FEATURE

Stress Protocol for Assessing Computer-Related Disorders

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The information gained from a psychophysiological stress profile when a person works at the computer can be used to assess and prevent repetitive strain injury (RSI)/computer-related disorders (CRDs). The following protocol offers recommendations for (a) placing sensors, (b) instructing the trainee about tasks, (c) debriefing the trainee after the task, and (d) interpreting physiological indicators concomitant with stress reactions. Suggestions for educational and clinical interventions and biofeedback training based on the stress profile are offered to reduce the risk for RSI/CRD.

Introduction

Psychophysiological stress protocols have been used for assessing general states of physiological arousal as well as specific disorders for more than two decades to identify psychosocial factors that evoke psychophysiological reactivity patterns (Credidio, 1980; Guck, Kreuch, & Franzen, 1985). Harvey & Pepper (1997), Peper and Gibney (2000), and Pepper et al. (1994, 1997) have developed specific assessment profiles for employees working at the computer to identify and ameliorate computer-related disorders (CRDs) often described as repetitive strain injury. CRD researchers have observed that (a) excessive autonomic arousal and/or (b) chronic lack of muscle tension awareness without episodic recovery breaks during typing and mousing tasks lead to increased muscle discomfort and upper extremity musculoskeletal disorders (Banks, Jacobs, Gevirtz, & Hubbard, 1998; Cram, 2003; Veiersted, Westgaard, & Andersen, 1993). This article describes a protocol for identifying CRD risk factors and suggests strategies for reducing and preventing computer-related disorders.

Patterns of CRD Risk

Assessing physical reactions during computer use requires identifying and monitoring specific physiological activity including surface electromyographic (SEMG) measurements from the neck, shoulder, and arm as well as measures of respiration, blood volume pulse (BVP), heart rate (HR), peripheral temperature, and skin conductance activity (SCA). A multichannel psychophysiological profile allows for interpretation of telltale patterns of reactivity that point to increased risk of CRDs. For example, excessive sympathetic activation stimulates trigger points that may result in referred pain (Gevirtz, 2006; Travell & Simons, 1983). Increased sympathetic activation may also cause cold or moist hands and rapid thoracic breathing, indicating subclinical hyperventilation during computing tasks (Lum, 1994; Nixon, 1994; Schleifer, Ley, & Spalding, 2002).

The CRD psychophysiological stress profile guides clinician-trainers in identifying patterns of CRD risk marked by dysponetic chronic muscle activity without episodic SEMG gaps, lack of awareness of stress, and other physiological reactivity patterns that contribute to CRD risk. The advantages of using a CRD stress profile include (a) demonstrating the risk factors of which the person was unaware and thereby facilitating attitude change about the task, (b) providing a baseline measure for comparing subsequent training assessments, and (c) providing documentation of progress for interested parties such as workers compensation providers or insurance companies.

Challenges in Dynamic Assessment

Any assessment protocol, especially one that monitors dynamic movement, is challenging because the sensors used to detect physiological arousal may interfere with task performance or be susceptible to artifacts. For example, awareness of sensors may induce unintended stress, leading to increased errors in performance. Moreover, excessive body movement may produce artifacts in the recording that make it difficult to compare task-related activity to baseline or no-activity assessment period. To reduce the challenges inherent in a dynamic assessment for employees working at the computer, explore the following:

1. Attach sensors to the fingers of the nondominant/non-mousing hand and tape the sensors and the leads to the skin to avoid movement artifacts.
2. Instruct the individual to disregard the sensors as much as possible.

3. Adapt the protocol to the individual needs of the setting. For example, do not place a BVP sensor on the digits used for typing; instead, record from the nondominant thumb, as it is used much less for tapping the space bar, or shorten the recording time to fit the work demands (e.g., a 5-minute baseline may need to be shortened to 20 seconds).

Suggested Sensor Placement and Equipment Settings

Assessing physiological signals may include placing sensors over wide or narrow monitoring areas. Regardless of the location of sensor placement, the following are suggested settings.

SEMG Muscle Activity

- Attach narrow-placement Triode™ electrodes on forearm flexors, forearm extensors, or deltoid muscles and use a wide bandpass filter of 20–500 Hz.
- Attach narrow-placement Triode™ electrodes (Thought Technology Ltd., Montreal, Quebec, Canada) on specific chest and shoulder muscles (e.g., trapezius or pectoralis muscles) or wide-placement electrodes (e.g., left scalene to right trapezius muscles, left scalene to right deltoid muscles) and use a narrow bandpass filter of 100–200 Hz.
- Set the range of all SEMG sensors to 0–50 mV.

