A COMPARISON OF TWO INSTRUCTIONAL APPROACHES FOR REDUCING WORK-RELATED BODY-PART DISCOMFORT AMONG COMPUTER OPERATORS

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ABSTRACT

A COMPARISON OF TWO INSTRUCTIONAL APPROACHES FOR REDUCING WORK-RELATED BODY-PART DISCOMFORT AMONG COMPUTER OPERATORS (332 words)

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Discomfort and injury among office computer operators are matters of concern to ergonomists, human resources personnel, and corporate executives. To date, most preventive strategies have been conceived in engineering terms, and have emphasized the tools (*e.g.,* monitor, keyboard, mouse) and the environment/workstation (*e.g.,* adjustable chairs, workspaces, footrests). Some preventive strategies have been structured in terms of administrative controls (*e.g.,* rest breaks and job rotation). Few have used an educational approach. Performing artists suffer the same types of upper extremity musculoskeletal disorders as computer operators, yet they view education as the first line of defense in the prevention of such disorders, and as an important component of the rehabilitation process. Insights from piano pedagogy, piano technique, performing arts medicine, ergonomics, and biomechanics were combined into an experimenter-designed instructional approach that provided office computer users with a booklet of written information about workstation adjustment, work posture, and keying technique, and a demonstration of how to use the written information. Using a pre-test/post-test design, the efficacy of this experimenter-designed instructional approach was compared with that of a

second instructional approach that provided office computer users with information about chairs, keyboards, screen placement, and rest breaks. Results showed that participant reaction to both instructional approaches was generally positive. Statistically significant increases in participant knowledge about workstation adjustment, work posture, and keying technique occurred in both groups. Both instructional groups reported significant decreases in work-related body-part discomfort in the eyes. The group that received the experimenter-designed instructional approach also reported significantly more reduction in discomfort in the upper- and lower-back, and in the right wrist; the group that received the alternative instructional approach reported significantly more reduction in discomfort in the back of the neck. The preponderance of the evidence supported the efficacy of the experimenter-designed approach with its emphasis on *extrinsic* and *intrinsic* ergonomic information, its inclusion of a demonstration, and its systematic structuring of information in terms of three basic questions: (1) ***What*** should I do?, (2) ***How*** should I do it?, and (3) ***Why*** should I do it?

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CHAPTER I

INTRODUCTION

In recent years, the number of workers experiencing work-related musculoskeletal disorders (WMSD) of the upper extremities has increased, and in 1990 office/clerical workers moved into the top ten job classifications in terms of the incidence and costs of these disorders (Brogmus & Marko, 1992). In addition, the increasing use of computers in office environments, and elsewhere, means that more individuals will be at risk for developing these disorders.

Worker's compensation claims related to WMSDs rose from 20,000 in 1981 to 146,900 in 1989, and to 223,600 in 1991, and the costs associated with these claims are substantial (Hag, 1994; Sellers, 1994). Although estimates of these costs vary greatly, the average cost of treating a single case of WMSD is reported to be about $10,000 (Brogmus & Marko, 1992). Total costs are estimated to be in the billions, and are expected to increase in the future (Leavitt, 1992; Sellers, 1994). Thus, many individuals and organizations are engaged in efforts to control, or reduce, the human and monetary costs of these disorders.

Efforts to respond to the increasing number of WMSDs among office computer operators have been of several types. Guidelines and standards have been prepared by organizations such as the American National Standards Institute and the Human Factors Society (ANSI/HFS 100-1988). The Occupational Safety and Health Administration (OSHA) has

attempted to begin to define ergonomic standards (New Ergo Draft, 1994; Cochran et al., 1994). This type of information can provide guidance for ergonomists, engineers, and designers, and it has been incorporated into the design of increasingly adjustable furniture (*e.g.*, chairs, keyboard trays, footrests). However, this type of information incorporates compromises between a variety of interests (Grandjean, 1987b) and is not structured to provide guidance to individuals who want to optimize the adjustment of their workstations. In addition, some organizations have instituted administrative controls involving the design/redesign of jobs, the use of job rotation, and/or the recommendation of rest breaks.

As illustrated in Figure 1, ergonomists and human factors practitioners/designers have traditionally sought to address problems related to WMSDs by using preventive strategies based on engineering and/or administrative controls. They have tended to view preventive strategies based on education and training as less desirable. Practitioners of performing arts medicine use a different approach. These physicians specialize in the treatment of highly skilled instrumentalists, singers, actors, and dancers who often suffer from the same types of injuries as clerical workers, grocery checkout clerks, and assembly line workers (Brandfonbrener, 1991). In contrast to ergonomists and human factors practitioners/designers, these physicians view education/re-education as the first line of defense against injury, and as an essential component of the rehabilitation following an injury (Hoppman & Patrone, 1991).

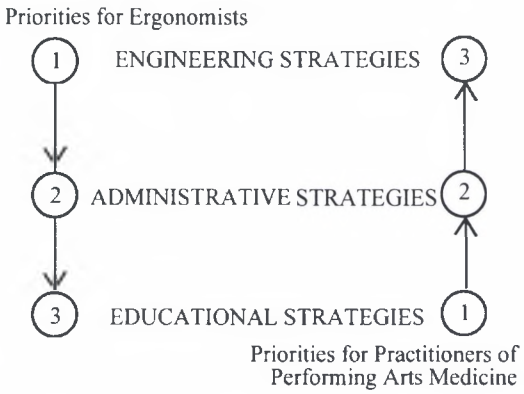


Figure 1. Contrasting priorities of ergonomists and practitioners of performing arts medicine (from Cameron & Moroney, 1994, p. 468).

However, there are indications that attitudes among ergonomists and human factors practitioners are changing, and there is a growing recognition that instruction has a place among the strategies available for reducing the incidence and severity of WMSDs. For example, Kroemer (1992) and Snook (1987) both advocate the use of education/training as a strategy to help prevent injury. The Australians have adopted education as one component of a national strategy for the prevention and management of WMSD (Liddicoat & Ellis, 1987). And, in a recent review of the literature concerning musculoskeletal disorders among VDT users, Carter and Banister (1994) concluded that "employers should realize that they can greatly reduce the incidence of musculoskeletal problems in workers through relatively inexpensive measures such as proper worker selection, education, workstation, and job design" (p. 1642). In addition, there are a few reports of instruction/training programs that have been designed specifically for office computer operators (*e.g.*, Goggins & Robertson, 1994; Robertson, 1994; Verbeek, 1991), and increasing numbers of training programs are becoming commercially available.

Some of these programs emphasize the importance of rest breaks and exercise. Some focus primarily on general ergonomic principles, or on workstation adjustment. However, Pascarelli and Kella (1993) have noted that there is a problem with focusing primarily on issues

related to workstation adjustment, or to what they call "*extrinsic ergonomic factors*" (p. 522; emphasis added). The problem is as follows: programs that focus on general ergonomics and workstation adjustment tend to ignore many of the equally important, individual "*intrinsic ergonomic factors*" (Pascarelli & Kella, 1993, p. 522; emphasis added) related to body posture, hand position, and especially, to inefficient styles of computer keyboard operation. This omission is noteworthy in view of Kilbom and Persson's (1987) finding that individual differences in work technique have a powerful influence on the development of musculoskeletal disorders.

Snook (1987) has argued that education/training is especially important in dynamic work environments where engineering and workstation design cannot eliminate situations that may result in awkward positions and postures. Office computer operators are faced with just such a situation, for their work environment is becoming increasingly dynamic as more and more adjustability is designed into chairs, workstations, computer components, and associated accessories (*e.g.*, footrests, wrist rests).

As a result, Cameron and Moroney (1994) have suggested that the conceptualization of a computer system in terms of the devices used to input, process, and output data/information is inadequate, and that these devices should be conceptualized as components of a larger, more inclusive system (see Figure 2). This larger system incorporates the person, the work environment (including furniture, lighting, etc.), the tool(s) (*e.g.*, computer keyboard and monitor), and the task(s). Adjustment of both the individual components of this system (*e.g.*, the chair), and the interactions of these components, is essential to optimize the adjustment of a particular workstation for a specific individual.

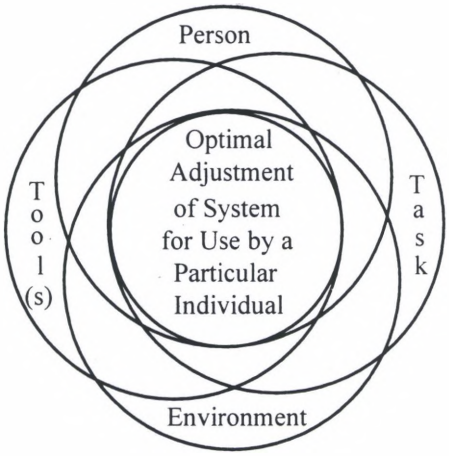


Figure 2. The Person/Environment/Tool(s)/Task(s) (PETT) System (from Cameron & Moroney, 1994, p. 469).

Purpose of this Study

The primary purpose of this study is to address the question: *Will office computer operators who are provided with information to help reduce work-related body-part discomfort (WBPD), use it in ways that result in a decrease in reported WBPD?* A secondary question is: *Will the content and presentation of the information provided to office computer operators have an effect on the amount of reported WBPD?*

These two research questions are based on three assumptions: (1) that prevention/reduction of work-related musculoskeletal disorders is possible, (2) that both education and ergonomics can help to prevent such disorders, and (3) that over time, a reduction in the WBPD experienced by office computer operators should contribute to a reduction in the incidence and/or severity of work-related musculoskeletal disorders among these individuals. It should also, eventually, lead to a reduction in the medical costs of the companies that employ these people.

Background

Within the field of ergonomics, it is common to differentiate between acute, or traumatic, injuries that occur as the result of a single specific event, and cumulative trauma disorders that are caused, or aggravated, by repetitive exertions over time. According to Kroemer (1989), these disorders are "characterized by discomfort, impairment, disability or persistent pain in joints, muscles, tendons and other soft tissues, with or without physical manifestations" (p. 274). In the literature, cumulative trauma disorders are described by a number of terms including work-related musculoskeletal disorders (WMSD), over-use injury, repetitive motion injury (RMI), repetitive stress injury (RSI), and repetitive strain injury (RSI), and they may be given a number of different medical diagnoses.

Although the exact causes of WMSDs are unclear, there is a growing awareness among ergonomists that awkward positions of the arms/hands, especially ulnar deviation and extreme wrist flexion/extension (Chaffin, 1987; Grandjean, 1984; Putz-Anderson, 1988), repetitive motions and forceful exertions (Stock, 1991; Silverstein, Fine, & Armstrong, 1986), and the velocity and acceleration of movement (Marras & Schoenmarklin, 1993) increase the risk and incidence of injury in the workplace. In addition, several authors have identified factors specifically related to discomfort and injury among computer operators.

Sauter, Schliefer, and Knutson (1991) have shown that good posture (*i.e.*, "erect" rather than "slumped" or "reclined") is associated with less frequent musculoskeletal discomfort among office computer operators. Pascarelli (Pascarelli & Quilter, 1994), a physician who has treated many injured computer users, has identified a several styles of keying that may increase the likelihood of injury. These problematic keyboard styles include keying with extreme dorsiflection (*i.e.*, with the hand bent up at the wrist as when pushing a heavy door open), keying

with radial deviation (*i.e.*, with the wrist angled sideways toward the thumb), keying with ulnar deviation (*i.e.*, with the wrist angled sideways toward the "pinkie"), and keying with excessive force. Brown (1992-3), a classically trained pianist who has been involved in retraining computer users who are experiencing discomfort, has identified other keying habits that may increase the likelihood of injury including keying while resting your wrist on your worksurface, lifting fingers high for each key stroke, and stretching/reaching for desired keys while maintaining contact with the home row. Stotko (1996, p. 1), a registered occupational therapist, certified hand therapist, and contributing editor to *CTD News* writes in a Prevention Supplement, "we identify and recommend remedies to some of the common risky hand and wrist postures and address some of the stressful keying styles." She directs attention to problems due to striking the keys too "hard," to having long fingernails, to reaching/stretching for keys while maintaining contact with the home row, and to using awkward two-key combinations with one hand (*e.g.*, holding down the control key with the "pinkie" while striking a letter to issue a command"). In addition, Pascarelli (Pascarelli & Quilter, 1994) and Brown (1992-3) also offer suggestions for re-training keying technique if needed.

Adjustment of Computer Workstations

Studies of computer workstation adjustment have been widespread since the 1980s. Despite differences in the experimental situation, studies of the relationship between workstation adjustment and preferred posture have tended to focus on two conclusions: (1) that the preferred postures of computer operators are based on the subjective experience of postural relaxation (Cushman, 1984; Grandjean, Nishiyama, Hunting, & Piderman, 1982; Grandjean, Hunting, & Piderman, 1983; Grandjean, 1987a), and (2) that the workstation adjustments preferred by computer operators have very little to do with individual anthropometric measurements

(Grandjean, et al., 1982; Grandjean, Hunting, & Piderman, 1983; Grandjean, 1987a). Computer workstation adjustment studies have also contributed to the definition of appropriate ranges of adjustment for various workstation components (*e.g.*, desks and chairs) (ANSI/HFS 100-1988; Grandjean, 1987a, 1987b, 1988).

Despite the lack of clarity about the exact nature of the relationship between workstation adjustment and individual anthropometric measurements, several approaches to determining the proper workstation adjustment for a particular individual have been devised (*e.g.*, Kroemer, 1985; Noro, 1992; Romero, Ostrom, & Wilhelmsen, 1993; Verbeek, 1991). However, these approaches provide little, if any, guidance on how to make the tradeoffs necessary to achieve the optimal adjustment for each of the several components that must be used together at the same time.

Use of Instruction in the Prevention of Occupational Injury

According to OSHA (1992), training is appropriate in work situations where problems "arise from lack of knowledge of a work process, unfamiliarity with equipment, or incorrect execution of a task" (p. 4). The issue of "unfamiliarity with equipment" can be very real to contemporary office computer operators because of the rapid rate of change in computer hardware, software, furniture, and accessories. In fact, studies have reported that many individuals do not know how to adjust their furniture/equipment to take advantage of whatever adjustability is designed into it (Andre & Segal, 1993; Kukkonen, Luopajarve, & Ruhimaki, 1983). In addition, the issue of "incorrect execution of a task" may also be relevant to office computer users for two reasons: (1) many of these individuals may have received little, if any, instruction regarding keying technique beyond that found in typing/keyboarding texts, and (2) the instruction in such books tends to focus primarily on proper relationships between fingers

and keys (*e.g.*, Crawford, Erickson, Beaumont, Robinson, & Ownby, 1987; Duncan, Warner, Langford, & VanHuss, 1986; Lloyd, Winger, Johnson, Hall, Morrison, & Rowe, 1982).

Two recent studies of different groups of workers (Dortch & Trombly, 1990; Weigl, 1994) have demonstrated that workers can learn new movement patterns. In the first of these studies, Dortch and Trombly (1990) worked with electronic assembly workers engaged in tasks with a high risk and incidence of upper extremity musculoskeletal disorders, and showed that these workers could learn new, less traumatizing and aggravating patterns of hand use. In the second of these studies, Weigl (1994) worked with automobile assembly line workers and taught work movements and sensory-motor awareness. He demonstrated statistically significant decreases in a variety of measures including the average frequency and intensity of muscle pain and the average frequency of joint pain. No similar studies exist for office computer operators, and this thesis is designed, in part, to address this gap.

The Present Study

Need for the Study

There is general agreement that the incidence of WMSDs is increasing, and, that figures based on data from insurance companies and/or from Occupational Safety and Health Administration records seriously under-estimate the magnitude of the problem (Brogmus & Marko, 1992). These sources provide information about the most serious cases, and this fact is important, because as the severity increases, the likelihood of permanent disability increases (Kroemer, 1989). However, in the early stages, WMSDs are often treatable and reversible, and interventions designed to reduce discomfort should help reduce both the incidence and costs associated with potentially disabling cases of these disorders.

The need to adjust individual workstations has been recognized for a number of years, and standards regarding ranges of adjustability exist. However, the use of instruction in workstation adjustment and keying technique to decrease discomfort has not been addressed systematically. Three factors suggest that education regarding workstation adjustment and keying technique is needed: (1) the dynamic nature of the system formed by an office computer operator and his/her work environment, tool(s), and task(s); (2) the evidence that many individuals do not know how to adjust their office furniture and equipment (Andre & Segal, 1993; Kukkonen, et al., 1983); and (3) the documentation of awkward keying technique among injured computer keyboard users (Brown, 1992-3; Duncan & Ferguson, 1974; Pascarelli & Kella, 1993; Pascarelli & Quilter, 1994; Stotko, 1996). Given this evidence, it seems reasonable to suggest that instruction in workstation adjustment, keying, and appropriate movement patterns could help reduce the incidence and severity of worker discomfort and injury. Thus, the essence of this study is a "proof of concept," that appropriately designed and presented instruction can be used to reduce office computer user discomfort.

Design

This thesis was designed as a two group pretest-posttest quasi-experimental study of the effects of instruction on: (1) the Work-Related Body-Part Discomfort (WBPD) experienced by office computer operators, and (2) the computer operator's knowledge about WBPD and workstation adjustment. Each of the two experimental groups received instruction that could be used to reduce WBPD, but the instruction differed in terms of the specific *content* provided, and the manner of *presentation*. One group received the Library of Congress publication *Ergonomics and VDT Use* (Library of Congress Collections Services VDT Ergonomics Committee, 1991). The other group received an experimenter-designed booklet of information that was based on the

practices described in Cameron and Moroney (1994), *plus* a presentation/demonstration covering the recommendations regarding positioning of the keyboard and monitor, adjustment and positioning of the chair and other workstation components, posture, and keying technique.

The effects of providing this information to office computer operators were determined by using questionnaires for three purposes: (1) to assess the computer operators' reactions to the instructional materials, (2) to assess changes in their knowledge about WBPD, workstation adjustment, work posture, and keying technique, and (3) to assess their experience of work-related body-part discomfort.

Independent Variables

Two independent variables were used in this study. (1) instructional condition and (2) time of measurement. The between groups variable, *instructional condition*, had two levels that corresponded to the two instructional groups in the study. The two levels of the within groups variable, *time of measurement*, corresponded to the pre-instruction and post-instruction administration of questionnaires designed to assess the computer operators' work-related body-part discomfort and their knowledge about workstation adjustment, work posture, and keying technique.

Dependent Variables

The primary dependent variable was work-related body-part discomfort which was assessed using the Severity, Frequency, and Duration Discomfort Scale developed by Cameron (1996). In addition, participants were asked a series of questions regarding their medical history and experience with WBPD.

Reduction in an office computer operator's subjective assessment of WBPD would provide one kind of evidence of the effectiveness of the instruction, and would represent the best

possible outcome in this study. However, there were two factors that made the possibility of such an outcome unsure. First, we do not know exactly how long it should take after making appropriate changes in workstation adjustment, work posture, and/or keying technique for office computer operators to experience a change in their subjective assessment of WBPD. Second, some studies have found that in the weeks immediately following an ergonomic intervention, discomfort increases rather than decreases (Hagberg, 1990; Reynolds, Drury, & Broderick, 1994). Two explanations have been advanced to account for this increase in reported discomfort: (1) increased awareness of discomfort as a symptom of importance and (2) use of the musculoskeletal system in ways that require "unlearning" ingrained habits (Anonymous, 1994; A. Bittner, personal communication, November, 1994; Hagberg, 1990).

As a result of these considerations, two other measures were also gathered. These measures were selected to correspond to the reaction and knowledge levels of Kirkpatrick's (1976; 1994) widely used four-level model of training evaluation (Salas, Burgess, & Cannon-Bowers, 1995).

According to Kirkpatrick's (1976; 1994) four-level model of training evaluation, the first level, r*eaction,* is concerned with the subjective response of participants in a training program. This level of evaluation addresses the basic question, "*Did the participants <u>like</u> the program?"* The second level, *knowledge*, is concerned with assessing the information that was gained by the training participants. The third level of training evaluation, *behavior*, is concerned with assessing changes in behavior in the training environment and in the actual work situation. In this study, behavior was observed; it was also assessed using self-report measures. While analysis of these data is beyond the scope of this thesis, it is planned for the future. The fourth, and highest, level

of Kirkpatrick's model of training evaluation, *results*, is concerned with the effects of behavioral changes on an organization (*e.g.* increased productivity, increased profit, decreased cost).

Work-Related Body-Part Discomfort as a Measure of Instructional Effectiveness

Data for assessing Kirkpatrick's fourth level of training effectiveness often come from corporate records related to production, employee attendance, or medical and insurance costs. In the absence of such records, the organizational impact of the two instructional programs was assessed using employee self-reports of WBPD. Over time, a reduction in WBPD should be accompanied by a reduction in the incidence and/or severity of work-related musculoskeletal disorders. Eventually, it should lead to a reduction in associated medical and insurance costs.

Unique Aspects of This Study

Several aspects of this study are unique. First, the content to be included incorporates not only principles of biomechanics and good ergonomic practice (*e.g.*, ANSI/HFS, 1988; Chaffin & Andersson, 1991; Grandjean, 1987a, 1987b; Tichauer, 1978), but also principles derived from the performing arts (Fink, 1992; Hoppman & Patrone, 1991; Lieberman, 1991; Matthay, 1918, 1964/1932; Norris, 1993). Second, the experimenter-designed instructional program presents the process of adjusting workstation components as a system of interacting parts, rather than as a series of adjustments to individual, isolated components. And, third, the planned evaluation includes not only the subjective evaluation of WBPD, but also measures of the computer operators' reactions to the materials, and written assessment of each participant's knowledge of workstation adjustment and keying technique. It is believed that instruction can, and should, become a part of the arsenal of preventive strategies designed to reduce the incidence and severity of WBPD among office computer operators.

Limitations of This Study

The design of this study has two major limitations. First there was no control group to provide baseline information about changes in discomfort over time that may have been experienced by employees who received no instruction. This limitation may be attributed to two factors: (1) the number of available participants, and (2) the time available. Second, despite the fact that data were collected about three distinct types of dependent variables, two large, and potentially important, classes of variables were not represented among the measures used in this study. The first class of variables includes those related to the immediate supervisor and to corporate management (*e.g.*, support, rapport, attitude toward employees, etc.). The second includes a variety of macro-ergonomic factors such as job control, job design, job satisfaction, and job stress.

Hypotheses

There are three pairs of hypotheses in this study:

1A. Participants in both instructional groups will report positive reactions to the instruction.

1B. Participants who receive the experimenter-designed instructional materials will react to them in a more positive manner than participants who receive the materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

2A. Nine weeks after instruction, both groups of participants will show an increase in knowledge about workstation adjustment, work posture, and keying technique as indicated by an increase in the mean number of correct responses on the knowledge portions of the pre- and post-instruction questionnaires.

2B. Nine weeks after instruction, the group that received the experimenter designed instructional materials will have a higher mean number of correct responses on a set of 12 knowledge

questions than the group that received the materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

3A. Both groups of participants will experience a decrease in WBPD.

3B. The group that receives the experimenter-designed instruction will experience a greater reduction in WBPD than the group that receives the instructional materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

CHAPTER II

METHOD

Participants

The 59 study participants were employed by a local company that produces telephone books for several hundred cities. Approximately one half (N= 30) of these individuals were engaged in data-entry tasks; the remainder (N=29) were engaged in tasks associated with the sale of advertising in the "yellow pages." As is common in office environments, the majority (N=57 out of 59) were female. All reported that they used a computer at least four hours per day both at the beginning of the study, and nine weeks later at the end of the study.

The participants were selected by on-site coordinators who assigned employees to participate in the study as part of their normal work schedule, and who placed them into groups according to their jobs and the locations of their workstations. The employees were sent a letter inviting them to participate, and asking them to confirm their willingness to do so by signing an informed consent form. Participants were free to choose not to participate. In the letter of invitation, participants were told that the purpose of the study was to evaluate two instructional programs designed to help individuals reduce the discomfort associated with office computer use, and they were assured that their responses would be kept confidential (see Appendix A).

Two Instructional Approaches

Each of the two treatment groups received a different instructional program. One group received the experimenter-designed instructional program that included both a booklet of information and a group presentation/demonstration covering the information in the booklet (see Appendix B). The other group received a handout of information developed by the Library of Congress (LOC) Collections Services VDT Ergonomics Committee (1991) entitled, *Ergonomics and VDT Use* (see Appendix C).

The experimenter-designed instructional program presented information about workstation adjustment, work posture, and keying technique and was based on the recommendations presented by Cameron and Moroney (1994) in their article: *A Systems Approach to Computer Keyboard Usage for Continuous Text Transcription*. These recommendations represent a synthesis of standard ergonomic recommendations, with insights from the performing arts, especially classical piano technique.

The presentation of these recommendations was structured in terms of three strategies that correspond to three factors that increase the risk of developing WBPD: (1) awkward positioning of equipment, (2) inappropriate work posture, and (3) inefficient keying technique. Each of the three strategies was presented in terms of an overarching principle that can guide an individual's choices about workstation adjustment, work posture, and keying technique.

The application of these three principles is described in terms of three basic questions: (1) ***What*** do I do? (2) ***How*** do I do it? and (3) ***Why*** do I do it? The first question, ***What*** *do I do?*, establishes the goal, or goals, for the strategy. The second, ***How*** *do I do it?*, describes a procedure for attaining the desired goal, or goals. The third, ***Why*** *do I do it?*, provides a justification for using the given recommendations. The three principles can be used despite

differences in work situation (*i.e.*, furniture, tools, and tasks) and individual anthropometry. A mnemonic device to help users recall the three principles was devised using the initial letters of key words from each of the principles (see Figure 3).

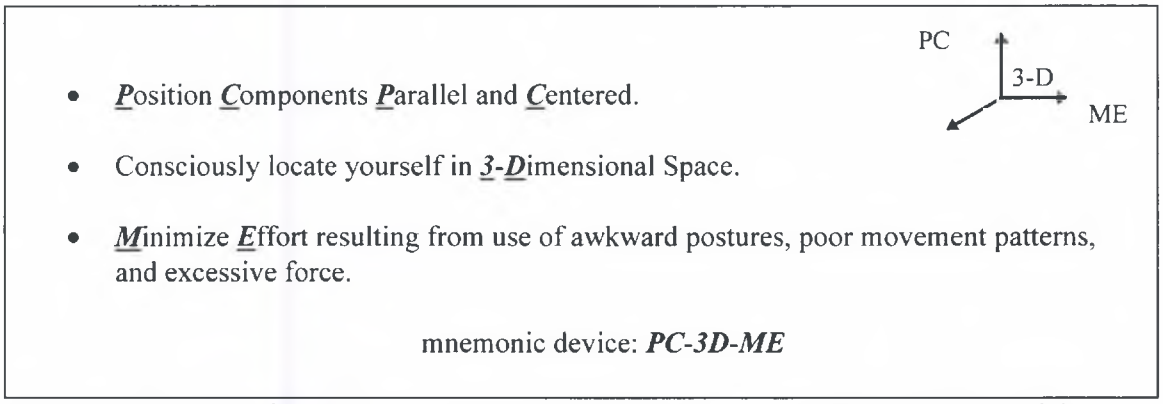


Figure 3. Three principles presented in the experimenter-designed (PC-3D-ME) materials.

The materials prepared by the Library of Congress Collections Services VDT Ergonomics Committee (1992) presented recommendations for adjustment of the computer operator's chair, keyboard, and monitor, and recommended the use of regular rest breaks. They also presented information about health problems among computer operators.

Both instructional programs provided information about the problem of work-related musculoskeletal disorders and about workstation adjustment. Both provided diagrams of recommendations for workstation setup. However, as shown in Table 1, the two instructional programs differed in terms of the *content* and the *presentation*. That is, the two instructional programs differed in terms of the specific topics addressed, the relative emphasis on *intrinsic*- and *extrinsic*-ergonomic factors, the presentation of the information, the structure of the information, and the sources of the information.

Table 1
Comparison of the *Content* and *Presentation* in the Two Instructional Programs

Feature	Instructional Program	
	PC-3D-ME	LOC
Topics addressed	Recommendations about positioning and adjusting workstation components, work posture, and keying technique	Recommendations about the placement and adjustment of chair, keyboard, and screen, and about the use of rest breaks
Emphasis:	• *Intrinsic* ergonomic factors related to work posture and work habits and the assumption of self-responsibility • Need for tradeoffs when setting up a workstation	*Extrinsic* ergonomic factors related to placement and adjustment of workstation components
Presentation	• Written information • Demonstration based on written information	• Written information only
Structure of information concerning monitor, keyboard, and chair	Organized in terms of three basic principles: • ***P***osition ***C***omponents ***P***arallel and ***C***entered • Consciously locate yourself in ***3-D***imensional space • ***M***inimize ***E***ffort resulting from use of awkward postures, poor movement patterns, and excessive force	Organized in terms of topic headings: • Chairs • Keyboard • Screen placement and viewing specifications
Sources used	Literature from human factors and ergonomics, performing arts medicine, classical piano technique, and Alexander technique	Literature from human factors and ergonomics

NOTE: The Alexander Technique is a form of movement education/re-education used by some highly skilled performing artists (*e.g.*, singers, actors, dancers, instrumentalists) who want to optimize the poise and efficiency of their movements (Barlow, 1990).

Procedure

The study was conducted in six phases as shown in Figure 4.

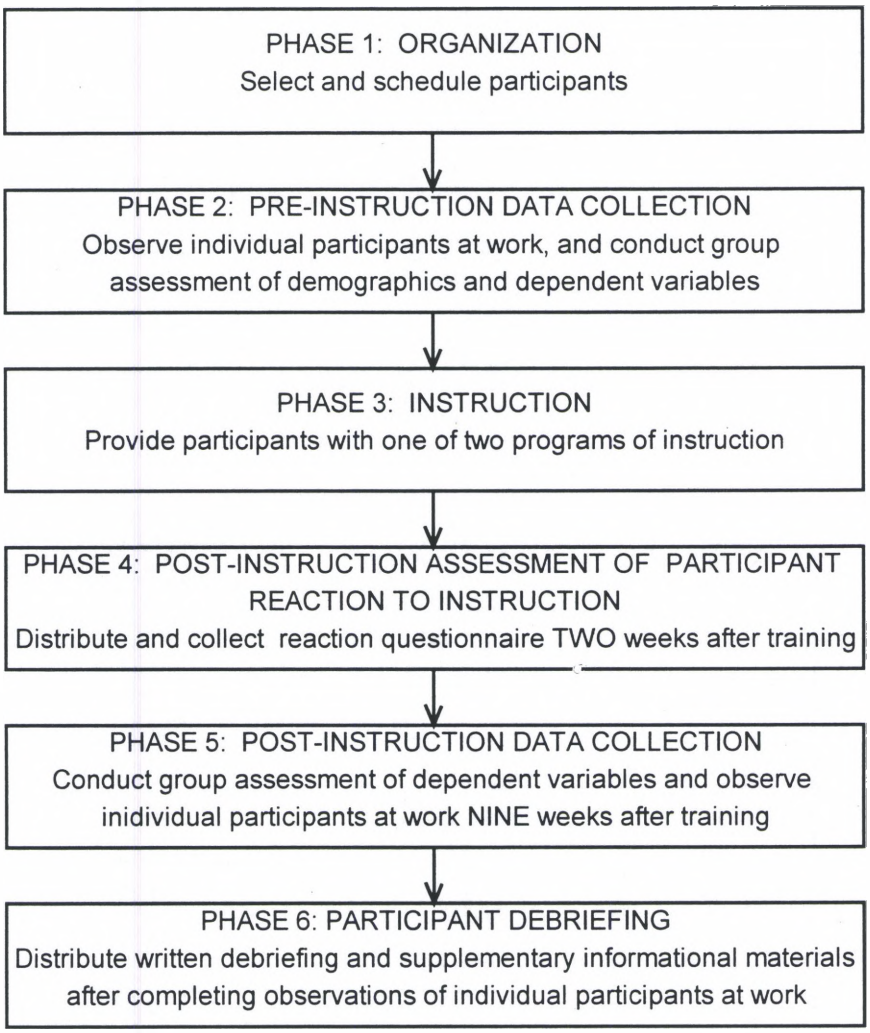


Figure 4. Flowchart depicting study procedure.

The first phase, *organization*, was devoted to participant selection and scheduling. Much of the work was performed by two on-site coordinators designated by corporate management. One on-site coordinator worked with participants who were engaged in data entry; the other

worked with participants who were engaged in telephone sales. During this phase, the supervisors selected participants who met the basic criterion of using a computer at least 4 hours per day, and the on-site coordinators assigned them to groups based on their work locations.

The on-site coordinators were provided with a letter of invitation signed by the Manager of the Human Resources Department that they distributed to the designated participants. This letter described the study, requested employee participation, and included an informed consent form (see Appendix A). As participants returned the signed informed consent forms, the on-site coordinators scheduled 30 minute appointments when the experimenter could observe the individual participants at work. Participants received a memo informing them of the time for this observation, and asking them to engage in normal computer tasks during the observation (see Appendix A).

The second phase, *pre-instruction data collection*, included observation of individual participants at work, and a group assessment of demographics and dependent variables. Observation of participants took about 30 minutes per person and spanned a period of about three weeks. The groups of participants designated by the on-site coordinators were assigned to one of the two instructional programs by the flip of a coin.

During this second phase, the on-site coordinators scheduled four group meetings on two consecutive days for purposes of completing the questionnaires used to gather demographic data and to assess dependent variables (see Appendix D). Two group meetings were provided for participants who received the PC-3D-ME instructional materials, one for participants engaged in data-entry tasks and one for participants engaged in telephone sales. The same plan was used with the participants who received the LOC materials; one group meeting was provided for participants engaged in data-entry tasks and one for participants engaged in telephone sales.

The third phase, *instruction*, took place immediately following the group meetings during which participants completed the pre-instruction questionnaire. In this phase, participants received one of the two instructional programs. One group received the experimenter-designed PC-3D-ME booklet and presentation/demonstration. The other group received the LOC materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

Phase four, *post-instruction assessment of participant reaction to instruction*, occurred two weeks after the participants had completed the initial questionnaire and received instruction. During this phrase, a brief questionnaire (see Appendix E) was distributed to all participants by interoffice mail. Participants were provided with pre-addressed envelopes. Participants sealed completed questionnaires in the pre-addressed envelopes and sent them by interoffice mail to the on-site coordinators who gave the sealed envelopes to the experimenter.

Phase five, *post-instruction data collection*, began with two days of group meetings during which participants completed another questionnaire. These meetings were held nine weeks after participants had received instruction. As in the initial group meetings, all participants at any one meeting were engaged in the same type of work, and all had received the same instructional materials. The questionnaire completed during these final group meetings (see Appendix F) was not as extensive as the initial one.

Post-instruction observations of individual participants at work were scheduled by the on-site coordinators, and began immediately following the second day of group meetings. As at the beginning of the study, participants received a memo informing them of the time for this observation, and asking them to engage in normal computer tasks during the observation. Completion of these observations took about a month.

Phase six, *participant debriefing*, was the final phase. It took place after all of the post-instruction observations had been completed. At this time each participant received a letter thanking them for their cooperation and participation (see Appendix A), and a copy of the written instructional materials that they had not received during phase four. Thus, each participant ended the study with copies of both sets of written instructional materials. Following data analysis, selected company managers and supervisors were provided with a summary of the results and some recommendations for continued ergonomic improvements.

Questionnaires for Assessing Instruction

Questionnaires were administered at three different times during this study: before providing participants with instruction (see Appendix D), two weeks after providing participants with instruction (see Appendix E), and nine weeks after providing the instruction (see Appendix F). The information gathered in these questionnaires was used to characterize the demographics of the participants and to assess the three dependent variables: reaction, knowledge, and work-related body-part discomfort.

Assessing Participant Reaction to Instruction

Two forms of the reaction questionnaire were developed (see Appendix E). They were identical except that the form used with participants in the PC-3D-ME instructional group included two additional questions asking for participant reaction to the demonstration.

These questionnaires asked participants to respond to a series of statements about the written materials, and about the presentation/demonstration if they had received it. Participants responded to these statements using a six-point scale of agreement. Participants were also asked to rate their current overall body-part discomfort and to respond to open-ended questions about

the information they had received, the demonstration (if they had received it), and any changes that they had made in their work areas as a result of the instruction they received.

Assessing Participant Knowledge About Work-Related Body-Part Discomfort, Workstation Adjustment, and Keying Technique

In order to assess any change in the participant's knowledge about WBPD, workstation adjustment, and keying technique, participants were asked twelve true/false questions. The same twelve questions were included near the beginning of both the pre-and the post-instruction questionnaires. All twelve of the questions could be answered on the basis of information contained in the experimenter-designed instruction. Only ten of the questions could be answered on the basis of the materials developed by the Library of Congress collections services VDT Ergonomics Committee (1991).

