ASSE Foundation Research

Promoting Behavior Change

Self-monitoring as an intervention among computer users

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BEHAVIOR-BASED SAFETY TECHNIQUES grew out of a research tradition of behavioral science and direct observations of behavior change over time. These techniques have resulted in improved safe practices and fewer occupational injuries (Komaki, Barwick & Scott, 1978; Krause, Seymour & Sloat, 1999). The process typically involves assessing current behaviors, determining what they should be to ensure safety and health, communicating these behaviors to the affected workers, developing an observation and feedback system to measure performance, training observers, setting goals for safety performance and, finally, observing workers. The observer then provides feedback to the person being observed and, when appropriate, offers recognition for attaining safety goals (McSween, 2004).

These observations are typically conducted by a worker's peer who provides immediate verbal feedback to the observed worker. This feedback can either be positive (e.g., because the observed worker followed prescribed behaviors) or corrective (e.g., because the observed worker violated prescribed behaviors). Providing feedback (verbal, written or graphic) as well as the act of observing itself (Alvero & Austin, 2004) have been shown to produce safety-related behavior change (Alvero, Bucklin & Austin, 2001).

Although behavior-based safety programs have helped to improve safety in various workplace settings, the peer observation component limits their application in certain settings—such as where people work alone or in settings where they cannot leave the work area. Research also suggests that peer observations may be aversive to some employees (Rohn, 2004). Additionally, although some studies have suggested that it might not be difficult to encourage employees to change their safety-related behaviors and postures while they are being observed directly (Gravina, Linstrom-Hazel & Austin, 2007; Sasson & Austin, 2004), these improvements may diminish over time in the absence of direct observations by others (Lebbon, Austin, Van Houten, et al., manuscript in preparation). Therefore, new approaches that will result in safe employee practices even when no one is watching need to be developed and refined.

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Self-Monitoring as an Intervention

Self-monitoring is one approach within an overall behavioral science strategy that can be used to address the difficulty of applying peer observations in certain situations. Self-monitoring is defined as "an individual recording the occurrences of his or her own target behavior" (Nelson & Hayes, 1981, p. 3). Self-monitoring, along with other behavioral safety intervention components, has been demonstrated to change the performance of truck drivers (Hickman & Geller, 2003), bus operators (Olson & Austin, 2001) and the postures of computer users (McCann & Sulzer-Azaroff, 1996). More specifically, McCann and Sulzer-Azaroff found that computer users worked in neutral postures (overall sitting and hand/wrist) more often after ergonomics training, discrimination training, self-monitoring and feedback were implemented.

Whereas those researchers used self-monitoring recorded at the end of the session, the current study introduced an automated (e.g., automatically prompted by and completed using a computer program) self-monitoring tool, first at 2 minutes, then extended to 15 minutes, in an effort to provide more opportunities to self-monitor throughout the session. Furthermore, in a similar study, Gravina, Loewy and Austin (manuscript in preparation) demonstrated that an intensive self-monitoring procedure coupled with self-monitoring accuracy training resulted in participants assuming neutral postures substantially more often than when compared to baseline. However, the self-monitoring schedule implemented in that study was more intensive (every 2 minutes) than what would be considered reasonable in an office setting.

Office ergonomic intervention field studies suggest that providing adjustable workstations, chairs and forearm support yields positive effects on body and visual symptoms (Nelson & Silverstein, 1998). Coupling ergonomic training with these design features (Robertson & O'Neill, 2003; Amick, Robertson, DeRango, et al., 2003) or ergonomics training alone (Brisson, Montreuil & Punett, 1999) also yielded positive results on influencing work postures and reducing musculoskeletal discomfort and pain. Integrating the concept of self-monitoring is one possible approach to encouraging and sustaining behaviors learned in the training.

The purpose of this study was to extend previous self-monitoring safety research to evaluate whether the technique is equally effective if the self-monitoring schedule is extended to a more manageable density. This information could be of value to those interested in designing effective self-monitoring safety interventions in organizations, especially for employees who work alone or in locations where peer observations are not feasible.

The Study

Potential study participants were recruited through a local newspaper advertisement. To be included, a participant had to be pain-free, have no history of musculoskeletal disorders and be able to perform data entry tasks using a computer. Participants signed an informed consent form in accordance with the Institutional Review Board and also gave permission to be photographed or videotaped during the study; however, they were not specifically told they were being filmed via a hidden camera. Three male and five female participants were included in the study, with ages ranging from 19 to 58. Participants were paid $15 per hour and received a $75 bonus at the conclusion of the study.

Participants performed a data entry task in which they entered simple text into a commonly used word processing application. Each session lasted 30 minutes, with a 10-minute break between each session. Each participant completed 20 sessions, with three to seven sessions occurring on each observation day for a total of 3 to 5 days across a 6-week period.

