

# THE ECOLOGICAL NATURE OF THE CLASSROOM ENVIRONMENT FOR THE PERCEPTUAL LEARNING OF ADDITIONAL LANGUAGE SPEECH

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DOI: <http://dx.doi.org/10.21165/gel.v21i1.3463>

**Abstract:** The aim of this paper is twofold: first, to discuss the notion of “environment” from the perspective of Ecological Psychology, and second, to identify potential affordances that learners may perceive in the additional language classroom, given their relations with social events and objects therein. Considering its importance in the field of speech perception, we set out to review the philosophical underpinnings of the Perceptual Assimilation Model (PAM) and its extension to Second Language Speech Learning (PAM-L2), proposed by Best (1995) and Best and Tyler (2007) respectively, especially regarding the distinction between learning additional languages “in natural communicative contexts vs. in more constrained contexts [...] where the target language is not widely used” (Best; Tyler, 2007, p. 19). According to the authors, the additional language classroom in non-native communities is considered “[...] a fairly impoverished context for L2 learning” (Best; Tyler, 2007, p. 19), highly dependent on non-native teachers’ “variable” or even “incorrect” pronunciation. However, we argue that additional language classrooms can promote the emergence of new action systems in learners so that new information in relatively unfamiliar speech can be picked up, and new affordances can thereby be perceived and acted upon (Gibson, E. J.; Pick, 2000).

**Keywords:** Perceptual learning. Additional language speech. Additional Language classroom environments. Potential affordances.

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## *A NATUREZA ECOLÓGICA DO AMBIENTE DA SALA DE AULA DE LÍNGUA ADICIONAL PARA A APRENDIZAGEM PERCEPTUAL DA FALA*

**Resumo:** O objetivo deste artigo é duplo: primeiro, discutir a noção de “ambiente” através da perspectiva da Psicologia Ecológica e, segundo, identificar potenciais possibilidades que aprendizes podem perceber na sala de aula de língua adicional, considerando suas relações com os eventos sociais e os objetos nela. Dada a sua importância no campo da percepção da fala, tencionamos rever os fundamentos filosóficos do Modelo de Assimilação Perceptual (PAM) e de sua extensão para a Aprendizagem da Fala de Segunda Língua (PAM-L2), propostos por Best (1995) e Best e Tyler (2007) respectivamente, especialmente quanto à distinção entre aprender línguas adicionais “em contextos comunicativos naturais vs. contextos mais restritos [...] onde a língua-alvo não é amplamente utilizada” (Best; Tyler, 2007, p. 19). Nessa perspectiva, a sala de aula de línguas adicionais em comunidades não nativas é considerada “[...] um contexto bastante empobrecido para a aprendizagem de L2” (Best; Tyler, 2007, p. 19), altamente dependente da pronúncia “variável” ou mesmo “incorreta” de professores(as) não-nativos(as). Contudo, defendemos que as salas de aula de línguas promovem novos sistemas de ação em aprendizes, permitindo que novas informações sejam captadas na fala relativamente desconhecida e, conseqüentemente, novas possibilidades sejam percebidas e postas em prática (Gibson, E. J.; Pick, 2000).

**Palavras-chave:** Aprendizagem perceptual. Fala em língua adicional. Ambientes de sala de aula de línguas adicionais. Possibilidades potenciais.

### **Introduction**

Obtaining information is vital for the survival of animals in the ecological niches of their communities. According to Reading (2011, p. 50), “[a]nimals and plants with more effective ways of detecting and responding to information have an adaptive advantage over less-capable individuals, especially when resources are limited.” The long-standing question of *how* we pick up information from the environment has pervaded the study of speech perception, an interdisciplinary field drawing on many disciplines, such as psychology, speech and hearing science, electrical engineering, artificial intelligence, computer science, mathematics, linguistics, physics, and biology (Pisoni, 1981, 1985; Sarma, M.; Sarma, K. K., 2013). Speech perception plays a key role in understanding how human animals use their languages with maximal effectiveness. It is crucial to recognize that verbal language, as proposed by Kendon (2009), should be seen as a speech-kinesis ensemble encompassing inseparable components, which are expressed both audibly

and kinesically. According to the author, they are manifested not only through patterns of vocalization, such as voicing and intonation, pausing and rhythmicity, but also through movements of the eyes, eyelids, eyebrows, mouth, as well as actions by the head, hands, forearms, and various postural and orientational changes.

According to Pisoni (2018), the earliest contributions to the field of speech perception can be traced back to the end of the nineteenth century, when researchers in speech and hearing science set out to investigate hearing loss with the aid of electrically recorded audio signals. Throughout its history, some theories and approaches have been proposed to explain and predict how humans perceive speech, but three main views may be distinguished (Best, 1995), depending on factors such as the nature of the objects of speech perception and the underlying perceptual philosophy and mechanisms.