Assessing Work-Related Body-Part Discomfort

Background

Within the literature of ergonomics, assessment of body-part discomfort has been used for a variety of purposes. Sauter, Schliefer, and Knutson (1991) assessed the location and frequency of body part discomfort to determine relationships between body posture, work station adjustment, and musculoskeletal discomfort. Lu and Aghazadeh (1994) assessed the location and intensity of body part discomfort in their study of the relationship between keyboard position and discomfort. Marley and Kumar (1994) assessed the location, frequency, and level of discomfort to determine if employee self-reports can be used to predict individuals who are likely to seek medical treatment for work-related discomfort. Stuart-Buttle (1994) assessed the location, and intensity of physical discomfort among poultry-processing workers as part of an effort to prioritize jobs for ergonomic intervention. Benden (1994) assessed the location of body-part

discomfort and the effects of this discomfort on work performance to evaluate an ergonomic intervention.

The Discomfort Assessment Tool

The questionnaire used to assess work-related body-part discomfort was developed after an extensive review of the literature concerning WBPD (Cameron, 1996, p. 396). It incorporates assessment of four distinct dimensions of WBPD: location (*i.e.*, *"Where does this discomfort occur?"*); severity (*i.e.*, *"How much does this discomfort affect work performance?"*); frequency (*i.e.*, *"How often does this discomfort occur?"*); and duration (*i.e.*, *" For how long has this discomfort occurred?"*). Participants indicated the location of discomfort through the use of line drawings of the front and the back of the human body. These drawings depicted 58 individual body-parts (*e.g.*, foot, ankle, wrist, forearm). The severity, frequency, and duration of discomfort are rated using numerical ratings, each of which was provided with a behavioral descriptor (see Table 2.This questionnaire appears to have face validity, however no reliability/validity data are available.

Table 2
Sample of Ratings Used in the Severity, Frequency, and Duration Discomfort Rating Scale

Dimension of Discomfort	Numerical Rating	Behavioral Descriptor
Severity	1	***MINIMAL DISCOMFORT:*** discomfort is present, but I can ignore it
Frequency	1	***NOT VERY OFTEN:*** a few times a month or less
Duration	1	***IT DOESN'T LAST LONG:*** discomfort usually goes away as soon as I stop what seems to cause it, or shortly thereafter

Based on Cameron (1996, p. 396).

Summary of Procedure, Variables, and Questionnaires

Table 3 provides a overview of the data collection process used in this study, and shows the relationship between the six phases in the procedure, the dependent variables assessed, and the questionnaires used. It also serves to summarize the data collection process.

Table 3
Summary of Procedure, Dependent Variables, and Questionnaire Measures

Phase	Variables Assessed	Questionnaires Used
1. ORGANIZATION: Select and schedule participants		
2. PRE-INSTRUCTION DATA COLLECTION: Observe individual participants at work and conduct group assessment of demographics and dependent variables	• Knowledge • Work-related body-part discomfort • Demographics with which to characterize the study participants)	• Pre-instruction questionnaire (see Appendix D)
3. INSTRUCTION: Provide participants with one of two programs of instruction		
4. POST-INSTRUCTION ASSESSMENT OF PARTICIPANT REACTION TO INSTRUCTION: Distribute and collect reaction questionnaire two weeks after instruction	• Reaction	• Reaction questionnaire (see Appendix E)
5. POST-INSTRUCTION DATA COLLECTION: Conduct group assessment of dependent variables and observe individual participants at work nine weeks after instruction	• Knowledge • Work-related body-part discomfort	• Post-instruction questionnaire (see Appendix F)

Table 3 (continued)
Summary of Procedure, Dependent Variables, and Questionnaire Measures

Phase	Variables Assessed	Questionnaires Used
6. PARTICIPANT DEBRIEFING: Distribute written debriefing and supplementary informational materials after completing observations of individual participants at work		

CHAPTER III

RESULTS

This chapter is divided into three sections. The initial section describes the subjects. The second section demonstrates initial group equivalence on key demographic variables. The third section is devoted to an evaluation of the two instructional approaches, and is structured in terms of the three dependent variables: reaction, knowledge, and discomfort. Because of the quantity of data, the section on discomfort is divided into five sub-sections: (1) a description of overall discomfort severity before instruction, (2) an examination of initial group equivalence of discomfort severity, frequency, and duration in the nine body parts selected for further study, (3) a comparison of overall changes in discomfort severity, frequency, and duration in nine selected body parts during the course of this study, (4) an overview of changes in *individual* discomfort severity, frequency, and duration in nine selected body parts, (5) a description of the procedure used to calculate *individual* change scores for discomfort severity, frequency, and duration in nine selected body parts and a presentation of the results of statistical analyses of the significance of changes in discomfort severity, frequency, and duration *between* the two instructional groups and *within* each instructional group.

Subjects

Fifty-nine of the seventy-five individuals who volunteered to participate in this study met the three qualifying criteria: (1) they reported that their typical work day included at least

four hours of computer use; (2) they were present for the instructional session; and (3) they completed all questionnaires and observations. Data from sixteen individuals were excluded from the analysis for the following reasons: eight reported fewer than four hours of computer use during a typical work day; three were not present for the instructional session; two did not complete all three questionnaires; one asked to withdraw from the study; one moved to a different part of the company and a different type of job; and one left the company before completion of the study. Thirty of the participants whose data is reported were assigned to the PC-3D-ME instructional group. The other twenty-nine were assigned to the LOC instructional group.

Demonstration of Initial Group Equivalence on Key Demographic Variables

Prior to assessing the effectiveness of the two instructional programs, the two groups of participants were compared to ensure group equivalence on the following demographic variables: self-reported hours of computer use on a typical work day; gender; age; length of time working for this company; length of time in current job; keying speed and technique; prior instruction/training concerning workstation adjustment, work posture, or keying technique; current and previous medical treatment and drug use for WBPD; and job satisfaction.

Self-Reported Hours of Computer Use on a Typical Work Day

On a typical work day, the mean number of hours of computer use was 6.24 (*SD*=1.56) for the PC-3D-ME instructional group, and 6.00 (*SD*=1.30) for the LOC instructional group. A one-way analysis of variance showed that the two instructional groups were not significantly different in their hours of computer use on a typical work day, $F(1, 57) = .39$.

Gender

Fifty-seven of the participants were female and two were male. One male was in the PC-3D-ME instructional group; the other was in the LOC instructional group.

Age

Participants were asked to indicate their age by choosing one of ten categories that ranged from "under 20" to "over 60." The youngest participants were under 20; the oldest were between 50 and 54. The chi-square statistic showed that the two instructional groups were not significantly different in age, χ^2 (3, N= 59) = 6.121.

Length of Time Working for This Company

The length of time that the study participants had worked for this local company ranged from 3 months to 204 months (17 years) with a mean of 62.49 months (SD = 53.69 months, median = 48 months). A one-way analysis of variance showed that the two instructional groups were not significantly different in the length of time that they had worked for this company, F (1, 57) = 1.15. However, because there was some concern about the normality of the distribution, the analysis of variance was repeated using both a square root transformation of the data and a $\log_{10}$ transformation of the data. In each case, the outcome of the original analysis (*i.e.*, no significant difference between the groups) was confirmed.

Length of Time in Current Job

The length of time that the study participants had held their current jobs ranged from 1 month to 204 months with a mean of 27.56 months (SD - 35.36 months, median = 13 months). One-way analysis of variance showed that the two instructional groups were not significantly different in the length of time that they had held their current jobs, F (1, 55) = .543.

Keying Speed and Technique

The participant's self-reported keying speed ranged from less than 40 words per minute to more than 60 words per minute. As shown in Table 4, the participant's self-reported keying technique included both traditional "touch typing" technique and idiosyncratic varieties of "hunt and peck" technique. Visual inspection of Table 4 shows that the two groups were not significantly different in keying speed. After collapsing the two "touch typing" categories into one category, and the two "hunt and peck" categories into a second category, the chi-square statistic showed that the two groups were not significantly different in keying technique: χ^2 (1, N = 59) = 0.37.

Table 4
Comparison of Keying Speed And Technique Reported By Two Instructional Groups.

Variable	Instructional Group	
	PC-3D-ME	LOC
Typing/keying speed:		
Slow (less than 40 wpm)	5	4
Moderate (40-60 wpm)	19	19
Fast (more than 60 wpm)	6	6
Typing/keying technique:		
True touch (without looking at the keyboard for letters, numbers, or symbols)	4	5
Touch (without looking at the keyboard for letters, but with some looking for numbers, symbols, and/or function keys)	19	20
Modified "hunt and peck" (looking at the keyboard as needed for letters, numbers, symbols, and/or function keys)	7	4
"Hunt and peck" (using one or two fingers on one or both hands, plus a finger, or a thumb, on the spacebar)	0	0

Prior Instruction /Training Concerning Workstation Adjustment, Work Posture, or Keying Technique

As shown in Table 5, only a few of the 59 study participants had received prior instruction or training concerning workstation adjustment, work posture, or proper keyboard technique for their current job tasks, and none of the differences between the two instructional groups were statistically significant.

Table 5
Number of Participants Reporting Prior Instruction/Training Concerning Workstation Adjustment, Work Posture, or Keying Technique

Question	PC-3D-ME		LOC		Fisher's Exact Test
	Yes	No	Yes	No	
"Have you been given information about how to adjust your workstation?"	2	28	4	25	0.42
"Have you received training on the proper work posture for your current job tasks?"	2	26	3	26	1.00
"Have you received training on proper keyboard technique for your current job tasks?"	4	24	3	26	0.71

NOTE: 2-tailed test of significance.

Current and Previous Medical Treatment and Drug Use for Work-Related Body-Part Discomfort

The initial questionnaire contained six questions (Appendix D, questions 25-30) that were used to ascertain whether participants had ever sought advice from a physician or other health professional concerning their WBPD, whether they had ever used over-the-counter or prescription drugs for their WBPD, and whether they were currently using over-the-counter or prescription drugs for their WBPD. As shown in Table 6, participants in the PC-3D-ME

instructional group were more likely to respond "*yes*" to these questions than the participants in the LOC instructional group. The only difference between the two instructional groups that was statistically significant was the number of participants who reported having gone to some type of health professional other than a physician: Fisher's Exact Test, Two-Tail, $p < .05$. That is, significantly more members of the PC-3D-ME instructional group had sought help from health professionals who were not physicians.

Table 6
Comparison of Two Instructional Groups on Visits to Health Professionals and Use of Drugs for Work-Related Body-Part Discomfort

	Instructional group			
	PC-3D-ME		LOC	
Question	Yes	No	Yes	No
25. "Have you gone to a physician about one or more of the areas of work-related discomfort you have identified on this questionnaire?"	10	20	5	24
26. "Have you gone to any other type of health professional (e.g., chiropractor, massage therapist, physical therapist, etc.) about one or more of the areas of work-related discomfort that you have identified on this questionnaire?"	8*	22*	1*	28*
27. "Have you ever taken over-the-counter drugs for work-related body-part discomfort?"	16	14	12	17
28. "Are you currently taking over-the-counter drugs for the discomfort you have identified?"	8	22	4	25
29. "Have you ever taken prescription drugs for work-related discomfort?"	6	24	2	27
30. "Are you currently taking prescription drugs for the work-related discomfort you have identified?"	1	29	1	28

* = $p < .05$, Fisher's Exact Test, Two-Tail.

Job Satisfaction

To assess job satisfaction, participants responded to the question "*How satisfied are you with your job?*" using a five point scale (1 = very satisfied, 5 = very dissatisfied). Both before instruction, and nine weeks after instruction, over half the participants reported that they were "satisfied" or "very satisfied" with their jobs. Both before instruction, and nine weeks after instruction, only 1 individual reported being "dissatisfied" or "very dissatisfied" with his/her job (see Figure 5). After collapsing the five categories of scores into two, (scores of 1, "very satisfied," and 2, "satisfied," equal 1; scores of 3, "somewhat satisfied," 4, "dissatisfied," and 5, "very dissatisfied," equal 2), the chi-square statistic showed that there was no significant difference between the two instructional groups either before (χ^2 [1, N= 59] = .039), or nine weeks after (χ^2 [1, N = 59] = .219), instruction.

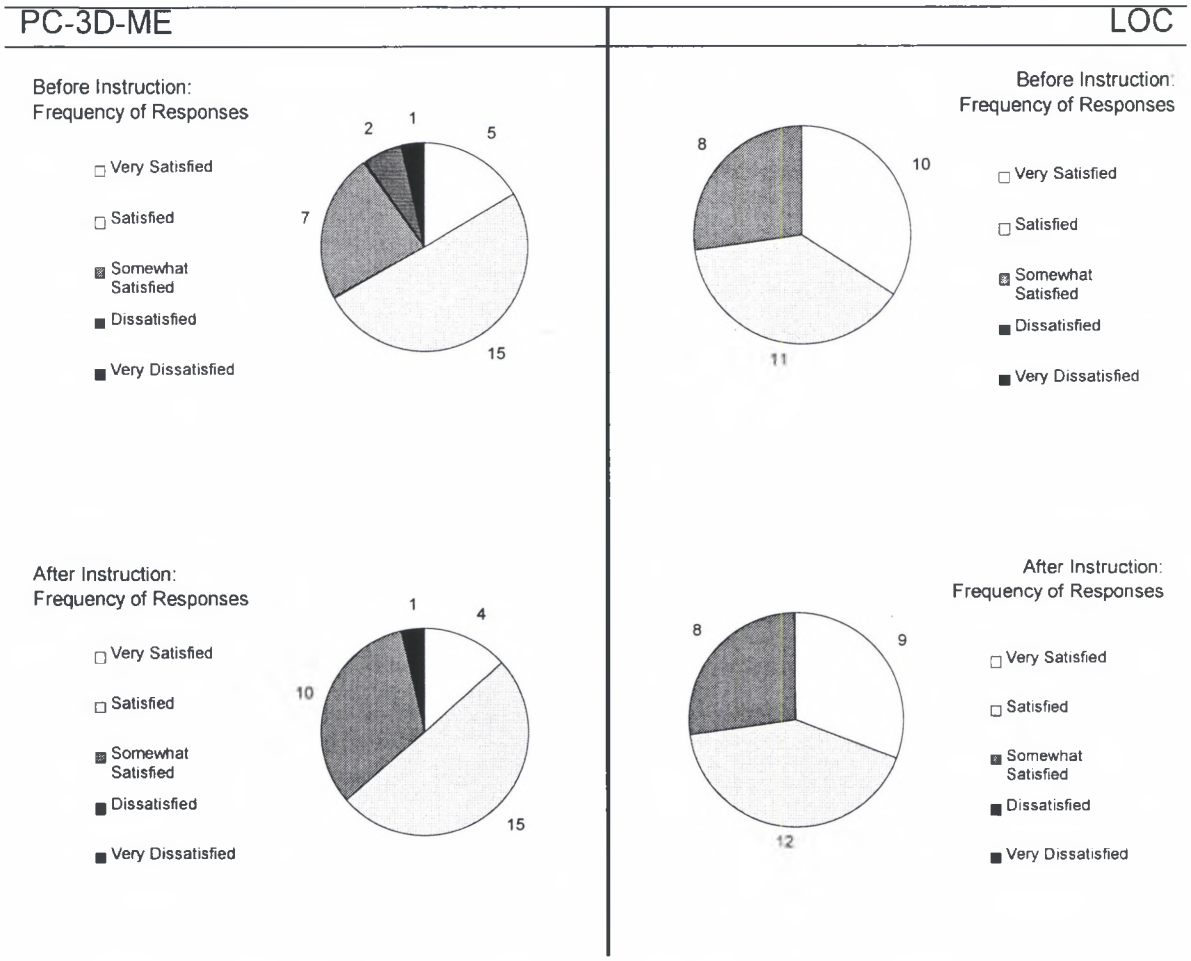


Figure 5. Comparison of job satisfaction between groups, before and after instruction.

Evaluation of Instructional Approaches

The evaluation of the two instructional approaches is organized in terms of the three dependent variables: reaction, knowledge, and discomfort. In Chapter 1, two hypotheses were associated with each of these variables. The first of each pair of hypotheses was descriptive in nature, and predicted an overall positive reaction to the instruction received, an increase in knowledge, and a decrease in discomfort (pp. 14-15, hypotheses 1A, 2A, and 3A). The second of each pair of hypotheses was comparative in nature, and hypothesized that the outcome for the

PC-3D-ME instructional group would be more positive than the outcome for the LOC instructional group (pp. 14-15 hypotheses 1B, 2B, and 3B).

Because of the quantity of information, the results for discomfort are presented in five sections: (1) a description of overall discomfort severity before instruction, (2) an examination of initial group equivalence of discomfort severity, frequency, and duration ratings in the nine body parts selected for further study, (3) a comparison of overall changes in discomfort severity, frequency, and duration ratings in nine selected body parts during the course of this study, (4) an overview of *individual* changes in discomfort severity, frequency, and duration ratings in nine selected body parts, (5) a statistical analysis of the significance of changes in discomfort severity, frequency, and duration ratings *between* the two instructional groups and *within* each instructional group.

Reaction

To assess the participants' reaction to the instruction they received, a brief questionnaire was distributed two weeks after the participants had received the instruction (see Appendix E). In this questionnaire, study participants reacted to statements by indicating whether they agreed, or disagreed, with each statement using a 6 point scale: 1 = "Decidedly Agree," 2 = "Substantially Agree," 3 = "Slightly Agree," 4 = "Slightly Disagree," 5 = "Substantially Disagree," and 6 = "Decidedly Disagree."

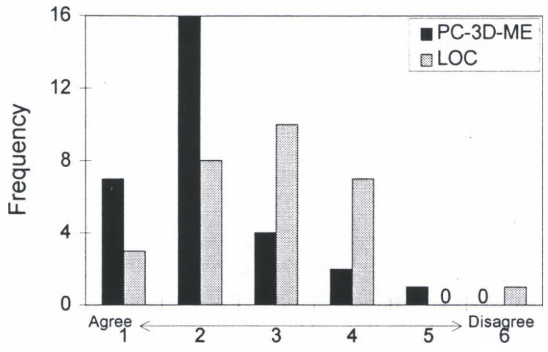
Four items from this questionnaire were used to compare the reactions of the two instructional groups. Study participants in the PC-3D-ME instructional group reacted to two additional items to determine if they believed that the presentation/demonstration they received

was of value. Figure 6 shows the six questions used to assess participant reaction. Visual inspection of data associated with each question shows that the majority of the participants in both instructional groups agreed with each item on the reaction questionnaire.

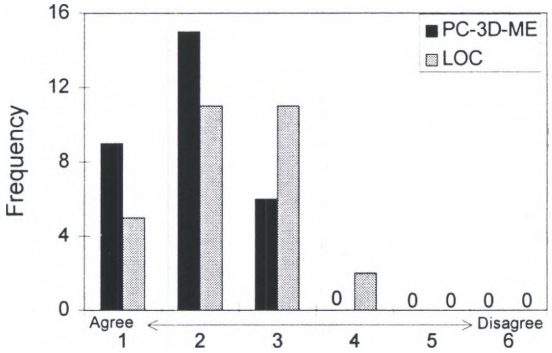
Table 7 shows the six items used to assess participant reaction to the instruction they received, and the mean value of the rating reported by each instructional group. All study participants responded to items 1, 2, 3, and 6; participants in the PC-3D-ME instructional group also responded to items 4 and 5. Examination of Table 7 shows that the mean values of all of the PC-3D-ME instructional group's ratings were consistently more positive (*i.e.,* lower) than the corresponding mean values of the LOC instructional group. It also shows that the mean values of the PC-3D-ME instructional group's reaction to the two items about the presentation/demonstrations (Table 7, items 4 and 5) were among the most positive (*i.e.,* lowest) reported. In addition, Table 7 shows that the differences in mean ratings between the two instructional groups were statistically significant in two cases. A *t*-test showed that the mean ratings between the instructional groups for the question, *"The information was mostly new to me"* were significantly different, $p < .01$, with the more desirable ratings being attained by the PC-3D-ME instructional group. For the question, *" I believe I could use the information to make adjustments to my workstation,"* a *t*-test showed that the differences in mean ratings between the two instructional groups were significantly different, $p < .05$. Again the more desirable ratings were attained by the PC-3D-ME instructional group.

PARTICIPANT REACTION TO INSTRUCTION

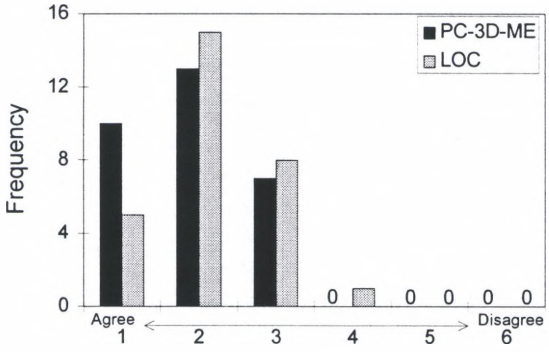
The information was mostly new to me



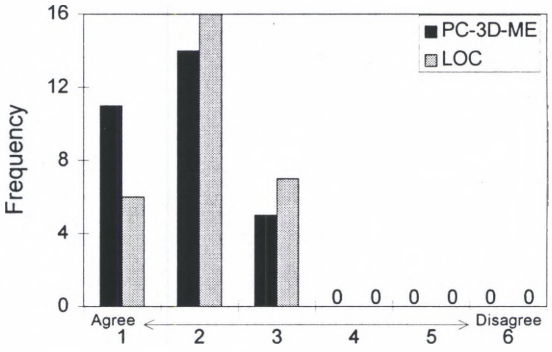
I believe I could use the information to make adjustments to my workstation



The quality of the written information was excellent

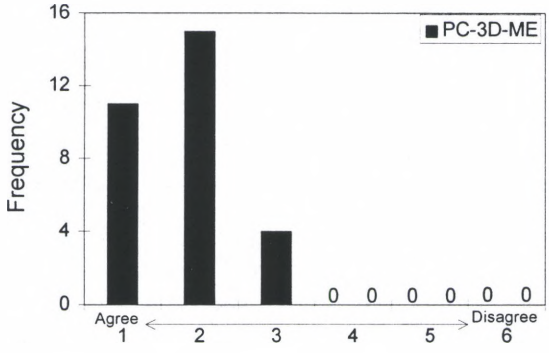


The material made me more aware of the connection between work-related discomfort and how I do my job.

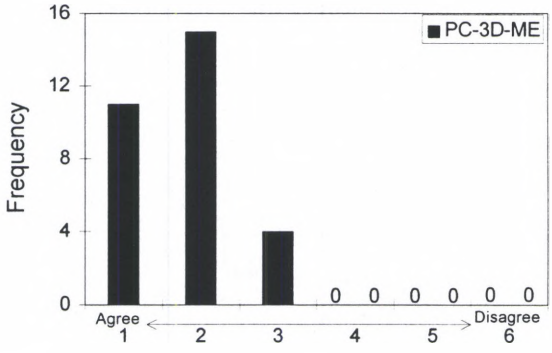


PARTICIPANT REACTION TO PRESENTATION/DEMONSTRATION
(PC-3D-ME instructional group only)

The quality of the demonstration was excellent.



The material covered in the demonstration added substantially to the written material.



Rating Scale:
1 Decidedly Agree
2 Substantially Agree
3 Slightly Agree
4 Slightly Disagree
5 Substantially Disagree
6 Decidedly Disagree

Figure 6. Distribution of participant reactions to statements about the instruction received.

Table 7
Mean Reactions of Study Participants to the Two Instructional Approaches

Questions	PC-3D-ME		LOC	
	Mean	*SD*	Mean	*SD*
1. The information was mostly new to me.	2.13**	.97	2.86**	1.12
2. I believe I could use the information to make adjustments to my workstation.	1.90*	.71	2.34*	.86
3. The quality of the written information was excellent.	1.90	.76	2.17	.76
4. The quality of the demonstration was excellent.	1.77	.68	N/A	N/A
5. The material covered in the demonstration added substantially to the written material.	1.80	.66	N/A	N/A
6. The material made me more aware of the connection between work-related discomfort and how I do my job.	1.80	.71	2.03	.68

NOTE: Participant reaction to these statements was assessed using a 6-point rating scale (1 = "Decidedly Agree," 6 = "Decidedly Disagree").
*$p < .05$, **$p < .01$ based on *t*-test.

Knowledge

Study participants were asked twelve true/false questions before they received instruction; they were asked the same twelve questions nine weeks after they received instruction (See Appendix D, questions 12-23, and Appendix F, questions 5-16.) As shown in Table 8, the mean number of correct responses in each instructional group nine weeks after instruction, was greater than it was before instruction.

Table 8
Mean Number of Correct Responses Before, and Nine Weeks After, Instruction

	PC-3D-ME		LOC	
Time of Measurement	Mean	*SD*	Mean	*SD*
Before Instruction	9.76	1.57	9.36	1.50
Nine Weeks After Instruction	10.69	1.00	10.64	0.87

NOTE: Based on paired samples only.

Visual inspection of Table 8 shows that the mean number of correct responses in the two instructional groups was similar both before, and nine weeks after, instruction. Analysis of variance showed that there was no significant difference between the two instructional groups in the mean number of correct responses either before, or after, instruction, $F(1, 55) = .74$. However, in both instructional groups, the mean number of correct responses after instruction was greater than the mean number of correct responses before instruction, and these differences were statistically significant, $F(1, 55) = 26.82$, $p < .01$.

An alternate way of examining the changes in knowledge experienced by the two instructional groups is shown in Figure 7. Visual inspection of this figure shows that before instruction approximately 80% of each instructional group responded correctly to 9 or more of the 12 questions (*i.e.*, they responded correctly to at least 75% of the questions). Nine weeks after instruction, 100% of the participants in each of the two instructional groups responded correctly to at least 9 of the 12 questions.

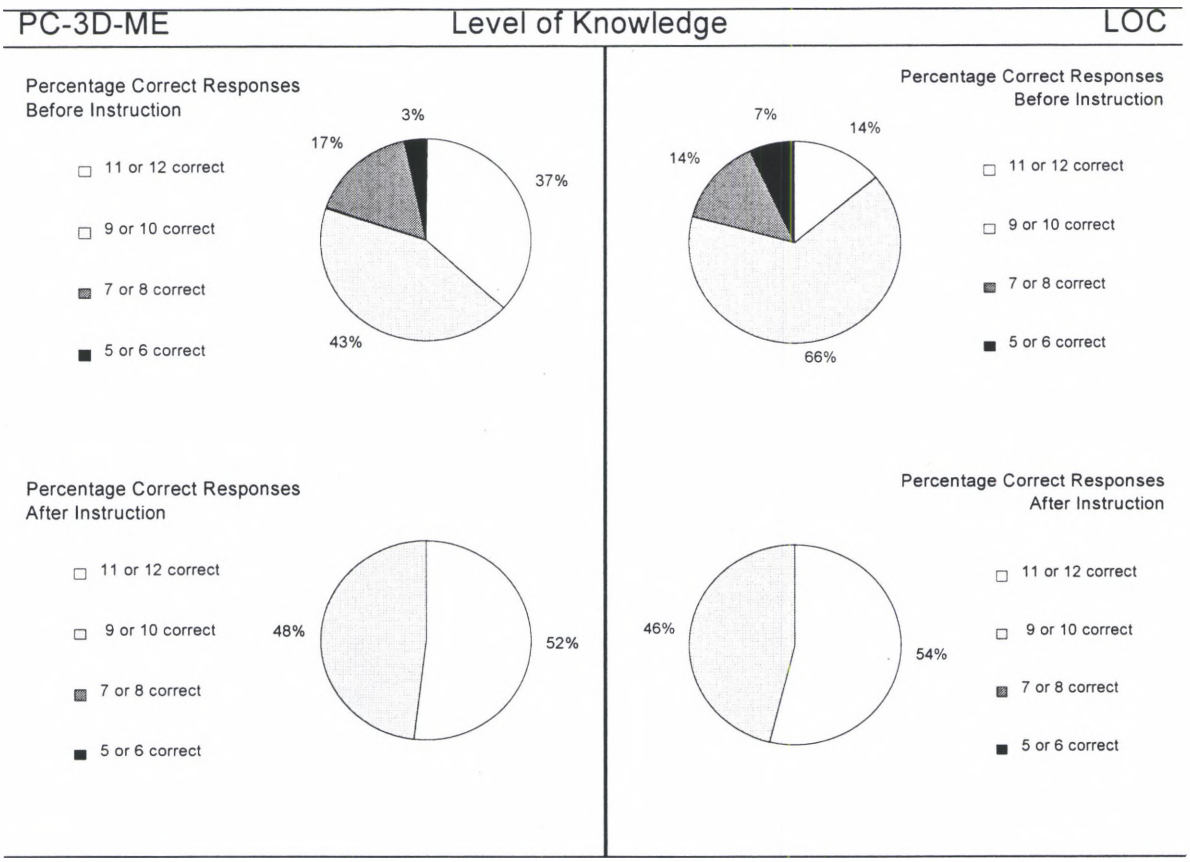


Figure 7. Percentage of respondents at each level of knowledge.

Discomfort

The results related to discomfort are organized into five sections. The first section is a description of overall discomfort severity before instruction. The second section is an examination of initial group equivalence of discomfort severity, frequency, and duration in the nine body parts selected for further study. The third section provides a comparison of overall changes in discomfort severity, frequency, and duration in nine selected body parts. The fourth section provides an overview of changes in *individual* discomfort severity, frequency, and duration in each of nine selected body parts. The fifth section includes a description of the procedure used to calculate *individual* change scores for discomfort severity, frequency, and

duration in nine selected body parts and the results of the statistical analysis of these change scores. The *between* groups analysis is first conducted using the total sample population, and then using only the sub-population whose change scores were not equal to zero (*i.e.,* including only those participants who reported either an increase, or a decrease, in discomfort severity, frequency, or duration over the course of this study). Like the second between groups analysis, the *within* groups analysis is conducted using the sub-population whose change scores were not equal to zero.

Description of Overall Discomfort Severity Ratings Before Instruction

At the beginning of the study, one or more participants reported discomfort in every one of the 58 body parts shown in the discomfort questionnaire (Appendix D, "Survey Packet for Office Computer Operators, Part 3"). The number reporting discomfort in a particular body part ranged from a low of three out of 59 in the left lower leg, to a high of 50 out of 58 in the back of the neck (see Appendix G).

The body parts used for the more detailed analysis of discomfort were selected by using the participants' initial self-reported rating of the severity of their WBPD. Participant ratings for frequency and duration of WBPD were not used in the selection process because, if a person has no WBPD in a particular body part, rating the frequency and duration of the WBPD is meaningless.

In nine body parts, thirty or more of the study participants (*i.e.*, at least 50%) rated the severity of their WBPD as greater than zero. As shown in Figure 8, the body parts in which at least 50% of the study participants reported discomfort included: eyes, front of neck, back of neck, upper back, lower back, left back shoulder, right back shoulder, right front shoulder, and right front wrist (palmar side). These nine body parts were selected for further analysis to

determine whether any of the self-reported changes in WBPD nine weeks after instruction were statistically significant.

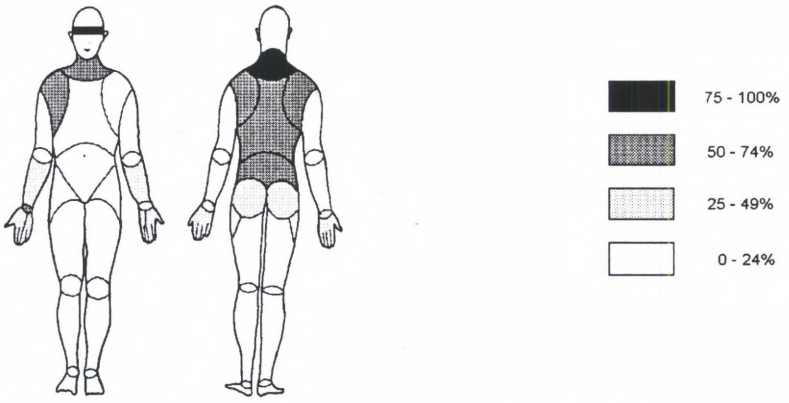


Figure 8. Percentage of study participants reporting discomfort in each of 58 body parts before instruction.

Descriptive statistics for each of the nine selected body parts are shown in Table 9. Examination of this table shows that the highest mean rating for discomfort severity was in the back of the neck; the lowest mean rating was in the right front shoulder. The median discomfort severity ranged from one to two, and the mode from zero to two.

Table 9
Descriptive Statistics for Severity of Discomfort in Nine Selected Body Parts

Body Part	Mean	Median	Mode	*SD*
Eyes	1.39	1.00	1.00	1.10
Front of the neck	1.31	1.00	0.00	1.24
Back of the neck	1.91	2.00	2.00	1.20
Upper back	1.55	2.00	2.00	1.22
Lower back	1.64	1.50	1.00	1.29
Left back shoulder	1.00	1.00	0.00	1.00
Right back shoulder	1.00	1.00	0.00	1.03
Right front shoulder	0.85	1.00	0.00	0.96
Right front wrist	1.08	1.00	0.00	1.12

NOTE: Severity of discomfort was rated using the following five point scale:
0 = "***NO DISCOMFORT***"
1 = "***MINIMAL*** (discomfort is present, but I can ignore it)"
2 = "***SLIGHT*** (discomfort is present and I can't ignore it)"
3 = "***MODERATE*** (discomfort affects my ability to work and to concentrate)"
4 = "***SEVERE*** (discomfort affects my ability to work and to concentrate)"
5 = "***INTOLERABLE*** (discomfort makes work and activities of daily living nearly impossible)" (Initial participant questionnaire, page 7; see Appendix D)

Examination of Initial Group Equivalence of Discomfort Severity, Frequency, and Duration Ratings

The initial discomfort severity, frequency, and duration ratings for the two instructional groups were compared for each of the nine body parts selected for further study. A Mann-Whitney test, corrected for ties, was performed for each of these nine body parts to determine if the two instructional groups had been drawn from the same population. As shown in Table 10, at the beginning of the study, the members of the PC-3D-ME instructional group experienced higher levels of discomfort severity, frequency, and duration in most, but not all, of the nine selected body parts. The mean ranks of the discomfort severity, frequency, and duration ratings were not statistically significantly except in the upper and lower back.

Table 10

Mean Ranks for Discomfort Severity, Frequency, and Duration in Nine Selected Body Parts and Significance of the Differences

		Mean Rank					
		Severity		Frequency		Duration	
Body Part	N	PC -3D- ME	LOC	PC -3D- ME	LOC	PC -3D- ME	LOC
Eyes	59	31.07	28.90	32.78	27.12	30.73	29.24
Front neck	†	30.55	28.45	31.02	28.95	30.83	28.17
Back neck	58	32.52	26.48	33.34	25.66+	32.88	26.12
Upper back	58	33.40+	25.32+	34.40*	24.25*	34.05*	24.63*
Lower back	58	33.98*	24.70*	34.58*	24.05*	33.93*	24.75*
Left back shoulder	59	29.03	31.00	29.12	30.19	28.17	31.90
Right back shoulder	59	30.33	29.66	30.43	29.55	29.95	30.05
Right front shoulder	59	28.52	31.53	29.62	30.40	28.20	31.86
Right front wrist	59	31.92	28.02	32.75	27.16	33.92	25.95+

NOTE: † In the front of the neck, N = 58 for discomfort severity and duration and 59 for discomfort frequency.

*Mann Whitney $p < .05$ two-tailed test, corrected for ties.

+Approaches significance: Mann Whitney $p < .10$ two-tailed test, corrected for ties.

