What Learning a Second Language Might Teach Us about Auditory Training

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ABSTRACT

In this article, we apply theory and research from the field of second language acquisition (SLA) to issues in auditory training for adults with postlingual deafness. Two areas of SLA theory and research are discussed. The first area concerns five hypotheses proposed by S. Krashen about SLA. We apply these hypotheses to issues in auditory training, such as the issue of using instructional techniques that promote development of implicit knowledge of target structures, the role of meaning-bearing comprehensible input, and the importance of creating an affectively positive learning environment. The second area concerns research on acoustic variability and second language (L2) learning. This research reinforces Krashen's hypothesis about attending to the nature of input during SLA, but does so with regard to how spoken input may be acoustically varied to facilitate acquisition. Studies have demonstrated that presentation formats with talker variability are effective for training learners on L2 phonemic contrasts and that presentation formats with talker, speaking-style, and speaking-rate variability (but not amplitude and fundamental-frequency variability) yield positive additive effects on L2 vocabulary learning. In light of these findings, we discuss how acoustically varied presentation formats may be used in auditory training.

KEYWORDS: Input hypothesis, explicit and implicit learning, acoustic variability

Learning Outcomes: As a result of this activity, the participant will be able to apply theory and research in the field of SLA to issues in auditory training.

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Researchers in the field of second language acquisition (SLA) seek to understand processes involved in the acquisition of nonnative languages. Questions addressed by SLA researchers commonly overlap with those in linguistics and psychology and may overlap with questions related to auditory training. For example, one important commonality between second language (L2) learning and auditory training is the need for learners to encode new form, or signal, and to map form onto meaning. L2 learners encode novel forms in the L2 and map these forms onto meaning. Similarly, clients who receive auditory training attend to new forms of the speech signal (that result from processing through a sensory aid) and map these forms onto meaning, even if the new forms in question are part of a previously acquired language that the person with hearing loss has come to perceive differently.

In this article, we explore potential applications of theory and research on SLA to a variety of issues in auditory training. More specifically, we consider five hypotheses about SLA[1–4] and recent research on the use of acoustically varied input during L2 learning in an effort to apply both general principles and specific research findings from SLA to issues in auditory training. We limit our focus to auditory training for adults with postlingual hearing loss who have received cochlear implants or hearing aids, as this group closely parallels the L2 learner who is required to map new phonological word forms onto a preexisting linguistic system. Many of the implications discussed, however, may be applicable to auditory training with other populations as well.

KRASHEN'S FIVE HYPOTHESES

From the late 1970s through the mid 1980s, Krashen[1–4] proposed five hypotheses that impacted greatly on the field of SLA and L2 instruction. These five hypotheses painted a general picture of what is needed for successful SLA and how, from a general perspective, SLA takes place. Within the field of SLA, Krashen's hypotheses have helped to stimulate a great deal of new research, such as research on principles of L2 input processing (see, e.g., VanPatten[5]). In terms of L2 instruction, the principles have provided impetus and underlying rationale for communicative language teaching, an instructional approach that emphasizes the use of linguistic form to convey meaning within an affectively positive learning environment. Table 1 provides a brief summary of the basic tenets of five hypotheses with regard to how they have been applied to SLA. Possible implications for auditory training are described in the sections below.

The Acquisition-Learning Hypothesis

Krashen's first hypothesis about SLA is that L2 learners are able to develop two distinct types of

Table 1 Summary of Krashen's Hypotheses

Hypothesis	Basic Tenets
Acquisition-learning hypothesis	Learned (explicit) L2 knowledge is independent from acquired (implicit) L2 knowledge.
Natural order hypothesis	L2 learners acquire the rules of a language in a predictable order.
Monitor hypothesis	L2 learners may use explicit knowledge as a monitor or editor during language production.
Input hypothesis	L2 learners acquire language when they receive comprehensible samples of the target language.
Affective filter hypothesis	Affective factors (e.g., increased anxiety) can prevent input from becoming available to the L2 learner's language acquisition device.

