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Group Training with Healthy Computing Practices to Prevent Repetitive Strain Injury (RSI): A Preliminary Study

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This pilot study investigated whether group training, in which participants become role models and coaches, would reduce discomfort as compared to a nontreatment Control Group. Sixteen experimental participants participated in 6 weekly 2-hr group sessions of a Healthy Computing program whereas 12 control participants received no training. None of the participants reported symptoms to their supervisors nor were they receiving medical treatment for repetitive strain injury prior to the program. The program included training in ergonomic principles, psychophysiological awareness and control, sEMG practice at the workstation, and coaching coworkers. Using two-tailed t tests to analyze the data, the Experimental Group reported (1) a significant overall reduction in most body symptoms as compared to the Control Group and (2) a significant increase in positive work-style habits, such as taking breaks at the computer, as compared to the Control Group. This study suggests that employees could possibly improve health and work style patterns based on a holistic training program delivered in a group format followed by individual practice.

KEY WORDS: repetitive strain injury (RSI); training; sEMG; computer.

Computers are ubiquitous in our modern society. An estimated 90% of office workers perform computer work. Approximately 40% of these workers spend at least 4 hr per day at the keyboard or mouse. Increased risk of forearm pain appears to be associated with more than 15 hr of keyboard use and 15–30 hr of mouse use per week (Andersen et al., 2003; Kryger et al., 2003). Computer-related injuries are sometimes debilitating and range from muscle pain to neurological symptoms, such as numbness or tingling. Common diagnoses, which include carpal tunnel syndrome, thoracic outlet syndrome, elbow or wrist tendonitis, or back pain, are generally labeled repetitive strain injury (RSI). Many individuals have nonspecific symptoms (Ferguson, 1987) that are difficult to treat. The common hypothesis that RSI is caused only by repetitive motions, exacerbated by poor

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posture, no rest breaks, and bad ergonomics (Brooks, 1993; Mullaly & Grigg, 1988) is often simplistic and inaccurate. Psychosocial factors, such as work organization (Christensen & Lundberg, 2002), lack of mental rest (Lundberg et al., 2002), lifestyle (Vogelsan, Williams, & Lawler, 1994), anxiety (Van Galen, Muller, Meulenbroe, & Van Gemmert, 2002), social support (Lecler, Landre, Chatang, Niedhammer, & Roquelaure, 2001), and time pressure (Birch, Juul-kristensen, Jensen, Finsen, & Christensen, 2000) have also been implicated in RSI.

Most of the interventions designed to reduce or prevent discomfort associated with computer use have focused upon three areas: (1) ergonomics, (2) individual work-style retraining, or (3) medical treatment after an injury has occurred. Although corporations and governments have established programs for the prevention of musculoskeletal disorders at the workplace (Hagg, 2003), the majority of these programs address ergonomics related to noncomputer jobs with high repetitive strain motions, such as assembly lines. In a newer and more extensive study of computer users at the worksite, Faucett, Garry, Nadler, and Ettare (2002) trained participants for 6 weeks with reinforcement training at 18 and 32 weeks. One group received biofeedback training with surface electromyography (sEMG) for lowering trapezius and forearm muscle tension. A second group received small group training to enhance stress management, problem solving, and communication skills. A third control group received no intervention. They concluded that symptoms increased for the control group, declined modestly for the education group, and changed little for the sEMG group after 6 weeks. The sEMG group was able to reduce muscle tension consistently in the trapezius muscles but had less success with forearm muscles. The authors identify the need for more periodic reinforcement and the combination of the two treatments, education and sEMG training, as potential factors for better results.

From our perspective, a comprehensive program must include a systems view of the person, the workplace, and the organizational structure and culture. Included are proper ergonomic principles and adjustments, awareness of work habits and styles, reducing muscle tension, training in stress management and lowering arousal (Peper et al., 2003). We propose that a lack of awareness and control of physiological arousal during computer use significantly contribute to RSI. Further, we recommend that training should be done in groups to reduce expense and encourage social support.