Overall Changes in Discomfort Severity, Frequency, and Duration Ratings During the Course of This Study

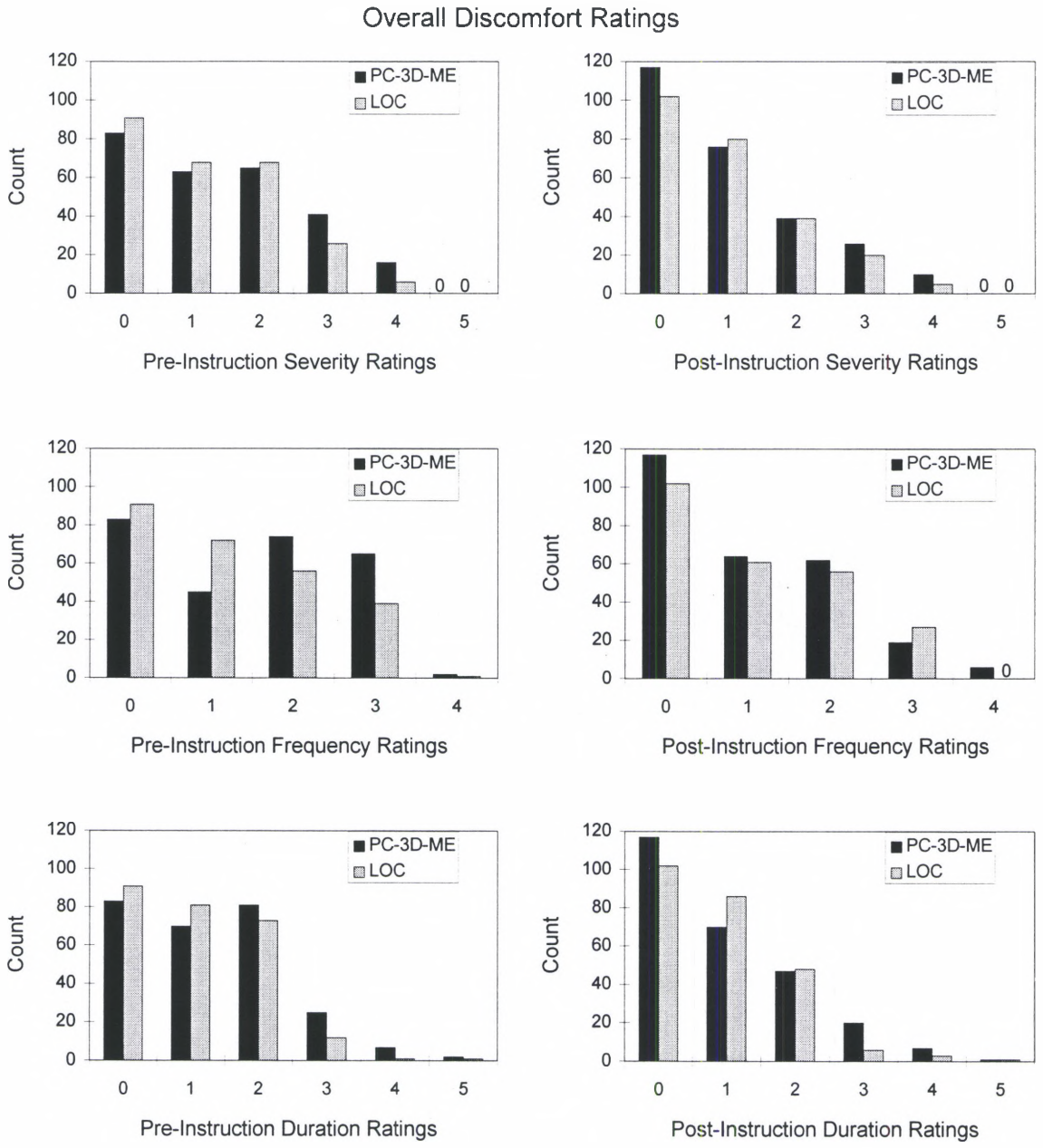
To gain an overview of changes in discomfort nine weeks after instruction, the number (count) of discomfort severity, frequency, and duration ratings was tabulated for each of the nine body parts selected for further study both before, and nine weeks after, instruction. Visual inspection of Figure 9 shows that nine weeks after instruction the number of participants reporting little or no WBPD was greater than it was before instruction. However, because each individual participant contributed more than one score to the overall figure, it was not possible to use a chi-square statistic to ascertain whether the changes in the distribution of discomfort ratings were statistically significant.

In each of the nine body parts selected for further study, the number (count) of discomfort severity, frequency, and duration ratings was tabulated both before and after

instruction, (see Figures 10 through 18). Visual inspection of these Figures reveals several characteristics of the discomfort experienced in these nine body parts.

First, no one reported a discomfort severity rating of "intolerable" (severity rating = 5) either before, or after, instruction. However, a few individuals rated the frequency and/or the duration of their discomfort at the highest possible levels in some of the nine body parts selected for further analysis (*i.e.,* frequency rating = 4, ALWAYS; duration rating = 5, IT DOESN'T GO AWAY). Second, the shapes of the distributions of discomfort severity, frequency, and duration ratings for a single body part were not necessarily consistent, and the modal value for one dimension of discomfort (*i.e.,* severity, frequency, and duration) in one body part was not necessarily the modal value for another dimension of discomfort in the same body part. Third, in all nine body parts, the distribution of discomfort severity, frequency, and duration ratings after instruction was different from the distribution of ratings before instruction.

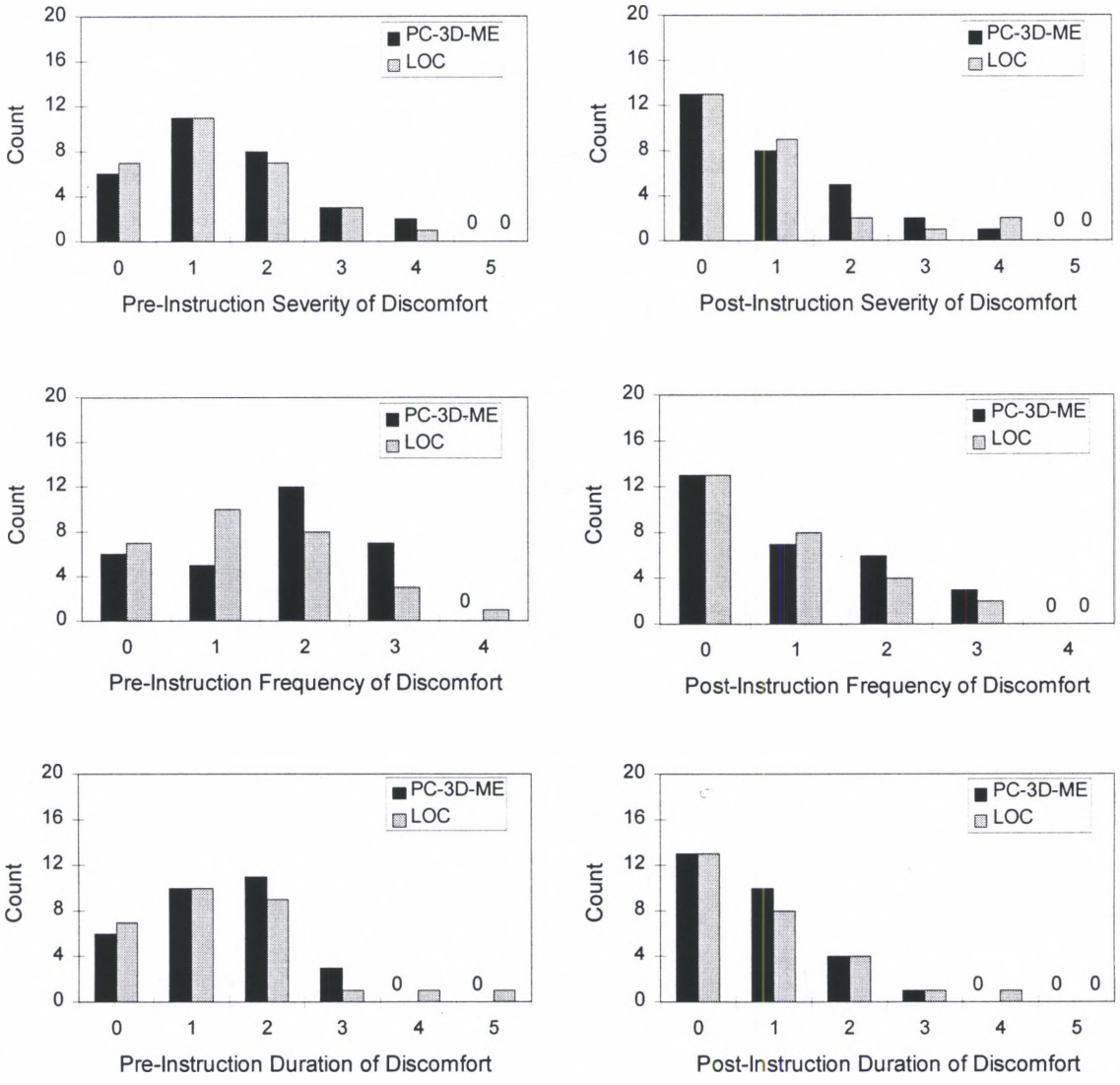
Descriptive statistics (see Tables 11, 12, and 13) for the nine selected body parts confirm the visual impression that in many cases, the modal value nine weeks after instruction was lower than the modal value before instruction (*i.e.,* the modal value went down from 2 to 1, or from 1 to 0). Descriptive statistics also indicate that is a most cases, the mean and median discomfort severity, frequency, and duration ratings also decreased.



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 9. Overall count of discomfort ratings in nine selected body parts before (pre-) and nine weeks after (post-) instruction.

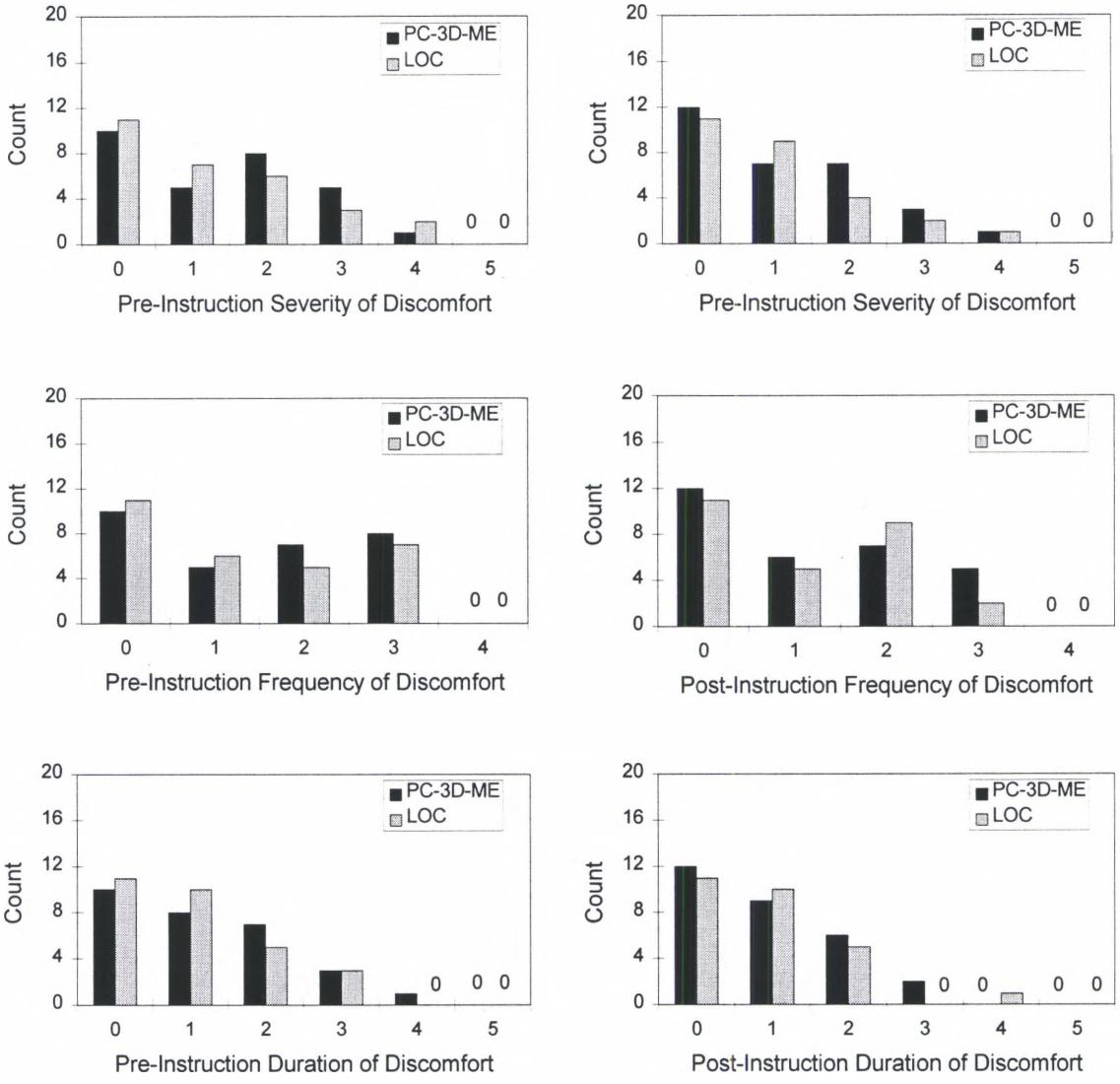
EYES



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 10. Pre- and post-instruction discomfort ratings in the eyes

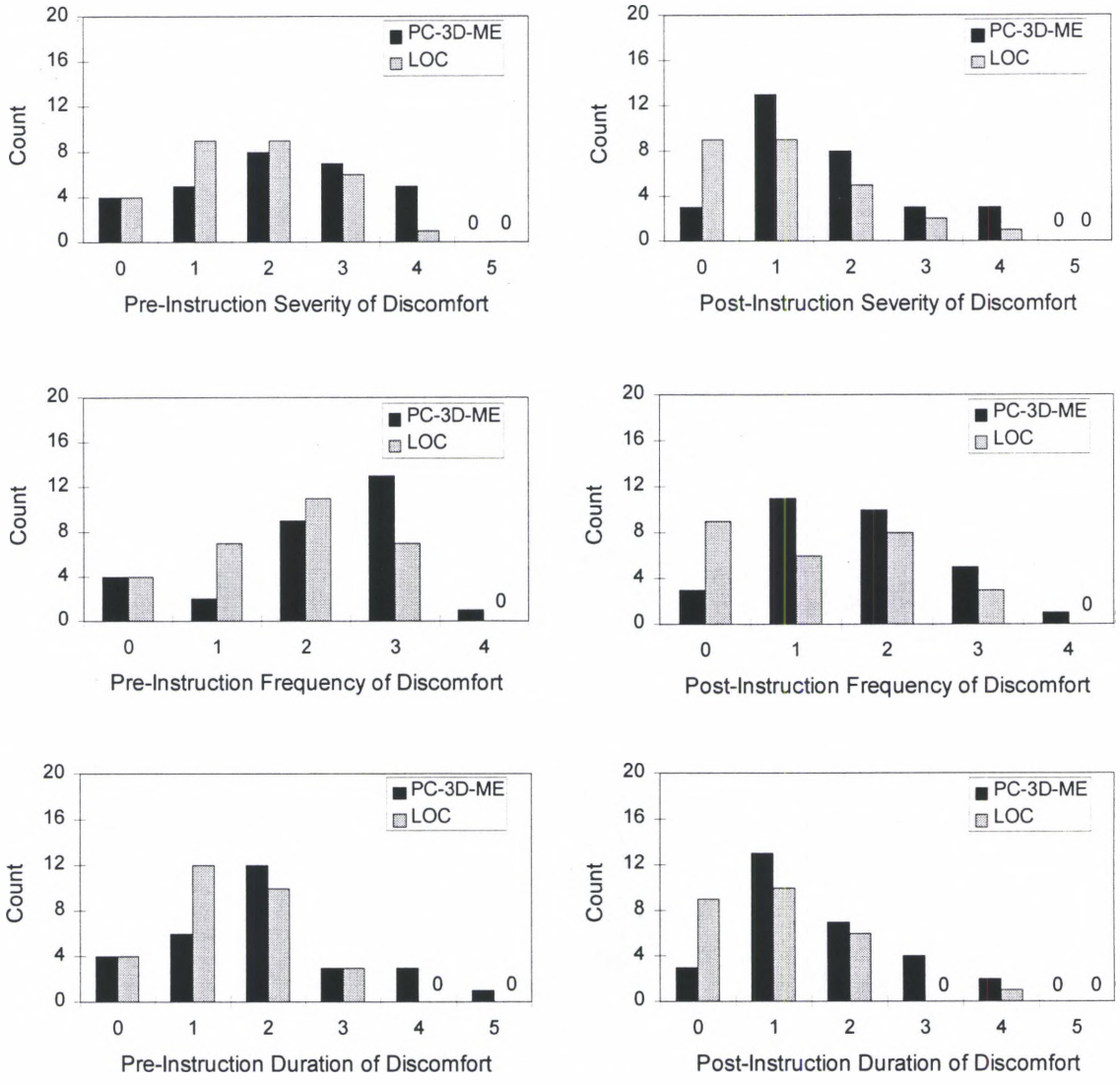
FRONT OF THE NECK



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 11. Pre- and post-instruction discomfort ratings in the front of the neck.

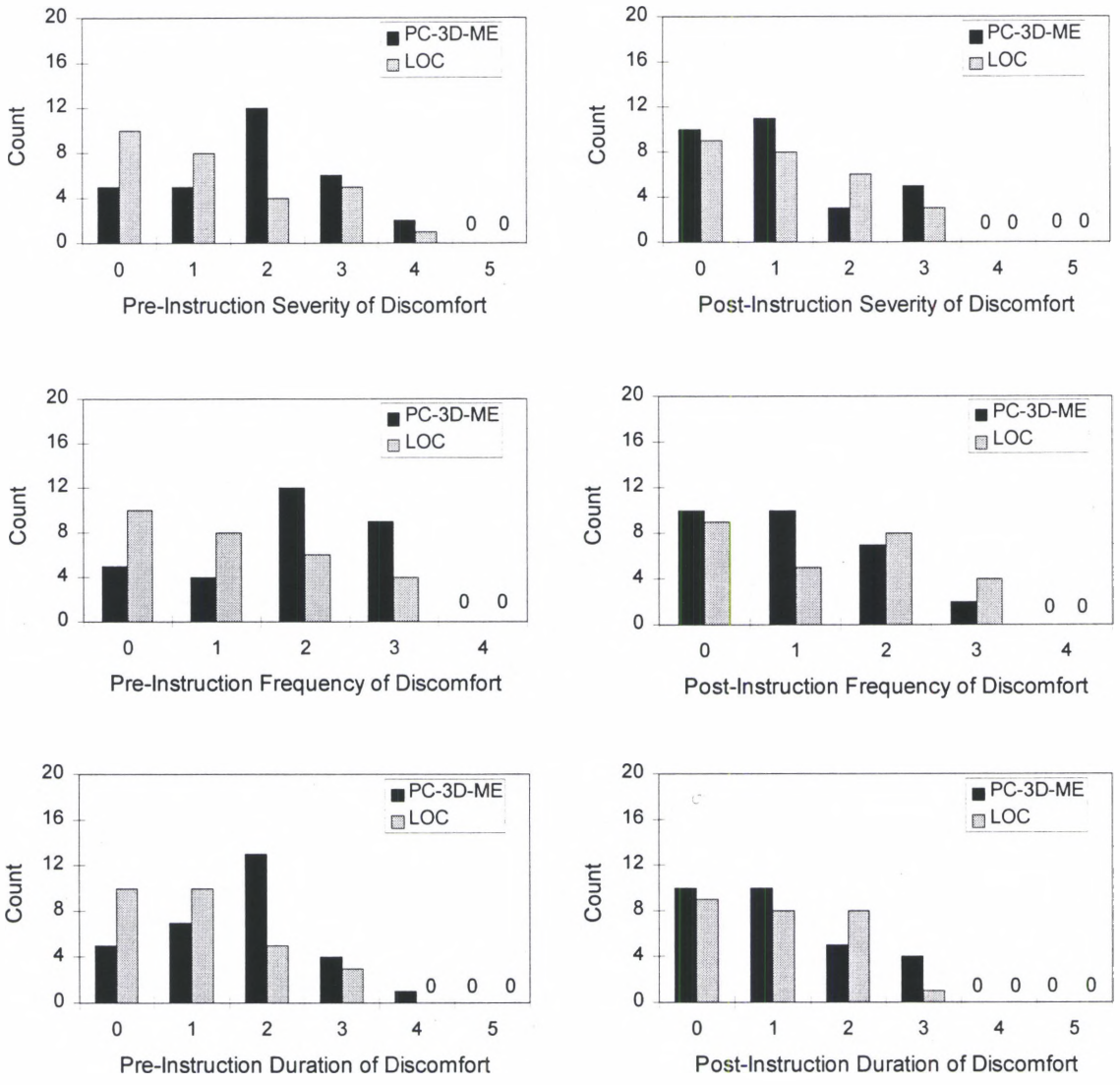
BACK OF THE NECK



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 12. Pre- and post-instruction discomfort ratings in the back of the neck.

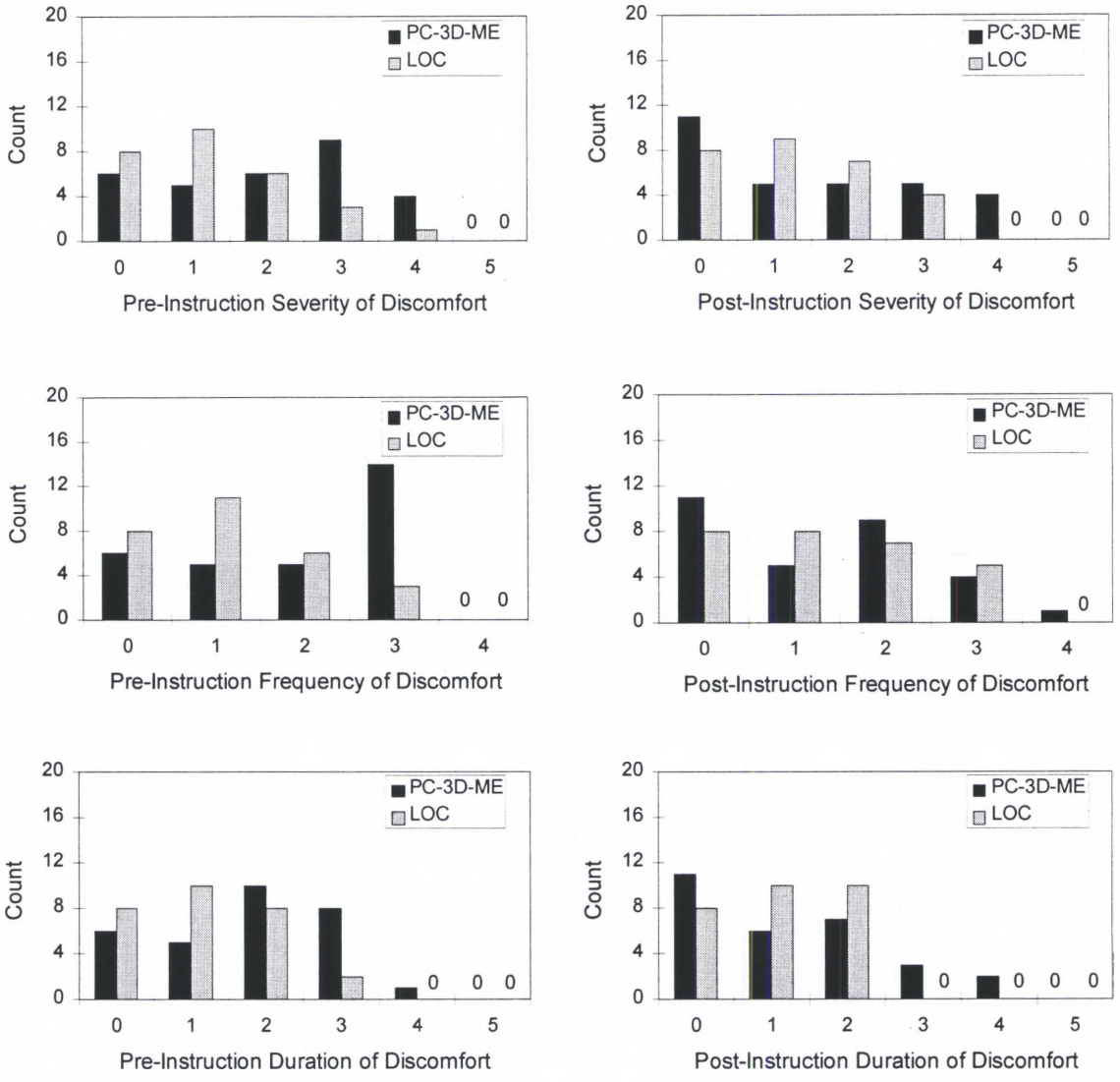
UPPER BACK



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 13. Pre- and post-instruction discomfort ratings in the upper back.

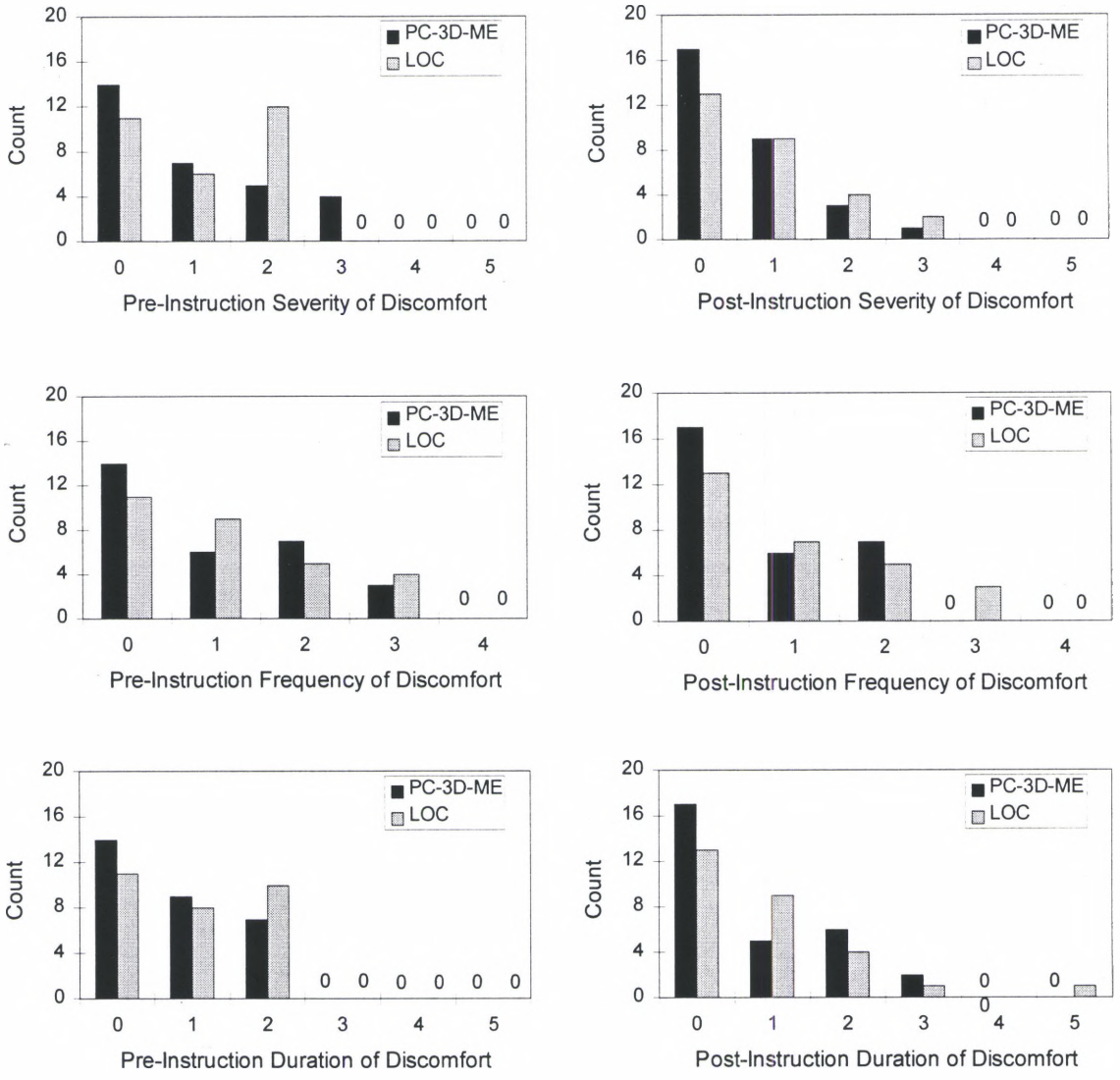
LOWER BACK



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 14. Pre- and post-instruction discomfort ratings in the lower back.

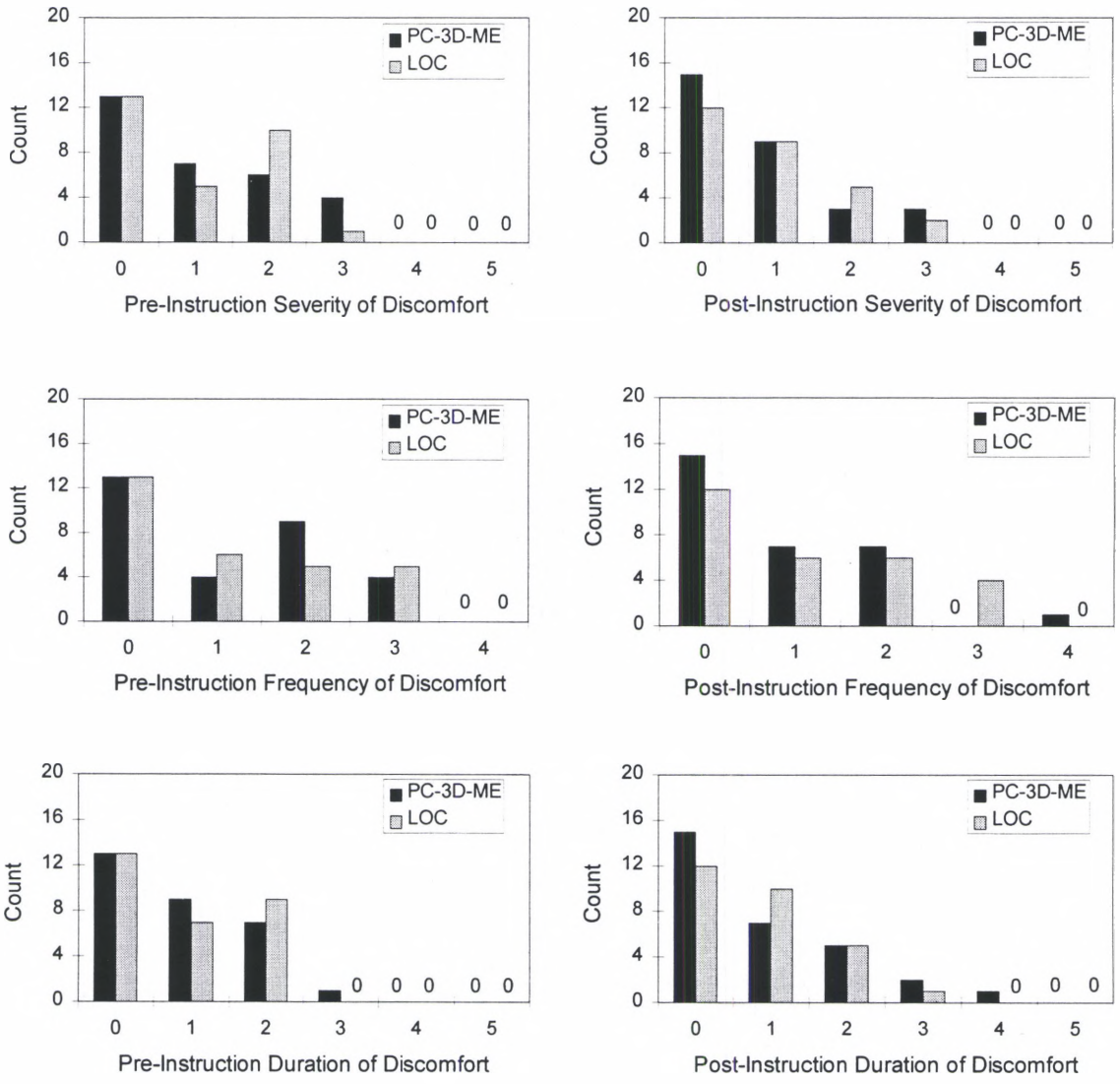
LEFT BACK SHOULDER



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 15. Pre- and post-instruction discomfort ratings in the left back shoulder.

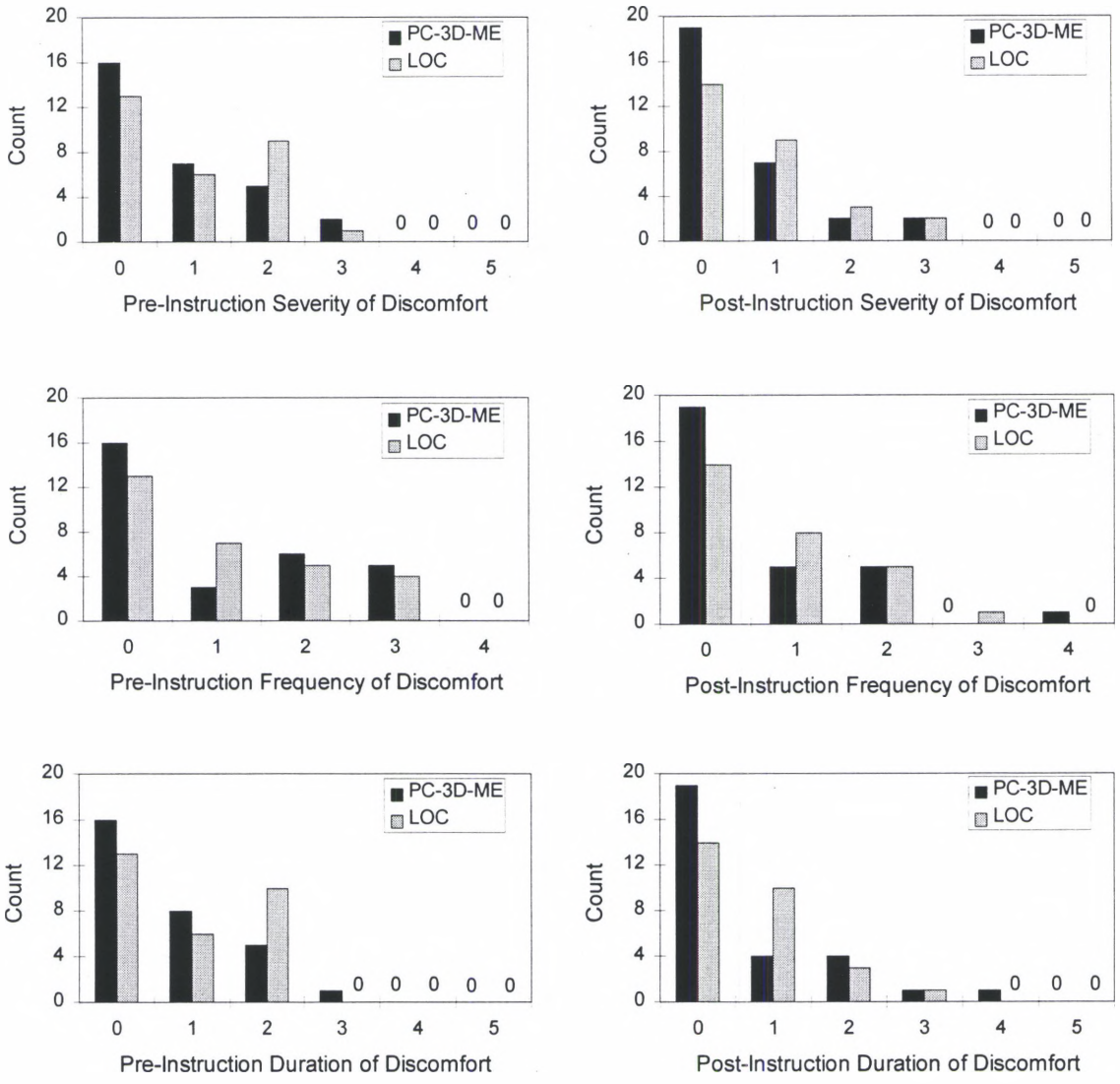
RIGHT BACK SHOULDER



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 16. Pre- and post-instruction discomfort ratings in the right back shoulder.

