GAME BIOFEEDBACK

as a Tool for Stress Assessment and Professional Training

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GAME BIOFEEDBACK
and
Professional Training

How it can be performed:
Individually or in Group?
Material and Method

• 65 students of the Novosibirsk Regional Firefighter Training Center of EMERCOM of Russia, males of 23 ± 3 years old

• Course of stress resilience training - 5 sessions of HR game biofeedback + 3 HRV sessions (N40)

• Psychological and psychophysiological assessment (LSI, STAI, MSTAT, Heim, HRV)
Game biofeedback – biofeedback-based computer game controlled by player’s pulse

Model of Stress Conditions
To win in the competition one has to stay calm, keep his/her pulse stable and not let it rise, as well he/she has to react fast to random stimuli.

Each session consists of separate trials
To win the player has to improve the result of the previous one.
This is a competition of two divers searching for treasures in the sea. The slower pulse of the player, the faster the left diver moves. The dynamics of inter-beat interval (biofeedback parameter) is shown as a graph at the bottom of screen.

VIRA!

Stress conditions were simulated as car racing game “Rally” or diving competition “Vira” where the speed of players inversely depended on their heart rate.

RALLY is a car race. The speed of player’s car depends on his/her pulse. The more calm he/she is, the faster the car moves. The player must respond (press Spacebar) asap when he/she sees a stone appear on the road.
The data to store and to study:

Inter-beat interval duration (RR) (measured in ms) - period between two successive heartbeats

Reaction time (RT) - period from the moment when a stimuli (rock) appears on the road to the moment when a player press Spacebar (measured in ms)
Increase of inter-beat interval (IBI) and decrease of reaction time (RT) as session effectiveness assessment.

Example of non-effective session: no positive IBI dynamics, increase of RT.
«VIRA-RALLY» TEST

Matrix of self-regulation abilities efficiency under stress

Probabilities of classification
HRV training protocol

1. Individual choice of breath rate 6 or 5.5 or 5 bpm?
2. Individual choice of respiratory cycle structure 50:50 or 40:60 or 30:70?

Result – individual regimen
Duration of the respiratory cycle is 10 sec

Inhale : Exhale
50 : 50

Inhale : Exhale
40 : 60
Structure of the respiration cycle scenario for HRV training matters!

Inhale : Exhale
50 : 50

Inhale : Exhale
40 : 60
Results

Self-defense Profile

Life Style Index, LSI
Plutchik-Kellerman-Conte

Denial
Repression
Regression
Compensation
Intellectualization
Displacement
Projecton

Exp.group Before
Exp.group After
Control group Before

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Result of training – non-adaptive self-defense level reduced
Self-defense Profile

Life Style Index, LSI
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Result of training – non-adaptive self-defense level reduced
Strategy of Manager

About 40% of all participants (38 of 65) demonstrated at 1st session the following behavior pattern: they had high efficiency of RT control and low ability to regulate RR.

When a person was trying to complete a given task in the most efficient way possible, it leads to an excessive expenditures of physiological resources.
Results

• This subgroup had high value of LF/HF index (> 2.0) that means sympathetic activation
• It was shown that 5 sessions of self-regulation biofeedback training changed the strategy when one controlled only RT (87,5% - 14 of 16)
• These major changes took place due to the active use of the biofeedback cognitive components
Material and Method

• 30 students of the Novosibirsk Regional Firefighter Training Center of EMERCOM of Russia, males of 22 ± 1 years old

• Course of training in VR with control of RR, GSR, Respiration - 5 sessions

• Psychological and psychophysiological assessment (STAI, MSTAT, visual SRT, FMNP, HRV)
“Starship Maze”
Game simulator for EMERCOM staff

The task of the test is to find the victim in the debris and return for the help asap – runtime of the quest & complexity of the trajectory are calculated.

Game control (speed of the player) is performed by physiological signals: RR, Respiration, SC, GSR.
Assessment of psycho-physiological ‘Cost’ of professional activity (PFCA)

Immersion in VR Game Plot for Assessment & Training: reaction time, spatial-temporal coordination, tolerance to ambiguity, memory, attention

Control (and/or monitoring): HR (RR), SC (GSR), RespRate

= PFCA
Results

Examples:

- **effective maze passage**
  
  The trajectory of both forward and backward lines is smooth

- **non-effective maze passage**
  
  The trajectory of the movement is not a smooth line
Projection of the cases on the factor-plane in PCA

Analysis of the spatial-temporal characteristics of the test’s outcome
Outliers marked as blue dots

Analysis of the physiological parameters of forward movement / backward movement of the lifeguard
Outliers marked as red dots
Maze passage time normalized by its length

RR averaged over way forward and backward in sessions:
Test (1,2)
Training1 (3,4)
Training2 (5,6)

V6 – trending down half way back
V7 - trending up half way back
V9 - trending up …
V8 - trending down …
Conclusions

• Game biofeedback can be used as a tool for assessing the level of the stress resilience
• This training allows for effective handling of a person’s behavior in stressful situations
• High motivation levels could interfere with one’s self-regulation abilities and weaken his/her resistance to stress
• Immersion into VR with adaptive feedback could reveal more accurate reasons for increasing a person’s PFCA level
• By means of VR biofeedback one trains to respond to various professional situations in a more effective way
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