To reduce the possibility that participants would change behaviors if they knew that behavior change was the primary focus of the study, they were initially told that the study was designed to assess a discomfort survey administered at the end of each 30-minute session. The survey asked participants to rate their level of discomfort for each body part and shade specific areas of discomfort on a front and back picture of the body part. They completed this survey on their own immediately after each 30-minute session.

At the end of the study, participants were asked what they perceived to be the study's purpose. All of them reported that it was to assess discomfort. In addition, when asked what they thought the purpose of the self-monitoring was, four participants reported that they thought it was to help them keep good postures "in mind"; the other four thought it was meant to measure/check their posture.

Study Setting

The study took place in a simulated office environment that included a height-adjustable desk, computer, wrist support, document holder and an ergonomic chair with several adjustable features. Before data were collected, participants completed a 90-minute ergonomic training session describing neutral postures and how to adjust the workstation and chair (Robertson & O'Neill, 2003; Robertson & Maynard, 2005). Participants also received an informational sheet highlighting key points of the neutral postures.

The participants' knowledge and understanding of the ergonomic principles described during the training were evaluated using a written 21-question test administered before and after the training. Overall, the average score improved from 14.9 correct responses on the pretraining test to 19.3 correct responses on the posttraining test. Using a *t*-test, this was statistically significant at the .001 level, which means that it is extremely likely that the training is responsible for the participants' improved ergonomic knowledge as measured by the pre/posttests.

Target Postures

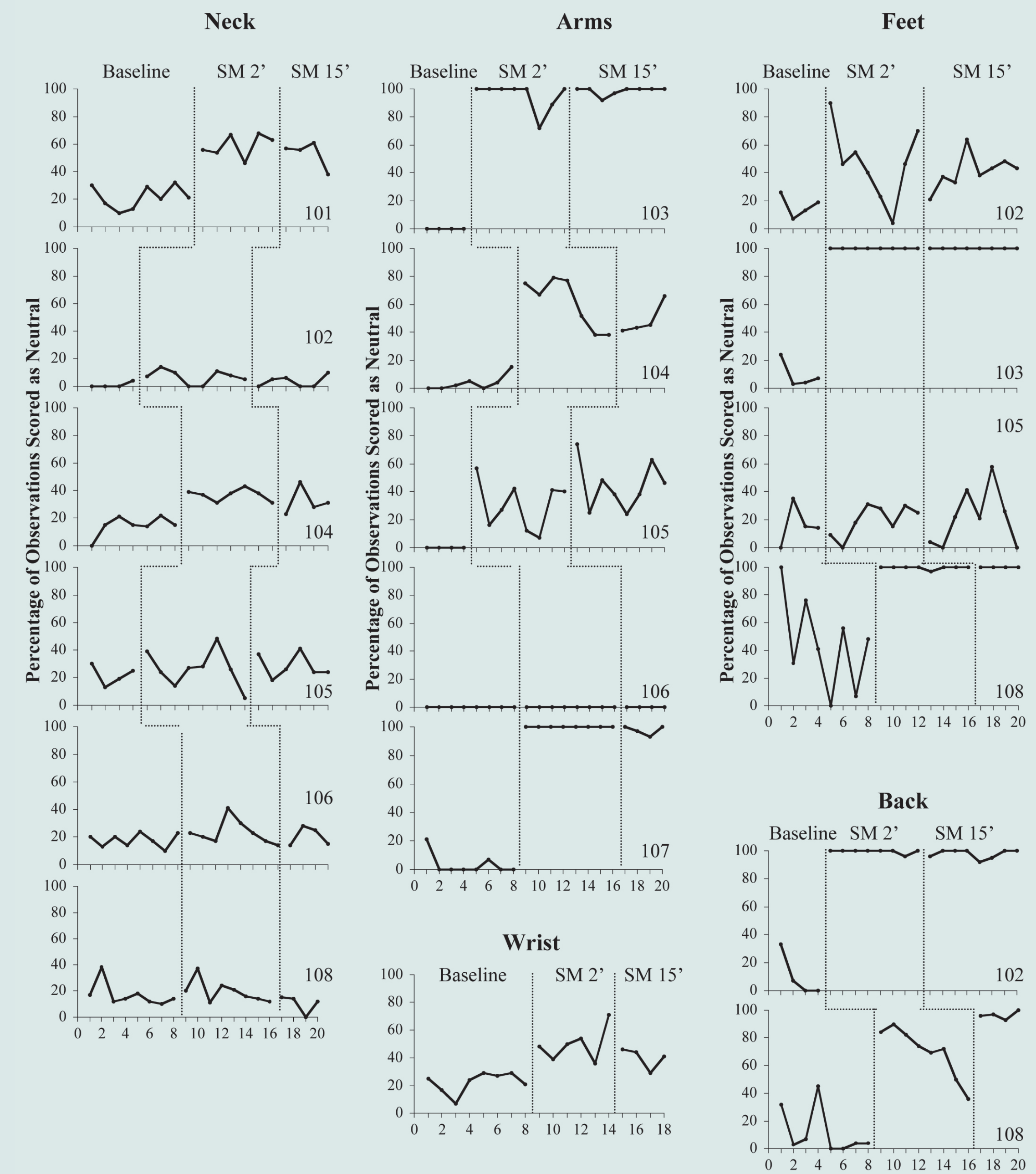
Participants' working postures were recorded via a hidden camera to prevent reactivity to observation. After each session, the video was sampled at 60 second intervals and each participant's posture was scored by a trained observer to determine whether a given posture met the definitions of neutral posture as described in the training. This information was used to estimate the percentage of neutral postures versus nonneutral postures exhibited during each session. The observer has previously scored postures for published studies and has previous training in observation and ergonomics.

