Tailoring Autonomic Biofeedback to Individual Strengths with a Dynamic Feedback Signal Set

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Abstract

Two studies examined the feasibility of a novel, multi-channel, biofeedback algorithm in its ability to reinforce autonomic control. Signals included skin conductance level, skin temperature, respiration rate, and low-frequency heart rate variability. The Dynamic Feedback Signal Set (DyFSS) weights and combines these four signals to provide a single measure of comfort to users. The weighting emphasizes signals that indicate success to reinforce the user’s most effective self-calming behaviors and accommodate for heterogeneity and individual differences in physiological responses. Study 1 tested a one-shot design comparing the DyFSS to a display of the four channels/graphs individually. Participants used the feedback to return to baseline levels of autonomic arousal following a stressor. Along with physiological measures, participants reported Subjective Units of Distress (SUDS). Study 2 examined user comments from teens diagnosed with Autism Spectrum Disorder (ASD). Participants provided qualitative data on their experience. Results of these preliminary trials are discussed with consideration for client preferences and applications.

Background

- Biofeedback is an effective intervention to teach control of anxiety and autonomic arousal.  
- Autonomic Dysregulation, exhibited as high levels of anxiety and arousal, is a major factor in symptoms of Autism Spectrum Disorder (ASD).  
- Teens with ASD are drawn toward science, technology, engineering, and mathematics (STEM) and computing.  
- We aim to improve existing biofeedback software by offering (a) multiple channels and (b) positive reinforcement  
- Dynamic Feedback Signal Set (DyFSS) uses four proxies of autonomic function:  
  - Skin Conductance Level (SCL), Skin Temperature (TMP), Heart Rate Variability - Low Frequency (HRV), Respiration Rate (RR)

Study 1: Test ability of college students to return to a calm state, aided by biofeedback (separate Graphs or DyFSS), following a stressor  
  - Analyze (1) SCL as a proxy for sympathetic arousal and (2) self-report Subjective Units of Distress (SUDS) 0 - 100

Study 2: Receive feedback from teens with ASD on preferences and willingness to use DyFSS

Method

1. Attach sensors  
   - Blood Volume Pulse (for HRV)  
   - Skin Conductance Level (SCL)  
   - Skin Temperature (TMP)  
   - Abdominal Stretch (for RR)

2. Baseline  
   - 2 min

3. Brief intro to biofeedback

4. Stressor  
   - 6±4 + 3 - 7
   - 5:30 min
   - comparison window 5:30 - 5:30
   - comparison windows x4

5. Biofeedback

Results and Discussion

- Main effect for time: Stressor is effective  
- No difference between DyFSS and Graphs groups  
- More participants needed to confirm (n = 6 for DyFSS)  
- DyFSS not immediately intuitive, more training may help  
- Single-trial biofeedback learning may not be feasible

DyFSS with Autism  

Initial Impressions:  
- Too simple for medical use, but too complex for a game  
- Setup is “bulky,” sensors are “creepy”  
- “Good for sitting and relaxing”  

References