Using this type of approach, Shumay and Peper (1997) individually trained 26 experienced computer users who reported mild or moderate RSI symptoms. The results following 7 weeks of training included (1) reduced trapezius sEMG activity, (2) reduced breathing rate, (3) increased peripheral temperature, and (4) decreased reports of physical symptoms during data entry. In a 1-year telephone follow-up the participants reported that the program had been very beneficial. They identified awareness and training in muscle tension as most beneficial followed by micro-breaks, ergonomics, relaxation skills, and breathing. Most recently, Huber, Peper, and Gibney (2002) investigated a multicomponent training program emphasizing somatic awareness with sEMG biofeedback for individuals doing mousing tasks at the computer (Peper et al., 2003). This study showed that a three-session intervention program significantly reduced discomfort during mousing as compared to the control group.

A major problem with the above studies is that they trained individual participants, which limits the utilization due to cost. Thus, the purpose of this pilot study was to determine if Healthy Computing concepts taught in a group setting would reduce symptoms and improve work style.

METHODOLOGY

Participants

Twenty-eight employees from different work units within a metropolitan university were invited to participate and signed appropriate consent forms. None of the participants had reported symptoms to their supervisors or were receiving medical treatment for repetitive strain injury. Four males and twelve females, average age of 43.8 years, were assigned to the Experimental (training) Group. One male and eleven females, average age 35.3 years, were in the Control Group. There were no differences with respect to age. The Control Group received neither personal contact nor training; they were randomly selected in order to serve as matched controls from similar units in the organization and had received no Healthy Computing training or coaching. There were no significant differences between the two groups with respect to the following variables: height (66.3 and 64.4 in.), weight (160.5 and 147.6 lbs), years worked with computers (means of 9.8 and 8.9), hours worked at home per day (mean of 0.8 for each group), percent mousing (mean percentages of 63.9 and 65.0), percent devoted to data entry (mean percentages of 45.4 and 46.7), and percent devoted to telephone activities (mean percentages of 28.9 and 41.7) for the experimental and control groups, respectively. However, the control group reported working more hours on the computer each day, mean = 6.8 ($SD = 1.4$) compared to the experimental group, mean = 4.9 ($SD = 1.7$; $t[21] = 2.59 p < .05$).

Instruments

Physiological activity was recorded throughout the program with portable single-channel Myotrac™ electromyographs (Thought Technology, Ltd., Canada) with a band-pass of 100–200 Hz. Muscles monitored on different occasions were (1) forearm flexor, (2) forearm extensor, (3) anterior deltoid, (4) upper trapezius, and (5) trapezius/scalene (Hermens et al., 1999; Peper & Gibney, 2000).

The posttraining questionnaire included questions on body-related symptoms and work-style habits. The participants rated their changes from the beginning of the program to its conclusion 6 weeks later. The scale was from +5 (*significantly better*) through 0 (*the same*) to −5 (*significantly worse*) for each of the questions. The body symptom questions asked participants to rate their changes in physiological comfort at the workstation. The question was "Compared to six weeks ago how has your comfort/discomfort changed in the following physical areas?" Areas rated included eyes, head, neck and shoulders, arms, wrists and hands, back, legs, and tiredness.

The questions on work style asked the participants about their workstation habits, such as the use of micro-breaks and diaphragmatic breathing. The work-style questions were "Compared to six weeks ago how has your work style and behavior changed?" The topics micro-, meso-, and macro-breaks were defined in questions such as, Taking micro-breaks (stopping your work and letting all muscles relax for one or two seconds). Other areas rated included breathing diaphragmatically and ergonomics. These questions were also scored from +5 to −5. A comment area was placed after each question.

Procedures

The training program consisted of six weekly 2-hr group sessions comprising an educational component and practice of sEMG awareness and control (see Table I for detailed outline of group training sessions). The practice component included using sEMG to demonstrate physiological responses during data entry, training in slow diaphragmatic breathing during computer work, and ongoing use of sEMG feedback at their workstations. Participants practiced both at home and at the worksite with portable sEMGs to observe (1) shoulder tension when typing or mousing, (2) the ability to relax forearms during micro-breaks, and (3) the effect of ergonomic positions on sEMG activity (Peper & Gibney, 2000). The educational component provided a general overview of Healthy Computing concepts that included somatic awareness, stress management, psychosocial support, ergonomic principles, work style, vision care, regeneration, and strength and flexibility training. In addition, it provided group support and supervision in learning to apply these skills personally and with others.

