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Editorial introduction: The 6th International Conference on Auditory Cortex

The 6th International Conference on Auditory Cortex brought over 250 scientists from more than 25 countries around the world to Banff, Alberta, Canada with the goal of better understanding the neurophysiological mechanisms that underlie auditory perception and cognition. The presented research spanned multiple methodologies and conceptual/theoretical paradigms, examined the structure and function of the auditory cortex, and provided a thoughtful synthesis of both human and animal research.

In his self-described “swan song”, Dexter Irvine opened our meeting with a retrospective look at how decades of study in auditory plasticity have brought about profound changes in our conceptualization of cortical function. Accordingly, he opens this special issue by elaborating on these ideas in an attempt to understand how complex auditory perceptual learning arises from distributed brain regions involved with perception and higher-level cognitive factors (Irvine, 2018).

A well-studied example of the distribution of auditory functions involves the distinct ventral and dorsal auditory streams that mediate auditory perception and audiomotor behaviours, respectively. Although the existence of these distinct pathways has been supported both functionally and anatomically, Da Costa and colleagues (2018) argue here that this binary division cannot explain a growing body of literature that suggests a bound representation of sound meaning and location is present in early auditory cortex. Instead, they provide data from human imaging experiments that are suggestive of a third, independent stream within auditory cortex that contributes to an individual's ability to track objects through space. Relatedly, Yang and colleagues (2018) provide a model of how cellular-level processes in primary auditory cortex may contribute to our ability to track and group sounds presented in temporal sequence.

A listener's ability to generate sound representations that are invariant over space and time are important phenomena, both for tracking objects through space, and in order to enhance the identification of behaviourally-relevant stimuli across presentations; Moreno and colleagues (2018) address the latter challenge in this issue. Throughout development, it is critical to strike a balance between neuroplasticity (i.e. the ability to reorganize brain structure and function in response to experience) and the stability of the resulting neural representations of sound stimuli. Here, Moreno and colleagues demonstrate that one mechanism responsible for this balance involves changes in the expression of the immediate early gene c-Fos in both auditory cortex and the noradregenic locus coeruleus, and that the rate of expression interacts with both internal state factors and experience.

Although these molecular mechanisms help shape stimulus representations based on bottom-up representations of sound features, a great deal of work on top-down influences on auditory cortical processing has focused on auditory selective attention, which is the enhanced representation of a sound that contains a cued feature (i.e. “signal”), and the suppression of competing non-cued stimuli (i.e. “noise”). However, this work has overwhelmingly focussed on the segregation of spatially-separated sounds cues. Here, Holt and colleagues (2018) suggest that the dynamic reweighting of many *non-spatial* sound features that occurs with experience can also be conceptualized as auditory selective attention. Further, Holt et al. (2018) provide a framework derived from non-human physiology to test a mechanistic connection between attention and speech perception, and suggest that this novel interpretation of auditory selective attention may be particularly important to speech perception.

Indeed, such a top-down influence may be integrated alongside ascending auditory inputs within a “voice patch” in auditory cortex, selective for conspecific vocalizations. In their review, Belin and colleagues (2018) summarize the evidence for such a voice-selective neural network consisting of discrete, interconnected cortical areas supporting increasingly abstract representations of the vocal input. While Belin and colleagues focus on the extent to which such a network may be conserved throughout evolution, Cusack and colleagues (2018) describe the developmental timeline of a speech-sensitive network in human infancy. In particular, they suggest that adult-like structural and functional connectivity of voice-sensitive cortical regions in early infancy exists despite a substantial delay in the onset of receptive and expressive language, highlighting the importance of experience in functional network development.

Hage (2018) continues the discussion of brain circuitry supporting communication by examining the extent to which auditory cortex may contribute to networks supporting vocal *production*. His work suggests that feedback control of vocalization in rhesus monkeys involves connections between auditory cortex and a network consisting of prefrontal, ventral premotor, and motor cortices, and the primary vocal motor network of the brainstem. In particular, he highlights how auditory stimuli modulate activity in the ventral premotor cortex, and suggests that this activity may be a precursor for the evolution of complex, learned audio-vocal integration systems, ultimately giving rise to human speech.

Indeed, the importance of effectively attending to complex signals, like speech, and gaining sufficient experience to optimize both perception and production presents a critical challenge to normally developing auditory cortex. However, due consideration must also be given to how hearing impairments, such as threshold shifts and tinnitus, as well as aging, impact auditory cortical function. In an effort to bridge animal and human studies, Paul and colleagues

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(2018) suggest that impairments in gap detection, a commonly used objective index of chronic tinnitus in animal models, might be useful in diagnosing deficits in humans. In addition, Recanzone (2018) provides a review of cortical changes that occur with age in a non-human primate model of presbycusis, and argues that a disruption of the balance between excitation and inhibition in the core and belt cortical regions of auditory cortex may underlie complaints of increased listening difficulty in the elderly.

Collectively, the papers in this special issue reflect an impressive breadth of research into the structure and function of auditory cortex, looking across model species to provide insights into development, normal function, and impairment. The research papers included represent ground-breaking work that continues to inform our understanding of auditory perception and cognition, while review articles from leaders in the field provide historical perspectives on the major challenges in the field and present new directions for exploration. We sincerely thank the authors for their enthusiasm, and look forward to continuing these discussions at the 7th International Conference on Auditory Cortex, to be held in Magdeburg, Germany in 2020.

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