In general, the objects of speech perception are construed as either articulatory or phonetic events. In spite of these two types of perceptual primitives, there is a wide range of competing explanations provided in the literature to account for the same objects. For instance, the Motor Theory (Liberman *et al.*, 1967; Liberman; Mattingly, 1985; Liberman; Whalen, 2000) and the Direct-Realist Theory of Speech Perception (Fowler, 1986, 1989) posit that the objects of speech perception are articulatory events. However, the Motor Theory postulates an innate, biologically specialized perceiving system that is speech-specific and allows humans to perceive spoken language by recovering information about invariant neuromotor commands to the articulators from the acoustic signal. As proposed by Liberman and Mattingly (1985, p. 3, emphasis added), “[t]o perceive an utterance, then, is to perceive a specific pattern of *intended* gestures.” On the other hand, in the Direct-Realist Theory of Speech Perception, the real objects of speech perception are not the intended phonetic gestures of the talker, represented in the brain as invariant motor commands, but the actual vocal tract movements.

Based on James and Eleanor Gibson’s ecological theory of perception in general (Gibson, J. J.; Gibson, E. J., 1955; Gibson, J. J., 1966, 1979/2015), Fowler (1986) proposes an event approach to speech perception. She argues that speech is an ecological event in its own right, occurring in the real world between talkers and listeners engaged in public communicative exchanges. Thus, the author claims that the perception of speech is direct, meaning that it requires events in the environment without the need for cognitive mediation. Therefore, speech perception must be described by a perceptual theory that adopts a direct-realist approach.

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As regards the third theoretical perspective, referred to as the General Approach<sup>3</sup>, it differs from the Motor Theory and the Direct-Realist Theory of Speech Perception in that it assumes that listeners recover the talker's linguistic message from the acoustic signal by perceiving the auditory qualities of the phonetic events. According to Diehl, Lotto, and Holt (2004, p. 154), "GA does not invoke special mechanisms or modules to explain speech perception."

There are two examples of non-native speech perception models based on these major theoretical perspectives: (1) the Perceptual Assimilation Model (PAM) and its extension to Second Language Speech Learning (PAM-L2), proposed by Best (1995), and Best and Tyler (2007) respectively, which are both based on the Ecological Theory of Perception (Gibson, J. J.; Gibson, E. J., 1955) and argue that the perceptual primitives are the articulatory gestures produced by the speaker's vocal tract; and (2) the Speech Learning Model (SLM; Flege, 1995, 2003; Flege; Bohn, 2021), which assumes the object of speech perception to be proximal acoustic cues, thereby following a psychoacoustic view of speech perception.

According to Alves and Silva (2016), a growing body of Brazilian research has discussed the models proposed by Flege (1995, 2003), Flege and Bohn (2021), and Best and Tyler (2007). Emphasizing the role of acoustic cues in speech perception, Alves and Magro (2011), Alves and Motta (2014), and Alves (2021) point out that explicit instruction contributes to both the perception and production of aspiration in English voiceless plosives in word-initial position, more specifically. These authors have shown that perceptual training enables additional language learners of English to perceive voice onset time (VOT) as the main acoustic cue in distinguishing between voiceless and voiced initial stops, which is crucial for phonological intelligibility. As regards PAM-L2, Perozzo and Alves (2016) and Perozzo (2017) suggest adjustments to the model that they consider necessary to account for speech perception in additional languages. They claim, for example, that speech perception should be viewed as a cognitive process mediated by computational or representational mechanisms, and thus, indirect realism is a more suitable philosophical theory.

Although these two models share the view that perceptual learning is present throughout the lifespan and is influenced by the language-learning history of the perceiver, the differences between them are not restricted only to the nature of their respective

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3 Unlike Liberman and Mattingly (1985), for example, who use the term "theory" to label this alternative perspective as "auditory theory", Diehl, Lotto, and Holt (2004) adopt the term "approach", considering that "[...] GA has too little content to be falsifiable" (Diehl; Lotto; Holt, 2004, p. 155).

primitives. In short, SLM diverges from PAM(-L2) in addressing both perception and production, postulating that L1 and L2 speech sounds coexist in a shared mental phonetic space, and taking into account only the phonetic properties of the language input. The SLM is designed to predict the formation of new L2 phonetic categories or composite L1-L2 phonetic categories. PAM(-L2), on the other hand, is concerned specifically with perception and, as mentioned earlier, rejects the need for mental representations of phonetic categories in L2 perceptual learning.<sup>4</sup>

Given its importance in the field of speech perception, this paper will focus on PAM-L2 by addressing issues surrounding the notion of “environment” from the perspective of Ecological Psychology. Particularly, our discussion has been motivated by some observations made by Best and Tyler (2007) regarding the distinction between learning an additional language (henceforth, AL) in contexts where it is widely used vs. in L1-dominant environments. According to the authors:

In many respects, FLA [Foreign Language Acquisition] is notably less than ideal with respect to the natural ecology of language learning: It usually occurs in a pervasive L1 setting and does not extend much outside the classroom (Best; Tyler, 2007, p. 19).