Participants were asked to keep logs of breaks they took when working at the computer in which they recorded micro-, meso-, and macro-breaks. An example of a micro-break was dropping one's hands on the lap and reducing forearm muscle tension for 1 or 2 s. An example of a meso-break was stopping to stretch or do total body movement for 5–20 s. A macro-break example was taking time out to go for a walk for a few minutes. They were also encouraged to install an interrupt program on their computer that reminded them to take breaks. Additionally, each participant was asked to coach a few other individuals in his or her work unit utilizing the portable sEMG and the knowledge and skills gained from the program (some coached 2 or 3; others 10 or more). The data in the logbooks were not assessed but all participants verbally reported during the group training sessions that they were taking breaks, practicing with sEMG, and teaching others.

At the conclusion of the study, the experimental and control groups, who were contacted and mailed or e-mailed the posttest rating forms, completed a work-related symptom and work-style questionnaire in which they rated their self-report changes as compared to the beginning of the training.

Data Analysis

A multivariate analysis of variance (MANOVA) compared symptom reporting (head, neck and shoulders, wrist and hands, arms, tiredness, eyes, back, and legs) and work-style changes (micro-break, meso-break, macro-break, breathing, and ergonomics) between Experimental and Control groups. A two-tailed t test assuming unequal variances was completed between the Control and the Experimental Groups for all measures. The level of significance was set at $p < .05$.

RESULTS

After 6 weeks, the Experimental Group as compared to the Control Group reported a significant overall reduction in work-related symptoms, $F(8, 19) = 3.254$, $p < .01$. The report of symptoms reduced significantly included muscle strain of the head, $t(23) = 2.24$,

Table I. Syllabus of 6 Week Coaches Training Program

Session 1
Introduction and presentation of the components that underlie Healthy Computing (Peper & Gibney, 2000).
Demonstration using multimodal biofeedback of physiological response patterns that occur during typing and mousing with emphasis on lack of awareness, muscle bracing of the deltoid and trapezius, absence of micro-breaks, emotional reactivity with electrodermal activity, and respiration pattern changes (Peper et al., 2003).
Demonstration and training with a Myotrac™, single-channel portable electromyography (EMG), for monitoring from the deltoid, trapezius, and forearm muscles.
Brief discussion of micro-, meso-, and macro-breaks.
Assignment of homework practices that included taking micro-, meso-, and macro-breaks; EMG practice; and assigned reading from *Healthy Computing with Muscle Biofeedback* (Peper & Gibney, 2000).
Recommendation to download and install a break reminder program.
Session 2
Group discussion of previous week's home practices. Guidelines on how to work with other people.
Demonstration and practice of micro-, meso-, macro-breaks and the importance of interrupt programs.
EMG feedback practice for micro-break training and how to optimize ergonomic positions.
Presentation of ergonomic guidelines and factors.
Assignment of homework practices that included practicing breaks, typing with relaxed shoulders, using the EMG personally and with coworkers, assessing personal workstation using the ergonomic check list, and assigned reading.
Session 3
Group discussion of previous week's home practices and how to monitor/teach others.
Review, demonstration, and practice with ergonomic options of keyboards, chairs, keyboard trays, etc.
Practice with EMG while testing out alternative equipment such as chairs, keyboards, headsets.
Group presentation on stress and breathing (Peper, 1990).
Assignment of homework that included continued practicing of breaks, ergonomic assessment, EMG practice, observing breathing, and assigned reading.
Session 4
Group discussion of previous week's home practices, problems that occurred while assessing others, and issues of work stress.
Presentation on diaphragmatic breathing and the role of cognitive stress/sympathetic arousal on trigger point activity and health.
Practice with EMG from the scalene/trapezius muscles to breathe diaphragmatically and continue to breathe during data entry.
Assignment of homework that included practicing diaphragmatic breathing at work and while lying down, implementing problem-solving strategies, practicing breaks, monitoring coworkers with EMG, and assigned reading.
Session 5
Group discussion of previous week's home practices.
Discussion and review of problem solving strategies (Peper, Gibney, & Holt, 2002).
Discussion of visual stress and teaching strategies to relax the eyes.
Physiological demonstration with multiple physiological signals (respiration, pulse volume amplitude, electrodermal activity, EMG, and heart rate) to show the sympathetic responses during stressful keyboarding and discussion of bracing patterns that occur during stressful or precise-time-driven tasks.
Teaching and practice of the Quieting Reflex (QR; Stroebel, 1982) and hand warming (Peper & Gibney, 2003).
Assignment of homework that included continued diaphragmatic breathing while working at the computer, practicing of QR in response to stressors, vision practices, typing with relaxed shoulders, coaching others.
Session 6
Group discussion reviewing previous week practices and coaching problems.
Discussion of self-practice: sEMG usage, breaks, blinking, QR, and breathing.
Case presentation by group participants of their intervention and coaching approaches with other employees.
Discussion and practical suggestions of how to deal with psychological work and social stress.
Guided practice in meso-breaks that included Feldenkrais exercises.
Assignment of homework that included working in pairs as coaches, practicing the many skills, and using the EMG.