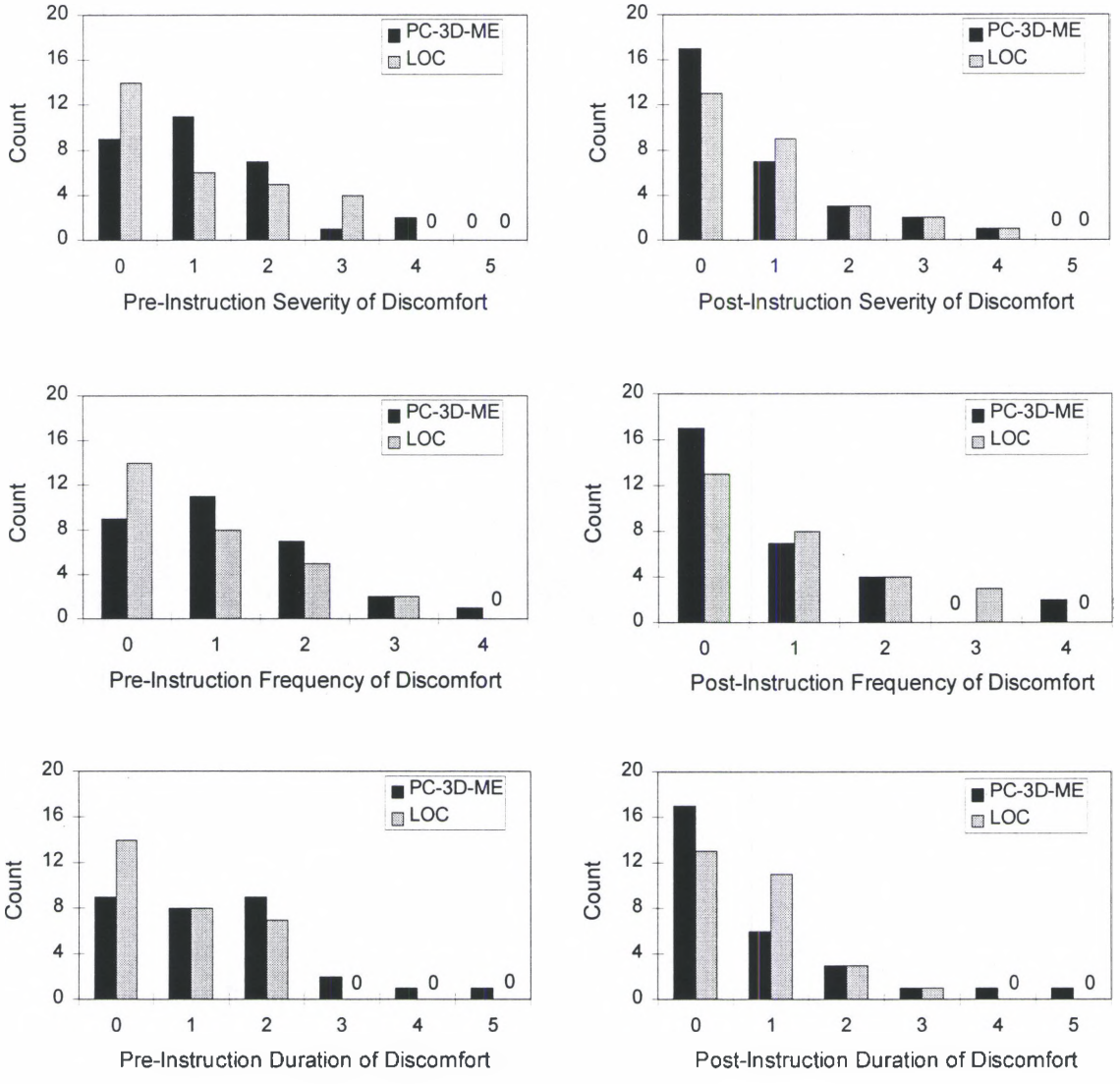
RIGHT FRONT SHOULDER



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 17. Pre- and post-instruction discomfort ratings in the right front shoulder.

RIGHT FRONT WRIST



SEVERITY	FREQUENCY	DURATION
0 = no discomfort	0 = never	0 = I do not have any discomfort
1 = minimal discomfort	1 = not very often	1 = it doesn't last long
2 = slight discomfort	2 = sometimes	2 = it lasts several hours
3 = moderate discomfort	3 = quite often	3 = it lasts overnight
4 = severe discomfort	4 = always	4 = it rarely goes away
5 = intolerable discomfort		5 = it doesn't go away

Figure 18. Pre- and post-instruction discomfort ratings in the right front wrist.

Table 11

Descriptive Statistics for Discomfort Severity in Nine Selected Body Parts

PC-3D-ME Discomfort Severity												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Severity+			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.47	1.00	1.00	1.14	0.97	1.00	0.00	1.12	-0.50	0.00	-1.00	-0.02
Front neck	1.38	1.00	0.00	1.24	1.13	1.00	0.00	1.17	-0.25	0.00	0.00	-0.07
Back neck	2.14	2.00	2.00	1.30	1.67	1.00	1.00	1.12	-0.47	-1.00	-1.00	-0.18
Upper back	1.83	2.00	2.00	1.15	1.10	1.00	1.00	1.08	-0.73	-1.00	-1.00	-0.07
Lower back	2.00	2.00	3.00	1.36	1.53	1.00	0.00	1.48	-0.47	-1.00	-3.00	+0.12
Left back shoulder	0.97	1.00	0.00	1.10	0.60	0.00	0.00	0.81	-0.37	-1.00	0.00	-0.29
Right back shoulder	1.03	1.00	0.00	1.10	0.80	0.50	0.00	1.00	-0.23	-0.50	0.00	-0.10
Right front shoulder	0.77	0.00	0.00	0.97	0.57	0.00	0.00	0.90	-0.20	0.00	0.00	-0.07
Right front wrist	1.20	1.00	1.00	1.13	0.77	0.00	0.00	1.10	-0.43	-1.00	-1.00	-0.03
LOC Discomfort Severity												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Severity+			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.31	1.00	1.00	1.07	0.89	1.00	0.00	1.19	-0.42	0.00	-1.00	+0.12
Front neck	1.24	1.00	0.00	1.27	1.00	1.00	0.00	1.11	-0.24	0.00	0.00	-0.16
Back neck*	1.69	2.00	1.00/ 2.00	1.07	1.12	1.00	0.00/ 1.00	1.11	-0.57	-1.00	-1.00/ -1.00	+0.04
Upper back	1.25	1.00	0.00	1.24	1.12	1.00	0.00	1.03	-0.13	0.00	0.00	-0.21
Lower back	1.25	1.00	1.00	1.11	1.25	1.00	1.00	1.04	0.00	0.00	0.00	-0.07
Left back shoulder	1.03	1.00	2.00	0.91	0.82	1.00	0.00	0.94	-0.21	0.00	-2.00	+0.03
Right back shoulder	0.97	1.00	0.00	0.98	0.89	1.00	0.00	0.96	-0.08	0.00	0.00	-0.02
Right front shoulder	0.93	1.00	0.00	0.96	0.75	0.50	0.00	0.93	-0.18	-0.50	0.00	-0.03
Right front wrist	0.97	1.00	0.00	1.12	0.89	1.00	0.00	1.10	-0.08	0.00	0.00	-0.02

NOTE: * Multiple modes exist.

+Change scores were calculated by subtracting the value nine weeks after instruction from the value before instruction.

Table 12
Descriptive Statistics for Discomfort Frequency in Nine Selected Body Parts

PC-3D-ME Discomfort Frequency												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Frequency[+]			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.67	2.00	2.00	1.06	0.97	1.00	0.00	1.05	-0.70	-1.00	-2.00	-0.01
Front neck	1.43	1.50	0.00	1.22	1.17	1.00	0.00	1.15	-0.26	-0.50	0.00	-0.07
Back neck	2.17	2.00	3.00	1.10	1.67	2.00	1.00	0.99	-0.50	0.00	-2.00	-0.11
Upper back*	1.83	2.00	2.00	1.05	1.03	1.00	0.00/ 1.00	0.94	-0.80	-1.00	-2.00/ -1.00	-0.11
Lower back	1.90	2.00	3.00	1.21	1.30	1.00	0.00	1.21	-0.60	-1.00	-3.00	0.00
Left back shoulder	0.97	1.00	0.00	1.07	0.67	0.00	0.00	0.84	-0.30	-1.00	0.00	-0.23
Right back shoulder	1.13	1.00	0.00	1.14	0.83	0.50	0.00	1.02	-0.30	-0.50	0.00	-0.12
Right front shoulder	1.00	0.00	0.00	1.20	0.63	0.00	0.00	1.00	-0.37	0.00	0.00	-0.20
Right front wrist	1.17	1.00	1.00	1.05	0.77	0.00	0.00	1.14	-0.40	-1.00	-1.00	+0.09
LOC Discomfort Frequency												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Frequency[+]			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.34	1.00	1.00	1.08	0.82	1.00	0.00	0.96	-0.52	0.00	-1.00	-0.12
Front neck	1.28	1.00	0.00	1.22	1.07	1.00	0.00	1.04	-0.21	0.00	0.00	-0.18
Back neck	1.72	2.00	2.00	1.00	1.19	1.00	0.00	1.06	-0.53	-1.00	-2.00	+0.06
Upper back	1.14	1.00	0.00	1.08	1.27	1.00	0.00	1.12	+0.13	0.00	0.00	+0.04
Lower back	1.14	1.00	1.00	0.97	1.32	1.00	0.00	1.09	+0.18	0.00	-1.00	+0.12
Left back shoulder	1.07	1.00	0.00	1.07	0.93	1.00	0.00	1.05	-0.14	0.00	0.00	-0.02
Right back shoulder	1.07	1.00	0.00	1.16	1.07	1.00	0.00	1.12	0.00	0.00	0.00	-0.04
Right front shoulder	1.00	1.00	0.00	1.10	0.75	0.50	0.00	0.89	-0.25	-0.50	0.00	-0.21
Right front wrist	0.83	1.00	0.00	0.97	0.89	1.00	0.00	1.03	+0.06	0.00	0.00	+0.06

NOTE: *Multiple modes exist.

[+]Change scores were calculated by subtracting the value nine weeks after instruction from the value before instruction.

Table 13

Descriptive Statistics for Discomfort Duration in Nine Selected Body Parts

PC-3D-ME Discomfort Duration												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Duration+			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.37	1.00	2.00	0.93	0.75	1.00	0.00	0.84	-0.62	0.00	-2.00	-0.09
Front neck	1.21	1.00	0.00	1.15	0.93	1.00	0.00	0.96	-0.28	0.00	0.00	-0.19
Back neck	1.93	2.00	2.00	1.28	1.62	1.00	1.00	1.08	-0.31	-1.00	-1.00	-0.20
Upper back	1.63	2.00	2.00	1.03	1.10	1.00	0.00	1.05	-0.53	-1.00	-2.00	+0.02
Lower back	1.77	2.00	2.00	1.16	1.28	1.00	0.00	1.28	-0.49	-1.00	-2.00	+0.12
Left back shoulder	0.77	1.00	0.00	0.82	0.77	0.00	0.00	1.01	0.00	-1.00	0.00	+0.19
Right back shoulder	0.87	1.00	0.00	0.90	0.90	0.50	0.00	1.12	+0.03	-0.50	0.00	+0.22
Right front shoulder	0.70	0.00	0.00	0.88	0.66	0.00	0.00	1.08	-0.04	0.00	0.00	+0.20
Right front wrist*	1.37	1.00	0.00/ 2.00	1.27	0.83	0.00	0.00	1.31	-0.54	-1.00	0.00/ -2.00	+0.04

LOC Discomfort Duration												
	Before Instruction				Nine Weeks After Instruction				Change in Discomfort Duration+			
Body Part	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*	Mean	Median	Mode	*SD*
Eyes	1.38	1.00	1.00	1.21	0.85	1.00	0.00	1.06	-0.53	0.00	-1.00	-0.15
Front neck	1.00	1.00	0.00	1.00	0.89	1.00	0.00	0.97	-0.11	0.00	0.00	-0.03
Back neck	1.41	1.00	1.00	0.87	1.00	1.00	1.00	0.98	-0.41	0.00	0.00	+0.11
Upper back*	1.04	1.00	0.00/ 1.00	1.00	1.04	1.00	0.00	0.92	0.00	0.00	0.00/ -1.00	-0.08
Lower back	1.14	1.00	1.00	0.93	1.07	1.00	1.00	0.81	-0.07	0.00	0.00	-0.12
Left back shoulder	0.97	1.00	0.00	0.86	0.89	1.00	0.00	1.17	-0.08	0.00	0.00	+0.31
Right back shoulder	0.86	1.00	0.00	0.88	0.82	1.00	0.00	0.86	-0.04	0.00	0.00	-0.02
Right front shoulder	0.90	1.00	0.00	0.90	0.68	0.50	0.00	0.82	-0.22	-0.50	0.00	+0.08
Right front wrist	0.76	1.00	0.00	0.83	0.75	1.00	0.00	0.93	-0.01	0.00	0.00	+0.10

NOTE: *Multiple modes exist.

+Change scores were calculated by subtracting the value nine weeks after instruction from the value before instruction.

Description of Changes in *Individual* Discomfort Severity, Frequency, and Duration Ratings in Each of Nine Selected Body Parts

In order to understand the nature of the changes in discomfort ratings that occurred in each of the nine body parts examined, each individual's pre- and post-instruction discomfort severity, frequency, and duration ratings were plotted against each other. Figures 19 through 27 show each possible combination of pre- and post-instruction discomfort ratings in each of the nine body parts examined, and the number of individuals who reported that combination. Shading is used to indicate the three possible discomfort outcomes:

These figures show the actual numbers of individuals in each instructional group who reported each combination of pre- and nine weeks post-instruction discomfort severity, frequency, and duration ratings. Addition can be used to calculate the number of individuals who reported decreased discomfort, no change in discomfort, or increased discomfort for either instructional group, for any body part, and for any dimension of discomfort (*i.e.,* severity, frequency, or duration). For example, examination of the upper left matrix in Figure 19 shows that, for the body part "eyes," five people in the PC-3D-ME instructional group reported no discomfort (*i.e.,* severity = 0) before instruction; thirteen people (the sum of the zero severity column) reported no discomfort (*i.e.,* severity = 0) nine weeks after instruction. Twelve people reported a decrease in discomfort severity from before instruction to nine weeks after instruction (the unshaded area). Fourteen people reported no change in discomfort severity (the diagonal shaded with horizontal lines). Three people reported an increase in discomfort severity (the lower area shaded with cross-hatching). Two of the people who reported an increase in discomfort reported an increase in discomfort severity from a rating of 1 before instruction to a rating of 2 nine weeks

after instruction; the remaining person reported an increase in discomfort severity from a rating of 1 before instruction to a rating of 3 nine weeks after instruction.

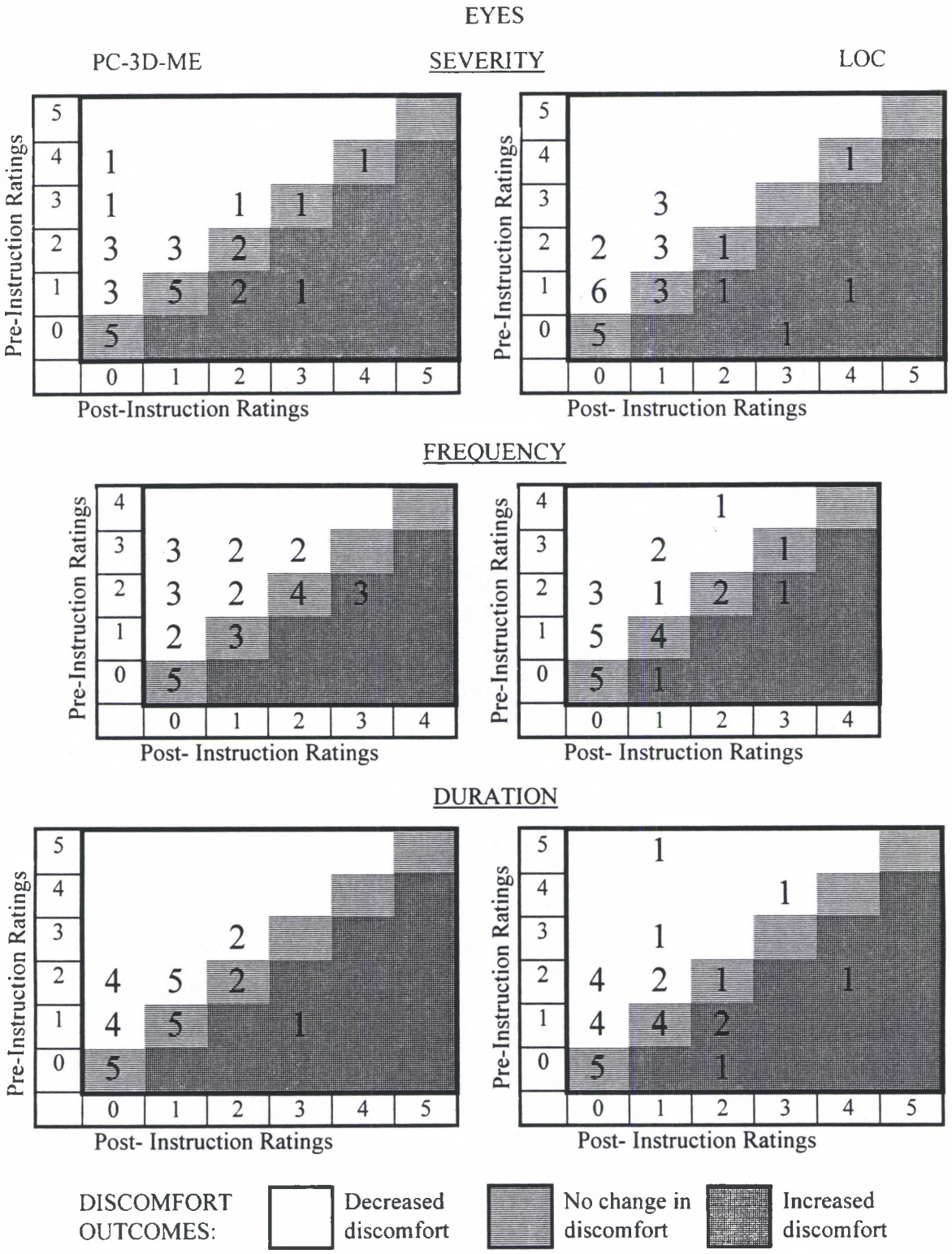


Figure 19. Change in discomfort ratings in the eyes from before (pre-) instruction to nine weeks after (post-) instruction.

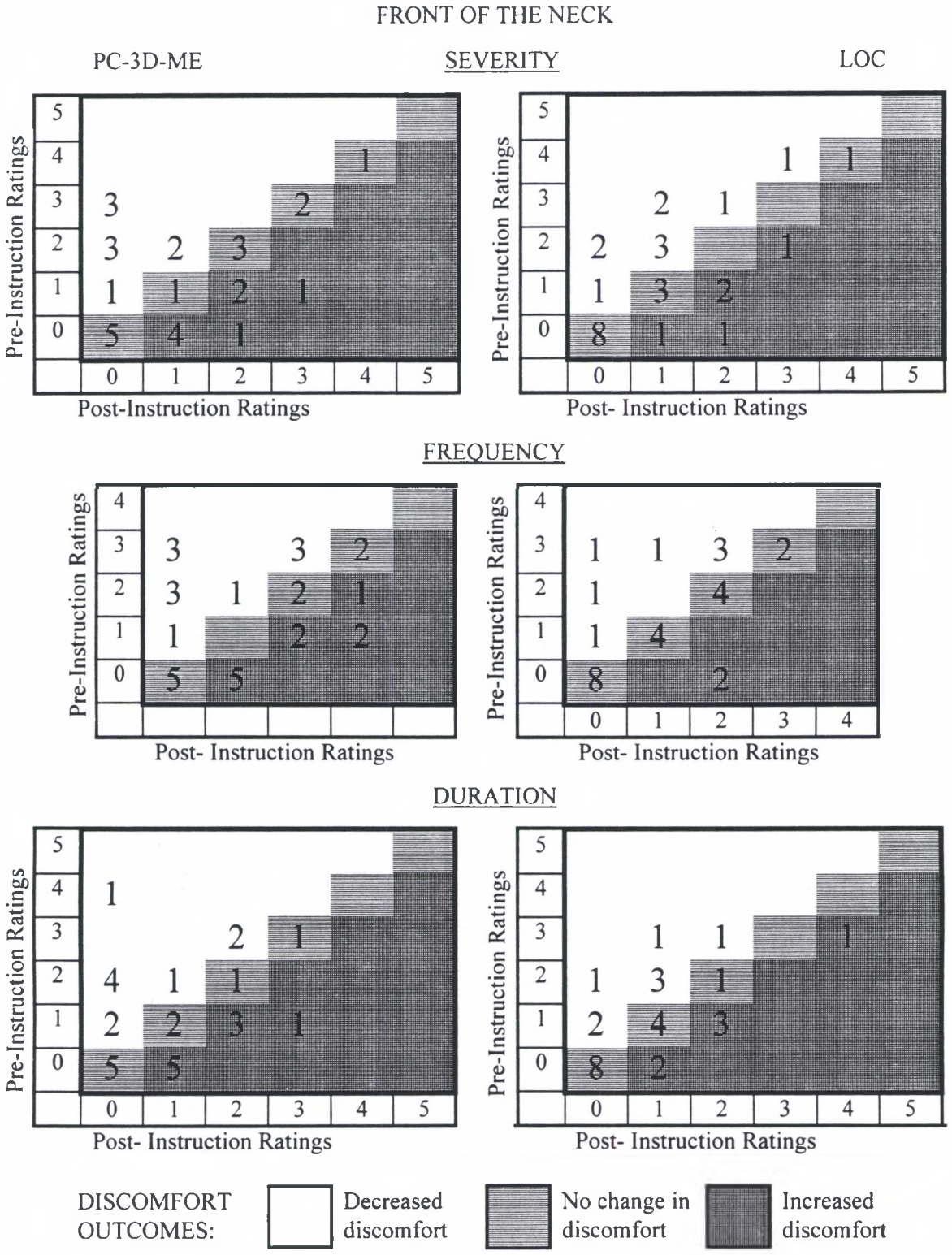


Figure 20. Change in discomfort ratings in the front of the neck from before (pre-) instruction to nine weeks after (post-) instruction.

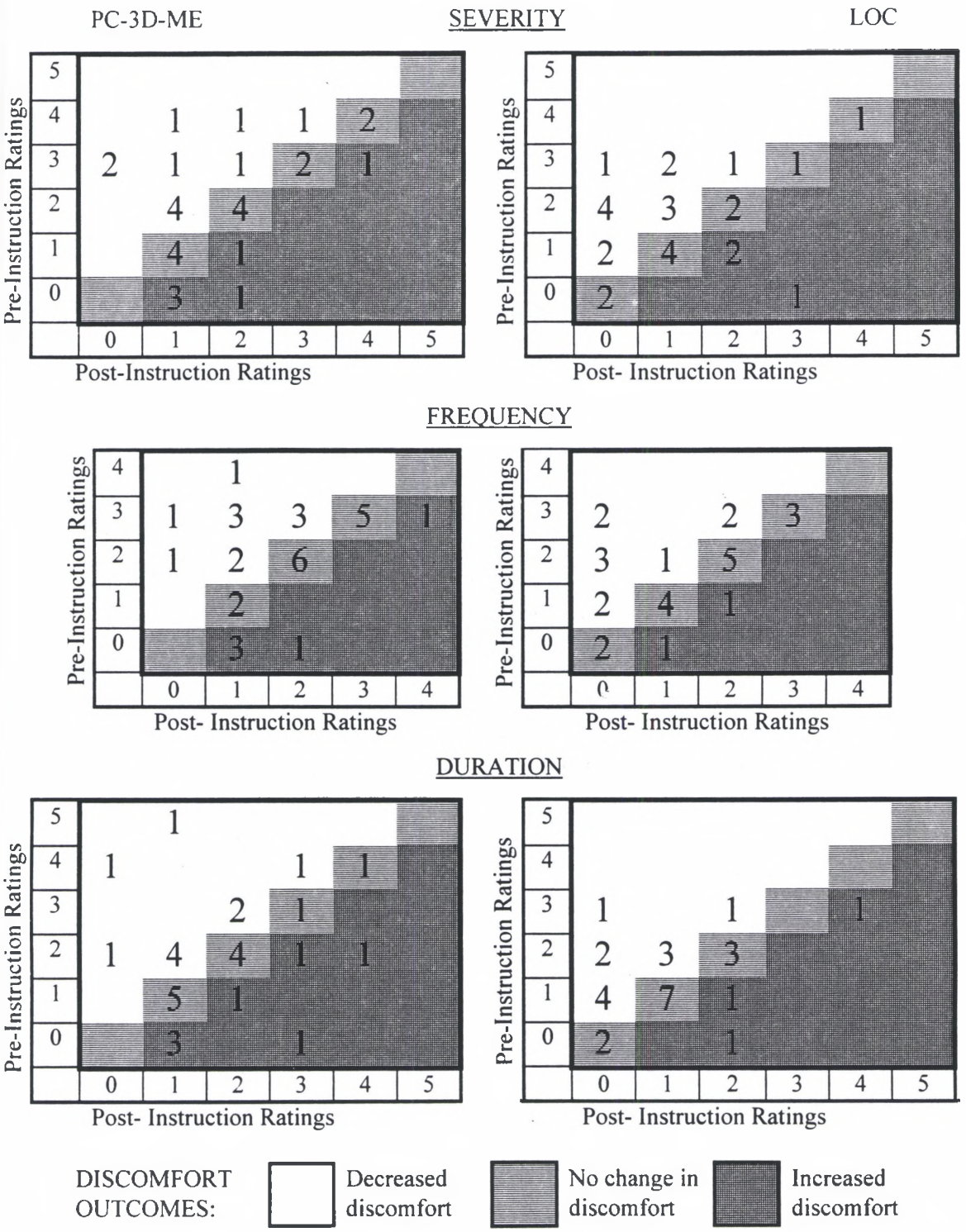


Figure 21. Change in discomfort ratings in the back of the neck from before (pre-) instruction to nine weeks after (post-) instruction.

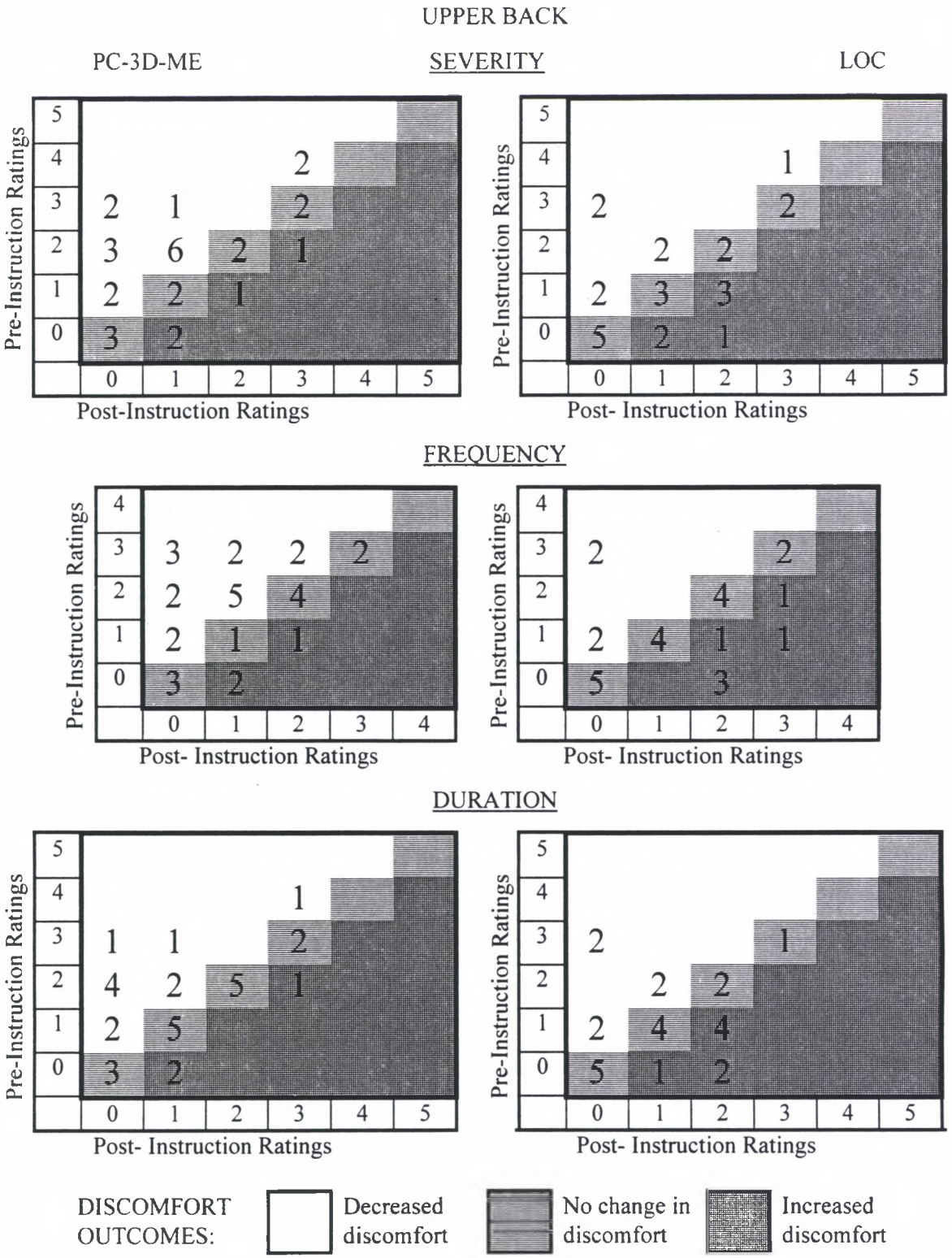


Figure 22. Change in discomfort ratings in the upper back from before (pre-) instruction to nine weeks after (post-) instruction.

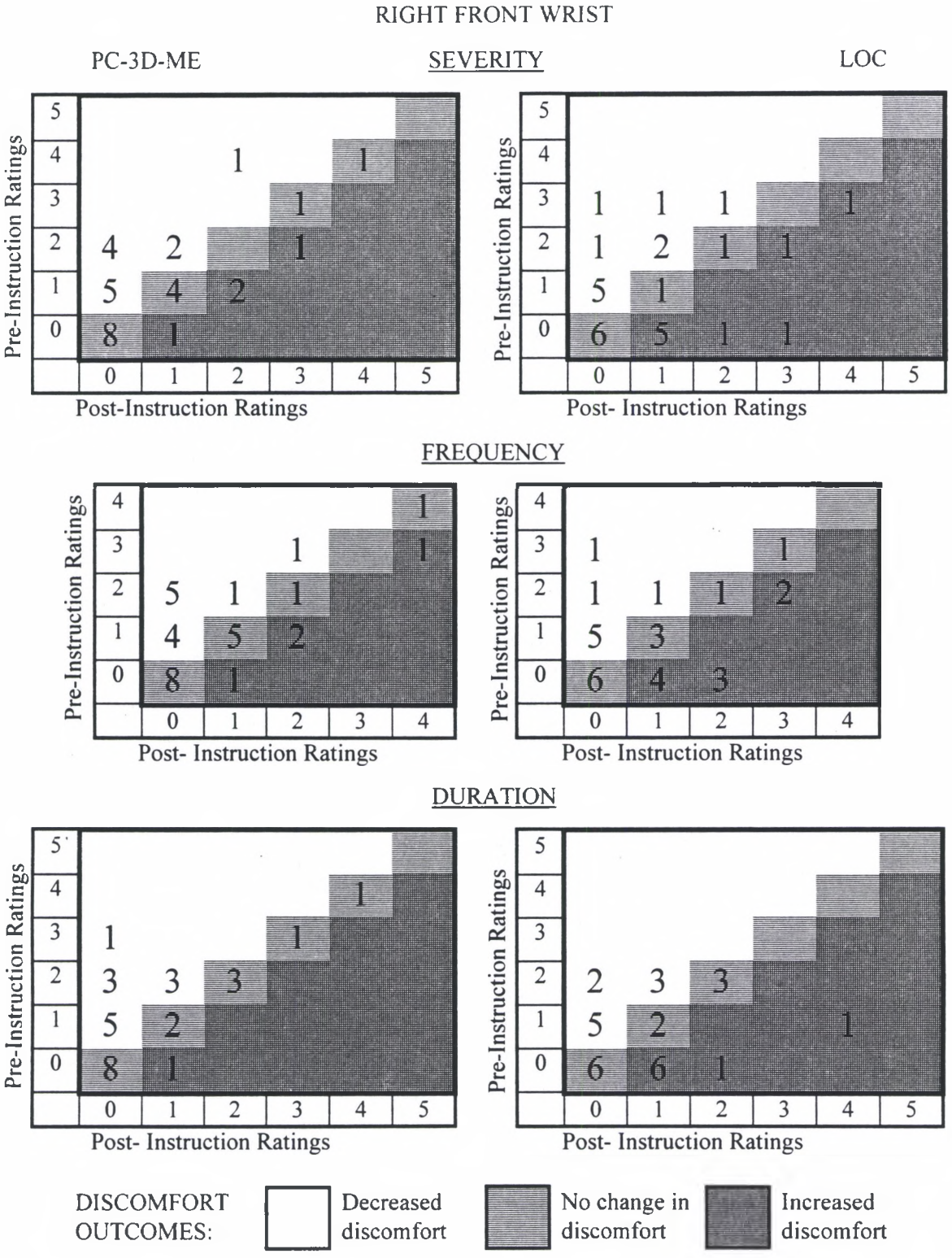


Figure 27. Change in discomfort ratings in the right front wrist from before (pre-) instruction to nine weeks after (post-) instruction.

Analysis of Significance of Changes in Discomfort Severity, Frequency, and Duration Ratings

Analysis of the significance of changes in WBPD was conducted using change scores calculated from each individual's pre-instruction, and nine weeks post-instruction discomfort severity, frequency, and duration ratings. The results of statistical analysis of these change scores will be presented following a description of the procedure used to calculate individual change scores. Description of the results will be structured in three sections: (1) significance of *between* groups changes in the total study population, (2) significance of *between* groups changes in the sub-population that reported a change in discomfort during the course of the study, and (3) significance of *within* groups changes in the sub-population that reported a change in discomfort during the course of the study.

Calculating *Individual* Change Scores for Discomfort Severity, Frequency, and Duration in Nine Selected Body Parts. Change scores for each individual's discomfort severity, frequency, and duration were calculated by subtracting each pre-instruction rating from the corresponding nine weeks post-instruction rating. The resulting scores were recoded as follows:

Minus 1 (-1)	=	Decreased discomfort, regardless of the magnitude of the decrease
Zero (0)	=	No change in discomfort
Plus 1 (+1)	=	Increased discomfort, regardless of the magnitude of the increase

These categorical change scores were then used for statistical analysis.

Significance of *Between* Groups Changes in Total Study Population. Chi square was used to determine whether the changes in discomfort severity, frequency, and duration ratings that were observed in the two instructional groups nine weeks after instruction were statistically significant. In order to avoid violating the chi-square assumptions concerning expected values,

the change scores were recoded with the individuals who reported no change in discomfort grouped together with the individuals who reported an increase in discomfort. This composite group was then compared with the group of individuals who reported a decrease in discomfort. The result of this grouping strategy was a *very conservative* test of those who reported a decrease in discomfort against all others. Table 14 shows the chi-square values associated with this comparison in each of the nine body parts analyzed. Examination of the differences between the two groups in the 27 body-part outcomes (9 body-parts x 3 dimensions of discomfort), shows that in 19 cases the outcome favors the PC-3D-ME instructional group; in 7 cases it favors the LOC instructional group, and there was one tie. Analysis of this difference using a Sign Test showed that the difference was significant (N = 26 [the one tie was dropped from the analysis], $k = 7$, $p = .014$). Because of differences in the initial level of discomfort in the two instructional groups, a second, more conservative Sign Test was conducted using only the 21 body parts in which the initial levels of discomfort were equivalent (N = 21, $k = 7$, $p = .095$). Again, the one tie was dropped from the analysis.

As shown earlier (see Figures 9-18), both groups reported decreases in discomfort severity, frequency, and duration ratings. In the majority of cases, the number of participants reporting a decrease in discomfort severity, frequency, or duration was greater in the PC-3D-ME instructional group than in the LOC instructional group (see Figures 19-27). However, the meaning of the one significant difference between the two instructional groups, the frequency of discomfort in the upper back, is difficult to interpret because before instruction the mean rank of the discomfort frequency rating for the upper back was significantly higher in the PC-3D-ME instructional group than in the LOC instructional group, Mann-Whitney Test of Mean Ranks $p < .05$ (see Table 10).

