FATIGUE DURING DEADLY FORCE DECISION-MAKING: MEASURING SKIN CONDUCTANCE RESPONSE DURING SIMULATIONS

Michael A. Winser[a], John M. Hinson[b], Stephen M. James[a], Bryan Vila[a], Paul Whitney[b], Hans P. A. Van Dongen[a]

[a] Sleep and Performance Research Center, Washington State University, Spokane, WA, USA
[b] Department of Psychology, Washington State University, Pullman, WA, USA

INTRODUCTION

Sleep deprivation impairs performance on computer-based tasks of risky decision-making administered in the laboratory.[1-3] It is unclear how such performance impairment may translate to more complex operational settings such as law enforcement officers' deadly force decision-making (DFDM). We set out to measure DFDM in a high-fidelity simulator developed for training law enforcement officers.
Skin conductance level (SCL), a measure of sympathetic arousal, increases in anticipation of risky decision outcomes and may be used as a measure of affective processes guiding risky decisions.[4] However, anticipatory SCL measurement is sensitive to movement and speech,[5] making its use potentially problematic in DFDM simulations, as these require use of an inert handgun and verbal interaction with characters on-screen. In this pilot study we evaluated anticipatory SCL signals during DFDM simulations with an inert handgun and with an alternate response device (a wireless mouse) as well as with and without verbal interaction.

METHODS

Seven civilian volunteers completed DFDM scenarios in a high-fidelity simulator (PRISim Suite, Advanced Interactive Systems, Seattle, WA). The simulator consisted of a sound-proof room (8.5m by 5.5m) with pre-recorded scenarios projected onto a screen (3.0m by 5.5m) at one end of the room. Subjects stood in the center of the room facing the screen, simulating the first-person perspective of a law enforcement officer responding to situations involving domestic disturbances, vehicle stops, or suspicious persons. Scenarios lasted between 15 seconds and 2 minutes, each leading up to a decision point where deadly force may or may not be appropriate.
During each of four 15-minute sessions, subjects experienced 4 scenarios randomly chosen from a full set of 16 scenarios. Within each session there was always one scenario where deadly force would not be appropriate. Two minutes of rest separated each scenario, and 30 minutes of rest in another room separated each session.
Every session was assigned one of four conditions (explained below), with each subject experiencing all four conditions in randomized order. Before each session, subjects were instructed to use force only when appropriate for the simulated situation presented, in ways that would minimize threats to bystanders or themselves and neutralize the threat from assailants. They were told to indicate a decision to use force using their dominant hand to pull the trigger on either a modified, inert Glock handgun, which fired an infrared laser at the screen, or a trigger-style wireless computer mouse held at their side (Gun or Mouse

conditions). Furthermore, they were told to either actively, verbally interact with the characters on screen or passively observe the scenarios (Active or Passive conditions).

During each session, two 8 mm Ag-AgCl electrodes filled with electrolyte gel were attached, using adhesive tape collars, to the palmar surface of the first and second medial phalanges of the non-dominant hand. This hand rested on a table adjusted to just below the subject's elbow. SCL data was recorded from the electrodes at 20 Hz using PsychLab Acquire software via a SC5 skin conductance monitor (Contact Precision Instruments, Cambridge, MA, USA).

Baseline SCL was calculated as the beginning SCL value for each simulation scenario. Peak SCL was calculated as the highest value before the decision point for each scenario. Area under the curve (AUC) of SCL from baseline to peak was used to quantify anticipatory SCL responses within scenarios.[6] SCL AUC data were analyzed with repeated-measures analysis of variance (ANOVA) with factors Device (Gun or Mouse) and Interactivity (Active or Passive) and their interaction.

RESULTS AND DISCUSSION

Figure 1 illustrates the SCL data (measured in microsiemens, μS) acquired during the study with an example of one subject's data over four scenarios in one session. As can be seen in the figure, within scenarios, SCL steadily increased from baseline to a peak just before the deadly force decision point. Indeed, across the whole dataset, there were significant increases from SCL baselines to SCL peaks ($F_{1,6}$=33.8, P=0.002).