The characterization of AL classrooms in learners’ native environment as “less than ideal” and their exclusion from the model have prompted us to reconsider and discuss the conditions of classroom additional language learning from the perspective of Ecological Psychology. Specifically, the debate proposed in this paper aims to address the following questions:

- (1) Is the AL classroom an ecologically impoverished environment for perceptual learning of AL speech, as suggested in Best and Tyler (2007)?; and
- (2) How can the AL classroom environment be optimized for perceptual learning?

The overall aim of this paper is to offer a theoretical discussion around these two questions. Thus, we begin by examining the basic tenets of the ecological theory, especially regarding the perceptual learning of speech. Then, we place greater emphasis on the notion of “environment”, aiming to better understand the ecological nature of the classroom and its potential affordances. Finally, we suggest possible contributions to research in the areas of Applied Linguistics, Additional Language Acquisition (ALA), and

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<sup>4</sup> For an alternative view that embraces mental representations in PAM-L2, see Perozzo (2017).

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Speech Perception, while also highlighting the need for further alignment of PAM-L2 with the notion of animal-environment reciprocity, given its importance for perceptual learning (Gibson, E. J.; Pick, 2000).

## **Perceptual development from a direct-realist perspective**

According to J. J. Gibson and E. J. Gibson (1955, p. 34), we learn to perceive by “[...] responding to variables of physical stimulation not previously responded to.” Similarly, Goldstone (1998, p. 585) highlights that perceptual learning leads to “relatively long-lasting changes to an organism’s perceptual system that improve its ability to respond to its environment.” Since the central tenet of the ecological approach is the animal-environment fit, such an improvement is related to the processes of detection, calibration, and attunement, meaning the ability of organisms to detect new information and adjust their behavior to it (Lobo; Heras-Escribano; Travieso, 2018).

According to J. J. Gibson (1979/2015), perceiving is an active process through which animals obtain information about the environment. Thus, the ecological approach to perceptual development, as conceptualized by E. J. Gibson and Pick (2000), posits that:

Learning always involves a change in the relation between an active organism and some affordance of the environment, especially the use of information about the environment in relation to the organism itself – the potential for perceiving and achieving the affordance (Gibson, E. J.; Pick, 2000, p. 50).

The concept of “affordance” was proposed by J. J. Gibson (1979/2015) to capture what the environment offers the animal, and it is the central theoretical notion of ecological psychology. According to the author, an affordance “[...] is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer” (Gibson, J. J., 1979/2015, p. 129). Despite some ambiguity in its definition, it is possible to note that this construct implies the relationship between the animal and the environment, covering not only perception but also the possibility of actions. In the case of babies, for example, perceptual learning is assumed to be the means by which they discover everything the world around them has to offer and what they can do (Gibson, E. J.; Pick, 2000).

Best (1995, p. 179) further explains that “[i]nfants detect information in ambient speech about the articulatory gestures that shaped it, as an integral part of learning to use the vocal tract as a tool for achieving language specific communicative goals.” This means



that long before appropriate action systems are functional for speech, infants are able to detect and differentiate information in their companions' speech that will help them learn their native language subsequently (Gibson, E. J.; Pick, 2000).

Considering the fundamental reciprocity of perception and action, the appropriate control of the action system is mastered by native speakers, that is, the use of the vocal tract for speech is maximally effective in their L1, after a long ontogenetic history that starts even before birth, since fetuses have been shown to detect low-pass filtered prosodic information and, moreover, to learn about human speech (Traxler, 2012; Gervain, 2018). As E. J. Gibson and Pick (2000, p. 53) suggest, “[n]ewborns have already learned to detect some characteristics of their native language”, first prenatally by means of the auditory system, and then multimodally, along with the exploratory visual system. However, when it comes to learning an additional language, perhaps one of the reasons why assimilation patterns may diverge from native constellations involves precisely the progressively reduced use of the visual systems by perceivers who have already benefited from the affordances emerging from visual and auditory exploration during L1 development in childhood. During this period, babies are especially engaged in discovering what the world and the people surrounding them have to offer through attentional and exploratory behavior (Gibson, E. J.; Pick, 2000).

The ecological direct-realist approach posits that the informational primitives in speech perception are dynamic articulatory-gestural patterns (Fowler, 1986), consisting of both phonetic details and phonological structure, each tapping different levels of invariant structure in a common gestural domain. Drawing on the ecological theory of perception (Gibson, J. J.; Gibson, E. J., 1955; Gibson, J. J., 1966, 1979/2015), which argues that perceptual learning implies changes toward greater specificity, a speech perception model known as “Perceptual Assimilation Model” (henceforth, PAM) is proposed by Best (1995) to account for cross-language speech perception effects. Then, this model is extended to address what Best and Tyler (2007, p. 14, emphasis added) call “*second language (L2) learner’s perception of L2 contrasts.*” The distinction between a foreign and a second language will be discussed in more detail regarding the ecological nature of these types of learning environments, but for now, suffice it to say that PAM-L2 aims to be restricted to learners acquiring the target language by immersion in countries where it is used as an L1.