Table 14

Chi-Square Test for Significance of *Between* Groups Change in Discomfort Severity, Frequency, and Duration in Each of Nine Selected Body Parts: Change in Total Sample Population‡

Body Part	df	N	χ^2	Group with Greater Number of Participants Reporting Reduced Discomfort
SEVERITY				
Eye	1	56	0.27	LOC
Front Neck	1	56	0.04	LOC
Back Neck	1	55	0.40	LOC
Upper Back	1	54	3.02+	PC-3D-ME
Lower Back	1	57	0.08	PC-3D-ME
Left Back Shoulder	1	58	0.00	PC-3D-ME
Right Back Shoulder	1	58	0.00	PC-3D-ME
Right Front Shoulder	1	58	0.00	PC-3D-ME/LOC
Right Front Wrist	1	58	0.00	PC-3D-ME
FREQUENCY				
Eye	1	56	0.00	PC-3D-ME
Front Neck	1	57	0.34	PC-3D-ME
Back Neck	1	55	0.00	PC-3D-ME
Upper Back	1	54	7.24**	PC-3D-ME
Lower Back	1	57	3.30†	PC-3D-ME
Left Back Shoulder	1	58	2.71	PC-3D-ME
Right Back Shoulder	1	58	2.44	PC-3D-ME
Right Front Shoulder	1	58	0.17	PC-3D-ME
Right Front Wrist	1	58	0.14	PC-3D-ME

NOTE: Total sample N = 59. All reported values calculated with continuity correction because the sample size is greater than 40.

‡Overall outcome in terms of group reporting greater number of participants with reduced discomfort favors PC-3D-ME (Sign Test N = 26, $k = 7$, $p = .014$; or without the five instances (Table 10) of significantly higher initial levels of discomfort, (Sign Text N = 21, $k = 7$, $p = .095$).

** $p < .01$, however before instruction, the mean rank of discomfort frequency in the upper back was significantly higher in the PC-3D-ME instructional group (see (Table 10)

+ probability approaches significance, $p < .10$. However before instruction, the differences in the mean rank for discomfort severity in the upper back approached significance (see (Table 10).

†probability approaches significance, $p < .10$. However before instruction the differences in the mean rank for discomfort frequency in the lower back approached significance (see Table 11)

Table 14

Chi-Square Test for Significance of *Between* Groups Change in Discomfort Severity, Frequency, and Duration in Each of Nine Selected Body Parts: Change in Total Sample Population‡

Body Part	df	N	χ^2	Group with Greater Number of Participants Reporting Reduced Discomfort
SEVERITY				
Eye	1	56	0.27	LOC
Front Neck	1	56	0.04	LOC
Back Neck	1	55	0.40	LOC
Upper Back	1	54	3.02+	PC-3D-ME
Lower Back	1	57	0.08	PC-3D-ME
Left Back Shoulder	1	58	0.00	PC-3D-ME
Right Back Shoulder	1	58	0.00	PC-3D-ME
Right Front Shoulder	1	58	0.00	PC-3D-ME/LOC
Right Front Wrist	1	58	0.00	PC-3D-ME
FREQUENCY				
Eye	1	56	0.00	PC-3D-ME
Front Neck	1	57	0.34	PC-3D-ME
Back Neck	1	55	0.00	PC-3D-ME
Upper Back	1	54	7.24**	PC-3D-ME
Lower Back	1	57	3.30†	PC-3D-ME
Left Back Shoulder	1	58	2.71	PC-3D-ME
Right Back Shoulder	1	58	2.44	PC-3D-ME
Right Front Shoulder	1	58	0.17	PC-3D-ME
Right Front Wrist	1	58	0.14	PC-3D-ME

NOTE: Total sample N = 59. All reported values calculated with continuity correction because the sample size is greater than 40.

‡Overall outcome in terms of group reporting greater number of participants with reduced discomfort favors PC-3D-ME (Sign Test N = 26, $k = 7$, $p = .014$; or without the five instances (Table 10) of significantly higher initial levels of discomfort, (Sign Text N = 21, $k = 7$, $p = .095$).

** $p < .01$, however before instruction, the mean rank of discomfort frequency in the upper back was significantly higher in the PC-3D-ME instructional group (see (Table 10)

+ probability approaches significance, $p < .10$. However before instruction, the differences in the mean rank for discomfort severity in the upper back approached significance (see (Table 10).

†probability approaches significance, $p < .10$. However before instruction the differences in the mean rank for discomfort frequency in the lower back approached significance (see Table 10).

Table 14 (continued)
Chi-Square Test for Significance of *Between* Groups Change in Discomfort Severity, Frequency, and Duration in Each of Nine Selected Body Parts: Change in Total Sample Population

DURATION				
Body Part	df	N	χ^2	Group with Greater Number of Participants Reporting Reduced Discomfort
Eye	1	55	0.02	PC-3D-ME
Front Neck	1	55	0.04	PC-3D-ME
Back Neck	1	54	0.05	LOC
Upper Back	1	54	0.65	PC-3D-ME
Lower Back	1	56	0.16	PC-3D-ME
Left Back Shoulder	1	58	0.02	LOC
Right Back Shoulder	1	58	0.02	LOC
Right Front Shoulder	1	57	0.01	LOC
Right Front Wrist	1	57	0.03	PC-3D-ME

Significance of *Between* Groups Changes in the Sub-Population That Reported a Change in Discomfort During the Course of the Study. A second, less conservative, approach to analyzing the statistical significance of the between groups changes in discomfort severity, frequency, and duration ratings is to look only at those participants who reported a change in WBPD during the course of the study. Using this approach has two major consequences: (1) all participants who experienced *no change* in discomfort were dropped from the analysis, and (2) the analysis was conducted using only a portion of the total sample population. Where possible, the analysis was conducted using chi-square, but when the data violated the Chi-square assumption concerning expected values, Fisher's Exact Test was used instead.

Table 15 shows that over the course of the study, approximately 50% (range 43% to 62%) of the total population reported a change in discomfort (*i.e.*, either an increase or a decrease in discomfort severity, frequency, or duration) in each of the nine selected body parts. Examination of Table 15 shows that the changes in the frequency of WBPD in upper and lower back, and in the duration of WBPD in the right front wrist were statistically significant ($p < .05$).

In each case the change favors the PC-3D-ME instructional group. However, as in the examination of change scores for the total sample population, the meaning of the differences in the upper and lower back is difficult to interpret because before instruction the mean ranks for discomfort frequency in the upper and lower back were significantly higher in the PC-3D-ME instructional group than in the LOC instructional group, Mann-Whitney Test of Mean Ranks $p < .05$ (see Table 10).

As in the preceding table showing the significance of change in the total sample population, examination of the differences between the two groups in the 27 body-part outcomes (9 body-parts x 3 dimensions of discomfort) shows that in 19 cases the outcome favors the PC-3D-ME instructional group. In 7 cases the outcome favors the LOC instructional group, and there is one tie. Analysis of this difference using a Sign Test showed that the difference was significant ($N = 26$, $k = 7$, $p = .014$). Because of differences in the initial level of discomfort in the two instructional groups, a second, more conservative Sign Test was conducted using only the 21 body parts in which the initial levels of discomfort were equivalent and dropping the one tie from the analysis ($N = 21$, $k = 7$, $p = .095$).

Interpretation of the change in discomfort duration in the right front wrist is clearer although the initial difference in mean ranks for discomfort duration in the right front wrist approached significance. Examination of the data for the right front wrist (see Figure 27) indicates that before instruction, a total of 22 of the study participants reported no discomfort—nine in the PC-3D-ME instructional group and 13 in the LOC instructional group. Nine weeks after instruction eight of the nine study participants in the PC-3D-ME instructional group continued to report no discomfort. In contrast, only six of the 13 study participants in the

LOC instructional group continued to report no discomfort. Analysis of this data shows that the difference approaches statistical significance ($p = .05$, Fisher's Exact Test, one-tailed).

Table 15

Test for Significance of *Between* Group Changes in Nine Selected Body Parts in Sub-Population That Experienced a Change in Discomfort Severity, Frequency, and Duration‡

SEVERITY							
Body Part	df	n,N	Minimum Expected Frequency	χ^2	χ^2 probability	Fisher's Exact Test	Group with Greater Number of Participants Reporting Reduced discomfort
Eye	1	32,56	2.81			.61	LOC
Front of Neck	1	32,56	6.09	.62	.43		LOC
Back of Neck	1	33,55	4.36			.25	LOC
Upper Back	1	33,54	3.94			.11	PC-3D-ME
Lower Back	1	31,57	5.81	.78	.38		PC-3D-ME
Left Back Shoulder	1	29,58	4.83			.40	PC-3D-ME
Right Back Shoulder	1	28,58	5.50	.15	.70		PC-3D-ME
Right Front Shoulder	1	25,58	4.32			.56	PC-3D-ME/LOC
Right Front Wrist	1	36,58	5.78	1.54	.21		PC-3D-ME

NOTE: The first number in the "n,N" column indicates the number of cases in the sub-population that reported a change in discomfort; the second number in the "n,N" column indicates the number of cases in the total study population.

Note also, Chi-square values and probabilities are presented where the data do not violate the Chi-square assumptions concerning expected values. when the data violate the assumption concerning expected values, the results of Fisher's Exact Test are presented instead.

‡Overall outcome in terms of group reporting greater number of participants with reduced discomfort favors PC-3D-ME (Sign Test N = 26, $k = 7$, $p = .014$; or without the five instances (see Table 10) of significantly higher initial levels of discomfort, Sign Text N = 21, $k = 7$, $p = .095$).

*$p < .05$. one-tailed. Note, however, that before instruction, the discomfort frequency in the upper back and the lower back was significantly higher in the PC-3D-ME instructional group (see Table 10).

Table 15 (continued)
Test for Significance of *Between* Group Changes in Nine Selected Body Parts in Sub-Population That Experienced a Change in Discomfort Severity, Frequency, and Duration

Body Part	df	n,N	Minimum Expected Frequency	χ^2	χ^2 probability	Fisher's Exact Test	Group with Greater Number of Participants Reporting Reduced discomfort
FREQUENCY							
Eye	1	32,56	2.81			.61	PC-3D-ME
Front of Neck	1	30,51	3.60			.19	PC-3D-ME
Back of Neck	1	28,55	3.00			.33	PC-3D-ME
Upper Back	1	29,54	3.10			.02*	PC-3D-ME
Lower Back	1	27,57	4.89			.02*	PC-3D-ME
Left Back Shoulder	1	28,58	4.71			.27	PC-3D-ME
Right Back Shoulder	1	30,58	4.77			.29	PC-3D-ME
Right Front Shoulder	1	26,58	3.46			.52	PC-3D-ME
Right Front Wrist	1	32,58	6.09	2.28	.13		PC-3D-ME
DURATION							
Eye	1	33,55	2.42			.19	PC-3D-ME
Front of Neck	1	33,55	6.36	.07	.80		PC-3D-ME
Back of Neck	1	31,54	4.52			.22	LOC
Upper Back	1	27,54	4.82			.09+	PC-3D-ME
Lower Back	1	25,56	3.52			.50	PC-3D-ME
Left Back Shoulder	1	28,58	6.04	.62	.43		LOC
Right Back Shoulder	1	26,58	5.50	1.42	.23		LOC
Right Front Shoulder	1	26,57	5.08	.74	.39		LOC
Right Front Wrist	1	31,57	3.77			.03*	PC-3D-ME

Significance of *Within* Groups Changes in Sub-Population That Reported a Change in Discomfort During the Course of the Study. The Sign Test was used to assess the significance of changes in discomfort severity, frequency and duration *within* each of the two instructional groups. Using this test, the change scores which were not equal to zero were compared to a table of probability values to determine the probability that the observed changes in the distribution of scores could have occurred by chance. Examination of the Sign Test probabilities associated with the changes in discomfort severity, frequency, and duration (see Table 16) shows that the changes in discomfort in the eyes were significant for both instructional groups. A total of nine of the other changes were statistically significant ($p < .05$). Six of these changes were associated with the PC-3D-ME instructional group, and three were associated with the LOC instructional group. Examination of the bar charts showing the frequency distributions of discomfort severity, frequency, and duration ratings (Figures 10 through 18) shows that in every case of statistically significant change, the change is associated with a decrease in discomfort severity, frequency, or duration, and, thus represents a positive outcome for the study participants.

CHAPTER IV

DISCUSSION

Overall, the results reported in Chapter Three supported the hypotheses presented in Chapter One. That is, the participants' reactions to the two instructional approaches were generally positive. Both groups of participants demonstrated an increase in knowledge nine weeks after receiving instruction, and a number of participants reported a decrease in discomfort nine weeks after instruction. In some cases, but not all, the changes were statistically significant. Details related to each of the three pairs of hypotheses presented in Chapter One will be discussed in turn. The final two sections of this chapter review the results in light of the differences between the two instructional approaches, and offer several conclusions.

Participants' Reaction to Instruction

Two hypotheses concerning the study participants' reaction to the two instructional approaches were proposed. The first hypothesis, 1A, predicted that participants would react in a positive manner to the instruction they received. The second hypothesis, 1B, predicted that the reaction of the PC-3D-ME instructional group would be more positive than the reaction of the LOC instructional group. To test these hypotheses, participants were asked to rate their level of agreement with four statements using a six-point rating scale (1 = "Decidedly Agree;" 6 = "Decidedly Disagree"). Using the same six-point rating scale, participants in the PC-3D-ME

instructional group also rated their level of agreement with two additional statements to assess their reaction to the presentation/demonstration they received.

HYPOTHESIS 1A

Participants in both instructional groups will report positive reactions to the instruction.

In both instructional groups, participant reaction was largely positive as demonstrated by the distribution of ratings presented earlier in Figure 6, and as summarized in the percentages presented in Table 17. In the PC-3D-ME instructional group, one-hundred percent of the participants agreed with the two statements about the presentation/demonstration (Table 17, Numbers 4 and 5), and with three of the other four statements (Table 17, Numbers 2, 3, and 6); ninety percent agreed with the one remaining statement (Table 17, Number 1). In the LOC instructional group over ninety percent of the participants agreed with three of the four given statements (Table 17, Numbers 2, 3, and 6), and more than seventy percent agreed with the remaining statement (Table 17, Number 1). Thus, I concluded that the participant reaction to both instructional approaches was generally positive.

Table 17

Percentage of Participants in Agreement with Statements on the Reaction Questionnaire

#	Statement	PC-3D-ME		LOC	
		% Agree	% Disagree	% Agree	% Disagree
1.	The information was mostly new to me.	90.0	10.0	72.4	27.6
2.	I believe I could use the information to make adjustments to my workstation.	100.0	0.0	93.1	6.9
3.	The quality of the written information was excellent.	100.0	0.0	96.6	3.4

NOTE: Participants ratings of 1, 2, or 3 ("Decidedly Agree," "Substantially Agree," or "Slightly Agree") are combined in the column designated "% Agree." Participant ratings of 4, 5, or 6 ("Slightly Disagree," "Substantially Disagree," or "Decidedly Disagree") are combined in the column designated "% Disagree."

Table 17 (continued)
Percentage of Participants in Agreement with Statements on the Reaction Questionnaire

#	Statement	PC-3D-ME % Agree	PC-3D-ME % Disagree	LOC % Agree	LOC % Disagree
4.	The quality of the demonstration was excellent.	100.0	0.0	N/A	N/A
5.	The material covered in the demonstration added substantially to the written material.	100.0	0.0	N/A	N/A
6.	The material made me more aware of the connection between work-related discomfort and how I do my job.	100.0	0.0	100.0	0.0

As shown in Table 18, the same conclusion is supported by the mean rating that participants assigned to each of the given statements. In every case, the numerical value of the mean rating (range 1.76 to 2.86) reflects the predicted positive reaction.

Table 18
Mean Rating of Agreement with Statements Assessing Participant Reaction to Instruction

#	Statement	PC-3D-ME Mean Level of Agreement	LOC Mean Level of Agreement
1.	The quality of the demonstration was excellent	1.76	N/A
2.	The material covered in the demonstration added substantially to the written material.	1.80	N/A
3.	The material made me more aware of the connection between work-related discomfort and how I do my job.	1.80	2.03

NOTE: Scale of agreement is as follows: 1 = "Decidedly Agree," 2 = "Substantially Agree," 3 = "Slightly Agree," 4 = "Slightly Disagree," 5 = "Substantially Disagree," and 6 = "Decidedly Disagree." That is, the smaller the mean, the greater the level of agreement.
*$p < .05$, **$p < .01$; based on *t*-test.

Table 18 (continued)
Mean Rating of Agreement with Statements Assessing Participant Reaction to Instruction

#	Statement	PC-3D-ME Mean Level of Agreement	LOC Mean Level of Agreement
4.	The quality of the written information was excellent.	1.90	2.17
5.	I believe I could use the information to make adjustments to my workstation.	1.90*	2.34*
6.	The information was mostly new to me.	2.13**	2.86**

HYPOTHESIS 1B

Participants who receive the experimenter-designed instructional materials will react to them in a more positive manner than the participants who receive the materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

Visual inspection of the mean ratings assigned to the statements assessing participant reaction to instruction (see Table 18) reveals that the mean ratings of the participants in the PC-3D-ME instructional group were consistently more positive (*i.e.,* numerically smaller) than the mean ratings of the participants in the LOC instructional group. Examination of the rank order of these means indicates that the rank order of the mean rating of agreement was identical in the two instructional groups.

The two statements with the highest mean rating of agreement, *"The quality of the demonstration was excellent"* (Table 18, Number 1) and "*The material covered in the demonstration added substantially to the written material,"* (Table 18, Number 2) were rated only by the participants in the PC-3D-ME instructional group because they referred specifically to the presentation/demonstration received by that group. The statements concerning the overarching message of both instructional programs, "*The material made me more aware of the connection between work-related discomfort and how I do my job"* (Table 18, Number 3), and

the quality of the written materials "*The quality of the written information was excellent*" (Table 18, Number 4), were rated positively by both instructional groups (*i.e.,* the mean rating was less than 4). However, the differences between the two instructional groups were not statistically significant. The two statements with the lowest mean level of agreement (*i.e.,* the largest numerical values) "*I believe I could use the information to make adjustments to my workstation*" (Table 18, Number 5), and *"The information was mostly new to me*" (Table 18, Number 6), were designed to direct attention to some of the major differences in *content* between the two instructional approaches. Interestingly, these two statements were the only ones where the differences in the mean ratings of agreement were statistically significant, and in each case, the mean rating of the PC-3D-ME instructional group was significantly more positive.

The statement "*I believe I could use the information to make adjustments to my workstation*" (Table 18, Number 5) was designed to reflect the underlying intent of the PC-3D-ME instructional approach—to empower people to make changes to their own workstations and to modify their work posture and keying technique. This intent led to the decision to structure the presentation of information in terms of three basic questions:

1. ***What*** do I do? (a statement of a goal or purpose)
2. ***How*** do I do it? (a procedure to use to achieve the designated goal/purpose)
3. ***Why*** do I do it? (a justification for implementing the stated goal/purpose)

This three part structure is very different from the topical presentation of information (*i.e.,* subject headings of "Chairs," "Keyboards," "Screen Placement and Viewing Specifications," and "Ergonomic Pauses") used in the LOC instructional approach (Library of Congress, 1991).

The statement "*The information was mostly new to me*" (Table 18, Number 6) was designed to reflect the fact that the PC-3D-ME instructional approach included information that

went beyond the recommendations included in the LOC instructional materials. The guidance in the PC-3D-ME instructional approach was consistent with that in the LOC instructional approach, but the PC-3D-ME instructional approach included a number of additional features. Specifically, the PC-3D-ME instructional approach addressed the process of workstation adjustment using an iterative process and employed a systems perspective in defining this process. It addressed the computer operator's position in terms of three-dimensional space (*i.e.*, up/down, right/left, in/out) rather than in terms of just one or two dimensions (*e.g.*, up/down or in/out). It included photographs showing positive and negative exemplars of hand positions when keying. And, it included with a checklist that participants could use to evaluate their workstation layout and adjustment, their work posture, and their keying technique.

On the basis of this evidence, I concluded that the differences in the two instructional approaches in terms of the *content,* and the *presentation,* had an impact on the participants' reaction to the instruction they received. The impact of the differences in *content* is shown by the statistically significant differences in the mean rating of agreement with the statements that "*I believe I could use the information to make adjustments to my workstation*" (Table 18, Number 5), and "*The information was mostly new to me*" (Table 18, Number 6). In each case, the more positive reaction was associated with the PC-3D-ME instructional group. The impact of the differences in *presentation* is suggested by the fact that the participants in the PC-3D-ME instructional group agreed more strongly with the two statements about the presentation/ demonstration they received, than with any of the other statements.

Changes in Participant Knowledge

Two hypotheses concerning changes in the study participants' knowledge nine weeks after instruction were proposed. The first hypothesis, 2A, predicted that nine weeks after instruction, the mean number of correct responses in each of the two instructional groups would be higher than it was before instruction. The second hypothesis, 2B, predicted that nine weeks after instruction, the mean number of correct responses for the PC-3D-ME instructional group would be higher than the mean number of correct responses for the LOC instructional group. To test these hypotheses, participants responded to a set of twelve true/false questions about workstation adjustment, work posture, and keying technique before receiving instruction and nine weeks after receiving instruction.

HYPOTHESIS 2A

Nine weeks after instruction, both groups of participants will show an increase in knowledge about workstation adjustment, work posture, and keying technique as indicated by an increase in the mean number of correct responses on the knowledge portions of the pre- and post-instruction questionnaires.

In both instructional groups, the mean number of correct responses to the set of twelve true/false questions was higher nine weeks after instruction that it was before instruction. In the PC-3D-ME instructional group, the mean number of correct responses increased from 9.76 to 10.69. In the LOC instructional group, the mean number of correct responses increased from 9.36 to 10.64. These changes *within* each instructional group were both statistically significant, $F(1, 55) = 26.82$, $p < .01$. Thus, the prediction of an increase in the mean number of correct responses was confirmed.

HYPOTHESIS 2B

Nine weeks after instruction, the group that received the experimenter-designed instructional materials will have a higher mean number of correct responses on a set of 12 knowledge questions than the group that received the materials developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

As stated in the discussion of hypothesis 2A, nine weeks after instruction both instructional groups showed an increase in the mean number of correct responses to the set of twelve true/false questions. However, the difference *between* the two instructional groups was not statistically significant.

This lack of statistical significance may be a reflection of several factors. It may be the result of a ceiling effect, despite a pilot test administration of the questionnaire to eliminate questions to which all participants responded correctly. Although participants were requested not to discuss the material provided to each instructional group, it is possible that there may have been some diffusion of the treatment through sharing between participants in adjacent work cubicles. It may be a reflection of the fact that the set of twelve questions emphasized *content* that was common to both instructional approaches. Thus, this set of twelve questions did not assess whether or not the participants who received the PC-3D-ME instruction had learned the *content* that was unique to that instructional approach.

The distribution of participant reactions to the statement on the reaction questionnaire, "*The information was mostly new to me.*" offers one kind of evidence that the participants in the two instructional groups might have responded differently to questions that addressed the *content* unique to the PC-3D-ME instructional approach. As shown in Figure 28, the distributions of participant reactions in the two instructional groups to this statement were different, and the participants in the PC-3D-ME instructional group agreed more strongly with the statement than

did the participants in the LOC instructional group. As noted in Chapter 3, a *t*-test showed that this difference was statistically significant, $p < .01$.

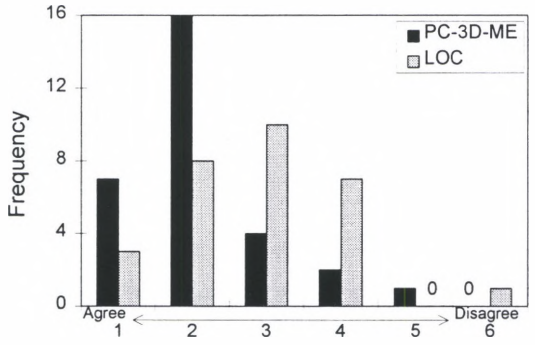


Figure 28. Comparison of participant reactions to the statement, "*The information was mostly new to me.*"

A second kind of evidence points to the possibility that the knowledge assessment did not tap into the unique *content* of the PC-3D-ME instructional approach. That evidence is found by examining the true/false statements to which fewer than 75% of the total study population responded correctly. Before instruction, there were five such statements (see Table 19). After instruction, there were only two (Table 19, Numbers 1 and 5), and those two statements addressed *content* unique to the PC-3D-ME instructional approach. In addition, before instruction there was only one statement to which fewer than 50% of the study participants responded correctly, "*The keyboard and monitor should [be] parallel with one another*" (Table 19, Number 5), and that statement is one of the two that addressed *content* unique to the PC-3D-ME instructional approach. Thus, I concluded that nine weeks after instruction, both groups of study participants knew more about workstation adjustment, work posture, and keying technique than they did before instruction. However, the statements used to assess participant knowledge were inadequate to detect *between* group differences in knowledge.

Changes in Work-Related Body-Part Discomfort

Two hypotheses concerning the participants' self-reported changes in WBPD were proposed in Chapter One. The first hypothesis, 3A, predicted that both instructional groups would experience a *decrease* in WBPD. The second hypothesis, 3B, predicted that nine weeks after instruction, the participants in the PC-3D-ME instructional group would experience a greater reduction in WBPD than the participants in the LOC instructional group. Discussion of the first of these hypotheses is straight forward. Discussion of the second is presented in two sections: (1) descriptive evidence, and (2) inferential evidence in the total study population and in the sub-population that reported a change in WBPD.

HYPOTHESIS 3A

Both groups of participants will experience a decrease in work-related body-part discomfort.

Two types of *descriptive* evidence support the hypothesis that both groups of participants will experience a *decrease* in work-related body-part discomfort: (1) an increase in the number of study participants who report "no discomfort" (*i.e.,* who report a discomfort severity rating of zero) nine weeks after instruction, and (2) a change in the distribution of discomfort severity, frequency, and duration ratings showing an increase in the number of lower-level discomfort severity, frequency, and duration ratings (*i. e.,* ratings of 1 or 2) and a decrease in the number of higher-level ratings (*i.e.,* ratings of 3, 4, or 5). The results related to each of these types of evidence will be discussed in turn.

Changes in the Number of Study Participants Who Reported "No Discomfort" Nine Weeks After Instruction

In both instructional groups, the *overall* number of discomfort severity ratings of zero (*i.e.,* "no discomfort") was greater nine weeks after instruction than it was before instruction (see

explanatory. Nevertheless, an examination of changes in the distributions of all levels of discomfort severity, frequency, and duration ratings is instructive.

Changes in the Distributions of Discomfort Severity, Frequency, and Duration Ratings

Visual examination of the distributions of discomfort severity, frequency, and duration ratings, both overall and in each of the nine selected body parts, shows that in both instructional groups the distributions are more highly skewed toward the lower discomfort ratings nine weeks after instruction than they were before instruction (see Figures 9-18). That is, the distributions nine weeks after instruction show more study participants reporting discomfort severity, frequency, and duration ratings of zero, one, or two, and fewer study participants reporting discomfort severity, frequency, and duration ratings of three, four, or five than was the case before instruction.

Insight into the impact of these changes in the distributions of discomfort severity, frequency, and duration ratings is provided by comparing median discomfort ratings before instruction with those nine weeks after instruction for each of the nine body parts. As shown in Figure 29, nine weeks after instruction the median discomfort severity, frequency, and duration ratings either decreased or showed no change. In no case, in either instructional group, did the median rating show an increase.

Comparison of the changes in median discomfort severity, frequency, and duration ratings (see Figure 29) shows a different pattern in each of the two instructional groups. In the PC-3D-ME instructional group, the median discomfort severity, frequency, and duration rating decreased in the majority of body parts selected for further study. In the LOC instructional group the median decreased in only one or two of these body parts.

As shown earlier in Tables 11, 12, and 13, the median discomfort severity, frequency, and duration ratings before instruction were generally 1.00 or higher in both instructional groups. The only exception was the right front should where the median discomfort severity, frequency, and duration ratings in the PC-3D-ME instructional group were all equal to 0.00. Thus, in the PC-3D-ME instructional group there was a possibility for a decrease in median discomfort severity, frequency, and duration in all cases except for the right front shoulder where the initial median was 0.00.

Based on the increases in the number of study participants who reported "no discomfort" nine weeks after instruction; changes in the distributions of discomfort severity, frequency, and duration ratings nine weeks after instruction; and the decreases in the median discomfort severity, frequency, and duration ratings nine weeks after instruction, I concluded that overall, participants in both instructional groups experienced a decrease in work-related body-part discomfort.

HYPOTHESIS 3B

The group that receives the experimenter-designed instruction will experience a greater reduction in work-related body-part discomfort than the group that receives the instructional material developed by the Library of Congress Collections Services VDT Ergonomics Committee (1991).

Two types of evidence, descriptive and inferential, provide some support for the hypothesis that the PC-3D-ME instructional group will experience a greater decrease in work-related body-part discomfort than the LOC instructional group. Discussion of the descriptive evidence is straight forward. Discussion of the inferential evidence in presented in two parts: (1) a consideration of changes in the total sample population, and (2) a consideration of changes in the sub-population that reported a change in discomfort severity, frequency, and/or duration nine weeks after instruction.

Descriptive Evidence

Further examination of the evidence presented in support of hypothesis 3A suggests that the decreases in work-related body-part discomfort experienced by the two instructional groups were not identical. Comparison of the percentage change in the number of study participants who reported "no discomfort" shows that in the PC-3D-ME instructional group, the percentage increased from 31% before instruction to 44% nine weeks after instruction—an increase of 13%. In the LOC instructional group the percentage increased from 35% before instruction to 39% nine weeks after instruction—an increase of only 4%. Changes in the discomfort frequency and duration ratings were of the same magnitude because individuals who report discomfort severity ratings of zero also report discomfort frequency and duration ratings of zero.

Examination of Table 20 suggests that the most substantial changes occurred in the eyes, the back of the neck, the upper back, the lower back, and the right front wrist—all body parts of considerable interest to those concerned about WBPD among office computer users. Comparison of the data for each of the nine selected body parts shows that in the PC-3D-ME instructional group, the number of study participants reporting a discomfort severity rating of zero increased for eight of the nine selected body parts (see Table 20). In the one remaining body part, the back of the neck, the number of participants reporting a discomfort severity rating of zero decreased by two. In the LOC instructional group, the number of study participants reporting a discomfort severity rating of zero increased for seven of the nine selected body parts and showed no change in two. Overall, the increase in the number of discomfort severity ratings of zero in the PC-3D-ME instructional group nine weeks after instruction was almost twice that of the LOC instructional group (Sign Test [N = 9, k = 1], p = .020). Thus, the instruction provided using the

PC-3D-ME approach appears to have been more effective in enabling people to reduce their discomfort to zero.

Table 20
Change in Number of Individuals Reporting Discomfort Severity Ratings of Zero ("No Discomfort") Nine Weeks After Instruction

Body Part	Discomfort Severity	
	PC-3D-ME	LOC
Eyes	+8	+7
Front of Neck	+2	+1
Back of Neck	-2	+6
Upper Back	+5	+1
Lower Back	+5	+1
Left Back Shoulder	+3	+2
Right Back Shoulder	+2	0
Right Front Shoulder	+3	+1
Right Front Wrist	+8	0
TOTAL	34	19

NOTE. The changes shown in Table 20 were calculated by taking the total number of individuals who reported no discomfort nine weeks after instruction and subtracting all those who had reported no discomfort before instruction whether or not they reported no discomfort nine weeks after instruction. Thus, the data in Table 20 include only individuals who reported discomfort severity greater than zero before instruction. Eight of nine body-part outcomes favor PC-3D-ME (Sign test, [N = 9, k = 1], p = .020).

Inferential Evidence

The statistical significance of changes in WBPD in the nine selected body parts were examined in two ways. First, changes in the total study population were examined using a very conservative Chi-square test that compared the number of participants in each instructional group who experienced a decrease in discomfort with all others (*i.e.*, with all who experienced an increase in discomfort plus all who experienced no change in discomfort). A second, less conservative, test was conducted using only the sub-population that reported a change in WBPD nine weeks after instruction. Participants who reported no change in discomfort were dropped from this second analysis.

Significance of Changes in WBPD in Total Sample Population. As shown in Table 14, the only statistically significant *between* groups change was the frequency of discomfort in the upper back. However, the meaning of this change is difficult to interpret because the two instructional groups were not equivalent in this dimension of discomfort before instruction (see Table 10).

It could be argued that the inclusion of study participants who reported "no change" is suspect, because not all could change freely either up or down. That is, study participants who reported discomfort severity, frequency, and duration ratings of zero (*i.e.*, "no discomfort") before instruction could report an increase in discomfort or "no change" in discomfort; they could not report a decrease in discomfort as all other study participants could. It could also be argued that an outcome of "no change" is difficult to interpret at face value. It may be that an individual made adjustments to their workstations, work posture and/or keying technique and nothing happened. It may be that an individual participant chose not to make changes to his or her workstation adjustment, work posture, and/or keying technique. It may be that an individual made changes only a few days before the end of the nine-weeks following instruction, and that there had not been sufficient time to detect any change. It may also be that at some levels of discomfort, nine weeks may not be an appropriate time span for detecting change. Given these possibilities, the appropriateness of the very conservative Chi-square test may be questioned. Thus, the changes in the nine selected body parts were examined a second time using only the sub-population who reported either a decrease or an increase in discomfort nine weeks after instruction.

Significance of Changes in the Sub-Population that Reported a Change in WBPD.

The significance of *between* groups changes in the sub-population that reported a change in WBPD were examined using a Chi-square test where possible. In cases where the data violated the Chi-square assumption concerning expected values, the Fisher's Exact Test was used. The results of these tests were presented in Table 15, and they showed statistically significant differences between the two instructional groups in three areas: (1) discomfort frequency in the upper back, (2) discomfort frequency in the lower back, and (3) discomfort duration in the right front wrist. In each case, the results favored the PC-3D-ME instructional group, but as in the analysis of *between* groups changes in the total study population, the meaning of these results is difficult to determine because of differences in the initial levels of discomfort severity, frequency, and duration in these areas. In the upper and lower back, the initial mean ranks for discomfort frequency were significantly different (Mann Whitney two-tailed test corrected for ties, $p < .05$; specifically $p = .018$ for discomfort frequency in the upper back, and $p = .014$ for discomfort frequency in the lower back). In the right front wrist, the initial mean ranks for discomfort duration approached significance (Mann Whitney two-tailed test corrected for ties, $p = .060$).

Nevertheless, it is interesting to note that the changes that were detected related not to discomfort severity, but to discomfort frequency and duration. This observation suggests that discomfort may be a multi-dimensional phenomena, and that the mechanisms underlying changes in the different dimensions may not be identical. Perhaps some kinds of change are related directly to ergonomic intervention while other kinds of change are more reflective of a healing process within an individual. The situation is somewhat clearer when looking at changes

within each of the two instructional groups, because one can at least say that this particular group of people has, or has not, experienced significant change.

The significance of *within* groups changes in the sub-population that reported a change in WBPD were examined using the Sign Test. The results of these tests were presented in Table 18 and showed statistically significant change in a total of 15 areas—nine for the PC-3D-ME instructional group and six for the LOC instructional group (see Table 21). Examination of Table 21 shows that both instructional groups reported statistically significant decreases in discomfort in the eyes. The PC-3D-ME instructional group also reported statistically significant change in the upper back, the lower back, and the right front wrist. In addition, the LOC instructional group reported statistically significant change in the back of the neck. Both groups reported changes that reflected discomfort severity, frequency, and/or duration, and all were in body parts that are of interest to those concerned with office ergonomics. In addition, most of the statistically significant change occurred in body parts that were addressed in differing ways in the two instructional approaches.

Table 21
Statistically Significant Change Within Each of the Two Instructional Groups

Body Part	PC-3D-ME			LOC		
	Severity	Frequency	Duration	Severity	Frequency	Duration
Eyes	*	**	**	**	*	*
Back of the Neck				*	*	*
Upper Back	**	**	**			
Lower Back		*				
Right Front Wrist	*		**			

NOTE: There were no statistically significant differences in discomfort severity, frequency, and duration in the other selected body parts (front of neck, left back shoulder, right back shoulder, and right front shoulder).
*$p < .05$. ** $p < .01$.

Given the preponderance of the descriptive and inferential evidence, I concluded that the PC-3D-ME instructional group did experience the greater reduction in WBPD. More individuals in the PC-3D-ME instructional group reported no discomfort nine weeks after instruction; the distributions of discomfort severity, frequency, and duration ratings became more highly skewed in favor of the lower discomfort ratings; the median discomfort severity, frequency, and duration ratings decreased in more of the nine selected body parts; and more of the statistically significant changes occurred in this instructional group.

Relationship Between Statistically Significant Changes and Differences in the Two Instructional Approaches

Overall, the pattern of observed changes seems to correspond to some of the major differences in the two instructional approaches. In Chapter Two, Table 1, these differences were described in terms of five issues: (1) the topics addressed, (2) the relative emphasis on *intrinsic* and *extrinsic* ergonomic issues, (3) the way of presenting the information, (4) the structure of the information provided, and (5) the sources of the information. These differences seem to provide some insight into reasons that may underlie the observed differences.