Abbreviations: L1, first language; L2, second language.

knowledge about the L2 that they are acquiring. Krashen refers to one type of knowledge as *learning*, or the act of obtaining conscious information about one or more aspects of the language. An example of learning in this sense would be if an L2 learner of English consciously learns a rule indicating that the third-person *–s* should be added to verbs in sentences with third-person singular subjects. This type of knowledge is distinct from a second type of knowledge, which Krashen refers to as *acquisition*. In contrast to learning, according to Krashen, acquisition refers to the subconscious process of developing an internalized linguistic system over time, much like the process that children undergo during first language (L1) acquisition. An example of acquisition in this sense would be if a learner of L2 English becomes able to use English third-person *–s* correctly based on exposure to this structure in the input over time without ever learning a conscious rule related to the structure.

According to Krashen, learning and acquisition are two mutually exclusive knowledge sources such that any learned knowledge cannot become acquired knowledge. This position is known as a strong *no-interface* position. A strong *interface* position, on the other hand, would posit that learned knowledge can become acquired knowledge quite readily. Weaker versions of the no-interface position would posit that although much learned knowledge cannot become acquired knowledge, a limited subset of learned knowledge may do so.

In the following discussion, we will use the term *implicit learning* to refer to what Krashen referred to as *acquisition* and the term *explicit learning* to refer to what Krashen referred to as *learning*. Ellis[6] defined *implicit learning* as "acquisition of knowledge about underlying structure of a complex stimulus environment by a process which takes place naturally, simply and without conscious operations" and defined *explicit learning* as "a more conscious operation where the individual makes and tests hypotheses in a search for structure" (p.1).

IMPLICATIONS OF THE LEARNING-ACQUISITION HYPOTHESIS FOR AUDITORY TRAINING

With advancements in device processing strategies, cochlear implant users now have greater potential for incidental learning. That is, simply by being exposed to speech in their environment, even if it is background sound such as a television playing or other people speaking, they may learn to recognize speech. Recent work by Stelmachowicz et al,[7] for example, found a significant improvement in novel word learning (i.e., learning of nonsense words presented in a 4-minute slide slow) by hearing-impaired children following a 10-dB sound pressure level (SPL) increase in presentation level. By implication, the audiologist might consider lowering the electrode thresholds when programming a cochlear implant device so that more sound is available to the user. During auditory training, decreased emphasis might be placed on explicit learning. Clinicians may engage in more informal instruction (i.e., training activities might be incorporated into other activities, such as conversation or learning) as opposed to formal instruction (i.e., training activities might not involve highly structured, drill-like activities).

From a broader perspective, application of Krashen's strong no-interface position to auditory training requires consideration of an approach to auditory training that emphasizes meaningful interaction during which improvement in sound discrimination takes place as a natural by-product of the communicative use of language. Some activities for auditory training, such as continuous discourse tracking,[8] lend themselves to this type of focus on real-world meaning. Other activities, such as same-different discriminations, involve less focus on real-world meaning. Clinicians may note how clients respond differently when they are engaging in the use of language for authentic communication as opposed to only form-oriented drills in which focus on form becomes divorced from focus on meaning. If a primary goal of auditory training is to improve communication in the real world, an approach that emphasizes successful perception of target structures in truly meaningful contexts should help clients to develop this type of competence. From the perspective of a strong no-interface position, this type of competence depends on the development of unconscious, implicit knowledge, as the focus of the language user (listener or speaker) outside of auditory training sessions

is going to be on the use of language (perception or production) for truly communicative purposes.

