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EDITORIAL

Editorial for special issue: "Auditory attention: merging paradigms and perspectives"

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How can we be so absorbed into some activity that we fail to hear our name being called, while some minutes later we perfectly understand a whispering voice? Questions like this tap into the issue of auditory attention. As in any other modality, information processing in audition is shaped by the listener's current goals. Consequently, perception of and responses to sound depend on inner states as much as on physical stimulus input. Diverse phenomena of auditory attention along the perception–action cycle have been addressed in various research groups. The field must, however, be described as somewhat scattered. In this special issue, we aim to provide an overview of the different research lines by bringing together 12 different perspectives on auditory attention. The 12 contributions comprise 5 review articles and 7 papers reporting original data.

Seeing the links between the different research approaches is sometimes complicated by the fact that they come from fundamentally different traditions: some approach the problem of auditory attention with a strong focus on perceptual processes, others take an action-oriented perspective. Some base their investigation on the top-down allocation of attention in accordance with the listener's goals, while others exploit the bottom-up capturing of attention resulting from stimulus saliency. While such dichotomies are difficult to avoid when structuring the available research material, we attempt to counteract them here by pointing out conceptual as well as methodological links between the various contributions.

In everyday life, the need for (selective) auditory attention arguably arises most prominently from the presence of multiple objects producing sounds at the same time. What enables us to listen to our conversation partner in a busy cafeteria? We must be equipped with a powerful mechanism giving priority to the processing of some parts of the auditory input over others. This allows us to focus on a momentarily interesting signal (e.g., our conversation partner) while ignoring less relevant input (e.g., other speakers and the cafeteria noise).

Many laboratory demonstrations of auditory selective attention in such scenarios rest on processing impairments for the unattended signals rather than on processing gains for the attended signals. The extent to which unattended signals are ignored is so surprisingly high that it has been termed inattentional deafness. This phenomenon is at the heart of the contribution by Koreimann, Gula, and Vitouch (2014). The authors provide an empirical demonstration of such perceptual failures in the ecologically valid case of listening to music: listeners, even musically trained ones, failed to notice an e-guitar improvisation in a piece by Richard Strauss when their attention was strongly focused on a certain aspect of the piece. This reflects a striking case of attentional over-selectivity. On the other hand, when the acoustic contrast between the e-guitar improvisation and the musical piece was increased, the inattentional deafness effect disappeared.

Such findings illustrate a fine balance between attentional selectivity—allowing to focus on the task at hand—and the "breakthrough of the unattended" (Moray, 1959; Treisman, 1960)—allowing to check task-irrelevant but acoustically salient, potentially important information. The

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review article by Dalton and Hughes (2014) covers both sides of this balance: Inattentional deafness findings are contrasted with studies on attentional capture by task-irrelevant sounds. The authors delineate the different paradigmatic approaches used for studying these processes, relying either on explicit verbal reports or on indirect inference from effects on primary task performance.

Intuitively, one would assume that attentional capture by task-irrelevant sounds—such as a ringing phone in the neighboring office—must lead to temporary impairments in task performance as the listener gets distracted (Escera, Alho, Winkler, & Näätänen, 1998). Many laboratory findings are consistent with this idea, yet some studies have yielded conflicting results. The review article by Parmentier (2014) comprehensively examines the conditions under which performance decrements occur, as well as the factors by which these performance effects are modulated, such as the predictability of the attention-capturing event.

The empirical contribution by Horváth (2014) rounds up the focus on attentional capture by task-irrelevant auditory signals. By means of event-related brain potentials (ERPs), the author investigates characteristics of the attentional orienting and reorienting processes assumed to underlie behavioral distraction by unexpected sounds. Horváth's results challenge long-held views about the functional interpretation of the involved ERP components P3a and RON (Schröger, Giard, & Wolff, 2000), and thereby provide inspiration for future research on recovery from distraction in terms of restoring an optimal attention set for processing important auditory events.

The first four contributions of this special issue have in common that they do not put emphasis on the power of auditory selective attention, but rather study the phenomenon by demonstrating its failures or the expenses at which it comes. A somewhat opposite perspective is taken by Bressler, Masud, Bharadwaj, and Shinn-Cunningham (2014) in their empirical contribution. These authors ask how it is possible to listen successfully to a target speaker amongst a mixture of different speakers. They identify a key mechanism underlying this ability: once a speaker is in the attentional focus of the listener, the processing of subsequent signals emitted by the same speaker is enhanced. Interestingly, this enhancement appears to happen effortlessly and in a bottom-up manner, without the need for top-down attentional involvement to keep focusing on the same speaker.

