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Evaluation of acute psycho-physiological reaction to law enforcement operational stress and tactical driving. 20 years of prospective italian research.

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Background: "Fight-or-flight" reaction to perceived danger may affect operational efficiency of police officers (POs), with negative impact on public safety. Therefore, there is a growing interest for methods to investigate stress occurring during highly-demanding operations. Stress-induced reactions are studied in psychophysiology integrating multiple parameters (ECG, EEG, respiration, electrodermal activity, salivary cortisol…), most of them unrecordable in real-world dynamic situations. Instead ECG, recordable also during physical activity, quantifies stress-related autonomic modulation (AM) through the analysis of heart rate (HR) and its variability (HRVa). We used ECG and a miniaturized wearable wireless telemetric device (mWTD) to monitor AM changes during realistic police tactical training (rPTT), police tactical driving (PTD), oleoresin capsicum exposure (OCE) and live-fire shooting competitions (LFSC). 20 years of research, aimed to understanding of mechanisms underlying human response in force-on-force scenarios and to design more efficient training methods for POs, are reported.

Method: We selected data of 185 healthy POs (33.6±4.4 years old) investigated during rPTT with different psycho-physiological impact. Until 2015, ECG was recorded with standard ECG-Holter, then the novel mWTD connected to a standard textile sensors garment (Nuubo) has been used featuring simultaneous recording of 3 ECG and 2 Skin potential responses (SPR) for real-time assessment of transient variation of AM with a novel fast algorithm for integration of time-variant HRV spectral parameters (HRVp) and of Root Mean Square value of the two SPR signals (SPRRMS).

Results: HR increment varied significantly among individuals undergoing the same tasks. Highest HR values (>180 bpm in 66%) were observed during LFSC, often associated with poor operational score. Standard short-term HRVa was inadequate to evidence short-lasting transient changes of AM response due to acute stress (dominant LF at the beginning of task and at medium workload, relative dominance of HF and inversion of LF/HF ratio at the zenith of HR, in high-stress tasks). Under OCE, 83% of POs were able to perform their tasks, despite typical physical symptoms, high HR increment (peak 161 bpm) and HRV decrement with LF prevalence. Discriminant Analysis of HRVp differentiated between physical and psychological stress (accuracy >80%). During PTD good correlation was found between stress-induced increment of SPR activity and driving demands.

Conclusion: The mWTD is reliable for on-duty compatible recordings and telemetric transmission of AM during highly-demanding operations of POs. Real-time calculation and monitoring of time-varying spectral HRVp with SPRRMS provide immediate multimodal information on AM response to emotional and physical stress reactions to tactical demands. Discriminant Analysis of HRVp is useful to differentiate psychological and physical stress during police operational activity.