The Natural Order Hypothesis

A second hypothesis proposed by Krashen is that L2 learners acquire the rules of a language in a predictable order such that some rules tend to be acquired before others. An example of this would be Dulay and Burt's[9] demonstration that L2 learners of English, regardless of their L1 (Spanish or Chinese), tended to follow a similar sequence in their acquisition of various structures in English (> refers to earlier in acquisition): (1) pronoun case > (2) article (*a, the*) > (3) progressive (*-ing*) > (4) contractible copula (*'s*) > (5) past regular (*-ed*) > (6) past irregular > (7) long plural (*-es*) > (8) possessive (*'s*) > (9) 3rd person (*-s*). From an instructional perspective, the order in which L2 learners can be expected to acquire different structures sometimes is referred to as the *learner's syllabus* or the *internal syllabus* of the learner.[10] Instructors may be at a greater advantage if they are more aware of what to expect with regard to the learner's internal syllabus and acquisition orders. If the sequencing of a language course is at odds with what we expect in terms of acquisition orders, more difficulties may arise. Awareness of research findings on acquisition orders on the part of instructors and L2 course developers can help to address this issue from a more informed perspective. The natural order hypothesis claims that learners have a predisposition to acquire structures in a particular order. When provided with sufficient amounts of meaning-bearing comprehensible input by the instructor (and other sources of input), learners will acquire structures in this order naturally.

IMPLICATIONS OF THE NATURAL ORDER HYPOTHESIS FOR AUDITORY TRAINING

In many auditory training curricula,[11,12] the assumption is made that persons who are learning to listen, whether it is after a sudden hearing loss or after receipt of a listening device, pass through a hierarchy of auditory skill levels. These levels may include sound awareness (awareness of when sound is present and not present), discrimination (ability to indicate whether two sounds are the same or different), identification (ability to label some auditory stimuli), and comprehension (ability to understand meaning in a spoken message). The goal of auditory training is to advance the client from one stage to the next. Structured listening tasks may initially present sounds and words that are comprised primarily of low-frequency sounds (e.g., /m/ and /mam/), with the assumption that individuals learn to recognize those items before items comprised of higher frequencies. With the advent of more sophisticated processing strategies, it is perhaps time to reassess points made by Krashen and others (see Corder[10]) with regard to the learner's internal syllabus.

For example, it may be that a new cochlear implant user is immediately capable of comprehension activities and that auditory training might focus on sound or word distinctions that are presented in the context of meaningful conversation or narrative comprehension rather than in more drill-oriented formats (see Tye-Murray's book[13] for a review of traditional discrimination and identification activities). Same–different discrimination tasks and word identification in closed-set formats may no longer be the optimal introduction to training. Instead, an initial activity might focus on comprehension activities. For instance, a client might be asked to comprehend the gist of a spoken sentence such as "The boys walked to school." Initially, it might not matter that the client heard the word "boys" as "boy." Later, it might be appropriate to focus the client's attention on making fine-grained distinctions, like listening for the /z/ and /s/ sounds that distinguish plural from singular forms. It also may be appropriate for clinicians to focus their clients' attention on high-frequency sounds early on in the program as most cochlear implant processing strategies code high frequencies. For instance, a client who uses a cochlear implant may have the capability of discriminating the words "sip" and "ship," an initial consonant distinction that is not perceptible to most hearing-aid users who have significant hearing loss. A comprehensive assessment of the listening capabilities of a new cochlear implant user, as well as information about how his or her device is programmed, should

inform the clinician about an individual's internal syllabus.

The Monitor Hypothesis

A third hypothesis put forth by Krashen is that although explicit knowledge (learning) cannot become implicit knowledge (acquisition), L2 learners may use explicit knowledge as a monitor or editor during language production. As Krashen[14] explains, "After a potential utterance is produced by acquired competence, the performer can refer to conscious rules and make certain corrections before the utterance is spoken or written" (p. 46). Krashen also notes that to use explicit knowledge to monitor production, L2 learners must have enough time to do so, must know the conscious rule in question, and must be focusing on form.