Reliability of measurement was evaluated by comparing the primary observer's scores to an expert ergonomist's scores of samples for each participant. Agreement averaged 88%. In addition, interobserver agreement was collected by a second trained student observer for 26% of observations and it averaged 90%. This is well above the recommended 80% agreement considered to be acceptable in observational research (Kazdin, 1982). Some postures were only viewable by the camera on the left side (as described in the posture definitions) and, therefore, no conclusions can be drawn about the effectiveness of the intervention for those postures.

Abstract: *The peer observation component of a behavior-based safety process can limit its application in certain settings—such as people who work alone or in settings where they cannot leave the work area. Self-monitoring is an approach that can be used to address this limitation. This article presents the results of a study of the application of this technique with a group of computer users.*

Figure 1

Observations of Neutral Postures



Note. Percentage of observations scored as neutral for each posture by phase for each participant. Each data point represents one 30-minute session.

Self-monitoring is one approach within an overall behavioral science strategy that can be used to address the difficulty of applying peer observations in certain situations.

The primary neutral postures measured were based on BSR/HFES 100, Human Factors Engineering of Computer Workstation: Standard for Trial Use, and were defined as follows:

- Head posture. Head is not bent up or down or turned left or right.
- Back posture. Lower and upper back is supported by the chair.
- Shoulder posture. Left arm is within 2 in. of the torso (right arm could not be viewed by camera from the side).
- Arm posture. Left arm elbow angle is between 70º and 135º (right arm could not be viewed by the camera from the side).
- Arms supported. At least two thirds of the lower left arm is resting on the desk, chair arm support and/or wrist support (right arm could not be viewed by the camera from the side).
- Wrist posture. Left wrist is not bent up more than 10º or down more than 30º (right wrist could not be viewed by the camera from the side).
- Hip posture. The angle between torso and thigh does not exceed 90º.
- Feet position. Both heel and toe are supported by the floor or a footrest.

Before the self-monitoring intervention was introduced, each participant was observed and postures that were neutral for the lowest percentage of the observations were noted as target postures for improvement for the participant. These postures (maximum of three) were then monitored during the intervention.

The Self-Monitoring Intervention

A computer program was used to assist the participants with self-monitoring; it produced an on-screen display every 2 minutes that prompted the participant to self-monitor his/her posture. This display included information about the definition of the targeted postures and asked the participant to score whether s/he was in that target posture at the time of the self-monitoring prompt. At the beginning of the study, these automated prompts were delivered at 2-minute intervals because previous research has demonstrated that such an interval is effective for increasing neutral postures (Gravina, Austin, Schroetder, et al., in press; Gravina, et al., manuscript in preparation).

Before the self-monitoring process was implemented, participants also received self-monitoring accuracy training. As part of this training, participants verbalized whether a target posture was neutral or not neutral while they performed the typing task. They were then given feedback from the experimenter regarding the accuracy of the self-assessment.

Training was finished when at least 20 trials had been completed and accuracy for the last 10 trials was at least 90%. All participants met the accuracy criterion within 20 trials with the exception of one participant who required 23 trials to reach the criterion.

At this point, self-monitoring was implemented during the experimental sessions, each lasting 30 minutes. During this initial intervention phase, participants self-monitored all of their target postures every 2 minutes.

After eight self-monitoring sessions were completed, the self-monitoring schedule was extended to 15-minute intervals. This was done to determine whether the increase in neutral postures that resulted from the 2-minute self-monitoring schedule would continue when the schedule was extended to more reasonable time intervals (i.e., 2 minutes vs. 15 minutes).