PAM emphasizes the influence of individuals’ experience with the phonological system of their L1 on non-native speech perception. Thus, the model makes a set of predictions about how gestural information will be detected in non-native speech by naïve listeners via integrated perceptual systems that have become attuned to pick up information to which they have been sensitized (Best, 1995). In short, PAM predicts that

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non-native phones are perceived by naïve listeners as: (1) either good or poor exemplars of L1 categories; (2) unrecognizable speech sounds; or (3) non-speech sounds.

The ability to pick up higher-order linguistic information from the multimodal flow of stimulation by perceivers requires an increasing, experience-based attunement to native speech, and such a long ontogenetic history of experience with the native language affects perception of non-native speech (Best, 1995; Gibson, E. J.; Pick, 2000). In fact, PAM presumes that “[t]he higher levels of linguistic structure in speech can only be detected by perceivers who have become attuned to language-specific coordinations of higher-order gestural constellations and referential meanings.” (Best, 1995, p. 179). In our view, such attunement also takes place in additional language classrooms, as will be elaborated in the following section.

### **The notion of animal-environment fit**

E. J. Gibson and Pick (2000) claim that animals obtain information about their surroundings and themselves solely through perceptual learning, a process of differentiation that encompasses the entire lifespan, starting from birth. In fact, the animal and its environment form an interactive system, which the ecological approach considers as its unit of study. According to the authors, three levels of description are necessary when analyzing perceptual learning from an ecological perspective: the environment, the information, and the process of perceiving, which will be discussed together hereafter.

The language classroom environment in non-native communities is considered to be “[...] a fairly impoverished context for L2 learning”, according to Best and Tyler (2007, p. 19). The authors contend that the additional language classroom in foreign environments:

[...] often employs formal instruction on lexical and grammatical information to a much greater extent than in live conversation. When spoken in the classroom, the L2 is often uttered by L1-accented teachers or, at best, by speakers from diverse L2 varieties, thus presenting a *variable* (or *incorrect*) model of L2 phonetic details (Best; Tyler, 2007, p. 19, emphasis added).

Undoubtedly, the authors place strong emphasis on the conceptual distinction between “second language” and “foreign language” when referring to learning an AL, although these terms have often been used interchangeably as synonyms (Stern, 1983). Regarding this dichotomy, when a non-native language is learned and used within a country where it is spoken as a native language, it may be referred to as a “second



language”, but if it is learned outside the speech communities whose members use it as their first language, then the term “foreign language” is typically applied, granted that this distinction is necessary. Despite this, we adopt the umbrella term “AL” according to Leung (2022, p. 171), who uses:

[...] the super-ordinate term ‘additional language’ to refer to both ‘second language’ and ‘foreign language’, partly because it provides wider conceptual cover for the language teaching field as a whole, partly because it is gaining currency in professional teaching communities, signalling a shift in subject identity (Leung, 2022, p. 171).

As regards the classroom environment, J. J. Gibson (1979/2015) highlights the relevance of *social* affordances for human beings and other social animals, given that “[t]he richest and most elaborate affordances of the environment are provided by other animals, and, for us, other people” (Gibson, J. J., 1979/2015, p. 135). Thus, he rejects the dualism between nature and culture while suggesting that culturally-altered or artificial environments, such as the classrooms, are the same environments modified by man:

It is a mistake to separate the natural from the artificial as if there were two environments; artifacts have to be manufactured from natural substances. It is also a mistake to separate the cultural environment from the natural environment, as if there were a world of mental products distinct from the world of material products. There is only one world, however diverse, and all animals live in it, although we human animals have altered it to suit ourselves (Gibson, J. J., 1979/2015, p. 130).

Since “[t]he environment provides opportunities and resources for actions, and information for what is to be perceived so as to guide action” (Gibson, E. J.; Pick, 2000, p. 14), it is important to note that the AL classroom environment, like any other environment, offers sources of information for both the physical objects that furnish the environment and the social events that take place in it. Take, for example, the use of technological tools in classrooms, which makes it possible for learners to be exposed to a wide range of both native and non-native inputs. Several digital resources allow learners to interact with both native and non-native speakers of the target language and can be efficiently used in activities classified as “realistic” or “real” (cf. Pennington, 1996), where learners should be unconsciously invested in reducing uncertainty by detecting the redundancy of the visual and auditory linguistic information to seek meaning. Similar to how people in general watch the news, interviews or videos on both TV and digital media for entertainment or

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informational purposes, learners may engage in interactions with classmates to discuss real-life situations or concerns prompted by the technology used in the classroom.

The primary purpose of employing technological tools is not only to facilitate learners' interaction with either native or other AL speakers of the target language, but also to further refine their exploratory systems, such as listening and observation, which begin at a very early age (Gibson, E. J.; Pick, 2000). Indeed, the use of digital tools, particularly since the onset of the COVID-19 pandemic in 2020, has significantly impacted social relationships. It has enabled individuals with Internet access to rely on online services for communication, thereby maintaining social connections. Undoubtedly, the use of applications and social media has not only influenced the way humans communicate, express themselves and stay in touch with one another, but it has also altered the dynamics of online interactions, including the variety of potential interlocutors people interact with online. Given the importance of the concept of animal-environment reciprocity for perceptual learning, it is crucial to describe and understand these emerging perceptual phenomena.