IMPLICATIONS OF THE MONITOR HYPOTHESIS FOR AUDITORY TRAINING

With regard to aural rehabilitation and speech-language therapy in general, including speech training, this hypothesis might predict that clinicians should not expect explicit information that they provide to clients (e.g., explicit information about how phonemic contrasts work in a language) to become implicit knowledge. This type of explicit information may be used by clients only to reflect upon or recall how the system works (monitoring) and cannot replace the implicit knowledge gained through use of the target structure in communicative contexts. With regard to auditory training in particular, clinicians may notice that some clients, perhaps adults in particular, are interested in learning explicit information about how a phonemic contrast or other aspect of speech works. The clinician may provide this type of information to clients, perhaps for the fact that the information itself is inherently interesting. Applying the monitor hypothesis, however, explicit information of this nature will be available to clients only as a means of monitoring how they should perceive speech accurately and not as a means of developing the ability to do so in an increasingly fluid manner during communication in naturalistic contexts.

Bradlow, Akahane-Yamada, Pisoni, and Tohkura[15] provide some evidence for positive effects of phonemic training on speech production in the absence of explicit instruction about speech production. In Bradlow et al's study, native Japanese learners of L2 English were trained on the English r/l distinction using minimal pairs (e.g., rock–lock) discrimination with feedback. Pre- and posttraining measures of perception (accuracy of identifying novel r/l minimal pairs) and production (ratings of r/l production by native English speakers) revealed significant improvements in both perception and production, despite receiving no explicit training on production. These results establish an important link between the production and perception of L2 and suggest that clinicians may use productive (in addition to receptive) measures as an additional index of the benefits of sensory aids.

The Input Hypothesis

A fourth hypothesis proposed by Krashen is the input hypothesis. This hypothesis is central to Krashen's explanation, in general terms, of how L2s are acquired. The input hypothesis asserts that we acquire language by comprehending messages in *comprehensible input*, or samples of the target language that can be understood by the learner. The input hypothesis also posits a general mechanism, or a general metaphor, for how language acquisition takes place. According to this hypothesis, language acquisition progresses when learners attend to input (samples of the target language) that contains linguistic data slightly beyond their current level of competence. Krashen refers to this type of input as $i+1$. Krashen[14] explains this general mechanism in the following manner: ". . . if an acquirer is currently at stage 'i', it is hypothesized that s/he can acquire 'i + 1' if s/he understands input containing i + 1" (p. 46). The notion of i + 1 therefore serves as a general metaphor for how L2 learners progress from lower to higher levels of proficiency in the gradual process of SLA.

IMPLICATIONS OF THE INPUT HYPOTHESIS FOR AUDITORY TRAINING

The input hypothesis holds several implications for auditory training. For instance, cycling is

sometimes incorporated into the auditory training program. The clinician works with the client until the individual reaches a prescribed benchmark of success. Later, say in one or two weeks, the clinician returns to the training objective to provide reinforcement and additional learning.[16] The notion of building from success also might be evident if the clinician interweaves activities that require listening only with activities that require both listening and watching. For instance, a clinician might present a training task using vision and audition to ensure that the client understands the task and is familiar with the vocabulary and language structures. Once the client experiences success in an audition-plus-vision condition, the task can be repeated in an audition-only condition. In this kind of scenario, the client is continually pressed to perform just beyond his or her current abilities while still receiving an opportunity to experience success. The input hypothesis, as does the acquisition-learning hypothesis, underscores the importance of meaningful listening. If the input is not meaningful, the spoken form in question cannot be attached to meaning. Techniques that might be employed for making spoken language comprehensible include a structured communication activity like Quest? AR.[17] In Quest?AR, the clinician asks a series of scripted questions (for auditory training, it would be in an audition-only format), and the client responds. The general implication here is that in auditory training, like L2 learning, form should not be divorced from meaning. The input needs to be both meaning-bearing and comprehensible.

The Affective Filter Hypothesis

The fifth and final of Krashens hypotheses is the affective filter hypothesis. This hypothesis posits that affective factors can prevent input from becoming available to the L2 learner's language acquisition device. Krashen[14] explains this hypothesis more specifically as follows: "If the acquirer is anxious, has low self-esteem, does not consider him/herself to be a potential member of the group that speaks the language, s/he may understand the input, but it will not reach the language acquisition device – a block, the Affective Filter, will keep the input out" (page 46). In a general sense, the main instructional implication of this hypothesis is to create a classroom environment that is affectively positive, that increases the self-esteem of the learners, and that encourages the learner to feel more like a member of the group that speaks the target language. In this way, following the Affective Filter Hypothesis, learners in the classroom will be less likely to raise their affective filter and block input containing data needed for the learner to progress in the L2 acquisition process.