In a similar vein, the empirical contribution by Spielmann, Schröger, Kotz, and Bendixen (2014) investigates whether the grouping of signals emitted by different sound sources over time happens in an automatic, bottom-up manner, or whether it is influenced by top-down auditory attention. The authors propose a new ERP-based paradigm for tackling this issue. Their findings are consistent with the conclusion reached by Bressler et al. (2014): certain aspects of sound grouping appear to be neither contingent upon nor affected by top-down auditory attention.

Now, if there is an automatic tendency to retain one and the same sound source (e.g., one out of several speakers) in the attentional foreground, one may wonder how it is possible to follow a vivid conversation in which speakers keep changing. A laboratory analogue to this situation is reported in the empirical contribution by Lawo and Koch (2014). These authors examined the ability to switch intentionally between two speakers. They found significant costs associated with switching attention to a different speaker, which provides a nicely consistent counterpart to the results of Bressler et al. (2014). Both studies can be seen as investigating target selection among several auditory candidates. Lawo and Koch (2014) further provide an empirical dissociation between processes of auditory target selection and response selection. With this joint investigation of attention effects at different processing stages, they provide a bridge between the perception- and action-oriented contributions to this special issue.

The contributions taking an action-oriented perspective typically create attentional conflict not by the presence of multiple sound sources at the same time, but by conflicting information given by a single source. For instance, an uttered word may be associated with one response by (arbitrary) task instruction, but at the same time with a different response by its inherent (ecological) properties. Incomplete attentional selectivity then leads to action interference effects rather than to perceptual confusion. The review article by Dittrich, Kellen, and Stahl (2014) takes a methodological perspective on such phenomena, outlining how the analyses of distributional properties of interference can shed light on differences between various types of action conflict, as well as between related phenomena in vision and audition. Although applied mainly in the context of response selection conflicts, the same analysis procedures could prove equally informative for paradigms focusing on interference at the level of perceptual processes.

The obligatory incorporation of given stimulus properties is also key to the empirical contribution by Vu, Minakata, and Ngo, (2014). The authors report on a specific form of conflict arising from spatial incompatibility within the stimulus–response set. They show how stimulus–response codes are shaped in the face of spatial incompatibilities, and they address the role of prior knowledge (e.g., inherent associations of pitch and space) as well as of crossmodal auditory-visual influences in resolving the incompatibility.

A qualitatively different level of conflict arises from the fact that top-down attentional control exerts influences on subsequent cognitive processes. After ignoring a given sound, the same sound is less efficiently processed when suddenly behaviorally relevant. Such sequential after-effects of attentional selection are covered in the review article by Frings, Schneider, and Moeller, (2014). The authors contrast sequential selection phenomena in vision and audition, and they develop a comprehensive set of principles for sequential selection in audition. While most of the auditory phenomena can clearly be linked to response selection, for some, in particular for auditory spatial negative priming, the crucial processing stage is less clear.

The latter aspect is further pursued in the empirical contribution by Mayr, Möller, and Buchner (2014). Mayr and colleagues investigate the mechanisms underlying auditory spatial negative priming. They argue that a perception- or memory-based explanation is more consistent with the empirical results than a response activation account.

The memory aspect brought up by Mayr and colleagues, along with the final contribution by Backer and Alain (2014), reminds us that investigating auditory attention along the perception–action cycle captures but a part of everyday experience. A widely neglected phenomenon consists in directing auditory attention to memory representations without immediate external correspondence. Backer and Alain review findings on reflective attention (i.e., attention to memory) in vision and audition, developing general underlying principles. One must acknowledge a strong under-representation of research on this topic among the many contributions on auditory attention with a direct sensory basis (which is proportionally reflected in the number of contributions to this special issue). Yet reflective attention is a classic in attention research, in that it was already pointed out by James (1890) as a major facet of attention—at the time called intellectual attention.

Upon quoting William James, it is all too tempting to close this editorial by asking whether we now know "what [auditory] attention is". As much as we would wish to give an affirmative answer, this would seem premature in the face of the very different concepts of auditory attention employed even within this special issue. The present series of contributions illustrates once more that auditory attention, just like its visual counterpart, comes in a variety of flavors. We do, however, hope that this collection provides a valuable basis for the different approaches to inform each other and to eventually be embraced within a joint theoretical framework.

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