$p < .05$, neck and shoulder, $t(19) = 2.98$, $p < .01$, wrist and hands, $t(22) = 3.02$, $p < .01$, arms, $t(22) = 2.16$, $p < .05$, and overall tiredness, $t(24) = 2.35$, $p < .05$. There were no significant reductions in symptoms reported for the eyes, $t(23) = 0.69$, $p > .05$, back, $t(23) = 1.63$, $p > .05$, and legs, $t(22) = 1.60$, $p > .05$. (see Fig. 1).

The Experimental Group as compared to the Control Group reported a meaningful overall improvement in work-style changes, $F(5, 23) = 5.232$, $p < .001$. Significantly more micro-breaks, $t(25) = 3.74$, $p < .01$, meso-breaks, $t(22) = 5.47$, $p < .01$, and macro-breaks, $t(20) = 4.16$, $p < .01$, were reported. The Experimental Group as compared to the Control Group also practiced more diaphragmatic breathing, $t(22) = 3.36$, $p < .01$, and applied more ergonomic principles at the workstation, $t(21) = 4.56$, $p < .01$ (see Figure 2).

DISCUSSION

The decrease in symptoms and improvements in positive work habits are very encouraging but must be interpreted with caution because the data consisted of self-report of changes that are very susceptible to the inherent demand characteristics of the study. Yet, the ongoing informal feedback from the members of the Experimental Group suggests that participating in the program was, and continues to be, beneficial. It is our observation that the biofeedback demonstrations of the physiological response patterns during data entry at the computer helped to change the participants' beliefs about the mind–body

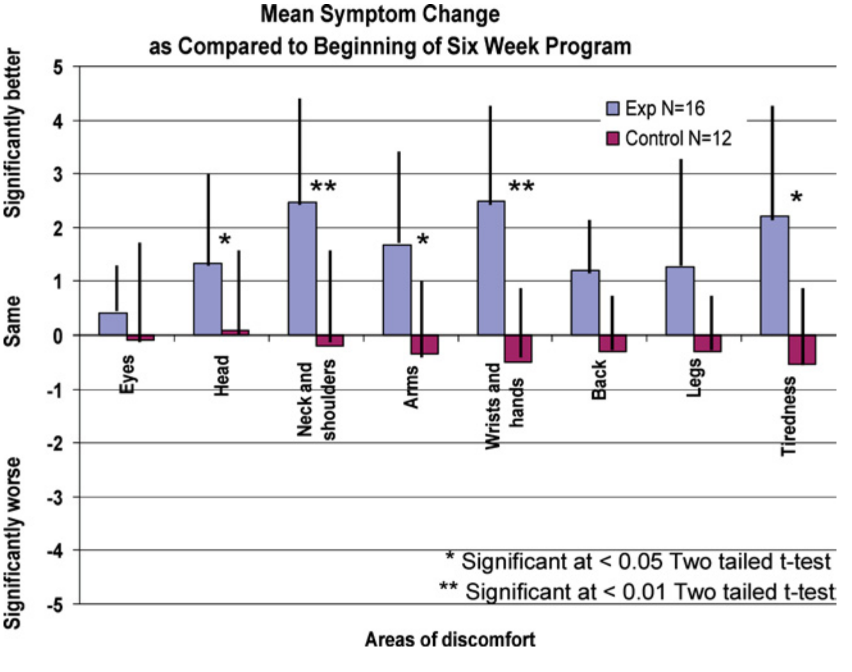

Fig. 1. Self-report of symptom changes as compared to the beginning of the training program (*SD* is represented by the vertical black line for each area of discomfort).