Respiration

- Attach abdominal strain gauge around the umbilicus.
- Attach thoracic strain gauge around the chest underneath the axilla.
- If only one strain gauge is available, attach it to midthorax crossing the chest near the xyphoid process.

Blood Volume Pulse

Attach the BVP sensor to the palm side of the trainee's nondominant/nonmousing thumb.

Temperature

- Set the display to Fahrenheit unless otherwise indicated.
- Attach the thermistor to the nondominant/nonmousing medial (thumb) side of the index finger.

Electrodermal Activity

Attach sensors directly to the palmar surface of the nondominant/nonmousing hand or on the proximal phalangeal segment of the index and ring fingers.

Procedure

Use the following steps for a CRD stress profile assessment. For all phases of the assessment, provide no visual or auditory feedback. After attaching sensors, begin the assessment by having the trainee sit at his or her normal computing work position and progress through the following steps:

1. Place hands on lap and relax (30 seconds).
2. Lift hands, allowing fingers to rest on the middle (home) row of keys (30 seconds).
3. Begin data entry by typing a standardized text (60 seconds).
4. Stop typing and rest fingers on the home row (30 seconds).
5. Place hands on lap and relax (30 seconds).
6. Rest hand on mouse (30 seconds).
7. Begin mousing by repeatedly cutting the last word of the text and pasting it to the beginning of the text as quickly as possible (60 seconds).
8. Stop mousing and rest hand on mouse (30 seconds).
9. Place hand on lap and relax (30 seconds).
10. Remember an emotionally negative event (e.g., a time when you were angry or frustrated).
11. When the memory/event is felt, nod your head and begin typing task while holding the emotional feelings (60 seconds).
12. Stop typing, place your hands on your lap and relax, letting go of the emotional experience (30 seconds).
13. Verbally describe your experience (60 or more seconds).
14. If the shoulder muscle tension does not return to baseline after resting with hands on lap, have the trainee shrug his or her shoulders and then rest his or her hands on his or her lap for additional 30 seconds.
15. Stop the recording.
16. Have the trainee fill out the self-assessment form (Figure 1).
17. Replay the recording and show the physiological data to the trainee (Figure 2).
18. Remove sensors.

Rate on the scale below your subjective feelings of relaxation/tension during each condition:

	Relaxed					Tense
Hands on lap	0	1	2	3	4	5
Fingers on home row	0	1	2	3	4	5
Typing	0	1	2	3	4	5
Fingers on home row	0	1	2	3	4	5
Hands on lap	0	1	2	3	4	5
Hand resting on mouse	0	1	2	3	4	5
Mousing	0	1	2	3	4	5
Hand resting on mouse	0	1	2	3	4	5
Hand on lap	0	1	2	3	4	5
Imagery and typing	0	1	2	3	4	5
Hands on lap	0	1	2	3	4	5

Rate on the scale below your emotional involvement with the image:

	None					High
Involvement	0	1	2	3	4	5

Figure 1. Physiological assessment at the computer subjective data form.

Interpreting the CRD Stress Profile

Each phase in the CRD stress profile can be used to identify representative warning signs for CRD risk. The following includes an analysis of the most common SEMG and respiration risks as well as recommendations for addressing those risks.

Resting With Hands in Lap Before or After Task Performance

1. SEMG risk indicator: muscle activity in the forearm flexors and extensors, deltoids, scalene, and trapezius muscles is greater than 3.5 μV with wide sensor placement and more than 2.0 μV with narrow Triode™ sensor placement. This occurs when an individual anticipates an upcoming task and readies for performance before performance is necessary.

Recommendation: Use SEMG feedback to teach arm, hand, neck, and shoulder relaxation and to increase somatic awareness of overexertion. Teach the trainee to wait for performance demands before engaging his or her muscles.

2. Respiration risk indicator: rate is more than 14 breaths per minute (BrPM). This is a possible indication of the trainee's performance anxiety.

Recommendation: Invite the trainee to explore the reasons for this response (e.g., what were you thinking, feeling, or anticipating?). Teach the trainee to breathe more slowly during rest conditions and to change his or her anxiety-producing thoughts and judgments.

Placing Fingers on the Home Row

1. SEMG risk indicator: muscle activity in the forearm flexors and extensors, deltoids, scalene, and trapezius muscles is greater than 3.5 μV with wide sensor placement and more than 2.0 μV with narrow Triode™ sensor placement. This occurs because the trainee unknowingly raises his or her fingers to avoid generating random characters on the screen. Continuously higher shoulder, hand, and finger muscle tension may also indicate unnecessary shoulder raising or overextending of the upper arms to reach the keyboard.