Both groups of study participants reported a significant decrease in discomfort severity, frequency, and duration in the eyes, and both instructional programs provided information about adjusting the monitor for ease of viewing. The information presented in the two instructional programs was not identical, but it did not conflict, and there is no way to judge whether or not there was some sharing of information between the two instructional groups. Study participants were asked to work independently, but in some cases, study participants in different instructional groups occupied cubicles across the aisle from one another.

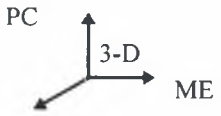
Differences in the relative emphasis on *intrinsic* and *extrinsic* ergonomic factors, and on the importance of self-responsibility may have influenced the outcome in the right front wrist.

The LOC instructional approach provided a few relevant comments about the wrist (*e.g.,* "The hands should be in a reasonably straight line with the forearm and the upper arm should be in a relaxed position at the side of the body" [p. 1]). The PC-3D-ME instructional approach provided several pages of information , line drawings, and photographs emphasizing the importance of good arm/hand alignment (*i.e.,* a *neutral* relationship between the arm and the hand rather than radial or ulnar deviation in the wrist). In addition, the PC-3D-ME instructional approach emphasized the importance of *intrinsic* ergonomic factors in the statement of the third principle: "***Minimize Effort resulting from the use of awkward postures, poor movement patterns, and excessive force,"*** and of self-responsibility in the mnemonic for this principle ***ME*** (as in PC-3D-ME).

Differences in the presentation, specifically the inclusion of a demonstration for the study participants in the PC-3D-ME instructional group, probably accounted for the decreases in discomfort in the right front wrist and in the upper and lower back. Both instructional approaches emphasized the importance of chair adjustment. However, the demonstration associated with the PC-3D-ME instructional approach illustrated the adjustment capabilities built into the chairs that were actually used by the majority of the study participants. The demonstration and the PC-3D-ME booklet of information also provided step-by step criteria for participants to use when adjusting their own chairs, and emphasized that adjusting a chair is an iterative process.

In addition, the structure of the information in the PC-3D-ME approach may have had an impact on the study participant's ability to retain and make use of the information provided. Four aspects of this structure are pertinent:

1. The information was structured in terms of three basic principles:
    - ***P***osition ***C***omponents ***P***arallel and ***C***entered.
    - Consciously locate yourself and your equipment in ***3***-***D***imensional space.
    - ***M***inimize ***E***ffort resulting from the use of awkward postures, poor movement patterns, and excessive force.
2. The principles were used to create a mnemonic device to help participants recall the key ideas:



3. Description of the application of these three principles in a computerized office was structured consistently in terms of three basic questions:
    - ***What*** do I do? (a statement of a goal or purpose)
    - ***How*** do I do it? (a procedure to use to achieve the designated goal/purpose)
    - ***Why*** do I do it? (a justification for implementing the stated goal/purpose)
4. The written PC-3D-ME instructional materials included a procedural checklist for workstation adjustment that may have helped participants apply the information that they were given.

Explanation of the statistically significant change reported by the LOC instructional group in the discomfort severity, frequency, and duration in the back of the neck is more difficult to determine. However, it may be that changes in the monitor placement and/or adjustment that resulted in significant decreases in discomfort severity, frequency, and duration in the eyes, may also have had an influence on the discomfort in the back of the neck. In the PC-3D-ME

instructional group this effect could have been masked by the participant's efforts to adjust their chairs and, perhaps, to implement the information about head/neck alignment.

Nevertheless, the preponderance of the evidence supports the idea that both the *content* and the *presentation* of the information provided to office computer users can influence their ability to use the information provided for their benefit. The emphasis in the PC-3D-ME group on *intrinsic* ergonomic factors related to keying technique appears to be reflected in the different patterns of outcomes found in the two instructional groups in the right front wrist. As shown in Figure 30, twelve of the participants in the PC-3D-ME instructional group reported a decrease in discomfort duration, while only one reported an increase. In the LOC instructional group, ten participants reported an increase in discomfort duration; eight reported a decrease.

	PC-3D-ME	**LOC**
Decreased Discomfort	12	10
Increased Discomfort	1	8

Figure 30. Self-reported changes in discomfort duration in the right front wrist.

The effects of the presentation/demonstration using chairs from the participant's work area seems to be reflected in the different patterns of discomfort frequency outcomes in the upper and lower back. As shown in Figure 31, sixteen members of the PC-3D-ME instructional group and 4 members of the LOC instructional group reported a decrease in discomfort frequency in the upper back while three members of the PC-3D-ME instructional group and six members of the LOC instructional group reported an increase. In the lower back, the pattern of

self-reported change in discomfort frequency in the lower back was similar. Twelve members of the PC-3D-ME instructional group and four members of the LOC instructional group reported a decrease; three members of the PC-3D-ME instructional group and eight members of the LOC instructional group reported a decrease in discomfort frequency (see Figure 32). Note, however, that the interpretation of these outcomes is difficult because the initial level of discomfort frequency in both the upper and lower back was significantly higher in the PC-3D-ME instructional group (see Table 10).

	PC-3D-ME	**LOC**
Decreased Discomfort	16	4
Increased Discomfort	3	6

Figure 31. Self-reported changes in discomfort frequency in the upper back.

	PC-3D-ME	**LOC**
Decreased Discomfort	16	4
Increased Discomfort	3	8

Figure 32. Self-reported changes in discomfort frequency in the lower back.

Clearly, both the *content* and the *presentation* of the two instructional programs appear to have influenced the outcome. Future studies could be developed to clarify the relative contribution of these two factors (*content* and *presentation*) to instructional efforts to reduce work-related body-part discomfort among office computer operators.

Conclusions

As shown in Table 22, the preponderance of the descriptive and comparative evidence supports the hypotheses presented in Chapter 1. That is, the reaction to the instruction was positive; the participants showed an increase in knowledge; and the participants reported decreased work-related body-part discomfort. In two cases, reaction and discomfort, the outcome favored the PC-3D-ME instructional group. In the third case, knowledge, the outcome was favorable for both instructional groups.

Based on evidence presented in Table 22, five conclusions can be drawn.

1. People who have had little relevant instruction concerning workstation adjustment, work posture, and keying technique react favorably to receiving instruction regardless of the specific *content* and the type of *presentation.*
2. People are capable of learning and of using relevant information to their benefit regardless of the specific *content* and the type of *presentation.*
3. Work-related body-part discomfort can be reduced through appropriate instruction.
4. The areas in which study participants reported a decrease in discomfort severity, frequency, and duration are those of most concern to ergonomists, human resources personnel, and corporate executives: the eyes, the back, the neck, and the wrist.
5. When increased knowledge was the measure of effectiveness, the two instructional approaches appeared to be equivalent. However, when reaction and reduced discomfort were the measures of effectiveness, the preponderance of the evidence favored the PC-3D-ME instructional approach that incorporated information about *extrinsic* and *intrinsic* ergonomic factors, and that included both written information and a demonstration of the use of that information.

APPENDIX A

LETTERS:

INVITATION TO PARTICIPATE AND INFORMED CONSENT FORM; SCHEDULING OF INDIVIDUAL OBSERVATIONS

July 25, 1995

To:

From: XXXXXXXXXXX
(Human Resources)

Subject: Ergonomics Study

You may be aware of media reports of computer operators who have experienced work-related discomfort. We ask that you participate in a study evaluating two training programs which are designed to help office computer operators reduce discomfort associated with computer use. By participating in this study, you will gain knowledge about how to set-up your workstation, and you will help researchers at the University of Dayton who are working to develop ways to help individuals reduce the discomfort associated with computer use.

The study will take place here in your work area during your normal work hours. You will be asked to complete a packet of questionnaires and will be observed by a UD researcher as you do your normal daily tasks. After the initial phase of information gathering by the researchers, you will receive one or two training packages. Later, you will be asked to evaluate the training package you received and to complete a packet of follow-up questionnaires. You will also be observed a second time, again by a UD researcher.

The questionnaires ask for information about you, your job, and your work area. They also request information about how you learned to operate a keyboard and adjust a workstation, and about your experience with work-related discomfort. All information that you provide by answering these questions and data gathered when being observed will be handled confidentially and will be available only to the researchers.

At the end of the study, participants will receive copies of the training materials used by the other group so that all of the participants will see all of the printed training materials. However, before that time, we ask that you not reproduce the materials or discuss them with your co-workers. The reason for this request is that if participants share information while the study is being conducted, it will be impossible for the researchers to evaluate the relative effectiveness of the two sets of training materials.

If you have questions about the study you may contact our _____ Company liaison for your area, _____ at extension _____. She has more detailed information about this project. If you wish to withdraw from the study at anytime, you may do so by contacting Joyce Cameron, the primary researcher from UD, at 298-7085.

The _____ Company believes that this is a unique opportunity to offer you training and to assist researchers who are studying a problem which is of concern to all computer users. We urge you to participate by signing the form below and returning it to ________________ no later than August 1st.

We thank you in advance for participating and hope the results of the training will help you in your daily computer activity as well as the UD researchers in regards to the issue of office ergonomics.

(signed) XXXXXXXXXX

detach here

- -

I agree to participate in this training evaluation study and, by signing below, agree to the terms described above.

Printed Name: ______________________________

Signature: ______________________________

Date: ______________________________

DATE: August 1, 1995

TO: _____

FROM: _____

SUBJECT: Scheduling of first observation for ergonomic study

During the next three weeks, Joyce Cameron, the primary researcher from the University of Dayton, will be here at _____ conducting the first phase of observations for the ergonomic study in which you have agreed to participate. I have scheduled you on

_____

at about _____.

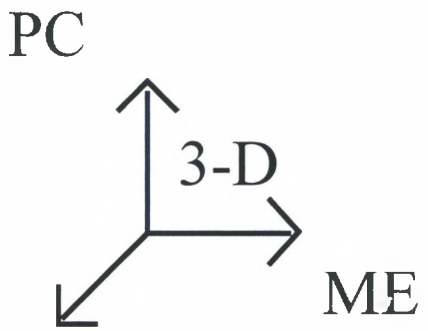
Joyce will be with you about 20-30 minutes and would appreciate it if you could plan your activities so that while she is with you, you will be engaged in normal work tasks that involve the use of a computer keyboard. We appreciate your assistance in this study and look forward to completion of this first phase of the study. You will be receiving information about the scheduling of the training sessions at a later date.

Thank you.

APPENDIX B

EXPERIMENTER-DESIGNED INSTRUCTIONAL BOOKLET

A STRATEGY TO HELP OFFICE COMPUTER USERS REDUCE WORK-RELATED DISCOMFORT



Position ***C***omponents ***P***arallel and ***C***entered.

Consciously Locate Yourself and Your Equipment in
3-Dimensional Space.

Minimize ***E***ffort
Resulting From the Use of Awkward Postures,
Poor Movement Patterns, and Excessive Force.

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INTRODUCTION

Today, it may be hard to find an individual who has not seen or heard media reports about health problems among office computer users. In fact, you, or someone you know, may have experienced work-related discomfort.

But, the news is not all bad, because many research findings are contributing to our understanding of factors that increase the risk of developing work-related discomfort. To date, researchers have identified several different kinds of risks including, but not limited to, poor workstation layout and adjustment, poor work posture, and poor work technique. The problem is that many research findings are presented in ways that are not readily usable by non-researchers.

Individual computer users have the capacity to reduce each of these risks to some extent, but many, if not most, lack relevant knowledge and skill. But, before going into the details of computer workstation layout, adjustment, and use, consider the possibility that as a computer operator, you are probably a small muscle athlete.

YOU ARE PROBABLY A SMALL MUSCLE ATHLETE

As a computer operator you may make 140,000, or more, keystrokes a day! Using your fingers and thumbs so many thousands of times each day makes you a small muscle athlete. Like a professional athlete, you need to know "the rules of the game," and you need to be "in shape" in order to perform well.

Professional athletes receive instruction and training in order to help them optimize their performance. Computer operators, as small muscle athletes, also need instruction and training in order to optimize the layout and adjustment of their workstations, and to minimize the physical stress of using a computer. Unfortunately, when it comes to setting up a workstation, choosing work postures and movement patterns, and using a keyboard or a mouse, "doing what comes naturally" does not necessarily result in doing things in the easiest and least physically demanding way.

In professional athletics, many aspects of the playing field and the equipment are standardized: the length of a football field, the height of a basketball hoop, the width of a tennis court, the diameter of a baseball, etc. The rules of the game and the ways of using the equipment are also fairly stable. Changes do occur, but the pace is relatively slow.

You, the contemporary computer operator, do not have many of these advantages. The dimensions of desks, keyboards, and monitors change, and new tools become available. The ways of performing tasks may change dramatically from one software package to another; they may change in more subtle ways with each new "upgrade." To some, change may be happening too fast.

In today's world, some people view the pace of change as a problem; others see it as an opportunity. The way it appears depends on many factors. One important factor is knowledge. What do the people facing the changes know? Do they know where their knowledge applies?

When it applies? How to apply it in new situations? Why it applies? In many cases, the answer to these questions is, "*NO.*" Thus, the purpose of this booklet is to help you learn a three-part strategy that you can use to improve your workstation layout, adjustment, and use.

This strategy uses three principles. These three principles are useful for evaluating workstation layout and adjustment, and for planning improvements. They are based on information from a wide variety of scientific sources, but they are not difficult to explain. They can be stated as follows:

1. Position components; parallel and centered (PC).
2. Consciously locate yourself and your equipment in 3-dimensional space (3-D).
3. Minimize effort resulting from the use of awkward postures, poor movement patterns, and excessive force (ME).

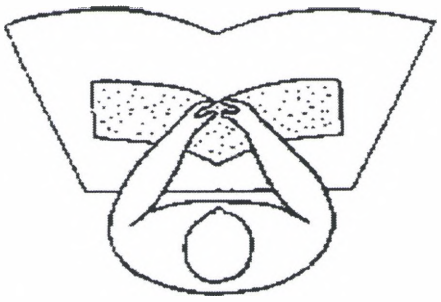
The graphic design on the front cover of this booklet provides a reminder of the three parts of this strategy for workstation layout, adjustment, and use. In this form (PC--3-D--ME), you can use these principles as reminders of good work postures and practices.

THREE PRINCIPLES TO HELP OFFICE COMPUTER ATHLETES REDUCE WORK-RELATED DISCOMFORT

Before describing the strategy for workstation layout, adjustment, and use, it is important to provide a more complete explanation of the three underlying principles. It is the use of principles, rather than rules, which provides you with information that you can use repeatedly as new changes are introduced into your work area.

The first principle says, ***position components parallel and centered***. Given a chance to think about it, most, if not all, people would recognize that we human beings are built symmetrically. That is, our head, neck, and spine form the central axis of our bodies. Our arms and legs are located symmetrically on either side of this central axis. This observation means that the best location for your tasks is directly in front of you--somewhere between your elbows and not too far away.

This area, where work is the easiest, is sometimes called the *normal work area* or the *preferred manipulation space.* To find your own normal, or preferred, work space, let your arms hang loosely from your shoulders with your palms facing your sides. Then, bend your arms so that there is a right angle (90°) at your elbows. (Your palms should end up facing one another.) Now, with your upper arms loosely at your sides, let your forearms gently swing in toward the center of your torso and out again. You should find that your forearms can swing all the way in to touch your torso, but they can swing only a very small distance beyond the span between your elbows before it becomes uncomfortable unless you move your elbows to a new position. When this principle is applied to setting up an office computer workstation, it suggests that the keyboard and monitor should be parallel with one another and positioned so that the most used part of keyboard is centered appropriately. (More details on proper positioning will be provided in the first part of the strategy for workstation layout, adjustment, and use described below.)



OVERHEAD VIEW SHOWING THE NORMAL, PREFERRED, WORK SPACE
(shaded)
Notice that the preferred work space is defined by the distance between the elbows as described above.

The second principle says, ***consciously locate yourself and your equipment in 3-dimensional space.*** We all realize that the same job can be made harder, or easier, by where you have to do it. Performing a task overhead, at arms' length, to one side, or in a stooped posture is hard work. Performing the same task directly in front of you and at about waist height is much easier. When this principle is applied to office computer work, it suggests that a computer user should pay attention to where the components are located in three-dimensional space--up/down, right/left, and in/out. Likewise, when a computer user starts to work, he/she is located in three-dimensional space. Is the keyboard too high? Too low? Too far to the right? Too far to the left? Too close? Too far away? Even when equipment can't be moved, a computer user nearly always has the responsibility of positioning his/her chair, and in some cases the difference of a few inches in the location of a chair can be the difference between two people--one of whom experiences discomfort, the other who is not so afflicted. (More details on proper positioning will be provided in the second part of the strategy for workstation layout, adjustment, and use described below.)

The third principle says, ***minimize effort resulting from the use of awkward postures, poor movement patterns, and excessive force.*** Although we do not know all the reasons that some computer operators experience discomfort while others don't, we do know some of the reasons, and much of this information is incorporated into this third principle. There is good scientific evidence that awkward postures and the use of excessive force can contribute to discomfort in many kinds of jobs. In some cases, these problems result from the way the work is laid out; in other cases these problems result from the way a worker does the work. Some problems in the way work is laid out can be reduced by using appropriate equipment, but problems in the way a worker does the work require the individual to take responsibility for the way he/she performs a particular task. In the case of computer operators, it is as if each operator's arms, hands, fingers, and thumbs are like precision tools, and they must be treated with the same care and respect as any fine piece of equipment.

APPLYING THESE PRINCIPLES IN A COMPUTERIZED OFFICE: A THREE-PART STRATEGY FOR WORKSTATION LAYOUT, ADJUSTMENT, AND USE

A *computer system* typically consists of a monitor, keyboard, central processing unit, and perhaps, some accessories such as a document holder, mouse, or footrest. However, these computer system components do not exist in isolation. Rather, they interact with you, and with your workstation, in many different ways. Their positioning and adjustment can affect how you work! The increasing adjustability in furniture, keyboards, and monitors, etc. requires computer users to develop an awareness of the fact that each of these components must be positioned and adjusted as part of a larger whole.

Each of the three parts of the strategy described below uses one of the principles described above and addresses one of the major kinds of risk factors for developing work-related discomfort. Part I of the strategy--***PC: Position Components; Parallel and Centered***--addresses risks due to awkward positioning of equipment and is designed to help you to minimize awkward positioning of equipment by locating frequently used items within easy reach. Part II of the strategy--***3-D: Consciously Locate Yourself and Your Equipment in 3-Dimensional Space***--addresses risks due to poor posture and is designed to help you adjust your workstation so that it is possible to achieve a good working posture. And, Part III--***ME: Minimize Effort Resulting from the Use of Awkward Postures, Poor Movement Patterns, and Excessive Force***--addresses risks due to inappropriate work technique by directing your attention to habits that may contribute to discomfort.

This strategy is designed to be usable by any computer operator. It is not dependent on the purchase of specific equipment, and it can be implemented at little or no cost. The goal is to provide you--the computer user--with knowledge and skill that will enable you to reduce work-related discomfort.

The strategy is described in terms of some of the questions often asked by journalists: What? How? and Why? The description of *What?* to do tells you about the overall goals of each of the three parts of the strategy. The description of *How?* provides you with step-by-step instructions about how to proceed. And, the description of *Why?* gives you information about the justification for particular recommendations. The ideas in the sections entitled W*hy?* are the ones that are especially useful when you encounter a new problem with your workstation and you want to try and figure out how to proceed to resolve the issue.

The first time you try to follow this three-part strategy for workstation layout, adjustment, and use, it may take you more than one try to feel that you have it right. However, once you are satisfied with your basic workstation layout and adjustment, it should not take more than a few seconds each time you sit down to work at your computer, to ensure that nothing has changed.

PART I: PC: POSITION COMPONENTS; PARALLEL AND CENTERED

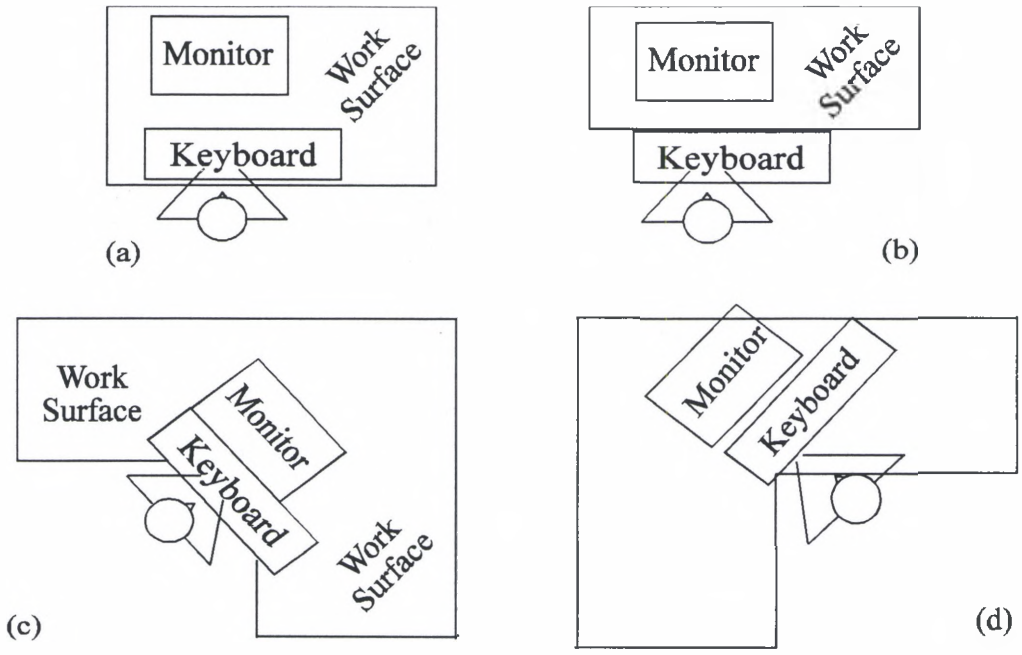
The first part of this strategy for workstation layout, adjustment, and use establishes the baseline for subsequent positioning and adjustment decisions. It sets the stage for the two essential points of contact between you and your computer--the connection between your eyes and your monitor, and the connection between your fingertips and your keyboard. This first part of the strategy will help you to minimize awkward positioning of your monitor and keyboard. It requires adjusting your computer monitor and keyboard so that the monitor screen is parallel with the length of the keyboard, and so that both are centered appropriately with respect to one another.

WHAT DO I DO?

- *POSITION* keyboard and monitor.
- *CENTER* keyboard and monitor with respect to yourself.

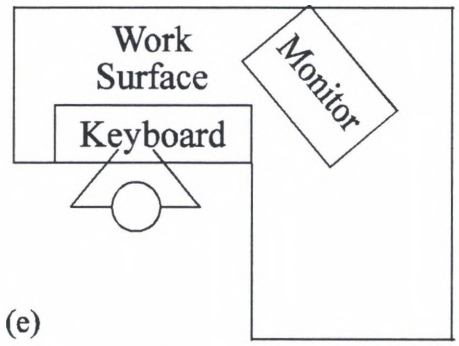
HOW DO I POSITION MY KEYBOARD AND MONITOR?

- Position your keyboard and monitor parallel with one another.
- If possible, position your keyboard and monitor parallel to the near edge of your work surface (see figures a, b, c, and d below).

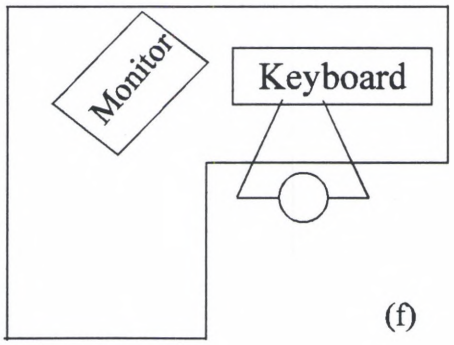


RECOMMENDED WORKSTATION LAYOUTS:

Notice, in each case, the monitor is directly in front of the user, and the keyboard and monitor are parallel to one another. Notice, also, that in figures (a), (b), and (c) the keyboard operator has room for his/her elbows to hang loosely from the shoulders without having to be held up over the edge of the work surface. In contrast, the operator in figure (d) has both arms on the *same* work surface. These illustrations do not exhaust all the possible ways of positioning your monitor and keyboard on your work surface, but they should provide some ideas to help you get started thinking.



(e)



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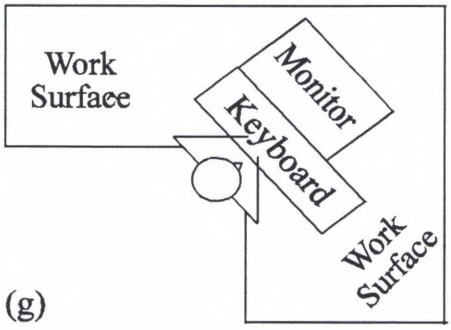


(g)

WORKSTATION LAYOUTS THAT ARE *NOT* RECOMMENDED

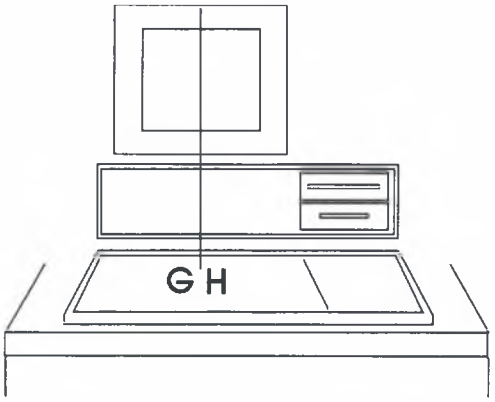
Notice that in figures (e) and (f), the monitor and the keyboard are *not* parallel with one another, and the computer operator has to look to one side to see the monitor. Both of these workstation layouts can be associated with increased discomfort in the neck, shoulders, and upper back. In figure (g), the monitor and keyboard are both directly in front of the keyboard operator which is good, but the operator's arms are lifted out to each side so that one can rest on each of the two work surfaces. This workstation layout, like those in figures (e) and (f), can be associated with discomfort in the neck, shoulders, and upper back.

HOW DO I CENTER MY KEYBOARD AND MONITOR WITH RESPECT TO MYSELF?

IT DEPENDS!

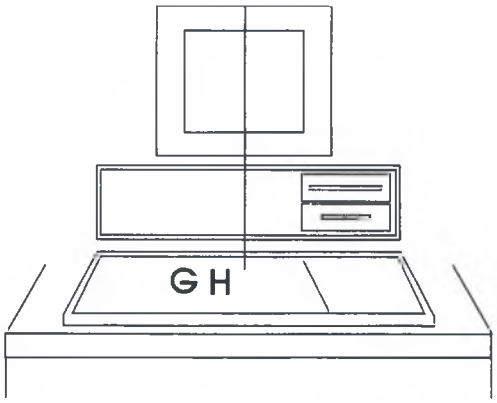
- If your task involves using both hands in the same way (e.g., using the keyboard like a traditional typewriter and typing mostly words and a few numbers), CENTER the homerow of your keyboard (the separation between the letters G and H) directly beneath the vertical midline of your monitor.

- If your task involves using primarily the numeric keypad, center the middle column (2 5 8) directly under the long middle finger of your right hand and comfortably within the right side of your normal, preferred work space (see p. 3). Then, when sitting parallel to the monitor and looking straight ahead, CENTER the vertical midline of your monitor directly in front of your nose. Notice the location of your torso with respect to the entire length of the keyboard unit and identify some "landmark" relationship between your torso and your keyboard (e.g., my naval is just in front of the space between the right CONTROL key and the left cursor key). Use this "landmark" to return to your desired position at the keyboard each time you move away from your keyboard to reach files or other materials.
- If your task involves numeric data entry and considerable mouse use, position your numeric keypad and mouse within your normal, preferred work space in such a way as to minimize poor movement patterns (see pp. 11-18).
- For tasks involving almost nothing except mouse use, position your mouse within your normal preferred work space to minimize poor movement patterns (see pp. 11-18). The location may be quite different depending upon whether you use your mouse with your right hand or with your left hand.



RECOMMENDED POSITION OF MONITOR AND KEYBOARD WHEN PERFORMING TYPING TASKS

Notice that the monitor appears off center with respect to the length of the keyboard unit, but that the center of the home row (the separation between the letters G and H) is directly beneath the vertical midline of the monitor. If the way you use your computer keyboard is not comparable to traditional "typing," it will be to your advantage to position your keyboard so that the task you perform is located in your preferred work space.



OFTEN SEEN, BUT *NOT* RECOMMENDED, POSITION OF MONITOR AND KEYBOARD WHEN PERFORMING TYPING TASKS

Notice the monitor and keyboard appear to make a symmetrical "tower." However, if the computer operator sits directly in front of the vertical midline of the monitor, then the home row of the keyboard (the separation between the letters G and H) is somewhat to his/her right--a fact that is likely to result in angles in the right hand and wrist that are more awkward than those in the left.

WHY DO I NEED MY MONITOR AND KEYBOARD PARALLEL AND CENTERED?

- To minimize twisting of your head, neck, and torso.
- To locate the part of your keyboard that you use the most in your normal, or preferred, work space.
- To minimize awkward positions in your wrists when you use your keyboard. (More on this below.)

The position of your monitor and keyboard should be checked each time you begin to use your computer. After the initial setup and adjustment of your workstation, *you may need to do nothing more than glance at your work environment to make sure that the monitor and keyboard are properly positioned with respect to your work surface, to one another, and to yourself. However, if different tasks require the use of different parts of the keyboard, you may benefit by positioning the keyboard and/or yourself accordingly.*

PART II: CONSCIOUSLY LOCATE YOURSELF AND YOUR EQUIPMENT IN 3-DIMENSIONAL SPACE: UP/DOWN; RIGHT/LEFT; IN/OUT

The second part of this strategy establishes your baseline working posture. It requires you to adjust your chair for maximum comfort and then to position yourself at your workstation. The trick is to find the proper balance between the various heights so that no part of your body has to work in an awkward, or cramped, position.

WHAT DO I DO?

- *ADJUST* your chair to fit yourself.
- *POSITION* yourself at your workstation.

HOW DO I ADJUST MY CHAIR TO FIT MYSELF?

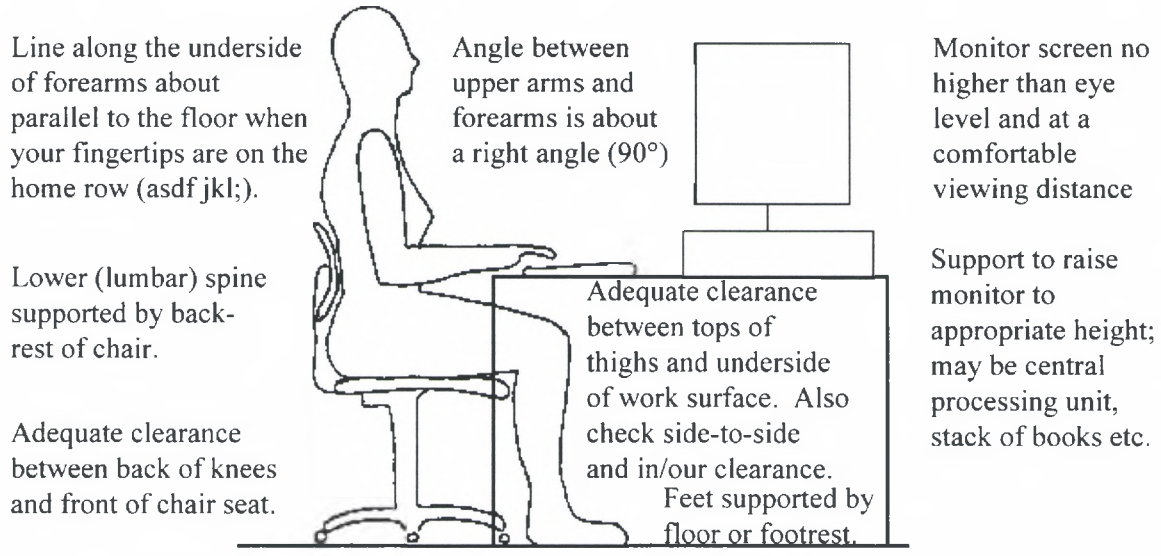
- Sit in the center of your seat, as far back as possible, with your back parallel to the backrest and supported by it.

  To be sure that you are seated as far back as possible, sit in the middle of your seat and lean forward from your hips. Then, while you are still leaning forward, slide as far back in your seat as you can. Finally, sit up again. You should be able to feel your back supported by the backrest of your chair.

WHY DO I NEED TO ADJUST EVERYTHING IN THREE-DIMENSIONAL SPACE?

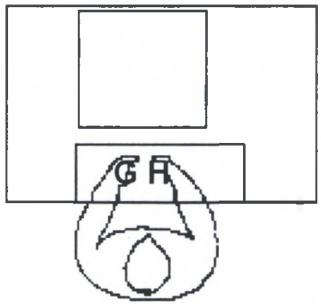
- To help minimize work-related discomfort.
- To avoid impaired circulation in your legs and feet.
- To support your lower (lumbar) spine and help ensure good posture.
- To minimize neck strain and maximize ease of viewing the monitor screen (especially important if you wear bifocals).
- To minimize awkward arm/hand/finger positions when operating your keyboard. (More on this below.)

In order to find the workstation layout and adjustment that satisfies you, it may be necessary to recycle through the steps in parts one and two of this strategy (pp. 4 - 10) several times. In addition, you may have to make some choices about what is most important to you, given the characteristics of your particular desk, chair, monitor, keyboard and task. However, *once you have determined your desired workstation layout and adjustment, you probably will not need to do anything more than glance at the position of your keyboard and monitor, and check your own position with respect to your keyboard and monitor each time you start keying.* You probably will not need to readjust anything unless someone else has used your workstation, or you have chosen to use a very different work posture. Despite the fact that each workstation layout is somewhat unique, be assured that each little improvement can help to reduce work-related discomfort. (See below for a figure which summarizes parts one and two of this strategy for workstation layout and adjustment.)



SIDE VIEW OF COMPUTER OPERATOR AT WORKSTATION

Monitor and keyboard parallel with one another; separation between G and H directly beneath vertical midline of monitor



Operator seated in center of chair with back parallel to, and supported by backrest.

Operator seated parallel with monitor and keyboard

Nose pointed at vertical midline of monitor screen; naval directly in front of the separation between G and H

OVERHEAD VIEW OF COMPUTER OPERATOR AT WORKSTATION SET UP FOR TYPING/WORD PROCESSING

PART III: MINIMIZE EFFORT RESULTING FROM THE USE OF AWKWARD POSTURES, POOR MOVEMENT PATTERNS, AND EXCESSIVE FORCE

One of the major risk factors for work-related discomfort is the use of excessive force (i.e., using more force than is necessary to get the job done). In addition, the use of awkward postures and poor movement patterns require extra effort and can contribute to work-related discomfort.

MINIMIZE AWKWARD POSTURES

WHAT DO I DO?

- Maintain good head/neck/torso alignment (ears, shoulders, and hips in a vertical line).
- Keep head balanced and poised on the top of your spine, not dropped forward, pulled down and back, and/or twisted or tilted to one side.
- Allow shoulders to assume their natural neutral and balanced position (not drawn up, pulled back, rounded forward, or asymmetrical).

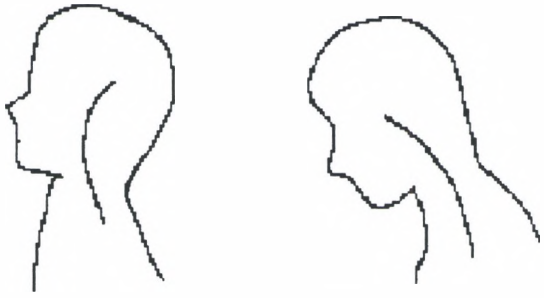
HOW DO I MINIMIZE AWKWARD POSTURES?

- Use your bones, not your muscles, for support.
  To get the feeling of using your bones for support, try the following demonstration. Sit forward in your chair so that your knees are a bit lower than your hips. Then, put your ears over your shoulders, and your shoulders over your hips and feel the weight of your head and torso going down into the seat of your chair. Now, lean in various directions and feel how your muscles have to help support you.
- Avoid excessive muscular tension.
- Rotate your head about the joint between your ears. (That is, you want to move your head without having to move your neck.)

LOCATION OF JOINT BETWEEN HEAD AND NECK

Notice that the head is balanced on the neck/spine at a pivot point which is located between your ears. Moving the head to lower or raise the eyes takes place here, not at the base of the neck. In this position the bones of your skeleton, rather than the muscles of your neck and shoulders, can do most of the work of supporting your head

There is no joint at the base of the neck.



TWO WAYS *NOT* TO MOVE YOUR HEAD UP AND DOWN

Notice that both of these postures require considerable muscular effort to maintain because there is little skeletal support for the head. Dropping your head forward from the base of your neck so that your eyes are looking downward, or drawing it backward from the base of your neck so that your eyes are looking upward, both put stress on the delicate structures of the spine and the neck.

