Electrocortical Responses to Ecologically Relevant Visual Stimuli among Professional Drivers with and without Cardiovascular Disease

Reza Emdad, Karen Belkić, Tores Theorell, Arne Wennberg, Maud Hagman, Lotta Johansson, Cedo Savic, and Stella Cizinsky

1National Institute for Psychosocial Factors and Health,
2National Institute for Working Life,
3National Institute for Mental Health,
4Department of Cardiology, Thorax Clinic, Karolinska Hospital

Abstract—Electrocortical responses were assessed using two simulated aspects of visual signals encountered in traffic: the Glare Pressor Test (GPT) and Event-Related Potential Avoidance Task (ERPAT) among four groups of male professional drivers: 12 with ischemic heart disease (IHD), 12 hypertensives, 10 borderline hypertensives, 34 who were apparently healthy and 23 nonprofessional driver healthy control subjects. The blood pressure (BP) responses immediately after the ERPAT were also measured. There was a significant between groups effect for the amplitude of the target N2 component in the ERPAT (p=0.02), with the lowest means among the drivers with IHD and the highest among those with hypertension. Drivers with IHD also showed the highest diastolic BP reactivity to the ERPAT. Significantly more than the expected number of drivers with IHD failed to recover alpha activity after the first glare impulse of the GPT. Professional drivers who failed to recover baseline levels of alpha activity after the GPT showed a significantly smaller N2 amplitude compared to those who recovered (p=0.01). There was a positive correlation between abundance of alpha activity at rest with P300 amplitude (p=0.02). An inverse relation was found between number of work hours behind the wheel and the amplitude of the target P300 (p=0.04). Results are interpreted in light of recent advances concerning integrative mechanisms of defence versus vigilance response patterns. The findings in this study justify further applications of these psychophysiologic methods to assess the relationship between simulated signals of the work environment and mechanisms of cardiac risk in this occupational group.

Key words—professional drivers, ischemic heart disease, hypertension, glare pressor test, Event-Related Potentials, avoidance task.

Introduction

Professional drivers are an occupational group at very high risk for developing cardiovascular disorders (Winkleby 1988; Belkić 1994). It is becoming increasingly recognized that the burden upon their central nervous system from the work they perform could play a...
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A key role in this process (Netterström 1988; Michaels 1991; Belkić 1994). Fuller (1984) has noted that, compared with most other activities, driving has a high potential for aversive consequences. The driver must continuously make adjustments, not only to attain some desired travel objective, but also to avoid undesired situations. Stimuli encountered in traffic that are not inherently aversive may become so by association with driving experience. This formulation has been corroborated by the findings of Belkić and colleagues (1992a): a sample of young professional drivers exhibited electrocortical arousal (EEG desynchronization) and somatic and autonomic responses when exposed to an automobile headlight (the Glare Pressor Test). In other words, the inherently neutral car headlight seemed to acquire specific relevance for the drivers, presumably because of its “association with the exigencies and consequences of driving behavior” (Belkić 1992b).

“Event-Related Potentials” have been used to evaluate certain aspects of mentally stressful work, notably task load (McCallum 1988; Ullsperger 1988). Zubin, Sutton and Steinhauser (1986) have emphasized that the revival of the psychosomatic field and its relation to stress ought be “harnessed” to event-related potential research. However, these methods have not, until recently, been applied with respect to work-related stress among occupational groups at high risk for cardiovascular disorders.

Steptoe and Vögele (1991) have emphasized the need for “ecological relevance” in mental stress testing, particularly as this relates to the cardiovascular system. Picton (1992) has also stressed within the context of event-related potential studies that the paradigm should be relevant to the group under study. In an attempt to achieve this, a GO/NOGO Contingent Negative Variation paradigm simulating the avoidance task performance aspects of driving was applied in healthy professional drivers. A pronounced electrocortical negativity was found among this group in response to imperative visual signals (Belkić 1992b). Skinner and colleagues (1987; 1991), have developed a model in which augmented electrocortical negativity to stimuli can be linked both clinically and experimentially to harmful cardiovascular responses (vulnerability to cardiac arrhythmias in CHD patients and hypertension) possibly correlated with the defense response. Skinner (1991) has concluded that “psychosocial stressors increase cardiac vulnerability through a learning-dependent noradrenergic process arising in frontocortical neurons.” It has been hypothesized that the heightened electrocortical responses among professional drivers to relevant stimuli might in some way be related to the high risk that this cohort bears for developing cardiovascular disease (Belkić 1994).

Thus far, only young, healthy professional drivers have been examined using the above-described neuro- and psychophyslogic methods. An integrated assessment of electrocortical responses to the glare pressor test and to the event-related potential avoidance paradigm is also lacking. It is the aim of this paper to investigate how professional drivers with prepathologic and manifest cardiovascular disease, as well as those who are still healthy, respond to an oddball visual reaction time avoidance task in which there is specific reference to the traffic situation. Here, both vigilance and defense reactions may be called into play. The interrelations between the electrocortical responses to this event-related potential paradigm and to the glare pressor test have been examined, focusing upon patterns of arousal and attention to simulated visual signals that are ecologically relevant to professional drivers.