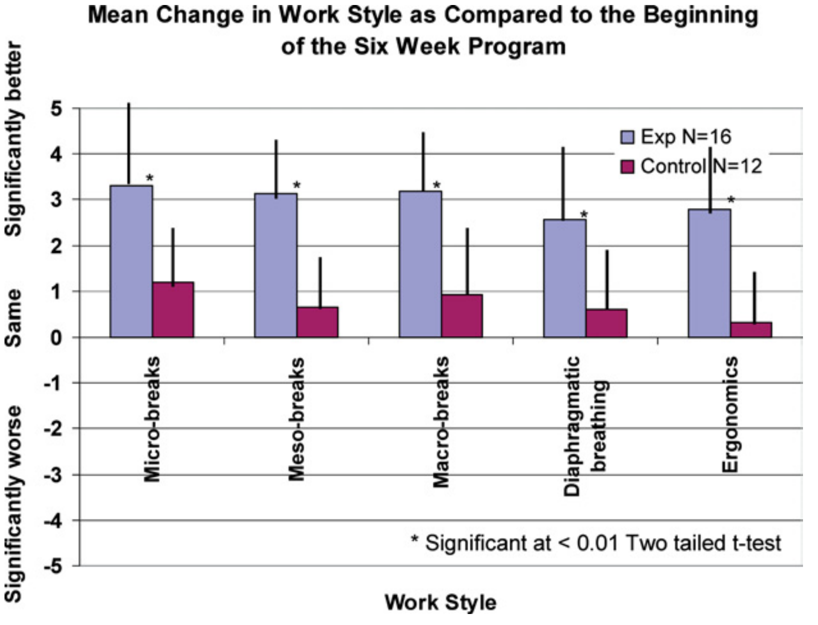

Fig. 2. Self-report of work-style changes as compared to the beginning of the training program (*SD* is represented by the vertical black line for each work style).

connection/relationship and what they could do to enhance their own health. The use of individualized sEMGs at the workstation allowed the participants to see and hear their covert muscle tension. They appeared to use this to encourage mastery of neck and shoulder relaxation, slower breathing, and taking micro-breaks while working at the computer. Finally, we attribute the self-reported reduction in body symptoms to the participants learning more self-awareness with EMG and taking more breaks during each workday. The group meetings and discussion appeared to encourage the homework practice, increase motivation to continue to practice, and provide social support. Many participants reported that coaching others enhanced their own commitment to practice and improve work style.

In the group discussions, most participants reported that breathing was the most helpful strategy to manage stress. As one participant stated, "The breathing break has improved my ability to pace myself while completing my tasks." Many reported having more energy at the end of the day. This is noteworthy in that prior to this program, they assumed that to feel tired and a little sore at the end of the day was normal.

Themes in the written comments by the Experimental participants of what was helpful were (1) visual feedback of the covert muscle bracing patterns and then the ability to relax the neck and shoulders—it made them believe in the training program; (2) practicing slower and lower breathing during computer work; (3) taking micro-, meso-, and macro-breaks throughout the day; (4) using ergonomic and work-style changes; (5) learning the skills not only for themselves but also for teaching other employees in their work units; and (6) receiving support and encouragement from their supervisors.

Although the employees in the Experimental Group reported significant benefit, the findings need to be replicated because the results are based only on subjective self-assessment and therefore very susceptible to the Hawthorne effect (Franke & Kaul, 1978).

In addition, there may have been a difference between the control and experimental participants as they were selected and not truly randomized that could confound the results. Systematic studies should objectively investigate and quantify pre- and post-symptom changes, actual number of practices performed, as well as independently monitoring of pre- and post-workstation behavior.

In summary, this pilot study suggests that employees, who do not report medical disabilities or overt symptoms, described by self- assessment a reduction of symptoms and improvement in work habits after they participated in a 6-week group-training program. We recommend that corporations explore preventive training programs to help their employees maintain and enhance health. In learning these skills, health at the computer workstation can be enhanced. After training, most reported having more energy at the end of the work day. As one participant said, "There is life after five."

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REFERENCES

Andersen, J. H., Thomsen, J. F., Overgaard, E., Lassen, C. F., Brandt, L. P., Vilstrup, I., et al. (2003). Computer use and carpal tunnel syndrome: A 1-year follow-up study. *JAMA*, *289*(22), 2963–2969.

Birch, L., Juul-Kristensen, B., Jensen, C., Finsen, L., & Christensen, H. (2000). Acute response to precision, time pressure and mental demand during simulated computer work. *Scandinavian Journal of Work, Environment and Health*, *26,* 299–305.