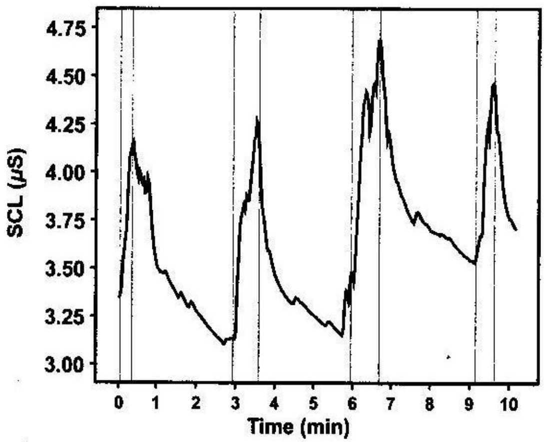

Figure 1. Example of SCL data (in microsiemens) observed during a DFDM simulation session when a subject was using a trigger-style wireless computer mouse while actively interacting with characters on the screen. (In this example, the first scenario was one in which deadly force was not appropriate.) Black curve: observed SCL. White areas: DFDM scenarios (from scenario start to scenario end). Gray areas: rest breaks before DFDM scenarios.

Figure 2 shows the SCL AUC results of the study (measured in microsiemens times seconds, $\mu S \cdot s$). There was a significant effect of Device, with the Mouse condition showing greater SCL AUC than the Gun condition ($F_{1,6}$=6.4, P=0.045). There was also a significant effect of Interactivity, with the Active condition actively showing greater SCL AUC than the Passive condition ($F_{1,6}$=9.8, P=0.020). There was no significant interaction of Device by Interactivity ($F_{1,6}$=2.9, P=0.14).

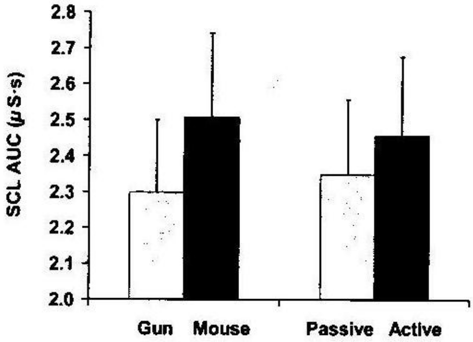

Figure 2. Mean (± standard error) of SCL area under the curve (in microsiemens times seconds) as a function of response device used (inert hand gun versus trigger-style wireless computer mouse) and level of interaction with the characters on the screen (active interaction versus passive observation).

Lower SCL when using the inert handgun and when passively observing may have been the result of reduced engagement with the simulation scenarios. The subjects in this study were civilians, who were generally unfamiliar with the use of handguns. This unfamiliarity may have been distracting and/or may have reduced simulator immersion, which can reduce anticipatory SCL.[7,8] Passive observation may have similarly reduced simulator immersion and reduced anticipatory SCL. Indeed, self-reports from law enforcement and military personnel in previous DFDM simulator studies have suggested that passive viewing is less engaging.

CONCLUSIONS

Our results indicate that SCL can be measured during DFDM in high-fidelity simulations with civilians as research subjects. Use of a trigger-style wireless mouse rather than an inert handgun and actively interacting with the simulation scenarios produced the most robust SCL responses.

These findings inform future studies of simulated DFDM during sleep deprivation, which will allow examination of affective processes underlying sleep loss-induced deficits in risky decision-making in the real world.

ACKNOWLEDGMENTS

This research was supported by U.S. Office of Naval Research grant N00014-13-1-0302.

REFERENCES

[1] Killgore WDS, Balkin TJ, Wesensten NJ. Impaired decision making following 49 h of sleep deprivation. Journal of Sleep Research 2006; 15:7-13.

[2] Venkatraman V, Chuah YML, Huettel SA, Chee MWL. Sleep deprivation elevates expectation of gains and attenuates response to losses following risky decisions. Sleep 2007; 30:603-9.

[3] Pace-Schott EF, Nave G, Morgan A, Spencer RMC. Sleep-dependent modulation of affectively guided decision-making. Journal of Sleep Research 2012; 21:30-9.

[4] Bechara A, Damasio H, Tranel D, Damasio AR. Deciding advantageously before knowing the advantageous strategy. Science 1997; 275:1293-6.

[5] Boucsein W, Fowles DC, Grimnes S, Ben-Shakhar G, Roth WT, Dawson ME, Filion DL. Publication recommendations for electrodermal measurements. Psychophysiology 2012; 49:1017-34.

[6] Dawson ME, Schell AM, Filion DL. The electrodermal system. In: Cacioppo JT, Tassinary LG, Berntson GG, eds. Handbook of psychophysiology, 3rd ed. New York: Cambridge University Press, 2007:159-81.

[7] Wong QJJ, Moulds ML. Impact of anticipatory processing versus distraction on multiple indices of anxiety in socially anxious individuals. Behaviour Research and Therapy 2011; 49:700-6.

[8] Kim K, Rosenthal MZ, Zielinski DJ. Effects of virtual environment platforms on emotional responses. Computer Methods and Programs in Biomedicine 2014; 113:882-93.