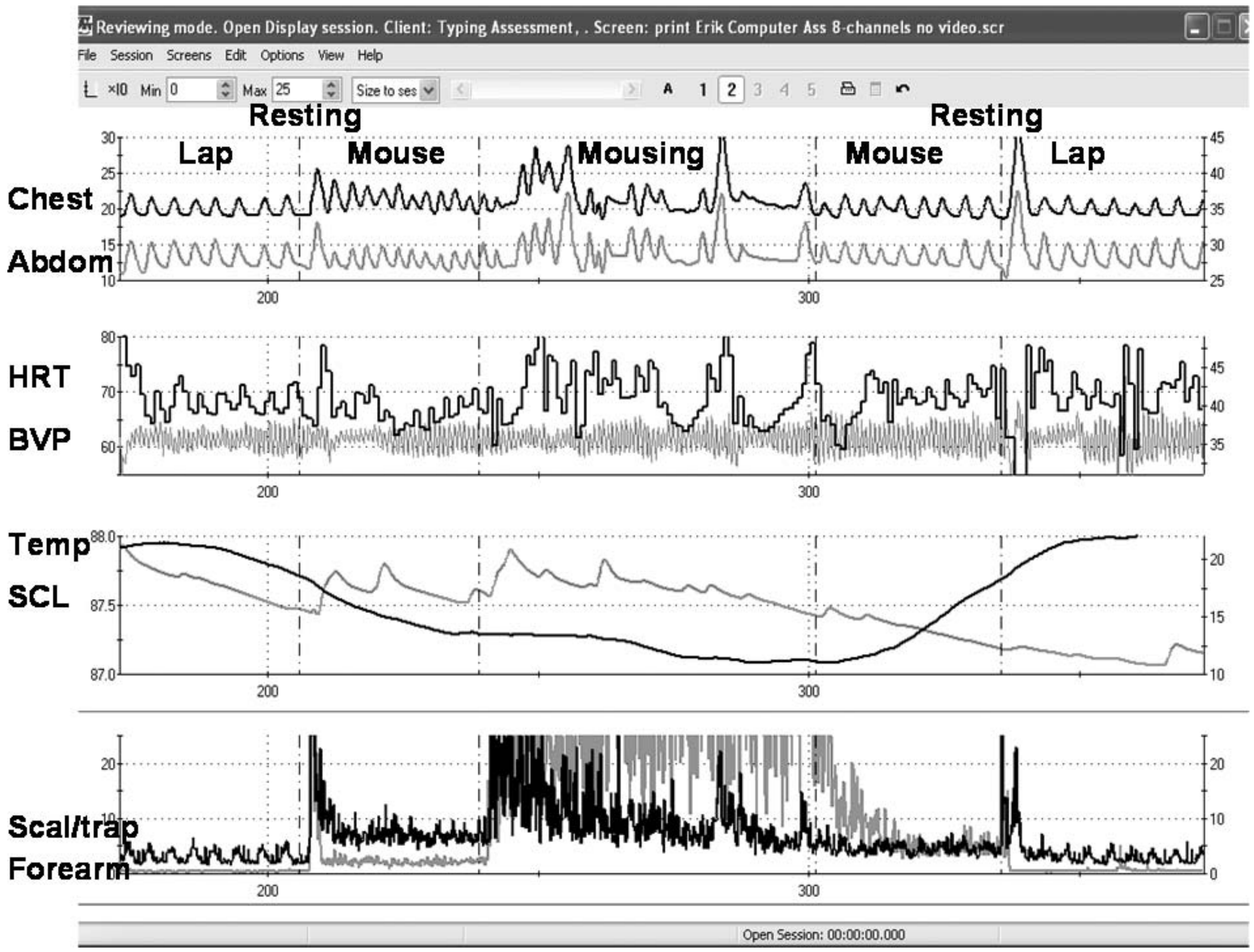

Figure 2. Sample physiological recording of mousing component of the computer-related disorder stress profile. Identified risks include increased scalene/trapezius and forearm surface electromyographic activity during hand resting on mouse condition, absence of microbreaks during hand resting on mouse and during mousing conditions, increased respiration rate during hand resting on mouse, increased respiration rate and breath holding during mousing, and decreased finger temperature during hand resting on mouse.

Recommendation: Use SEMG feedback to teach arm, hand, neck, and shoulder relaxation and to increase somatic awareness of overexertion. Teach the trainee to drop his or her hands onto his or her lap and instantly relax. Also, use SEMG scalene/trapezius feedback to remind the trainee how to keep the shoulders relaxed while his or her hands are resting on the keyboard.

2. Respiration risk indicator: rate is more than 14 BrPM. This usually indicates that the trainee is aroused, hypervigilant, and may be at risk for hyperventilation. This may also indicate the self-critical judgments characterized by internal thoughts such as "Am I good enough?"