IMPLICATIONS OF AFFECTIVE FILTERING FOR AUDITORY TRAINING

Clinicians sometimes note anecdotally that auditory training has reduced their clients' anxiety levels during everyday listening. With some individuals, listening becomes less effortful following training, as they are able to devote more mental energy to comprehending the meaning of the message and less effort toward identifying sounds and words spoken (see Witt[18] for a case report). One major benefit an individual derives from auditory training is an overall greater self-confidence in his or her ability to recognize speech, in addition to the series of specific perceptual improvements that a client gains over time. The individual may be less likely to raise what Krashen refers to as an *affective filter*, and more likely to process auditory input with full mental powers. For new device users, many of whom feel unsure about their new listening skills and carry the baggage of having experienced communication breakdowns repeatedly, a clinician's praise and encouragement might decrease anxiety and increase the new user's ability to process input. Means by which a clinician may lessen anxiety include focusing on the positive, providing test data (and error data from listening tests) about how much better the individual performs with a device than without it, and providing multiple opportunities for the client to experience success.

EFFECTS OF ACOUSTIC VARIABILITY

In the preceding section, we used Krashen's theoretical framework to discuss how general

principles of SLA might inform practices in auditory training. We turn next to a specific instance of extending Krashen's proposals about the role of input in SLA and why not all input is created alike with regard to its effects on acquisition. Specifically, we summarize research on L2 phonemic training[19,20] and recent work from our laboratories on acoustic variability and L2 word learning[21,22] and then propose how research in both of these areas might have important implications for auditory training. The findings of this research has demonstrated that the use of acoustic variability, or acoustically varied presentation formats, is an effective instructional technique for teaching learners L2 phonemic contrasts and new L2 vocabulary. These findings reinforce Krashen's hypothesis about attending to the nature of input during SLA but, in this instance, with regard to the extent to which input is acoustically varied in addition to being meaning bearing and comprehensible.

A traditional view of learning is that repeated presentations of verbal material increase the strength of association between the presented items.[23] According to this perspective, if we wanted to teach the L2 learner of Spanish the new form-meaning relationship "pez"—"fish," we might repeatedly pair these two items until the relationship had been acquired. Similarly, if we wanted to teach the new user of a sensory aid the relationship between the modified (due to perception via the new device) signal and a preexisting concept (e.g., fish) during auditory training, we would again repeatedly pair these two items. A hallmark of both L1 and L2 training from this perspective is input consistency, whereby repeated presentations of the identical stimuli add information to the organizational structure originally created for that item. Some studies on human memory, however, have demonstrated that under some circumstances memory for an item can improve when varied, as opposed to consistent, exemplars are presented during a learning phase.[24,25] To provide one example of this stimulus variability effect, Nygaard, Sommers, and Pisoni[25] used a serial recall task to investigate whether variations in speaking rate and talker characteristics (voice) could improve memory for spoken words compared with conditions in which words were spoken by the same talker or at the same speaking rate. A key manipulation in this study was the interstimulus interval (ISI; i.e., time between items in a list). Nygaard et al reasoned that at short ISIs, listeners would not have sufficient time to encode either rate or talker information and therefore would not exhibit a benefit of variability. At longer ISIs, however, the researchers predicted that participants would have sufficient time to encode the variability and the additional rate and talker information would serve as supplemental retrieval cues to increase recall performance. Consistent with these predictions, Nygaard et al found no benefit (and in some cases, a cost) for variable input (multiple talkers and multiple rates) at ISIs below 1000 milliseconds (ms), but improved recall performance for variable input at ISIs above 1000 ms. These findings suggest that at least under some circumstances varied, rather than consistent, input can produce improved memory performance for familiar L1 words.