The belief that only a "second language" is widely used in the environment surrounding learners has led Best and Tyler (2007) to stress the vital importance of the abundant native input available for this subset of language learners worldwide. Certainly, such learners have a multitude of affordances to explore, but so do the "foreign language" learners, as extracting invariant information that specifies the affordances offered by the environment is essential for guiding action and is present throughout the entire lifespan of the organism. This is suggested by E. J. Gibson and Pick (2000) when they point out that:

The categories of objects are many – people, animals, things to sit on, pictures of things, and even symbols, such as letters and numbers. Learning to perceive the affordances and the features of all these things is a task that begins at birth and continues throughout life (Gibson, E. J.; Pick, 2000, p. 24).

This raises some questions regarding the ecological nature of the AL classroom environment: if the classroom is a setting designed for language learning, why is it considered as "a fairly impoverished context for L2 learning"? Does it lack affordances? If not, what type of affordances can it offer? Our discussion on the reciprocal relation of an animal and its environment will be guided by addressing these questions.

Best and Tyler (2007) seem biased against non-native models, which they consider as "variable" or even "incorrect". However, while variability has been generally accepted as an inherent property of any linguistic system (Weinreich; Labov; Herzog, 1968; Tollefson, 2007; Guy, 2011; Verspoor; Lowie; De Bot, 2021), the authors appear not to be interested in

variation, similarly to how “[...] linguistics has had real difficulty in accepting *intralinguistic variation* as intrinsic to the very existence of languages.” (Pradilla Cordona, 2020, p. 398).

It is important to note that the common L1-L2 phonological space proposed in PAM-L2 is itself constituted by variation, such as that between the L1 and L2 phonetic realizations of the same phonological category. Although the proponents of the model admit that “[...] dialect differences can interfere with perception even for native listeners of the L2” (Bundgaard-Nielsen; Bohn, 2004 *apud* Best; Tyler, 2007, p. 19), they disregard that such differences are widespread and highly variable both within and across speakers.

Overall, the so-called “second language learners” are likely to be exposed to a great deal of cross-dialectal variability, especially but not only in multicultural and/or border regions where speech communities exhibit high degrees of variation. The idea that speech communities are variable in nature is shared by (socio)linguists in general, despite the divergence and plethora of definitions of the speech community concept in empirical linguistics and particularly sociolinguistics. In fact, in recent years, following a complex, dynamic account, Verspoor, Lowie, and de Bot (2021, p. 2) claim that variability is an essential component of the learning process and is as prevalent as apple pie, arguing that it is “[...] inherent in all processes and that actually stability—something being exactly the same as before—is something that hardly ever occurs [...]”.

In terms of linguistic realities concerning dialect variation, Patrick (2002) advocates for speech community models that take a comprehensive approach to this phenomenon, which can address key issues, such as complex patterns of membership, nested communities, linguistic uniformity from the perspective of structured variation. According to the author, these issues can be handled “[...] simply by taking seriously the requirement for explicitly multi-variety situations, since there is no principled limit to language/dialect contact and creation.” (Patrick, 2002, p. 541). In fact, the contact between language users of different dialects is a pervasive and constant phenomenon experienced by all speakers in general (Chen; Tai, 2009).

Following Pratt’s (1987) critique to the utopian uniformity and homogeneity commonly associated with speech communities, Rampton (1999, p. 422) proposes that sociolinguists should direct their attention to a “linguistics of contact”, instead of the “linguistics of community”. This shift aims to understand “[...] the intricate ways in which people use language to index social group affiliations in situations where the acceptability and legitimacy of their doing so is open to question, uncontrovertibly guaranteed neither by ties of inheritance, ingroup socialization, nor by any other language ideology.” An interesting example of how speakers from different social groups mix varieties to mark their affiliations is illustrated by Jones (2016, p. 169):

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At the same time, many speech communities are characterized not by a single variety, or even just a repertoire of varieties, but by the characteristic ways that members *mix* varieties. This is a point illustrated dramatically by Barrett (1997) in his description of ways of speaking employed by African American drag queens in Texas bars. To claim membership in this speech community, he notes, members must be able to switch between a range of incongruous linguistic styles indexing groups as diverse as white women and African American men, at strategic moments (Jones, 2016, p. 169).

Speech communities, then, are heterogeneous in terms of language use, as dialect contact is a fact of life (Martinet, 1968 *apud* Weinreich, 1968; Kerswill, 1996; Stanford, 2012). This implies that “[...] a variable (or incorrect) model of L2 phonetic details” (Best; Tyler, 2007, p. 19) is not confined solely to the language classrooms in non-native settings but also occurs in countries where the target language is used as an L1: learners are likely to interact with L1 speakers of different dialects or other non-native speakers from different (or the same!) mother-tongue backgrounds.

