

English summary

Within four similar EEG experiments, the ability to follow the content of one narrator in a realistic “Cocktail-Party” situation was addressed. The aim of these studies was to investigate selective auditory perception and the restriction of attentional focus with the underlying electrophysiology (ERPs; event-related potentials) in a setting with 2 or 4 speakers. Listeners’ attention was assumed to be directed to a specific set of sounds, sound sources and not to others (cocktail party problem).

A special technique for a virtual spatial presentation of auditory stimuli was used to avoid a simple right-left presentation. Individual HRTFs (head related transfer function) from different angles were measured first. These HRTFs of a certain spatial angle were convolved with the actual stimulus material (stories, phonemes and white noise). The subject’s task was always the same from experiment to experiment: to attend one of the two or four concurrent and simultaneously presented stories.

The experimental difference involved the superimposed probe stimuli (task irrelevant) which were either phonemes or white noise bursts. These probes, especially the phonemes, varied in fundamental frequency and/or spatial location in the four experiments. By doing so, the question about the nature, characteristics and precision of the attentional focus should be investigated. The working hypothesis was that directed attention to one ear would cause an attenuation of stimulus processing on the other ear reflected in a Nd/PN (negative difference/processing negativity) which was experimentally confirmed. There was an additional Pd component in two of four experiments indicating an initial selection in novel and unfamiliar situations. Furthermore, it was observed that the focus of attention is absolutely restricted to the to-be-attended auditory object only. Not only large deviants in frequency and spatial location, but even slight differences elicited a N1, PN or MMN (mismatch negativity) and P3 or RON. These were taken as a sign of attenuated stimulus processing and/or deviance detection as well as an attentional shift. Furthermore, all these effects show that there are two stages in auditory selection: a later attentional selection process (Nd/PN, P3a, RON) besides an early stimulus driven selection (Pd, N1, MMN).

The spatial and frequency effects suggest that these deviants were not included into the actual focus of attention anymore and are processed as unattended stimuli with a distracting potential. The spectral content seems to also play an important role in auditory selective attention as well. Only stimuli with exactly the same frequency spectrum as the to-be-attended auditory object (one story respectively in those four studies) fell into the attentional focus, others with less or even more frequencies in the spectrum are thoroughly excluded.

No definitive differences were found in stimulus processing within a more complex “Cocktail-Party” situation (four speakers) compared to two-speaker settings. Similar ERP components were found in both settings which suggest that the same attentional mechanism underlay the stimulus processing. Nevertheless, the four-speaker experiment compared with the two-speaker experiment revealed an apparent mirror effect for ERP results in the attended to the unattended hemispace. The only difference between both hemifields was seen in a slight shift in processing level for the unattended side, in parallel below the one for each analogous stimulus on the attended side. This result indicates that even unattended stimuli are distinguished and not treated as if they were the same stimulus. Perhaps, due to evolutionary reasons, it is highly important to be able still to differentiate between incoming information and thus, to be prepared for potentially dangerous objects.

The results also indicate that only attended stimuli are processed and elaborated deeply whereas any deviants or unattended stimuli experience an attenuated processing depending on the working memory capacity and the load of the primary task. Thus, the attentional focus is absolutely restricted to the to-be-attended object and its features only. Any changes in a feature would lead to an exclusion from the actual focus. This fact finally led to the novel “modification hypothesis” further explained in this dissertation.

Altogether, these experiments have demonstrated the validity of using HRTFs for an auditory spatial virtuality. Furthermore, it was shown that the attentional focus is highly restricted to all features of the to-be-attended stimulus. The combination of, for example, fundamental frequency, spectrum and spatial location is attended, and not just one of these features. Finally, two selective stages (early and late) decide which stimulus is included in or excluded from attentional focus.