching of EFL. The combination of linguistic and social cues in experiments is, thus, a step towards the understanding and acceptance of language in a more natural context.

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Marina Ivanova is a PhD student of English Linguistics at Chemnitz University of Technology. Her PhD project uses psychophysiological evidence from experiments with Electroencephalography (EEG) and Event-Related Potentials (ERP) to study how speakers of Slavonic Englishes perceive word stress cues. In addition to perceptual cues, her research also explores the production features of Slavonic Englishes and the application of cues and features in authentic text-to-speech systems with the aim of improving the learning outcomes of students from different language backgrounds.

Josef Schmied was the Chair of English Language & Linguistics at Chemnitz University of Technology from 1993 to 2021. His current research projects focus on the synthesis and perception of artificial non-native accents, the use of internet data in linguistic analysis, innovation in remote online learning, disciplinary conventions of academic writing, and national and subnational variation of Englishes in Africa and China. He enjoys the academic discourse with his PhD students and (Alexander-von-Humboldt) guest professors and his guest professorships in Italy (in 2019 and 2022) and China (2015 and 2023).