Interestingly, research on L2 learning also has demonstrated that acoustically varied input can produce positive effects on learning L2 phonemic contrasts and L2 vocabulary learning. In the following sections, we provide background about research on acoustic variability in L1 speech processing and describe recent research supporting the beneficial effects of acoustic variability in memory for L1 words, L2 phonemic training, and L2 vocabulary learning. Finally, we discuss how these findings might be applied to auditory training.

Acoustic Variability and L1 Speech Processing

Studies on L1 speech processing have demonstrated that presenting words in acoustically varied formats negatively affects performance on L1 speech processing tasks such as vowel perception,[26] word recognition, and word naming.[27,28] These effects have been produced using talker, speaking rate, or voice type as sources of acoustic variability. Other research, in contrast, has demonstrated that some sources of variability render no effects on these same dependent measures. Sommers, Nygaard, and Pisoni[29] found null effects for amplitude

variability on L1 word identification, as did Sommers and Barcroft[28] for fundamental-frequency variability. One explanation for this overall pattern of results is that only those sources of acoustic variability that affect phonetically relevant properties of speech will produce decrements in L1 speech processing.[29]

Acoustic Variability and Memory for L1 words

In contrast, considerable evidence is now available to suggest that acoustic variability can improve memory for L1 words presented in word lists. Mullennix, Pisoni, and Martin[27] demonstrated, for example, that memory for words spoken by multiple talkers was significantly better than memory for words spoken by only a single talker. Similarly, Goldinger, Pisoni, and Logan[24] found that when listeners are given sufficient time to encode voice characteristics, serial recall is better for items spoken by multiple talkers as compared with single talkers. This improved memory performance for acoustically varied stimuli has been attributed to listeners' ability to encode both linguistic and indexical information and to use the latter as an additional retrieval cue.

Acoustic Variability and L2 Phonemic Training

Another body of research suggests that acoustically varied presentation formats also can be useful for teaching L2 phonemic contrasts, such as when training native Japanese speakers on the English contrast between liquid consonants /r/ and /l/. A series of studies has demonstrated the effectiveness of using acoustically varied, as compared with acoustically consistent, presentation formats during training for this English contrast[19,20,30,31] (see also Hardison[32]). Of particular importance to the issue of auditory training is that these studies demonstrate that (1) variable input during training facilitates listeners' ability to perceive the contrasts produced by novel talkers, (2) variability improves long-term retention of the contrasts, and (3) variability during perceptual training can lead to improved production as assessed by intelligibility ratings. These findings provide an important extension to the work on acoustic variability and memory for L1 words because they demonstrate that at least some sources of acoustic variability can improve L2 learners' ability to learn novel phonetic forms.

Acoustic Variability and L2 Vocabulary Learning

A more recent series of experiments[21,22] assessed the effects of acoustic variability on L2 vocabulary learning. Barcroft and Sommers[21] examined the effects of variability in voice type and talker on the ability of English speakers to learn Spanish vocabulary. Speaking style (also referred to as voice type) and talker were selected as sources of variability because they represent both intraspeaker (speaking style) and interspeaker (talker) variations that occur naturally. The general methodology used in these experiments was to compare vocabulary learning in conditions with no variability (one talker or one speaking style), moderate variability (three talkers or three speaking styles), and high variability (six talkers or six speaking styles). For all sources of variability, speed and accuracy of picture-to-L2 recall and L2-to-L1 translation were dependent measures. The findings for both sources of variability indicated a positive and additive effect of acoustic variability; the participants were faster and more accurate in both types of recall when they learned the words in acoustically varied compared with acoustically consistent formats. Moreover, learning performance with high variability was better (faster and more accurate) than for moderate variability, which, in turn, was better than with no variability.

Sommers and Barcroft[22] extended the investigation of acoustic variability and L2 vocabulary learning to three previously untested sources of variability: overall amplitude, fundamental frequency, and speaking rate. Sommers and Barcroft hypothesized that two of these sources of variability, overall amplitude and fundamental frequency, may not affect L2 vocabulary learning. This prediction was based on earlier experiments[29] designed to test the phonetic relevance hypothesis for the effects of acoustic variability on L1 speech processing.