Recommendation: Invite the trainee to explore the reasons for hypervigilance (e.g., what were you thinking, feeling, or anticipating?). Teach the trainee to breathe more slowly during rest conditions and to change his or her anxiety-producing thoughts and judgments.

Task Performance

1. SEMG risk indicator: continuously increased muscle tension without momentary relaxation breaks (e.g., less than 2.0 μV). This may be caused by raising the shoulders while typing or mousing, reaching forward with the upper arms while typing or mousing, or tensing the neck to bring the "nose to the screen" while reading text.

Recommendation: Teach deliberate 1-second microbreaks or larger movement breaks (e.g., stretching, getting up) to allow unrestricted blood flow leading to tissue regeneration. For example, use SEMG feedback to teach microbreaks by asking the trainee to serially type for 30 seconds, take a break for 1 second, type for 30 seconds, take a break for 1 second and encourage "flow typing" with hands and arms moving fluidly. Use SEMG feedback to teach larger movement breaks by asking the trainee to serially type for 2 minutes, stretch arms, type for 2 minutes, stand, and so on until awareness is raised.

2. Respiration risk indicator: rate is more than 14 BrPM, which may be due to the waist's being constricted by tight clothing so that the person has to breathe more shallowly and rapidly. It may also indicate that the trainee is aroused and/or excessively vigilant and may be at risk for hyperventilation. Cognitively, it may indicate self-critical judgments characterized by internal thoughts such as "Am I performing well enough?" or "I hope I don't make mistakes."

Recommendation: Invite the trainee to loosen his or her clothing around the waist and explore the reasons for hypervigilance (e.g., what were you thinking, feeling, or anticipating?). Teach the trainee to breathe more slowly during rest and data entry conditions and to change his or her anxiety-producing thoughts and judgments.

Imaging Stressful Circumstances During Tasks

1. SEMG risk indicator: continuously tightening muscles without momentary breaks (e.g., less than 2.0 μV). SEMG gaps usually disappear when the person feels angry, fearful, or vigilant. During the increased emotional state, most people are unaware of the increased tension in their bodies such as their trapezius muscle activity.

Recommendation: Use SEMG feedback to train shoulder and neck muscle relaxation during "flow typing" accompanied by increased awareness of the effects of stressful thoughts on physiology.

2. Respiration risk indicator: breath holding or shallow chest breathing. This usually indicates that the trainee is overvigilant and may be at risk for hyperventilation.

Recommendation: Invite the trainee to explore the reasons for breath holding and shallow breathing related to uncertainty/anxiety experiences of the stressful memory. Teach the trainee to breathe more fully during task performance and to acknowledge his or her anxiety-producing thoughts and judgments. Invite the trainee to explore the reasons for breath holding and shallow breathing related to the task. Teach the trainee to breathe more fully and to let go. If possible, encourage the use of laughter to reduce the tension.

BVP, HR, Temperature, and SCA Risk Factors

BVP, HR, temperature, SCA, and respiratory sinus arrhythmia (RSA) measures each indicate specific risk patterns. The risk patterns prior to, during, and after task performance, especially without awareness, include one or more of the following patterns of physiological reactivity and recovery: low finger temperature, increased skin conductance level, decreased blood volume amplitude, and, during rest periods, absence of synchrony between respiration and heart rate rhythms. (Note that all sensors, especially BVP, are sensitive to movement artifact. Interpret only artifact-free data.)

Recommendation: Invite the trainee to be aware of patterns of physiological reactivity and recovery during task performance and rest periods. The feedback training usually has two goals: (a) reducing excessive reactivity during task performance, for example, raising peripheral temperature during typing, and (b) promoting rapid recovery during rest periods, for example, increasing cardiorespiratory synchrony (RSA), a process that may reduce sympathetic arousal and trigger-point activity. Achieving these training goals will promote regeneration.

Conclusion

This protocol presents a quick yet powerful approach for reducing CRD risks to promote health while computing. Overwhelmingly, trainees are surprised by their patterns of physiological reactivity and recovery during and after computing tasks. This increased awareness motivates them to change their behavior, to develop awareness of cognitive and social stressors, to reduce excessive muscle tension, to breathe lower and slower, and to take breaks. For example, trainees become cognizant of increased use of restorative microbreaks (momentary rest breaks) as well as of diaphragmatic breathing. Using this approach, Peper et al. (2003, 2004) have shown that employees report a significant reduction in CRD symptoms while working at the computer. The authors recommend adapting this protocol for other uses such as increasing awareness of overexertion in reaction to stressful cognitive (e.g., negative thoughts) or physical (e.g., task performance) circumstances.

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