WHY DO I NEED TO MINIMIZE AWKWARD POSTURES?

- To minimize muscular fatigue.
- To maximize ease of movement.
- To reduce the likelihood of experiencing work-related discomfort.

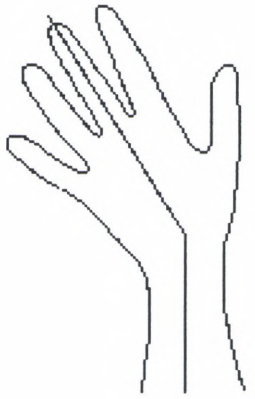
MINIMIZE POOR MOVEMENT PATTERNS WHEN USING THE KEYBOARD

WHAT DO I DO?

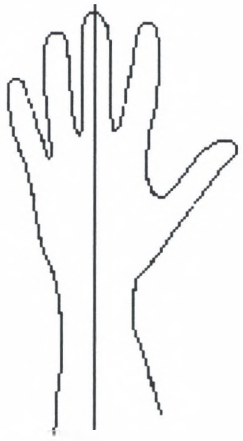
- Maintain good hand/arm alignment.
- Keep a "flat," neutral wrist position.
- Employ a natural, curved hand shape.
- ***M o v e***, don't reach, to access desired keys!

HOW DO I MINIMIZE POOR MOVEMENT PATTERNS?

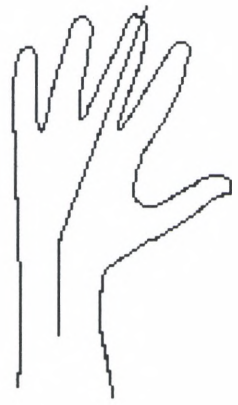
- Align your forearm and hand so that there is a straight line from the tip of your middle finger, along the back of your hand and the length of your forearm.



(a) ULNAR DEVIATION
(*NOT* recommended)



(b) GOOD FOREARM/HAND ALIGNMENT
(recommended)

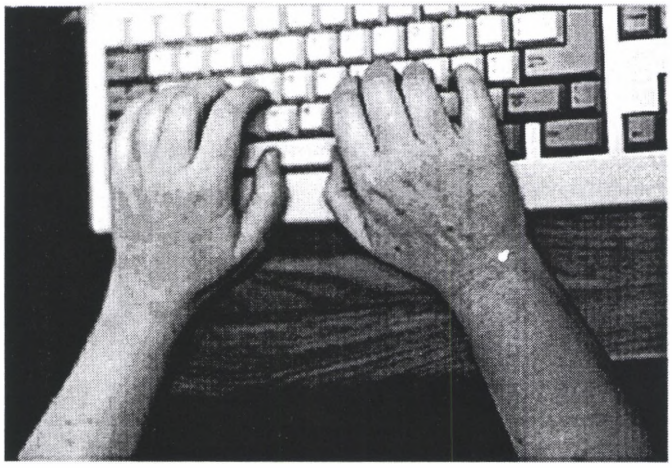


(c) RADIAL DEVIATION
(*NOT* recommended)

Notice, when there is GOOD forearm/hand alignment (b) a line drawn through the length of the forearm can be continued straight through the length of the hand and the long middle finger. When there is POOR forearm/hand alignment--either ulnar deviation (a) or radial deviation (c), a line drawn through the length of the forearm and the length of the long middle finger has an angle in it either toward the "pinkie" side of the hand (ulnar deviation) or toward the thumb side of the hand (radial deviation).

- Keeping good forearm/hand alignment, find a hand position where your wrist is "flat.". That is, your wrist is neither bent toward the palm of your hand (flexed) nor bent back (extended).

  Both of these wrist positions (flexion and extension) produce pressure on the tendons and nerves which run through the wrist and are not to be recommended. Extension often occurs when a computer operator leans on his/her work surface when operating a keyboard. Flexion may result when a computer operator uses one hand to operate two keys at the same time. Avoiding awkward hand positions reduces one risk factor associated with work-related discomfort.



EXTENSION OF WRIST RESULTING FROM RESTING FOREARM WHILE OPERATING COMPUTER KEYBOARD

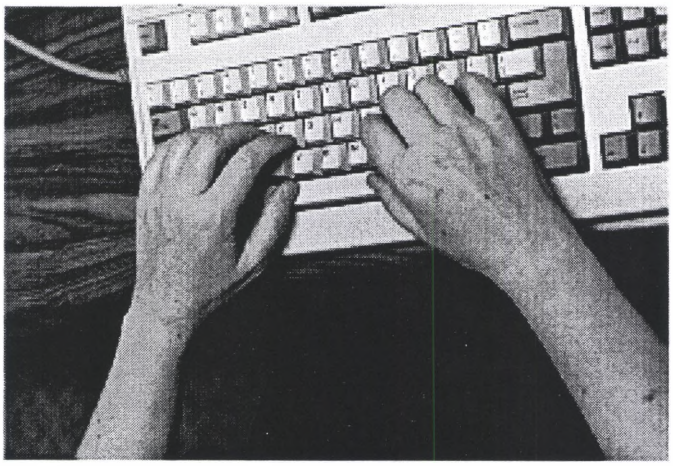
Notice that the hands and fingers are positioned above the wrist which results in extension of the wrist. Extension of the wrist while working can contribute to discomfort.

FLEXION OF WRIST RESULTING FROM AWKWARD POSITIONING OF ONE HAND DEPRESSING TWO KEYS

Notice that the hand and fingers are located below the wrist which results in flexion of the wrist. Flexion of the wrist while working can contribute to discomfort.

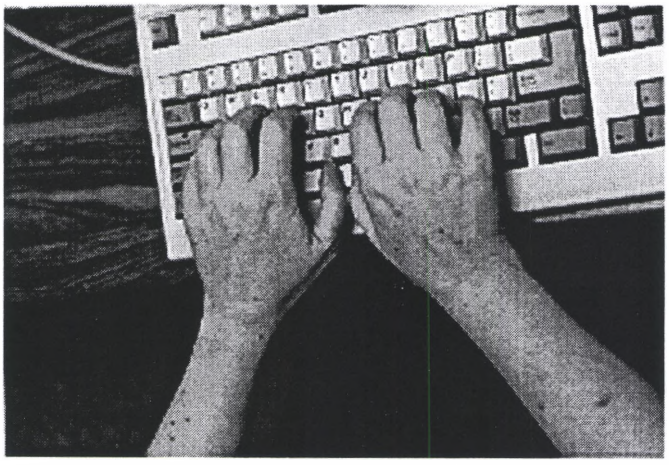
- Keeping good forearm/hand alignment and a neutral ("flat") wrist position, locate your hands on your keyboard in a natural, curved hand shape, and contact the keys with your fingertips.

  To find your own natural, curved hand shape, place the underside of your right hand wrist into the up-turned palm of your left hand so that your right hand and forearm are both supported.. Now extend the fingers and thumb of your right hand until they are straight and flat, and notice what that feels like. Then let your right hand fingers and thumb return into their normal curved shape and notice how that feels. These two positions should feel different. Notice which feels more relaxed.



NATURAL, CURVED HAND SHAPE AT THE KEYBOARD WITH GOOD FOREARM/HAND ALIGNMENT

Notice that the extension of the line through the length of the forearm would pass through the length of the long middle finger.



NATURAL, CURVED HAND SHAPE AT THE KEYBOARD WITH *POOR* FOREARM/HAND ALIGNMENT

Notice the ulnar deviation (the bend in both wrists toward the "pinkie" side of the hand).

- Position your thumbs on, or near, the spacebar and without visible tension. The thumb should rest easily on the space bar in the same alignment as the forearm and hand. It should *NOT* be held up, and away from the hand.
- Keep your hand small and access desired keys by ***m o v i n g*** rather than by reaching or stretching.

When your fingertips are on the home row (asdf jkl;) in their natural curved shape, and your thumb is relaxed, your hand is "small." Reaching for keys while maintaining contact with the home row, instead of moving the hand to gain access to desired keys tends to create tension in the hands and to result in the use of awkward finger, and wrist positions.

- Use two hands when using two-key combinations.

  The advent of computer software has led to the use of combinations of fingers that are not even mentioned in typing/keyboarding books. Many programs now require the user to depress two and even three keys at the same time to issue a single command to the computer (e.g., SHIFT + F7 or ALT + F). Many computer operators use one hand to depress two keys which results in awkward hand and/or wrist positions that would be unnecessary if one hand were used for each key. Also, some programs require extensive use of a single key that is rarely used in normal typing (e.g., the TAB key to change fields in a table or spreadsheet). In typing, the TAB key is normally operated with the little finger of the left hand, but when used unceasingly, it may be preferable to use another, "stronger" finger for the job.

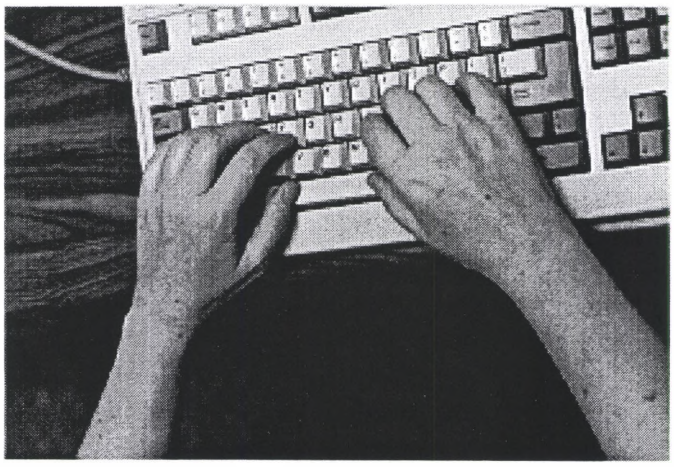
WHY DO I NEED TO MINIMIZE POOR MOVEMENT PATTERNS?

- Tendons don't like to go around corners.

  Tendons attach muscles to bones and some of the important muscles that move the fingers are located in the forearm. If there is an angle at the wrist, then some of these tendons have to go around a "corner." This situation results in extra wear and tear on the tendons.
- Tension within finger joints is lowest when your fingers are curved.
- Moving, rather than reaching or stretching, reduces awkward arm/hand/finger positions.

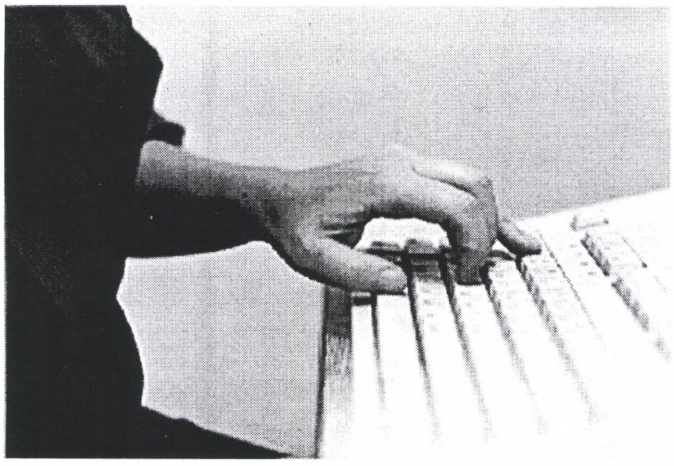
OVERHEAD VIEW OF THE RIGHT HAND "PINKIE" REACHING TO THE SIDE TO USE THE SHIFT KEY WHILE MAINTAINING CONTACT WITH THE HOME ROW
Notice the amount of ulnar deviation which results from this action.

AN EXAMPLE OF A *POSITION TO AVOID* WHEN USING A COMPUTER KEYBOARD



OVERHEAD VIEW OF REACHING UP AND FORWARD WHILE MAINTAINING CONTACT WITH THE HOME ROW

Notice that the right hand long middle finger is extended forward to gain access to a number while the other fingers maintain their position over the keys of the home row. Reaching with other fingers while maintaining contact with the home row can lead to awkward hand and wrist positions. These awkward positions contribute to the risk of work-related discomfort.



SIDE VIEW OF REACHING UP AND FORWARD WHILE MAINTAINING CONTACT WITH THE HOME ROW

Notice that the left hand ring finger is to gain access to a number while maintaining contact with the home row.

TWO MORE EXAMPLES OF *POSITIONS TO AVOID* WHEN USING A COMPUTER KEYBOARD

MINIMIZE EXCESSIVE FORCE

WHAT DO I DO?

- Use only the force necessary to depress the keys, no more.
  With contemporary computer keyboards, the "force" needed to depress a key can be as little as an ounce, or even less.
- Avoid unnecessary tension resulting from awkward hand positions.

HOW DO I MINIMIZE EXCESSIVE FORCE?

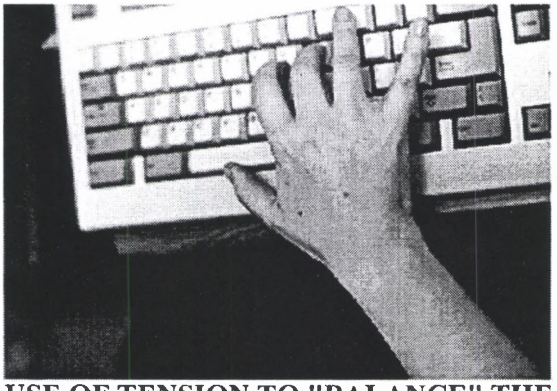
- Avoid using so much force that fingertips and/or knuckles blanch (turn white).
- Avoid using so much force the fingertips bend backward at the end.
- Minimize the sound of the keys hitting the bottom of the "keybed"

WHY DO I NEED TO MINIMIZE EXCESSIVE FORCE?

- Excessive force is a major cause of work-related discomfort and injury.
- Minimizing tension reduces stress within your musculoskeletal system.

USE OF EXCESSIVE FORCE WHEN DEPRESSING A KEY

Notice that the tip of the left hand index finger is bent backward, and blanched white.



USE OF TENSION TO "BALANCE" THE HAND

Notice that the right hand is "balanced" by the extended thumb and "pinkie." The thumb and "pinkie" function like the out-riggers on a canoe to keep the hand from tipping to one side or the other.

The two letters, "**M**" and "**E,**" that serve as a reminder to ***Minimize Effort*** resulting from the use of awkward postures, poor movement patterns, and excessive force also have a second meaning: They spell the word "ME." In this second context, they can be taken as a reminder that each individual computer operator is responsible for using his/her arms, hands, and fingers in ways that honor their natural anatomical structures.

WHERE DO I BEGIN? PROBLEM SOLVING USING THE PC--3-D--ME STRATEGY FOR WORKSTATION LAYOUT, ADJUSTMENT, AND USE

You may be thinking, "This all seems so complicated that I don't even know where to get started!" Actually, once you have some tools to work with--like the three principles just described,--it can be sort of fun to try and figure out which options work best for you.

This first thing you need to do to get started is to compare your current workstation layout with the suggested options. What do you want to keep? What do you want to change? To help you think about your workstation layout and adjustment, there is a checklist on pages 21 and 22 of this booklet. The questions in the checklist correspond to the main points made in the discussion of each of the three parts of the ***PC--3-D--ME*** strategy. They are worded so that if you respond "NO" to a question, you might want to consider some change related to the issue addressed by that question.

The second thing you need to do to get started is to consider your current equipment. What is adjustable? What is not adjustable? What is modifiable? The options available to one person will be different from those available to another. The trick is to start with the resources that you have and to make them work together to your advantage.

Once you know what aspects of your workstation layout and adjustment you would like to keep, and what aspects you might like to change, and once you know what resources you have available, then the fun begins. Allow yourself to think creatively, then check your ideas against the three principles ***PC--3-D--ME***. And, most important of all, *learn to listen to your body*. It will give you lots of good information that you can learn to translate into improvements in your workstation layout, adjustment, and use.

APPLYING THE PC--3-D--ME STRATEGY TO A NEW CHALLENGE: "WHAT DO I DO WITH MY MOUSE?"

Computer mice were introduced in 1982. Today they inhabit the workstations of many, if not most, computer users. Yet, there are no official, scientifically based guidelines concerning mouse placement and use. Thus, computer users, are left on their own to find answers to questions such as How do I hold the mouse? Where do I put the mouse? etc., etc., etc.,

Given this situation, the PC--3-D--ME strategy presented in this booklet can provide some principles to consider when deciding how to incorporate a mouse into your workstation. These principles can also furnish insights into how to use the mouse in ways that may help to minimize the likelihood of developing work-related discomfort. The following ideas are based on these principles and may serve to help you start thinking about the question "What do I do with my mouse?"

- Find a way to hold your mouse using good hand arm alignment (i.e., no ulnar, or radial, deviation; see pp. 13 - 14).
- Maintain good hand/arm alignment when using the mouse (see pages 13-14).
- Hold your mouse gently. If your fingertips blanch or bend back at the ends, you are "squeezing" your mouse, not just holding it and using it.
- Keep the mouse within you normal, preferred, work space if possible (see pages 2-3).
- Avoid long reaches to the side, or to the front, when using your mouse.
  For intensive mouse use (e.g., graphic design) which makes very little use of the keyboard, you may want to move the keyboard away from the center of your preferred work space, and put the mouse right in front of you.
- Avoid large amounts of wrist flexion and extension when using the mouse (see page 14).
  You may find that placing your hand on top of the mouse so that your fingers hang over the edge and you operate the mouse button by "grasping" with your fingers rather than by "hitting" it from above may make is easier to find a good wrist position.
- Avoid awkward positions that come from habits such as using your elbow like an anchor so that all of the movement has to take place in the wrist.

As you try various options, be aware of how they look and feel. Good? Bad? Can't decide? And, check them against the three principles and guidelines of the PC--3-D--ME strategy for workstation layout, adjustment, and use. Despite the absence of official, scientifically based guidelines for mouse use, there is no doubt that a person can use it in ways which are more, or less, likely to contribute to work-related discomfort.

DOES WORKSTATION LAYOUT, ADJUSTMENT AND USE REALLY MATTER?

You may be thinking, "Is it worth the trouble to bother about workstation layout, adjustment, and use?" I believe that it is. The idea that office computer operators are small muscle athletes suggests that office computer operators, like athletes, have to take care of themselves if they are to perform to the best of their ability. There is no doubt that reports of work-related discomfort are increasing and that the costs (medical and otherwise) associated with this discomfort are increasing. Fortunately, we know about some of the factors which can decrease the likelihood of discomfort. Proper workstation layout and adjustment are important. Proper work posture and work technique are also important.

Using this three-part strategy is an ongoing process. Every little change can help, and no one change will fix all the problems. Different furniture and tools will bring new changes and

challenges. It is our hope that the ***PC--3-D--ME*** principles will empower you to find your own unique ways of addressing these challenges.

When it comes to work-related discomfort, it is clear, that
the writer of an old English proverb had it right:

"An ounce of prevention is worth a pound of cure."

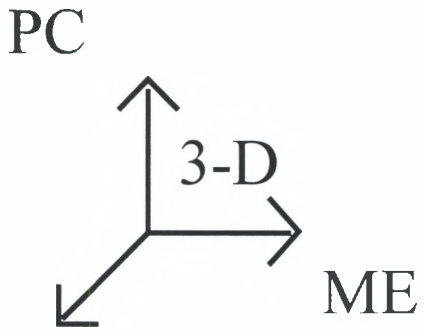
CHECKLIST TO EVALUATE THE LAYOUT, ADJUSTMENT, AND USE OF YOUR WORKSTATION

Evaluate your workstation by marking YES, or NO, [(X)] in the column labeled "DID I FIND IT?"

STRATEGY	WHAT DO I LOOK FOR?	DID I FIND IT?*
PART I: PC Positioning on work surface	Is your monitor screen parallel with the length of your keyboard?	[ ] YES [ ] NO
	Is the "landmark" you have chosen for positioning your torso at your keyboard (see p. 7) directly beneath the vertical mid-line of your monitor?	[ ] YES [ ] NO
PART II: 3-D Adjusting chair	Are you sitting in the center of your seat?	[ ] YES [ ] NO
	Is your back parallel with the back rest of your chair?	[ ] YES [ ] NO
	Are you sitting as far back in your chair as possible?	[ ] YES [ ] NO
	Is there some clearance between the back of your knees and the front of your chair seat?	[ ] YES [ ] NO
	Is your back supported by the back rest of your chair?	[ ] YES [ ] NO
Adjusting workstation and positioning yourself at your workstation	Are you sitting so that your torso is parallel with your keyboard and monitor?	[ ] YES [ ] NO
	Is your nose pointing at the vertical mid-line of your monitor screen?	[ ] YES [ ] NO
	Is your naval directly in front of the appropriate "landmark?" (Separation between G and H for traditional typing; your chosen landmark for numeric keypad operation [see p. 7]).	[ ] YES [ ] NO
	Is your monitor screen no higher than your eye level and preferably somewhat lower?	[ ] YES [ ] NO

STRATEGY	WHAT DO I LOOK FOR?	DID I FIND IT?*
PART II: 3-D (continued)	Is the underside of your forearm parallel with the floor when your fingertips are on the home row?	[ ] YES [ ] NO
	Is the angle between your upper arms and forearms about 90°?	[ ] YES [ ] NO
	Do you have adequate clearance for your knees in all three dimensions?	[ ] YES [ ] NO
	Are your feet supported by the floor or by a foot rest?	[ ] YES [ ] NO
	Is your mouse in your normal, preferred, work space?	[ ] YES [ ] NO
	Is your monitor screen free of glare and/or reflection?	[ ] YES [ ] NO
PART III: ME Minimize effort from use of awkward postures, poor movement patterns, and excessive force	Do you have good head/neck/torso alignment? That is, are your ears, shoulders, and hips in a vertical line?	[ ] YES [ ] NO
	Is your head balanced and poised on the top of your neck/spine?	[ ] YES [ ] NO
	Are your shoulders in their neutral and balanced position, and even with one another?	[ ] YES [ ] NO
	Is there a straight line through the length of your forearm, hand and long middle finger?	[ ] YES [ ] NO
	Is your wrist in a neutral position, neither flexed nor extended?	[ ] YES [ ] NO
	Are your hands in a natural, curved shape?	[ ] YES [ ] NO
	Are your thumbs relaxed at the side of your hand at all times (i.e., neither lifted up nor sticking out to one side).	[ ] YES [ ] NO
	Do you move, rather than reach or stretch, to get to desired keys?	[ ] YES [ ] NO
	Do you use only the force necessary to depress the keys?	[ ] YES [ ] NO
	Do you use only the force necessary to hold the mouse?	[ ] YES [ ] NO
	Is it impossible to hear you typing when standing a few feet away?	[ ] YES [ ] NO

* Each response of "YES" indicates a characteristic of a well laid out and adjusted work station.



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APPENDIX C

INSTRUCTIONAL MATERIALS PREPARED BY THE LIBRARY OF CONGRESS COLLECTIONS SERVICES VDT ERGONOMICS COMMITTEE (1991)

Ergonomics and VDT Use

The introduction of video display terminals (VDTs) has changed work methods. VDT operators are able to work at a continuous, rapid pace using a limited number of small muscle groups. Keystrokes entail prolonged and repetitive use of the upper extremities and eyes. There are, also, relatively long periods of immobilization of large muscle groups.

Researchers conclude that health problems associated with working at a VDT can be alleviated by maintaining good posture, refocusing the eyes, taking frequent rest pauses, exercising, and reconfiguring the workstation. VDT operators can maximize their comfort and maintain good posture by keeping a well organized workstation with adequate free working space and frequently used material and equipment within easy reach.

Repetitive strain injuries can result from too frequent and too forceful strokes and from prolonged sitting subjecting the spine, back muscles, and legs to added stress. Bad posture can contribute to this stress. Each key stroke an operator makes requires the muscles to contract and tendons to move. As the tendons slide over bone and against tissue, they can become irritated causing painful inflammation. To maintain proper posture and avoid problems, the VDT literature suggests that operators adopt the following recommendations.

Chairs

Use a chair with adjustable seat height (in a range of 15 to 21 inches from the floor to accommodate most operators). Adjust seat height so that the thighs are relatively horizontal, the lower legs vertical, and the feet planted firmly on the floor or a footrest. A seat that is too high cuts the circulation in the thighs and legs. When too low, it may cause the arms to assume an uncomfortable angle. Adjust the seat back angle and height to provide needed back support and comfort.

Keyboard

Once the chair is adjusted, adjust the keyboard height so that the upper arm and forearm form a right angle when the hands are placed on the keyboard. The hands should be in a reasonably straight line with the forearm and the upper arms should be in a relaxed position at the side of the body. Adjust the slope of the keyboard to maintain a flat wrist position. The recommended keyboard height is between 23.5 to 30.5 inches from the floor. The VDT literature recommends a slope of between 0 and 15 degrees.

Screen Placement and Viewing Specifications

Adjust the height of the screen so that the top of the screen is no higher than eye level. Lower heights are required if you wear bifocals. Incorrect positioning of the screen affects posture. Screens placed too low or angled improperly frequently cause the operator to slouch.

The recommended distance between the eyes and the screen is between 18 and 30 inches. Place source documents on the side of the dominant eye and at the same height and angle as the screen to avoid unnecessary neck and shoulder strain. To achieve this use a document holder or bookstand.

Adjust the position and angle of the VDT screen and keep it clean to minimize glare and increase character sharpness. To clean a VDT screen wipe it very lightly every day with a damp, not

wet, paper towel. When not in use, cover the monitor with a plastic cover (where supplied). Other techniques to minimize glare are: 1) reduce overhead lighting 2) close blinds over windows 3) use a hood or anti-glare screen, (the latter may reduce clarity). When overhead lighting is reduced to address glare problems, task lighting may become necessary.

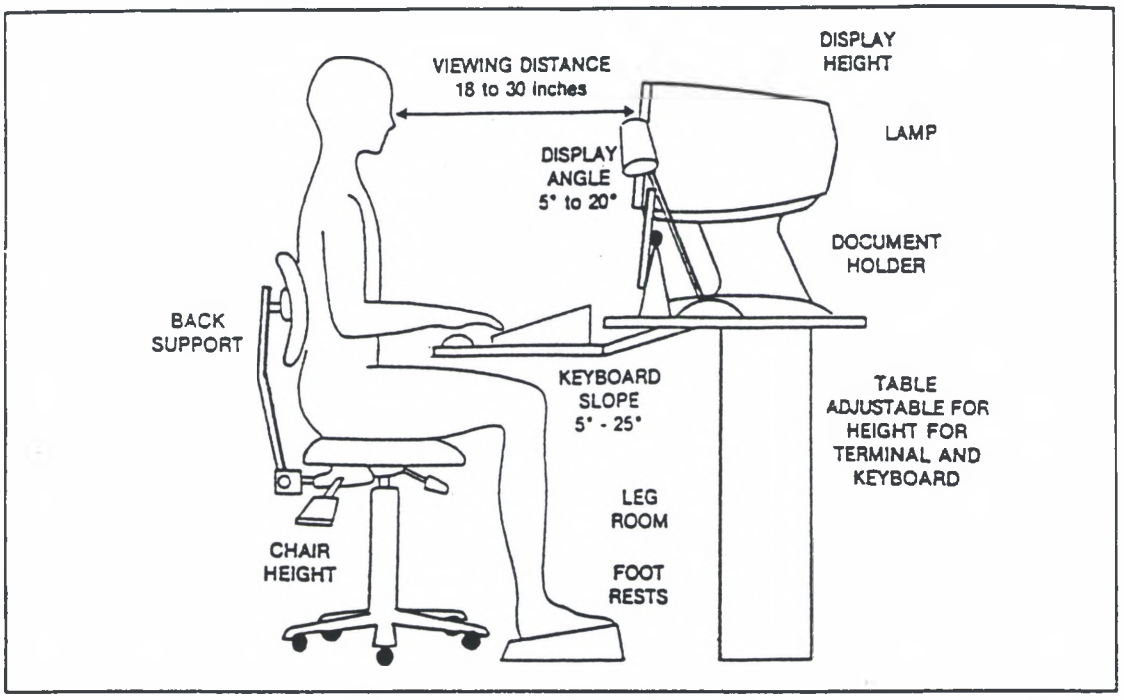


Diagram adapted from "The ABCs of VDTs"

Ergonomic Pauses

Take short, frequent rest pauses in preference to longer, more infrequent ones. Short pauses can prevent the accumulation of stress symptoms. Rest pauses should incorporate exercises, stretches, and movement to stretch, limber, and strengthen muscles.

Refocus the eyes periodically by looking away from the monitor at something in the distance. Blinking, yawning, moving the eyes up and down, left and right, etc. are also beneficial.

The information in this broadside was collected by the Library of Congress Collections Services VDT Ergonomics Committee from:

- The ABCs of VDTs: an AFSCME Safety & Health Guide. Washington, D.C.: AFSCME, 1989.
- American National Standard for Human Factors Engineering of Visual Display Terminal Workstations. (ANSI HFS 100-1988) Santa Monica, CA: Human Factors Society, Inc., 1988.
- Dodge, Christopher H. Video Display Terminals and Problems of Modern Office Health, Safety and Policy: An Update. (CRS Report for Congress) Washington, D. C.: Library of Congress, 1989.
- Hembree, Diana. "Warning: computing can be hazardous to your health." MacWorld. January 1990:150-157.
- Tjerina, Louis. Optimizing the VDT Workstation: controlling glare and postural problems. Dublin, Ohio: OCLC Online Computer Library Center, c1983.

Issued 1991

APPENDIX D

PRE-INSTRUCTION QUESTIONNAIRE

NAME: _____ ID NUMBER: _____
Please Print

DATE: _____

BEFORE YOU BEGIN, please fill the date at the top of this page. Then, work through this packet, completing each part in turn. Please do not return to a previously completed part to modify your responses in any way. Your first impressions are most valuable to us.

SURVEY PACKET FOR OFFICE COMPUTER OPERATORS

In recent years, you may have seen media reports about injuries suffered by office computer operators. Such reports indicate that individuals, employers, and government regulatory agencies are becoming aware of these problems, and are beginning to address them.

The information you provide on the surveys in this packet, and on the other surveys used in this study, is very important to us. It will be used to help us evaluate training programs for office computer operators. The information will be available only to the researchers, and will be used only for scientific, statistical purposes. It will not be possible for people other than the researchers to identify the responses made by a particular participant.

To assure confidentiality, this page is the only one that shows both your name and your ID number. We will remove this page when you return the completed survey packet, and only the researchers will have access to it. All other materials will use only your ID number.

* * * * *

The attached survey packet has five parts. It asks for information about:

PART 1: You as an individual (for example, gender, age, educational background, hobbies).
PART 2: Your knowledge about work-related discomfort, work-station adjustment, and typing/keying technique.
PART 3: Your experience with work-related discomfort (for example, Have you, or others you know, experienced work-related discomfort? If so, where have you experienced this discomfort? How severe is it? How frequently does it occur? How long has it persisted?).
PART 4: You, your job, and your work area (for example, How long have you worked at your current job? How many hours per day do you use a computer keyboard?).
PART 5: Your typing/keying education and your experience regarding workstation adjustment (for example, How did you learn to use a computer keyboard? Have you received formal instruction? Do you just do "what comes naturally?").

Thank you for helping in this study.

ID NUMBER: _____

DATE: _____

PART 1: YOU AS AN INDIVIDUAL

Part 1 of this survey asks for background information about you. Please answer each question as accurately as you can. All of your responses will be treated confidentially.

QUESTIONS 1 - 7 ASK FOR GENERAL BACKGROUND INFORMATION.

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

1. What is your gender? [ ] male [ ] female

2. What is your height? |___| feet |___|___| inches

3. Which hand do you use the most at work?
   [ ] right-hand
   [ ] left-hand

4. How old are you?
   [ ] under 20
   [ ] between 20 and 24
   [ ] between 25 and 29
   [ ] between 30 and 34
   [ ] between 35 and 39
   [ ] between 40 and 44
   [ ] between 45 and 49
   [ ] between 50 and 54
   [ ] between 55 and 59
   [ ] over 60

5. Have you graduated from high school?
   [ ] **YES.** *Please continue with this question.*
   [ ] **NO.** *Please go on to question #6.*

   *If **YES**, please "X" the amount of post high-school education you have completed.*
   [ ] none
   [ ] less than 2 years
   [ ] 2 - 4 years
   [ ] more than 4 years

6. For how many years (e.g., 1.5 years) have you worked (paid work, volunteer work, etc., *not* school work) using a computer?
   ____ . ____ years of work-related computer use

7. Do you participate in exercise or sports at least once a week?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #8.*

*If **YES,** please list the kind(s) and how often (2-3 times a week, once a month, etc.) on the lines to the right.*

Kind(s) of exercise/sports	How often
_____	_____
_____	_____

8. Do you participate in hobbies or crafts such as playing a musical instrument, gardening, embroidery and/or recreational computer activities?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #9.*

*If **YES,** please list the hobbies/crafts and how often you participate (2-3 times a week, once a month, daily during spring and summer, etc.) on the lines to the right.*

Instrument(s)	How often
_____	_____
_____	_____

Hobby(ies)/craft(s)	How often
_____	_____
_____	_____

QUESTIONS 9 - 11 ASK ABOUT YOUR EXPERIENCE WITH WORK-RELATED DISCOMFORT.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

9. Do you have any work-related discomfort which you attribute to your job as a computer keyboard operator?

[ ] **YES.** *Please go on to question #10.*
[ ] **NO.** *Please go on to question #12.*

10. How would you rate the OVERALL SEVERITY of your current, work-related discomfort?

[ ] MINIMAL DISCOMFORT (discomfort is present, but I can ignore it)
[ ] SLIGHT DISCOMFORT (discomfort is present, and I can't ignore it)
[ ] MODERATE (discomfort affects ability to work and to concentrate)
[ ] SEVERE (discomfort affects not only ability to work, but also many activities of daily living)
[ ] INTOLERABLE (discomfort makes work and activities of daily living nearly impossible)

11. How would you describe the OVERALL FREQUENCY of your current, work-related discomfort?

[ ] NOT VERY OFTEN (a few times a month or less)
[ ] SOMETIMES (a few times a week)
[ ] QUITE OFTEN (nearly every day)
[ ] ALWAYS (if never goes away)

Please continue with PART 2 of this survey. It begins below.

PART 2: YOUR KNOWLEDGE ABOUT WORK-RELATED DISCOMFORT, WORKSTATION ADJUSTMENT, AND TYPING/KEYING TECHNIQUE

Part 2 of this survey asks questions about work-related discomfort, workstation adjustment, and technique.

QUESTIONS 12 - 23 PRESENT STATEMENTS ABOUT WORK-RELATED DISCOMFORT, WORKSTATION ADJUSTMENT, AND TYPING/KEYING TECHNIQUE.

To complete the questions in Part 2 of this survey, circle "T" for "True" or "F" for "False" to indicate whether you believe the statement is "True" or "False."

12. Experts know very little about the factors that contribute to work-related musculoskeletal disorders. Therefore, individual computer users can do very little, if anything, to avoid suffering from such disorders. **T F**

13. When using a keyboard, your hands and forearms should be in a reasonably straight line. **T F**

14. The location of your keyboard on your work surface has no effect on your comfort. **T F**

15. It doesn't matter whether you use fingers that are on the same, or different, hands when you use a combination of keys (e.g., SHIFT plus a function key, ALT + F, or CONTROL + C). **T F**

16. As long as the key goes down, it doesn't really matter how hard you strike the keys on the keyboard. **T F**

17.	The distance between you and your keyboard is *not* particularly important.	**T**	**F**
18.	The height of the monitor should be the same whether a person uses single vision or bifocal lenses.	**T**	**F**
19.	When using a keyboard, the angle between your upper arms and your forearms should be about a right angle (90°).	**T**	**F**
20.	The location of documents containing information for entry into your computer does *not* have any effect on discomfort.	**T**	**F**
21.	Adjusting the tilt of your monitor screen helps reduce glare and reflection.	**T**	**F**
22.	Operating a computer keyboard requires extensive use of small muscles.	**T**	**F**
23.	The keyboard and monitor should parallel with one another.	**T**	**F**

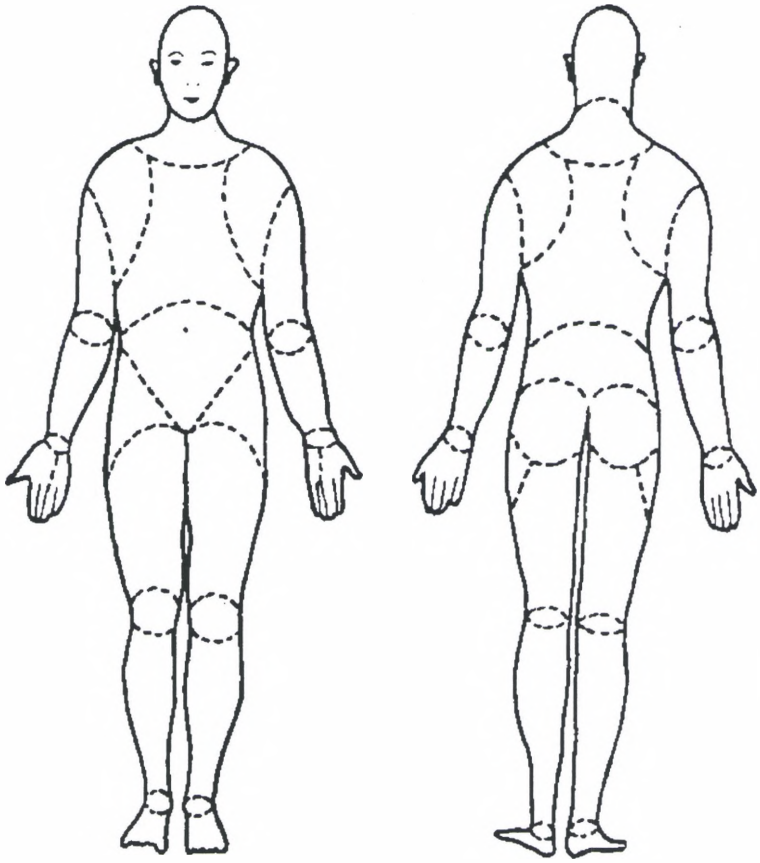
Please continue with Part 3 of this survey. It begins on page 5.

