misleading perceptual resemblances. The results reviewed here suggest an alternative position that even seemingly abstract cognitive tasks can be accomplished by educating perceptual processes. Sophisticated understandings do not merely trump perception. Sophisticated understandings shape perception, and vice versa.

Cross-References

- ▶ Adaptation and Learning
- ▶ Animal Perceptual Learning
- ▶ Discrimination Learning Model
- ▶ Expertise
- ▶ Generalization Versus Discrimination in Learning
- ▶ Neuropsychology of Learning
- ▶ Routinization of Learning
- ▶ Sensorimotor Adaptation
- ▶ Similarity Learning
- ▶ Simultaneous Discrimination Learning
- ▶ Visual Perception Learning

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Perceptual Learning in Speech

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Synonyms

Recalibration; Retuning

Definition

Perceptual learning in speech describes a change in the mapping from acoustic cues in the speech signal to abstract linguistic representations. Learning leads to a lasting benefit to the listener by improving speech comprehension. The change can occur as a response to a specific feature (such as a talker- or accent idiosyncrasy) or to a global degradation of the signal (such as in synthesized or compressed speech). In perceptual learning, a top-down process is involved in causing the change, whereas purely bottom-up, signal-driven phenomena are considered to be adaptation.

Theoretical Background

Perceptual learning provides listeners with a mechanism for coping with an immense amount of variability in the speech signal. The realization of acoustic cues that are associated with particular speech sounds vary considerably from talker to talker, even in the most favorable listening conditions, because of differences in the anatomy of the vocal tract, individual habits, or accents. As listeners, we often adjust to such variation without effort: the speech perception system maintains an impression of constancy by adjusting, sometimes quite rapidly, to changing listening situations. These adjustments are stored in memory so that they can be reused: for example, being familiar with a particular talker facilitates comprehension of that talker on subsequent encounters (Nygaard et al. 1994). Perceptual learning is also a means to overcome drastic degradation of the speech signal, resulting from compression, filtering, or synthesis, for example, in the use of auditory prostheses. Comprehension of such signals can often be improved through perceptual learning, although this may be more effortful and proceed relatively slowly. Understanding how perceptual learning operates has had important implications for cognitive models of human speech perception and may inform the design of artificial speech recognition systems, where dealing with variability in the input signal represents one of the major challenges to the field. How to optimize perceptual learning is also a topic of investigation in settings where explicit training on speech takes place, such as second-language learning and rehabilitation from hearing impairment.

Important Scientific Research and Open Questions

Specificity Versus Generalization

A fundamental challenge for the perceptual system is to decide under which conditions a previously learned adjustment should be applied. Generalization of learning can be beneficial: for example, when an unfamiliar talker speaks with a familiar accent, what was learned about that accent on previous occasions with other talkers can improve the intelligibility of the novel talker. In contrast, a learned adjustment to a talker's speech impediment will not benefit intelligibility when overgeneralized to the context of a different talker who does not have the impediment. One of the earliest studies on perceptual learning in speech already demonstrated that learning becomes more reliable when the exposure situation provides a representative sample of the underlying variation. If learning is based on a very restricted set of exposure materials, it does not tend to generalize to broader contexts (Greenspan et al. 1988).

Levels of Processing

While most studies on perceptual learning have simply used changes in intelligibility as an outcome measure, a few recent studies have investigated more explicitly at which point in the speech perception system learning may take place, and how the learning mechanism operates (Cutler et al. 2010; Samuel and Kraljic 2009). This research suggests that learning affects the pre-lexical level of processing. A pre-lexical locus of learning is advantageous since an adjustment to a phonemic category can generalize across the entire lexicon, and is thus beneficial whenever that sound is encountered again in novel lexical contexts. These studies have also revealed that lexical knowledge can be a driving force in perceptual learning. A speech sound that is perceptually opaque can often be disambiguated by the word context in which it occurs. Repeated exposure to the opaque sound in the context of different words leads to an adjustment of the phonemic representation of that sound, sometimes in a talker-specific manner. Other types of disambiguating context may be used as well. For example, visual information from the face of the talker is effective in inducing perceptual learning at the phoneme level (Bertelson et al. 2003), and it is likely that there are other types of contextual information which can be exploited by a perceptual-learning mechanism if they occur with sufficient reliability.

Applications

Several lines of research have investigated how best to use perceptual learning in explicit training situations. For example, adult users of cochlear implants need to learn to adjust to a considerable spectral degradation of the acoustic signal they receive from the environment. Perceptual learning under such conditions is typically slow and effortful, but can be maximized by providing explicit feedback and by introducing a realistic degree of phonetic variability in the training materials (Stacey and Summerfield 2007). In second-language learning, a high degree of variability in training materials is often beneficial for the acquisition of a novel phonemic category, for example, by hearing the critical new speech sound produced by many different talkers and in different contexts.

Cross-References

- ▶ Acoustic and Phonological Learning
- ▶ Adaptation and Learning
- ▶ Bottom-Up and Top-Down Learning
- ▶ Categorical Representation
- ▶ Perceptual Learning
- ▶ Phonetics and Speech Processing
- ▶ Phonological Representation
- ▶ Psycholinguistics and Learning

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