Brooks, P. (1993). Repetitive strain injury. *BMJ*, *307*(6915), 1298.

Christensen, H., & Lundberg, U. (2002). Musculoskeletal problems as a result of work organization, work tasks, and stress during computer work. *Work and Stress*, *16,* 89–93.

Faucett, J., Garry, M., Nadler, D., & Ettare, D. (2002). A test of two training interventions to prevent work-related musculoskeletal disorders of the upper extremity. *Applied Ergonomics*, *33*(4), 337–347.

Ferguson, D. A. (1987). RSI: Putting the epidemic to rest. *The Medical Journal of Australia*, *147*(5), 213–214.

Franke, R. H., & Kaul, J. D. (1978). The Hawthorne experiment: First statistical interpretation. *American Sociological Review*, *43,* 623–643.

Hagg, G. M. (2003). Corporate initiatives in ergonomics—An introduction. *Applied Ergonomics*, *34*(1), 3–15.

Hermens, H. J., Freriks, B., Merletti, R., Stegeman, D., Blok, J., Rau, G., et al. (1999). *European recommendations for surface electromyography.* Enschede, The Netherlands: Roessingh Research and Development b.v.

Huber, M., Peper, E., & Gibney, K. H. (2002). *Reducing computer mousing symptoms: A controlled biofeedback outcome study*. Proceedings of the 33rd Annual Meeting of the Association for Applied Psychophysiology and Biofeedback. Wheat Ridge, CO: AAPB.

Kryger, A. I., Andersen, J. H., Lassen, C. F., Brandt, L. P., Vilstrup, I., Overgaard, E., et al. (2003). Does computer use pose an occupational hazard for forearm pain; from the NUDATA study. *Occupational and Environmental Medicine*, *60*(11), e14.

Lecler, A., Landre, M., Chatang, J., Niedhammer, I., & Roquelaure, Y. (2001). Upper-limb disorders in repetitive work. *Scandinavian Journal of Work, Environment and Health*, *28,* 268–278.

Lundberg, U., Forsman, M., Zachau, G., Ekloef, M., Pamerud, G., Melin, B., et al. (2002). Effects of experimentally induced mental and physical stress on motor unit recruitment in the trapezius muscle. *Work and Stress*, *16,* 166–178.

Mullaly, J., & Grigg, L. (1988). RSI: Integrating the major theories. *Australian Journal of Psychology*, *40*(1), 19–33.

Peper, E. (1990). *Breathing for health*. Montreal: Thought Technology Ltd.

Peper, E., & Gibney, K. H. (2000). *Healthy computing with muscle biofeedback: A practical manual for preventing repetitive motion injury*. Woerden: Biofeedback Foundation of Europe. Available in USA from Work Solutions USA, 2236 Derby Street, Berkeley, CA.

Peper, E., & Gibney, K. H. (2003). A teaching strategy for successful hand warming. *Somatics*, *XIV*(1), 26–30.

Peper, E., Gibney, K. H. & Holt, C. (2002). *Make health happen: Training yourself to create wellness*. Dubuque, IA: Kendall-Hunt.

Peper, E., Wilson, V. S., Gibney, K. H., Huber, K., Harvey, R., & Shumay, D. (2003). The integration of electromyography (sEMG) at the workstation: Assessment, treatment and prevention of repetitive strain injury (RSI). *Applied Psychophysiology and Biofeedback*, *28*(2), 167–182.

Shumay, D., & Peper, E. (1997). Healthy computing: A comprehensive group training approach using biofeedback. In G. Salvendy, M. J. Smith, & R. J. Koubek, (Eds.), *Design of computing systems: Cognitive considerations* (pp. 555–558). New York: Elsevier.

Stroebel, C. F. (1982). *QR the quieting reflex*. New York: G. P. Putnam's Sons.

Van Galen, G., Muller, M., Meulenbroe, R., & Van Gemmert, A. (2002). Forearm EMG response activity during motor performance in individuals prone to increased stress reactivity. *American Journal of Industrial Medicine*, *41,* 406–419.

Vogelsan, L., Williams, R., & Lawler, K. (1994). Lifestyle correlates of carpal tunnel syndrome. *Journal of Occupational Rehabilitation*, *4,* 141–152.