Based on the discussion thus far, we contend that if we are to study speech perception from an ecological perspective, it is crucial to consider the fit between the perceiver and their environment, as well as the inherent variability in the perceptual development of learners who are actively involved in obtaining new information about the additional language, the world, and themselves. Indeed, we view the classroom as an optimal environment for students to gain control over their behavior when foraging for information. Further elaboration on this point will be provided in the following section.

### **Potential affordances in the learner-classroom system**

It should be emphasized that the concept of affordance, defined as “[...] the user-specific relation between an object or event and an animal of a given kind” (Gibson, E. J.; Pick, 2000, p. 15), implies a dynamic nature. Affordances are emergent possibilities for actions that arise from the animal-environment system, rather than being predetermined (cf. Chemero, 2003; Stoffregen, 2003; Wagman; Stoffregen, 2020). This means that affordances are not static characteristics of either the animal alone or the environment alone (Chemero, 2003). For example, an apple may be perceived as a nutritious fruit that offers the possibility of eating its thalamus to satisfy hunger or of using it with other ingredients such as flour, fat, and water to bake a pie. The larger ability of eating depends on smaller scale abilities, such as biting, chewing, and swallowing. Additionally, an apple may be offered as a gesture of human kindness to a familiar person or someone in need, or as a means of attracting a pet’s attention.

Nevertheless, there is a wide range of other potential affordances that cannot be fully predicted due to the complex nature of the animal-environment system. The range of possible actions that a human animal can perform with an apple emerges from the situation where the animal and the object find themselves. By picking up higher-order invariants from the meaning-laden environment, an individual may perceive the “playability” affordance of an apple and use it as a juggling prop in a pleasant environment. But in the absence of better objects available in a dangerous and stressful situation, the “throwability” affordance may be perceived and acted upon by an observer in need of a means of defense.

The same applies to the variety of potential affordances that learners may perceive in the relations resulting from the social events and objects in a language classroom. Affordances are considered as relations due to the associations between an animal's abilities and a set of situations in which each of them can be exercised (Chemero, 2003). Chemero (2003) argues that affordances are both real and perceivable, meaning they are the relations emerging between the perceiver and the aspects of a whole environmental situation. Therefore, the classroom, as an animal-environment system specifically designed to facilitate additional language learning, should optimize learners' behavior.

Although we are usually not aware of our, say, listening, gesturing or speaking abilities, conceived of as functional properties of the animal that may or may not become manifest even in ideal circumstances, Chemero (2003, p. 191) claims that humans are the only animals capable of improving their perception through training:

Humans, however, can – with training, and when so inclined – perceive things about their abilities and the features of the environment. Most nonhuman animals, perhaps all of them, are simply incapable of this (Chemero, 2003, p. 191).

This is precisely one of the main advantages of the classroom environment: learners can be trained to perceive important aspects of the target language by focusing on smaller-scale abilities, such as those involved in speaking or listening. Moreover, what Best and Tyler (2007) regard as “variable” or “incorrect” input may also provide an opportunity to raise learners' phonological awareness (cf. Kivistö-De Souza, 2021), as a result of directly picking up information about the main difficulties they face, considering the challenges posed by their L1. In fact, J. J. Gibson (1979/2015) puts forward the idea of “awareness-of”, maintaining that perceiving involves not just awareness, but awareness of the environment and of oneself in it:

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Perceiving is an achievement of the individual, not an appearance in the theater of his consciousness. It is a keeping-in-touch with the world, an experiencing of things rather than a having of experiences. It involves awareness-of instead of just awareness. It may be awareness of something in the environment or something in the observer or both at once, but there is no content of awareness independent of that of which one is aware (Gibson, J. J., 1979/2015, p. 239).

For J. J. Gibson (1979/2015), awareness is not simply knowledge stored in the brain; it is a direct pickup of information available in the environment, encompassing both its features and the self. However, since perception is not considered merely a response to a stimulus but rather an act of information pickup, the author suggests that perceptual awareness “[...] depends on the age of the perceiver, how well he has learned to perceive, and how strongly he is motivated to perceive” (Gibson, J. J., 1979/2015, p. 57).

As can be observed, learners can be motivated and trained to explore the gestures or intonation patterns produced by the native speakers of the target language, thereby obtaining new information about the AL and perceiving new affordances, especially if their pronunciation goals and aspirations are to achieve a native-like performance. Indeed, even during conversations with peers, learners may perceive gaps in their performance, leading to the use of “variable” or even “incorrect” models in an AL classroom that might spur exploratory activities and engage learners in experiencing disparities between the AL and their own performance. This may be particularly helpful for adult learners who tend to seek interactions focused on learning and practicing the target language to become more proficient.