According to the phonetic relevance hypothesis, listeners will encode and retain indexical properties of the speech signal such as talker characteristics and speaking rate that affect acoustic features, such as format frequencies and transitions, which are used for phonetic identification. In contrast, sources of variability that do not alter phonetically relevant speech features, such as overall amplitude (overall amplitude affects perceived loudness, but does not alter formant frequencies or other phonetically relevant parameters of the speech signal), either will be ignored or will be processed more automatically (in the same way that an automatic gain control functions to maintain a constant loudness level). In applying the phonetic relevance hypothesis to studies of acoustic variability and L2 vocabulary learning, Sommers and Barcroft[22] reasoned that if the beneficial effects of talker and speaking-style variability are a result of listeners encoding and retaining phonetically relevant sources of variability (i.e., they serve as an additional retrieval cue), then variability based on sources that do not affect phonetically important speech features may not affect L2 vocabulary acquisition. Consistent with this prediction, Sommers and Barcroft found that neither variations in overall amplitude nor variations in fundamental frequency affected L2 vocabulary learning based on the same dependent variables used by Barcroft and Sommers.[21] Speaking-rate variability, however, produced positive effects on L2 vocabulary learning, as would be predicted by the phonetic relevance hypothesis.

USE OF ACOUSTIC VARIABILITY IN AUDITORY TRAINING

Auditory training programs that rely on acoustic variability include the *Natural Speech Program* proposed by Tye-Murray, Tyler, Lansing, and Bertschy.[33] Its premise was that individuals learn by exploring and extracting invariance from their environment.[34,35] Clients who receive a cochlear implant learn to listen through repeated exposure to sounds and words in different contexts and by different talkers. For example, the word "rice" is still the word "rice," regardless of whether it is spoken by a man with a general American English accent or spoken by a woman with a southern drawl (and hence, spoken with a heavily diphthongized vowel and a higher fundamental frequency). In a *Natural Speech Program*, through the process of implicit learning (Krashen's first hypothesis), Tye-Murray et al[33] proposed that listeners abstract the invariant aspects of words and their component sounds by means of repeated exposures and varying contexts. This process should result in overall better listening performance in everyday environments. In the original *Natural Speech Program,* training activities included same-different discrimination tasks and three-interval forced-choice drills.

In today's auditory training curriculum, training programs that incorporate acoustic variability might be supplemented by activities that are more meaningful, such as comprehension-level activities (Krashen's hypotheses 1, 2, and 4). Clinicians could use technology such as digitized speech samples stored on a computer to present speech spoken by a variety of talkers, with sounds and words presented in a variety of contexts, as a means of incorporating acoustic variability into the learning experience. The training materials may be arranged along a hierarchy of listening difficulty, in consideration of the client's internal syllabus (Krashen's hypothesis 2). Outside of the clinical setting, clients might be encouraged to interact with a variety of talkers and in a variety of environments to reinforce skills developed in the clinical setting.

FUTURE RESEARCH ON ACOUSTIC VARIABILITY AND AUDITORY TRAINING

Whereas extant research on acoustic variability and L2 learning suggest that talker, speaking-style, and speaking-rate (but not amplitude and fundamental-frequency) variability might help to facilitate auditory training, new research on the effects of these sources of variability on auditory training is clearly needed, to avoid overextending the current L2 findings. We are in the planning stages for conducting new research on the use of talker variability during auditory training for clients who have cochlear implants and clients who are hearing impaired. If new

research documents that benefits of acoustic variability on L2 learning extend to auditory training, such a finding would afford two important benefits. First, it would provide direct evidence of the effectiveness of incorporating more acoustic variability within auditory training programs. Second, it would suggest that at least some areas of research on L2 learning may serve as initial testing ground for addressing issues in auditory training.

ABBREVIATIONS

ISI interstimulus interval
L1 first language
L2 second language
SLA second language acquisition
SPL sound pressure level

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