Psychophysiological mechanisms of hierarchical novelty detection in the human auditory brain

Results:

The goal of the present project was to demonstrate that novelty detection is a basic principle of the functional organization of the auditory system, expanding from lower levels along the auditory pathway in the brainstem up to higher-order areas of the cerebral cortex. As novelty detection requires the modelling of regularity in the acoustic environment, we go beyond by proposing that increasing levels of complexity in acoustic regularity will be encoded in higher levels of the auditory system's hierarchy. Traditionally, auditory novelty detection has been studied by means of the mismatch negativity (MMN) event-related brain potential, generated in the auditory cortex with a latency of about 100-150 ms. In the present project, we found that auditory stimuli differing in intensity or in location from the preceding acoustic regularity not only elicited the MMN but much earlier deviance-related correlates, by the Na for location and by the Na-Pa transition for intensity changes, respectively. These effects occurred only at 20-30 ms from change onset, revealing that deviance detection is a pervasive property of the auditory system. Moreover, as the experiments were appropriately controlled, so that deviant stimuli were compared to identical low probability stimuli but occurring on a context of other low probability stimuli, the results support a mechanism of regularity encoding for deviance detection. Also, we proposed a model where much more complex types of regularity would be encoded higher up in the auditory hierarchy yielding change-related effects only by the latency window of the MMN.

Published Works:

Full papers

Althen, H., Grimm, S., & Escera, C. (2011). Fast detection of unexpected sound intensity decrements as revealed by human evoked potentials. PLoS ONE, 6(12): e28522. doi:10.1371/journal.pone.0028522.

Grimm, S., Recasens, M., Althen, H., & Escera, C.CA (2012). Ultrafast tracking of sound location changes as revealed by human auditory evoked potentials. Biological Psychology, 89(1):232-239.

Grimm, S. & Escera, C. (2012). Auditory deviance detection revisited: Evidence for a hierarchical novelty system. International Journal of Psychophysiology, 85, 88-92.

Grimm, S. & Escera, C. (2013). Differential effects of frequency adaptation and sequential predictability on auditory evoked potentials. Manuscript in preparation.

Areas of interest:

Psychophysiology, Cognitive Neuroscience, Auditory Neuroscience

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