It is crucial to notice that a speech event consists of a complex set of data concerning the environment (such as whether the conversation is occurring in a quiet or a noisy setting), the speakers (including factors like gender, age, origin, race, social class, educational level, internal state, etc.), and their relationship with the listener (including the comfort level of the perceiver in the environment, the proximity between the listener and the speaker, and the nature of their relationship, such as whether they are strangers, friends, young or old, male or female, teacher or student, employer or employee, etc.).

Language users, in general, tend to perceive the compound information provided by the perceptual activity as a unified whole, with its parts indistinguishable upon reaching awareness (Dellantonio; Pastore, 2017). Drawing on Dellantonio and Pastore’s (2017) description of vision, it can be assumed that when learners interact with either native or non-native users of an additional language, they are typically unaware of the complex network of information constituting their speech. Therefore, AL learners might benefit



from exploratory activity to gain knowledge about their own capabilities and articulatory gestures, which may appear to be simple units of action but are, in fact, highly complex (Gibson, E. J.; Pick, 2000).

Similarly, like one-month-old infants who can already detect sound-meaning correspondences through the intonation patterns of others' speech to them (Gibson, E. J.; Pick, 2000), learners can benefit from exploring how intonation patterns express subtle information about the speaker's attitudes and emotions. Considering the situation as a whole, the pick-up of intonational invariants might help learners achieve higher-level communicative goals. In fact, based on evidence of prenatal experience with native speech, Gervain (2018, p. 1) puts forth the hypothesis that prosody plays a major role in shaping infants' speech perception systems and might serve as their "[...] first gateway to language, ensuring the link between prenatal and postnatal language experience."

In view of the meanings carried by tone, we now turn to Brazil's (1985, 1994) Theory of Discourse Intonation, which has not only contributed to a discourse approach to intonation but also to the teaching of everyday speech. This approach to intonation is proposed by Brazil, Coulthard, and Johns (1980, p. 11), who argue that:

[...] intonation choices carry information about the structure of the interaction, the relationship between and the discourse function of individual utterances, the interactional 'give-ness' and 'newness' of information and the state of convergence and divergence of the participants<sup>5</sup> (Brazil; Coulthard; Johns, 1980, p. 11).

Learners' perception of AL speech events, as inferred from the discussion so far, results from a continuous act of information pickup, which may not occur even in the presence of information (Gibson, J. J., 1979/2015). However, when learners are trained to actively forage for new affordances, they have the opportunity to extract "information relevant to the guidance of their own articulatory activities" (Fowler, 1986, p. 20). Thus, the simultaneity of sights and sounds is considered a powerful invariant specifying the unity of a speech event, perceived through different modalities.

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5 The two most frequent pitch movements in the authors' data are the falling-rising ( $\searrow\nearrow$ ) and the falling ( $\searrow$ ) tones and, according to Brazil, Coulthard, and Johns (1980), these are used to distinguish two basic meanings expressed by tone. The first occurs when the message is (thought to be) shared by the participants and is thus part of the existing common ground they occupy at a given moment in an ongoing interaction (marked by the fall-rise tone, also called the referring tone, whose graphic and typographic symbols are  $\searrow\nearrow$  or r, respectively). On the other hand, the contrastive meaning indicates that the information is expected to enlarge the area of common ground, since the participant in the speaking turn considers it as new (and so chooses the falling tone, referred to as the proclaiming tone, symbolized as either  $\searrow$  or p).

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As a matter of fact, as J. J. Gibson (1966) points out, speech is a multimodal source of information about distal articulatory events:

An articulated utterance is a source of a vibratory field in the air. The source is biologically “physical” and the vibration is acoustically “physical.” The vibration is a potential stimulus, becoming effective when a listener is within range of the vibratory field. The listener then *perceives* the articulation because the invariants of vibration correspond to those of articulation. In this theory of speech perception, the units and parts of speech are present both in the mouth of the speaker and in the air between the speaker and the listener. Phonemes are in the air. They can be considered physically real if the higher-order invariants of sound waves are admitted to the realm of physics (Gibson, J. J., 1966, p. 94).

In view of J. J. Gibson’s (1966) elaboration, it is possible to assume that perceivers, in general, must detect both the auditory and visual information that specifies the articulatory events occurring in the environment to perceive a given affordance. It is crucial, then, that language classrooms promote the emergence of new action systems in AL learners so that new information produced by either L1 or AL speakers can be picked up, and new affordances can thereby be perceived and acted upon (Gibson, E. J.; Pick, 2000). As J. J. Gibson (1966, p. 94) explains, “[...] the units and parts of speech are present both in the mouth of the speaker and in the air between the speaker and the listener.”

The observations made here indicate that the AL classroom can be as rich an environment as any other. Consequently, we believe that our discussion has direct implications for the AL classroom environment and may well improve the teaching practice. Thus, to answer our second question regarding how the AL classroom environment can be optimized for perceptual learning, we further suggest that instead of simply employing the technique referred to as “listen and imitate” (Celce-Murcia *et al.*, 2010) to correct “mispronunciation aspects” in learners’ AL speech, teachers should make full use of a wide variety of techniques and activities available in the extensive Applied Linguistics literature. These may include phonetic training, visual aids, recording of learners’ production, and role play, among others (for more in-depth discussion, cf. Tench, 1981; Dalton; Seidlhofer, 1994; Pennington, 1996; Celce-Murcia *et al.*, 2010; Levis, 2018).