Experimental Design

The study used a single-subject (i.e., within-subject) multiple baseline design across participants to evaluate the effects of the intervention. Single-subject designs involve taking repeated, frequent measures, which allows for each participant's progress to be evaluated over time and has been recommended for use in this type of research (Tankersley, McGoey, Dalton, et al., 2006). When using the multiple baseline design, the intervention is implemented in a staggered fashion. When the dependent variable changes immediately, and only when the intervention is implemented, the change can be attributed with confidence to the independent variable rather than an external factor (e.g., practice or a common event in time).

Table 1

Observations of Neutral Postures

		Percentage of observations in neutral position		
		Baseline	Self-monitoring 2 minutes	Self-monitoring 15 minutes
Participant 101	Neck	21.5	59.0	53.0
	Wrists	22.4	49.7	40.0
Participant 102	Neck	0.5	6.9	3.3
	Back	10	99.5	97.9
	Feet	16.3	46.8	40.9
Participant 103	Arms supported	0	95.1	98.63
	Feet	9.5	100	100
Participant 104	Neck	14.6	36.7	32
	Arms supported	3.9	60.9	48.8
Participant 105	Neck	21.8	26.4	31.1
	Arms Supported	0	30.3	44.5
	Feet	16.0	19.5	21.5
Participant 106	Neck	17.6	23.1	20.5
	Arms supported	0	0	0
Participant 107	Arms supported	3.5	100	97.5
	Back	11.9	69.6	96.5
Participant 108	Neck	16.9	19.4	10.3
	Feet	44.9	99.6	100

Note. *The average percentage of observations scored as neutral for each posture by phase for each participant. These were calculated by dividing the number of observations participants were scored as being in the neutral position by the total number of observations for that phase.*

Results

Although participants received training regarding ergonomic work practices before the intervention began, each participant still assumed at least two non-neutral postures during this experiment. Overall, 18 postures were exposed to the intervention. For 12 of them, the percentage of time they were scored in the neutral position increased above baseline levels when the 2-minute self-monitoring intervention was introduced. The change in behavior observed during the initial 2-minute intervals was maintained above baseline for all postures (with some minor variability up or down) when the schedule was extended to 15 minutes. Figure 1 displays graphs for each posture exposed to the intervention. Table 1 displays the average percentage of observations scored as neutral for each posture by phase for each participant.

The percentage of time participants were in the neutral posture was calculated by dividing the number of observations participants were scored as being in a neutral posture by the total number of observations for that phase. As noted, these observations were taken every 60 seconds from the video recordings.

Discussion

The results of this study suggest that self-monitoring after training may be an effective intervention for influencing long-term, sustained safety-related behavior changes. In this study, similar improvement results were obtained during both the 2-minute and 15-minute monitoring schedules, suggesting the more practical 15-minute schedule could be used. In fact, perhaps even less frequent monitoring could be effective. Participants reported that the 2-minute schedule was not reasonable, but 7 out of 8 stated that the 15-minute schedule seemed more reasonable for a computer-related office job.

One limitation of the study is that participants' self-monitoring and the video could not be matched exactly; therefore, no information regarding self-monitoring accuracy can be reported. As noted, another limitation is that the right side of the body could not be observed from the camera's angle. Thousands of observations of participants' postures were taken, but the results only reflect one side of the body and, thus, only provide a limited picture of participants' response to the self-monitoring intervention.

In addition, the findings of this study should be interpreted with caution. Although the intervention appeared to be effective at changing behaviors, other factors that relate to overall safety when using a computer were not considered within the design of this study. An increased focus on maintaining specific postures could actually lead to more discomfort, as suggested by studies of heightened muscle activation in computer users maintaining static postures.

It is also possible that more dynamic movement and/or sitting in comfortable positions as well as other ergonomic practices such as rest breaks and work environment design would be more effective in decreasing discomfort and injuries. In this case, self-monitoring could be implemented to encourage those behaviors as well. Lastly, the findings do not suggest that self-monitoring should replace safety training. Study participants were exposed to training before data were collected and it is possible that without this information the self-monitoring intervention could have been less effective.

Conclusion

Self-monitoring may be a viable alternative to peer observations in a behavior-based safety process. Self-monitoring does not require feedback or observation by others, which some employees may find uncomfortable, nor does it require a person to leave the workstation, which may not be feasible in some work environments. In addition, the technique can be used to encourage behavior change among employees who work alone. Further research should examine the concept of self-monitoring and scheduling as it pertains to various work organization conditions (e.g., rest breaks, work demands and pacing) and work environment design factors. ■

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Acknowledgments

The authors thank the ASSE Foundation and Liberty Mutual Research Institute for supporting this research through the Liberty Mutual Research Fellowship, as well as Margaret Rothwell, Glenn Pransky, Angela Garabet, Barbara Fritz and Candace Perry for their assistance.