DETECTION OF AUDIO SIGNALS IN AUTONOMOUS DRIVING AS REVEALED BY THE FRONTAL-P3 ERP

Remo M.A. van der Heiden*, Christian P. Janssen*, Lotte E.S. Hardeman*, Keri Mans*, J. Leon Kenemans*
*Experimental Psychology & Helmholtz Institute, Utrecht University, The Netherlands

As in-car automation increases, the role of the human driver changes from manually controlling the vehicle to monitoring the vehicle's state. However, for some levels of automation, the driver might at times need to intervene, for example after they are warned by an auditory alert. We investigated how susceptible people are to auditory signals in semi-autonomous driving situations using an EEG event-related potential (ERP) technique with a novelty-oddball paradigm. Standard tones were presented regularly, with occasionally a deviant (10% of stimuli) or unique novel sound (10%). Previous work has shown a 300-ms-latency ERP deflection (frontal P3 or fP3) in response to novels, relative to standards, under stationary conditions, but this component is reduced when driving. This has been interpreted as a reduced capacity of the brain during driving to generate an interrupt signal in response to an unexpected but potentially relevant auditory event. We replicated this study in a driving simulator (n= 18), but also added an autonomous driving condition (within-subjects). We also varied between-subjects whether a button-press response was needed when hearing a deviant tone (active) or not (passive). We computed the difference between the fP3 to novel tones and that to standard tones at FCz. We found a significantly reduced fP3 during active driving AND during autonomous driving, relative to the stationary condition. This reduction was not modulated by the active-passive manipulation. However, in all three conditions the fP3 was significantly enlarged during the active condition. Our results suggest that there is reduction of the impact of unexpected auditory stimuli on cognitive processing in autonomous driving situations, and this effect may even be stronger when the driver is distracted. At the same time, engagement in a secondary auditory task may reverse the reduction in susceptibility.