The perception-action reciprocity needs to be taken into consideration in classrooms since exploratory actions yield information and knowledge. Consequently, helping learners realize and exercise smaller scale abilities, such as the production of AL speech sounds, makes them equipped to activate new action systems and thereby perceive new environmental possibilities and affordances. Considering the vital importance of

exploration for perceptual learning, E. J. Gibson and Pick (2000) suggest that “[...] the opportunity of observing another perform the actions promotes realizing the utility of a behavior for an observed consequence.” We also believe that AL learners should be encouraged to hear and observe not only native speakers of the target language but also many other non-native speakers with different L1s. Therefore, teachers may provide students with circumstances for attentive visual exploration of a given distal articulatory gesture, for exercising it and for noticing the gaps between their own and others’ speech production, because it is not only optical information that is available in speech: learners may obtain mechanical and acoustical information as well, such as when they hear the speech sounds produced by moving toward the talker and/or by regulating their own articulators (Gibson, E. J.; Pick, 2000). In fact, E. J. Gibson and Pick (2000, p. 22-23) highlight that “[...] the perception-action relation is a reciprocal one, a kind of continuous cycle with perception guiding action, and action furnishing new information for perception”.

### **Final remarks**

This paper aimed to address two questions: (i) is the language classroom in an L1 setting an ecologically impoverished environment for perceptual learning of AL speech, as suggested in Best and Tyler (2007)?; and (ii) how can the AL classroom environment be optimized for perceptual learning? Considering the so-called distinction in the literature between the natural ecology of countries where the target language is predominantly used vs. the impoverished ecological nature of classrooms in AL learners’ native environment, when the classroom environment is compared to a native speech community in terms of language learning, some aspects of the latter are usually pointed out as advantages. These include the relatively higher levels of quantity and quality of input from native users and the L1:L2 usage ratios, which tend to favor the L2, thereby indicating a wider variety of social settings in which the additional language is used. Certainly, the higher proportions of L2 over L1 in these categories tend to be taken as evidence for the inadequacy of the AL classroom environments by Best and Tyler’s (2007) PAM-L2. However, these patterns are generally determined by self-report in research focusing on the amount of L1 and AL usage (Grosjean; Byers-Heinlein, 2018). Moreover, the fact that there is an ever-increasing number of people around the world who are able to effectively use the AL and have learned it in their L1 communities seems irrelevant and it is not even taken into account.

Based on our discussion, we answer the first question in the negative. It seems that the AL classroom plays a crucial role in perceiving potential affordances emerging from learners’ relations with the environment, its objects, and the other people in it. We have observed that AL learners may extract relevant information that specifies the affordances

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offered by the classroom environment, as learning to perceive the affordances is a continuous activity present throughout the entire lifespan of the organism (Gibson, E. J.; Pick, 2000).

Following the concept of “affordance” outlined by Chemero (2003), who defines affordances as relations between the abilities of animals and features of the environment, we aim to answer the second question by highlighting certain features of situations in the classroom that can be beneficial for perceptual learning. For example, phonetic training can promote the emergence of new action systems in the production of AL speech, which may help learners perceive new affordances, such as new lower-order gestural constellations. In fact, even the AL models considered as “variable” or “incorrect” because they are not native can help learners notice the gaps between their own and others’ speech production. Furthermore, visual, acoustical, and mechanical information may be made available in the AL classroom, enabling learners to become familiar with AL speech and aware of its complex nature.

Speech perception studies have long focused on how specific AL segments and contrasts are perceptually learned, but very little research has been done on the perception of prosodic patterns. We believe that speech perception researchers need to broaden the scope of speech perception models, redirecting attention away from the traditional emphasis on the perception of isolated speech sounds towards the perception of actual speech. This may help us understand the contribution of prosody to speech perception, as prosodic features are essential for distinguishing pragmatic meaning across languages (Hirschberg, 2017). Fortunately, such a line of investigation has been undertaken in the last few years, but not without significant challenges for researchers in current data collection practices.

Finally, understanding how exploratory and performatory activities engage in perceptual learning may also contribute to the field of speech perception. Investigating speech perception through an ecological approach means considering learners not only as AL listeners, but as AL *users* who interact with speakers producing a chain of gestures and sounds as an integrated whole, perceive their speech in a unique situation – which cannot possibly be reproduced –, and respond to them.

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**COMO CITAR ESTE ARTIGO:** REIS, Felipe Santos dos; ALVES, Ubiratã Kickhöfel. The ecological nature of the classroom environment for the perceptual learning of Additional Language speech. **Revista do GEL**, v. 21, n. 1, p. 245-268, 2024. Disponível em: <https://revistadogel.gel.org.br/>.

Submetido em: 29/09/2022 | Aceito em: 21/04/2024.

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