PART 3: YOUR EXPERIENCE WITH WORK-RELATED DISCOMFORT

Work-related activities can sometimes result in physical discomfort. For purposes of this part of the survey, consider that work-related body-part discomfort may include one or more of the following sensations: pain, tenderness, numbness, tingling, tension, fatigue, soreness, heat, cold, tremor, aching, burning, tiredness, cramping, stiffness, swelling, weakness, and loss of color.

This discomfort survey has two parts:

1. Diagrams of the front and the back of the body (see below) on which to locate and identify any current, work-related body-part discomfort.
2. Questions about your medical history and about any medical treatment you have received for work-related body-part discomfort. These questions are located on page 7.



As in all the other parts of this survey, all information you provide will be kept confidential and will be used only for statistical, scientific purposes.

PART 4: YOU, YOUR JOB, AND YOUR WORK AREA

Part 4 of this survey asks questions about you, your current job, and your work area. Please answer each question as accurately as you can, and be assured that your responses will be kept confidential and available only to the researcher.

QUESTIONS 34 - 55 ASK FOR INFORMATION ABOUT YOU AND YOUR CURRENT JOB.

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

34. How long have you worked for this company? |__|__| years |__|__| months

35. Please write your current job title here → _____

36. How long have you worked at your current job? |__|__| years |__|__| months

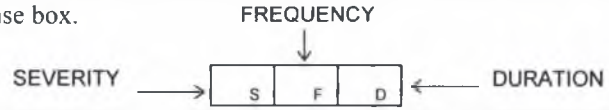
37. On average, how many hours per week do you work at your current job?
[ ] less than 10
[ ] 11 - 19
[ ] 20 - 34
[ ] 35- 40
[ ] 41 - 50
[ ] more than 50

38. Which category best describes your normal typing/keying speed?
[ ] *slow* (less than 40 wpm)
[ ] *moderate* (40-60 wpm)
[ ] *fast* (more than 60 wpm)

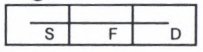
39. How would you describe your typing/ keying technique?
[ ] *true touch* (without looking at the keyboard for letters, numbers, or symbols)
[ ] *touch* (without looking at the keyboard for letters, but with some looking for numbers, symbols, and/or function keys)
[ ] *modified "hunt and peck"* (looking at the keyboard as needed for letters, numbers, symbols, and/or function keys)
[ ] *"hunt and peck"* (using one or two fingers on one or both hands, plus a finger, or a thumb, for the space bar)

INSTRUCTIONS

As you complete this part of the work-related body-;art discomfort survey, please read the descriptions of discomfort *very* carefully (see below). Then complete this part of the survey as honestly and as accurately as you can. for each body part where you CURRENTLY experience work-related-body-part discomfort, write a number from the SEVERITY scale in the left-hand (s) response box, a number from the FREQUENCY scale in the middle (F) box, and a number from the DURATION scale in the right-hand (D) response box.



For each body part where you DO NOT CURRENTLY experience any work-related-body-part discomfort, fraw a horizontal line through all three boxes of the three-part rating box, like this:



SEVERITY SCALE

How much does this discomfort affect your ability to work and to engage in activities of daily living (e.g., eating, dressing)/

-- = ***NO DISCOMFORT***
1 = ***MINIMAL*** (discomfort is present, but I can ignore it)
2. = ***SLIGHT*** (discomfort is present and I cant' ignore it)
3 = ***MODERATE*** (discomfort affects my ability to work and to concentrate)
4 = ***SEVERE*** (discomfort affects not only my ability to work, but also many of my activities of daily living)
5 = ***INTOLERABLE*** (discomfort makes work and activities of daily living nearly impossible)

FREQUENCY SCALE

How often do you experience work-related body-part discomfort?

--= ***NEVER***
1 = ***NOT VERY OFTEN*** (a few times a month or less)
2 = ***SOMETIMES*** (a few times a week)
3 = ***QUITE OFTEN*** (nearly every day)
4 = ***ALWAYS*** (it never goes away)

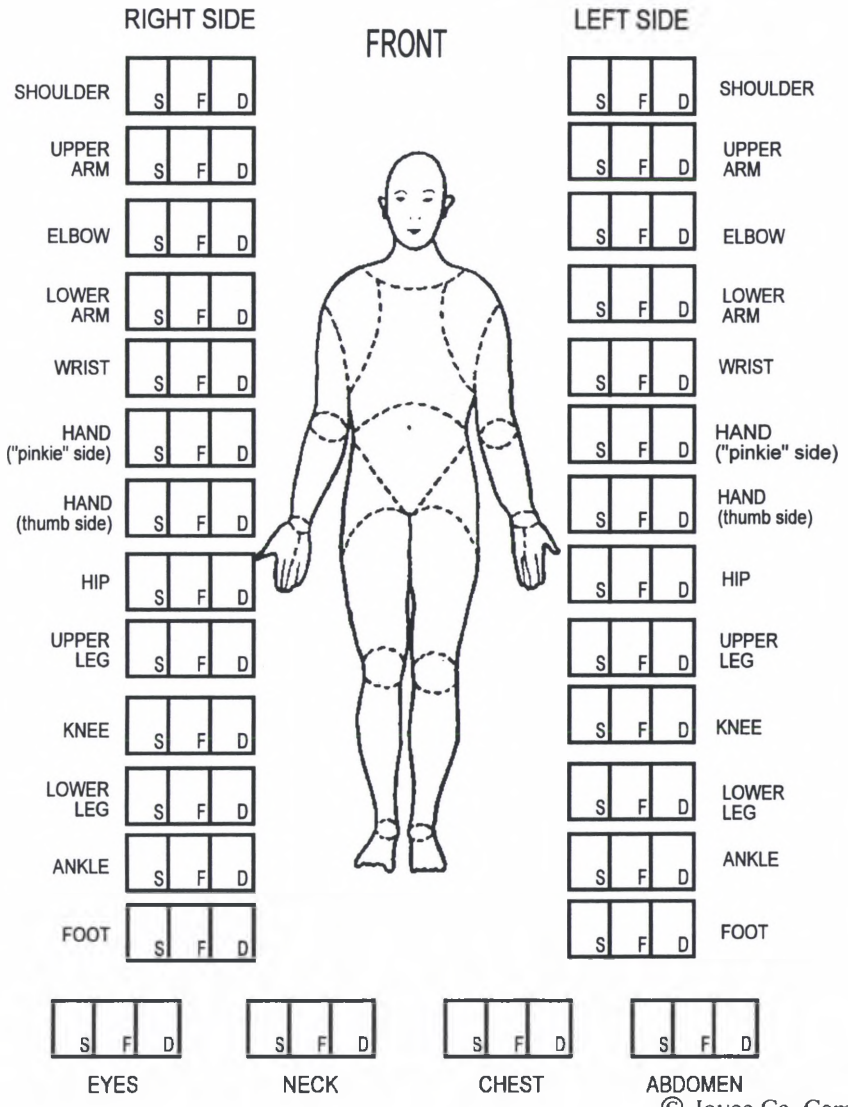
DURATION SCALE

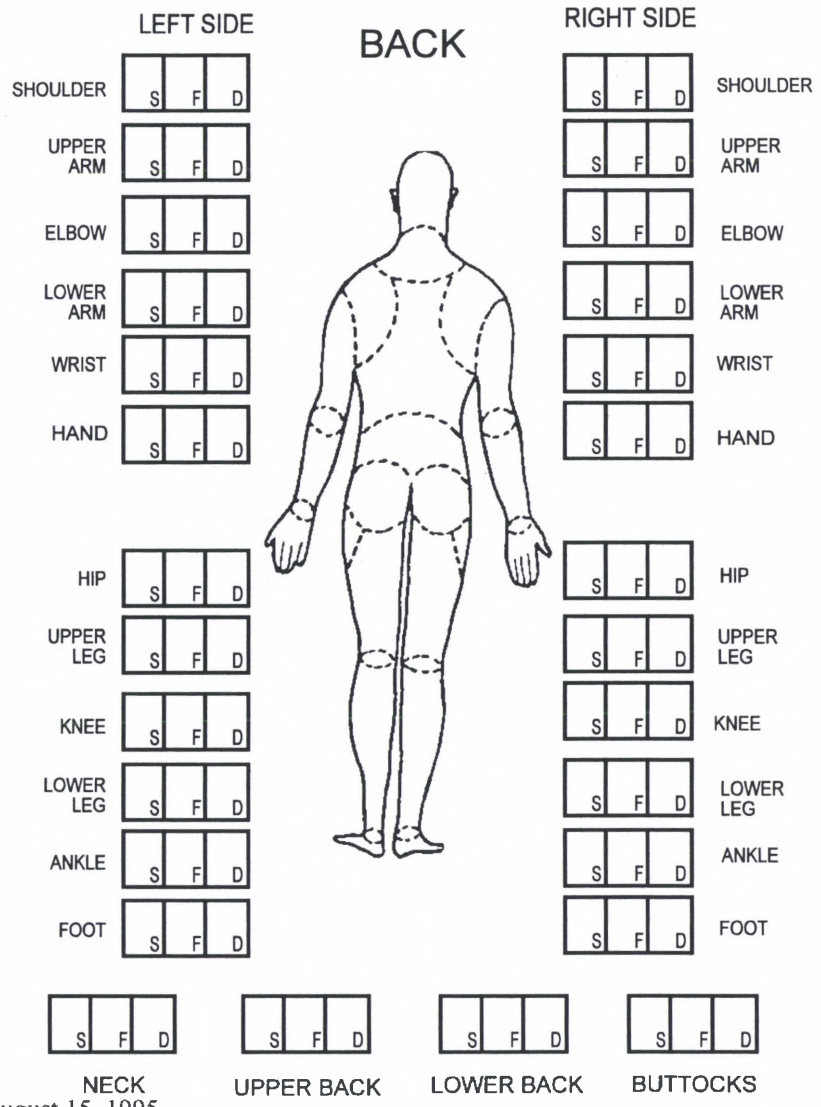
How dong does this work-related body-part discomfort last when it occurs?

-- = ***I DO NOT HAVE ANY DISCOMFORT***
1 = ***IT DOESN'T LAST LONG*** (my discomfort usually goes away as soon as I stop what seems to cause it, or shortly thereafter)
2 = ***IT LASTS SEVERAL HOURS*** (my discomfort usually goes away with hours of stopping the activity that seems to cause it)
3 = ***IT LASTS OVERNIGHT*** (my discomfort usually does not go away over night)
4 = ***IT RARELY GOES AWAY*** (my discomfort may go away over weekends, and it usually goes away over vacations)
5 = ***IT DOESN'T GO AWAY***

EXAMPLE

A computer operator uses a keyboard for 5 or 6 hours a day. By the end of the day, this person usually ends up with a lot of tension and soreness in his/her neck. This discomfort is annoying, but does not really affect work performance. It also seems to go away overnight. However, this person is concerned because it has continued for over a year. This person would complete the response boxes describing his/her neck using a "2" for severity, a "3" for frequency, and a "2" for duration as shown below.





QUESTIONS 24 - 33 ASK ABOUT YOUR EXPERIENCE WITH WORK-RELATED-BODY PART DISCOMFORT

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

24. Has anyone you know well (family or friends) experienced work-related body-part discomfort? [ ] **YES** [ ] **NO**

25. Have you gone a physician about one or more of the areas of work-related discomfort you have identified on this questionnaire?
[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #26.*

*If **YES**, were you given a diagnosis?*
[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #26.*

What was the diagnosis? → ↑ _____

What body part(s) was/were affected? _____

26. Have you gone to any other type of health professional (e.g., chiropractor, massage therapist, physical therapist, etc.) about one or more of the areas of work-related discomfort that you have identified on this questionnaire? [ ] **YES** [ ] **NO**

27. Have you ever taken over-the-counter drugs for work-related body-part discomfort? [ ] **YES** [ ] **NO**

28. Are you currently taking over-the-counter drugs for the discomfort you have identified? [ ] **YES** [ ] **NO**

29. Have you ever taken prescription drugs for work-related discomfort? [ ] **YES** [ ] **NO**

30. Are you currently taking prescription drugs for the work-related discomfort you have identified? [ ] **YES** [ ] **NO**

31. Are you currently pregnant? [ ] **YES** [ ] **NO** [ ] **DOES NOT APPLY**

32. Are you currently using birth control pills? [ ] **YES** [ ] **NO** [ ] **DOES NOT APPLY**

33. Have you ever been diagnosed as having any of the following (please "X" all that apply):

ruptured disk in the neck	[ ] **YES** [ ] **NO**	diabetes	[ ] **YES** [ ] **NO**
ruptured disk in the back	[ ] **YES** [ ] **NO**	gout	[ ] **YES** [ ] **NO**
thyroid problems	[ ] **YES** [ ] **NO**	alcohol addiction	[ ] **YES** [ ] **NO**
kidney problems	[ ] **YES** [ ] **NO**	lupus	[ ] **YES** [ ] **NO**

Please continue with Part 4 of this survey. It begins on page 9.

40. Do you use glasses, or contact lenses, when working at the computer?

[ ] **YES**. *Please continue with this question, and then go on to question # 41.*
[ ] **NO**. *Please go on to question # 41.*

*If **YES**, check the type you use when working at the computer at work.*

[ ] contact lenses
[ ] all purpose, single vision glasses
[ ] all purpose bifocals--with, or without, lines
[ ] all purpose trifocals--with, or without, lines
[ ] "computer" glasses with half-lenses ("granny" glasses)
[ ] "computer" glasses with single vision lenses
[ ] "computer" bifocals--with, or without lines
[ ] "computer" trifocals--with, or without lines

41. Before you begin the next few questions, we would like you to think back to your last typical work day. Assuming that your LAST WORK DAY was a TYPICAL WORK DAY, complete the schedule below by placing an "X" in the "box" to describe your activities during each half hour that you were at work. That is, during each half hour that you were at work were you involved doing "mostly computer work," or "mostly NOT computer work" (e.g., for most people, their lunch period would involve "mostly NOT computer work"). If your LAST WORK DAY was not a TYPICAL WORK DAY, please complete the schedule as if it had been a TYPICAL WORK DAY.

TIME	TYPICAL WORK DAY		TIME	TYPICAL WORK DAY	
	mostly computer use	mostly NOT computer use		mostly computer use	mostly NOT computer use
7:00	[ ]	[ ]	12:30	[ ]	[ ]
7:30	[ ]	[ ]	1:00	[ ]	[ ]
8:00	[ ]	[ ]	1:30	[ ]	[ ]
8:30	[ ]	[ ]	2:00	[ ]	[ ]
9:00	[ ]	[ ]	2:30	[ ]	[ ]
9:30	[ ]	[ ]	3:00	[ ]	[ ]
10:00	[ ]	[ ]	3:30	[ ]	[ ]
10:30	[ ]	[ ]	4:00	[ ]	[ ]
11:00	[ ]	[ ]	4:30	[ ]	[ ]
11:30	[ ]	[ ]	5:00	[ ]	[ ]
12:00	[ ]	[ ]	5:30	[ ]	[ ]

42. On the basis of the schedule you just completed, how many half hours of your typical work day included mostly computer work? (Just count the number of "X's" in the column labeled "mostly computer use.")

Typical work day: _____ half hours.

QUESTIONS 56 - 61 ASK FOR INFORMATION ABOUT YOU AND YOUR WORK AREA.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

56. How comfortable is the current set-up of your workstation (desk/table, chair, keyboard, and monitor)?

If you checked "somewhat comfortable" or "not very comfortable," please use the lines to the right to explain what you believe makes your workstation uncomfortable.

[ ] very comfortable *Please go on to question #57.*
[ ] reasonably comfortable *Please go on to question # 57.*
[ ] somewhat comfortable *Please continue with this question.*
[ ] not very comfortable *Please continue with this question.*

_____

_____

57. Has the location of your work area changed in the last 3 months? That is, have you moved to a new floor or to a new location on the same floor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #58.*

*If **YES**, are your MONITOR, KEYBOARD, and DOCUMENTS in the same relative position in both your old and your new work areas? (e.g., your monitor is to your left in both your old and your new work areas).*

[ ] **YES.**
[ ] **NO.**

58. Have there been any changes in your workstation equipment (desk/table, chair, keyboard, monitor, etc.) in the past 3 months?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #59.*

*If **YES**, please list the equipment that has been changed (e.g., different chair), or removed, from your workstation on the lines to the right.*

Changed:_____

_____

Removed:_____

_____

59. Have you personally added anything (e.g., cushion, foot rest) to modify your workstation?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #60.*

*If **YES**, please specify the item(s) added on the lines to the right.*

_____

_____

60. Have you used the adjustment capability (e.g., turned a knob, lifted a lever, etc.) of one, or more, of the major components of your workstation (desk/table, chair, keyboard, and/or monitor)?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #61.*

*If **YES**, how often do you use the adjustment capability of one, or more, of the major components of your workstation?*

[ ] I use it several times each day
[ ] I use it every day
[ ] I use it almost every day
[ ] I used it within the last month
[ ] I used it within the last 6 months
[ ] I used it about a year ago
[ ] I used it more than a year ago

61. Do you use the adjustment capability of some component of your workstation once a day or more?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #62.*

*If **YES,** please specify the component(s) you adjust daily on the lines to the right.*

Components adjusted daily:_____

_____

*If **YES**, what are your reasons for using the adjustment capability of your workstation daily? (Please check all that apply.)*

[ ] other people share my workstation
[ ] I can not get comfortable
[ ] to perform different tasks
[ ] to use different equipment
[ ] to change position
[ ] other (please specify below)

_____

62. Is there a sufficient range of adjustability in your workstation?

[ ] **YES.** *Please go on to question # 63.*
[ ] **NO.** *Please continue with this question.*

*In **NO**, what part of your workstation would you like to be able to adjust? (Please write your response on the lines to the right.)*

_____

_____

QUESTIONS 63 - 68 ARE ABOUT THE CHAIR YOU SIT IN WHEN USING YOUR COMPUTER.

To complete question 63, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

63. Does your chair provide you with any adjustment capabilities? That is, can you change, or move, any part (e.g., seat, back rest) of your chair?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #64.*
[ ] **DON'T KNOW.** *Please go on to question #64.*

*If **YES**, please list the features that are adjustable on the lines to the right.* _____

_____

To complete questions 64 - 66, place an "X" in the "box" preceding the word YES or NO in the left column labeled "IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED . . ." Then, if you answered "NO," please complete the right column labeled "If NO, WHAT WAS YOUR REASON FOR <u>NOT</u> CHANGING?" by circling the number that goes with your response.

	IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED. . .		***If NO*, WHAT WAS YOUR REASON FOR <u>NOT</u> CHANGING?**				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
64.	the height of the SEAT of your computer chair?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
65.	the position of the BACKREST of your computer chair up or down?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
66.	the position of the BACKREST of your computer chair forward or backward?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

To complete questions 67-69, place an "X" in the "box" associated with your desired response like this, **[X].**

67. Does your chair have arm rests?
- [ ] **YES.** *Please continue with this question.*
- [ ] **NO.** *Please go on to question #68.*

If YES, do the arms of your chair prevent you from sitting at the distance you would like when using your keyboard?
- [ ] **YES.** *Please continue with this question.*
- [ ] **NO.** *Please continue with this question.*

If YES, do the arms of your chair prevent you from sitting at the distance you would like when writing on your work surface/desktop.
- [ ] **YES.**
- [ ] **NO.**

68. Is there about two inches of clearance between the back of your knees and the front of your chair when you sit at your computer?
- [ ] **YES.** *Please go on to question #69.*
- [ ] **NO.** *Please continue with this question.*
- [ ] **DON'T KNOW.** *Please go on to question #69.*

*If **NO**, how much clearance is there?*
- [ ] less than 1 inch
- [ ] more than 3 inches

69. Is there enough clearance for your legs and feet when you sit at your computer?
- [ ] **YES.** *Please go on to question #70.*
- [ ] **NO.** *Please continue with this question.*

*If **NO**, in which dimension(s) do you need more room? (Please "X" all that apply.)*
- [ ] I need more up/down clearance between the tops of my thighs and the bottom of the surface on which my keyboard rests.
- [ ] I need more side-to-side clearance for my legs and feet.
- [ ] I need more forward/backward (in/out) clearance for my legs and feet.

QUESTIONS 70 - 72 ARE ABOUT YOUR KEYBOARD

To complete questions 70 - 72, place an "X" in the "box" preceding the word YES or NO in the left column labeled "IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED . . ." Then, if you answered "NO," please complete the right column labeled "If NO, WHAT WAS YOUR REASON FOR NOT CHANGING?" by circling the number that goes with your response.

	IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED. . .		*If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
70.	the HEIGHT of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
71.	the SIDE-TO-SIDE? location of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
72.	the FORWARD/ BACKWARD location of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

QUESTIONS 73- 82 ARE ABOUT YOUR MONITOR

To complete question 73, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

73. Does your monitor provide you with any adjustment capabilities? That is, can you change, or move any part (e.g., the tilt, the swivel, or the brightness/contrast) of your monitor?

[ ] **YES.**
[ ] **NO.**
[ ] **DON'T KNOW.**

To complete questions 74 - 79, place an "X" in the "box" preceding the word YES or NO in the left column labeled "IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED . . ." Then, if you answered "NO," please complete the right column labeled "If NO, WHAT WAS YOUR REASON FOR NOT CHANGING?" by circling the number that goes with your response.

	IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED. . .		*If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
74.	the forward/backward TILT of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

	IN THE LAST SIX (6) WEEKS HAVE YOU CHANGED...		*If NO*, WHAT WAS YOUR REASON FOR *NOT* CHANGING?				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
75.	the side-to-side SWIVEL of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
76.	the BRIGHTNESS/ CONTRAST of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
77	the HEIGHT of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
78	the SIDE-TO-SIDE location of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
79	the FORWARD/ BACKWARD location of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

To complete questions 80 - 82, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

80. Is the distance to your computer screen comfortable for viewing? [ ] **YES.** [ ] **NO.**

81 Is the brightness/contrast of your monitor screen adjusted so it is comfortable for viewing? [ ] **YES.** [ ] **NO.**

82 Do you notice glare/reflection on your monitor screen when you work? [ ] **YES.** [ ] **NO.** [ ] **DON'T KNOW.**

QUESTIONS 83- - 86 ARE ABOUT OTHER EQUIPMENT YOU MAY HAVE IN YOUR WORKSTATION

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X}, or write your response on the line(s) provided.

83. Do you have a document holder?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #84.*

*If **YES**, what percentage of the time that you are using your computer do you use your document holder?*

_____ % of the time that I am using my computer

84. Do you have a wrist rest?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #85.*

If YES, do you use the wrist rest when you use your computer?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #85.*

If YES, what percentage of the time do you LEAN on the wrist rest?

[ ] 0 - 24 percent of the time
[ ] 25 - 49 percent of the time
[ ] 50 - 75 percent of the time
[ ] 76 - 100 percent of the time

85. Do you have a foortrest?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #86.*

If YES, do you use this footrest when you use your computer?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #86.*

If YES, what percentage of the time do you use your footrest?

[ ] 0 - 24 percent of the time
[ ] 25 - 49 percent of the time
[ ] 50 - 75 percent of the time
[ ] 76 - 100 percent of the time

86. Does your desk/work surface have a centered, shallow drawer for pencils, etc.?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #87.*
[ ] **DON'T KNOW.** *Please go on to question #87.*

If YES, is it possible to open this drawer without having to change the position of your keyboard?

[ ] **YES.**
[ ] **NO.**
[ ] **DON'T KNOW.**

QUESTIONS 87 - 94 ARE ABOUT POSITIONING *YOURSELF* AT YOUR COMPUTER KEYBOARD AND MONITOR.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X].

87. Do you habitually check the position of your torso with respect to your keyboard?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your torso with respect to your keyboard?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your torso with respect to your keyboard?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

88. Do you habitually change your position if you find that the position of your torso with respect to your keyboard is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move keyboard up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the keyboard where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

89. Do you habitually check the position of your arms and hands with respect to your keyboard?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your arms and hands with respect to your keyboard?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your arms and hands with respect to your keyboard?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

90. Do you habitually change your position if you find that the position of your arms and hands with respect to your keyboard is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move keyboard up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the keyboard where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

91. Do you habitually check the position of your torso with respect to your monitor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES**, how often do you check the position of your torso with respect to your monitor?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO**, do you ever check the position of your torso with respect to your monitor?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

92. Do you habitually change your position if you find that the position of your torso with respect to your monitor is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES**, what changes do you usually make? (Please check all that apply.)*

[ ] move monitor up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO**, what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the monitor where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

93. Do you habitually check the position of your head and eyes with respect to your monitor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES**, how often do you check the position of your head and eyes with respect to your monitor?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO**, do you ever check the position of your head and eyes with respect to your monitor?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

94. Do you habitually change your position of you find that the position of your head and eyes with respect to your monitor is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES**, what changes do you usually make? (Please check all that apply.)*

[ ] move monitor up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO**, what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the monitor where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

Please continue with PART 5 of this survey. It begins on page 24.

PART 5: YOUR TYPING/KEYING EDUCATION AND YOUR EXPERIENCE REGARDING WORKSTATION ADJUSTMENT

Part 5 of this survey asks questions about how you learned to type or use a computer keyboard, and about any education you may have received concerning workstation adjustment, work posture, and work technique.

QUESTIONS 95 - 96 ARE ABOUT HOW YOU LEARNED TO USE A TYPEWRITER OR THE ALPHANUMERIC PART OF YOUR COMPUTER KEYBOARD

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

95. What kind of keyboard did you use when you first learned to use a typewriter or computer keyboard?

- [ ] a manual typewriter
- [ ] an electric, or electronic, typewriter
- [ ] a computer with an attached keyboard
- [ ] a computer with a detached keyboard

96. Did you first learn to use a typewriter or computer keyboard in a formal classroom situation?

- [ ] **YES.** *Please continue with this question.*
- [ ] **NO.** *Please continue with this question.*

*If **YES**, approximately how long was this formal classroom instruction*

- [ ] less than 4 months
- [ ] 4 - 8 months
- [ ] 9 - 12 months
- [ ] more than 1 year
- [ ] more than 2 years
- [ ] more than 3 years

*If **NO**, in what kind of situation did you first learn to operate a typewriter or computer keyboard?*

- [ ] formal one-to-one instruction
- [ ] self-instruction using formal instructional materials
- [ ] self-instruction by doing it
- [ ] other (please specify):

_____

QUESTIONS 97 - 99 ARE ABOUT HOW YOU USE YOUR CURRENT KEYBOARD.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

97. Do you regularly use a particular hand to depress the CONTROL key?
[ ] **YES.** *Please continue this question below.*
[ ] **NO.** *Please go on to question #98.*

*If **YES**, which hand do you regularly use?*
[ ] right hand
[ ] left hand

98. Do you regularly use a particular hand to press the ALT key?
[ ] **YES.** *Please continue this question below.*
[ ] **NO.** *Please go on to question #99.*

*If **YES**, which hand do you regularly use?*
[ ] right hand
[ ] left hand

99. Do you regularly use the fingers on one hand to depress two different keys at the same time?
[ ] **YES.**
[ ] **NO.**

QUESTIONS 100 - 103 ARE ABOUT HOW YOU LEARNED TO USE THE NUMERIC KEYPAD ON YOUR COMPUTER KEYBOARD

100. Do you use the numeric keypad when you work at your computer?
[ ] **YES.** *Please go on to question #101.*
[ ] **NO.** *Please go on to question #104.*

101. When did you learn to use the numeric keypad?
[ ] at the same time as I learned to "type" (to use the letters on the keyboard.
[ ] at a different time.

102. Please describe the situation in which you learned (e.g., classroom, self-taught, etc.) and the kind of machine on which you learned (e.g., 10-key adding machine, hand-held calculator, etc. on the lines to the right.

Situation	Kind of Machine
_____	_____
_____	_____

103. Which finger(s) of your right hand do you use to operate the numeric keypad? (Check all that apply.)
[ ] thumb
[ ] index finger
[ ] long middle finger
[ ] ring finger
[ ] little finger ("pinkie")

QUESTIONS 104 - 114 CONTAIN DESCRIPTIONS REGARDING KEYBOARD OPERATION.

To complete these questions, please place an "X" in the "box" preceding the word NO or YES in the left column labeled " I HAVE HEARD OF THIS" **THEN,** ***if you answered "YES," please complete the right column labeled "I DO THIS" by circling the number that goes with the appropriate response.***

		I HAVE HEARD OF THIS	*If you answered YES, please complete this column.* **I DO THIS**		
			YES	**I TRY TO**	**NO**
104.	The body should be centered opposite the "J" key.	[ ] **NO** [ ] **YES**	1	2	3
105.	The fingertips should be vertical over the keys of the home row (asdf jkl;)	[ ] **NO** [ ] **YES**	1	2	3
106.	The shoulders should be relaxed.	[ ] **NO** [ ] **YES**	1	2	3
107.	The wrists should be low but not touching the keyboard unit.	[ ] **NO** [ ] **YES**	1	2	3
108.	The body should be located a "handspan" from the keyboard.	[ ] **NO** [ ] **YES**	1	2	3
109.	The thumbnail should be at right angles to the spacebar.	[ ] **NO** [ ] **YES**	1	2	3
110.	The feet should rest on the floor.	[ ] **NO** [ ] **YES**	1	2	3
111.	Reach for desired keys, keeping other fingers in typing position over the keys of the home row (asdf jkl;)	[ ] **NO** [ ] **YES**	1	2	3
112.	The forearm should be parallel with the keyboard.	[ ] **NO** [ ] **YES**	1	2	3

		I HAVE HEARD OF THIS	*If you answered YES, please complete this column.* I DO THIS		
			YES	I TRY TO	NO
113	Use a quick sharp stroke to strike each key.	[ ] NO [ ] YES	1	2	3
114	Use a down-and-in motion to strike the space bar	[ ] NO [ ] YES	1	2	3

QUESTIONS 115 - 119 ARE ABOUT HOW YOU LEARNED ABOUT WORKSTATION ADJUSTMENT AND WORK POSTURE/TECHNIQUE.

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

115. Have you been given information about how to adjust your workstation?

[ ] **YES.** *Please go on to question #116.*
[ ] **NO.** *Please go on to question #118.*

116. Did you find this information useful?

[ ] **YES.** *Please go on to question #117.*
[ ] **NO.** *Please go on to question #117.*

117. What was the source of this information? (Please "X" all that apply.)

[ ] it was provided by personnel/training associated with my current employer
[ ] it was provided in my education
[ ] it was provided by a prior employer

[ ] from other people (please specify on the line below: e.g., supervisor, friend, doctor etc.)

_____

[ ] from a booklet, video, or film
[ ] from the media (e.g., TV, newspapers, magazines)
[ ] other (please specify below):

_____

118. Have you received training on the proper work posture for your current job tasks?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #119.*

*If **YES**, please specify the source(s) of this training on the lines to the right (e.g., supervisor, video, medical personnel, etc.).*

_____

_____

119. Have you received training on proper keyboard technique for your current job tasks?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *This is the end.*

*If **YES**, please specify the source(s) of this training on the lines to the right (e.g., supervisor, video, medical personnel, etc.).*

_____

_____

Thank you for taking the time to complete this survey.

APPENDIX E

QUESTIONNAIRE USED TO ASSESS PARTICIPANT REACTION TO INSTRUCTION

ID NUMBER:_____

DATE:_____

TRAINING EFFECTIVENESS EVALUATION SURVEY

The attached survey is meant to serve two purposes:

1. To obtain information about your reaction to the demonstration and the written materials, "PC--3-D--ME," that you received.
2. To evaluate the effectiveness of these materials.

Feel free to consult the written material as you complete this survey. However, if you have NOT yet read these materials, please do NOT complete this survey until you have done so.

When you have completed this survey, please return it in the enclosed envelope to:

Joyce Cameron
c/o_____

Using the enclosed envelope and the unique ID number provided on your form will help assure the confidentiality of your reply.

Completed surveys should be returned by Monday, September 18, 1995.

ID NUMBER:_____

DATE:_____

PART I: EVALUATION OF MATERIALS AND DEMONSTRATION

In order to assess the value of the written materials and the demonstration you received, please complete the following by circling the number which corresponds to your level of agreement with each of the following statements.

		Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1.	The information was mostly new to me	1	2	3	4	5	6
2.	I believe I could use the information to make adjustments to my workstation.	1	2	3	4	5	6
3.	The quality of the written information was excellent.	1	2	3	4	5	6
4.	The quality of the demonstration was excellent.	1	2	3	4	5	6
5.	The material covered in the demonstration added substantially to the written material.	1	2	3	4	5	6
6.	The material made me more aware of the connection between work-related discomfort and how I do my job.	1	2	3	4	5	6

Please continue with Part 2 which begins on the next page.

PART 2: YOUR EVALUATION AND SUGGESTIONS FOR IMPROVEMENT

Please write your responses to the following questions on the lines provided.

7. What do you consider to be the strong point of the written materials you received?

_____

_____

8. What do you consider to be the strong point of the demonstration you received?

_____

_____

9 Wat information did you need that was not provided in either the written materials or the demonstration?

_____

_____

10 What information did you get in either the written materials or the demonstration that was not useful?

_____

_____

11 What would you add to make either the written materials or the demonstration better?

_____

_____

Please continue with the nest page of this survey.

Please evaluate each of the three parts of the PC--3-D--ME demonstration and written materials by circling the number which corresponds to your level of agreement with each of the following statements.

12. The information in Part I:--PC: ***P***osition ***C***omponents; ***P***arallel and ***C***entered--was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

13. The information in Part II--3-D: Consciously locate yourself and your equipment in ***3-D***imensional space--was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

14. The information in Part III--ME: ***M***inimize ***E***ffort resulting from the use of awkward postures, poor movement patterns, and excessive force--was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

PART 3: WHAT CHANGES HAVE OCCURRED SINCE YOU RECEIVED THIS WRITTEN MATERIAL AND DEMONSTRATION?

For each question in Part 3, please place an "X" in the box associated with "**YES**" or "**NO**," and complete the follow-up question on the lines provided.

15 Was your discomfort reduced by your use of the information provided?

[ ] **YES.** *On the lines to the right, please specify the location (e.g., right wrist, left shoulder, lower back) of the discomfort that was reduced.* _____ _____

[ ] **NO.**

Please continue with the next page of this survey.

16 Did you make any changes to your workstation as a result of the written material and demonstration you received? [ ] **YES.** [ ] **NO.**

On the lines below, please describe the changes you have made to your workstation, OR describe why you did not make changes to your workstation.

_____

_____

_____

17. Were therre any changes that you wanted to make to your workstation, but that you could not make? [ ] **YES.** [ ] **NO.**

*If **YES**, please describe the changes you would have liked to make and why you were unable to make them.*

_____

_____

_____

PART 4: GENERAL COMMENTS

18. Please write any additional comments that you feel would help us to improve the WRITTEN PC--3-D--ME materials.

_____

_____

19. Please write any additional comments that you feel would help us to improve the DEMONSTRATION of the PC--3-D--ME strategy for improving workstation layout, adjustment, and use.

_____

_____

Thank you for taking the time to complete this survey.

When you have completed this survey, please return it in the enclosed envelope to:

Joyce Cameron

c/o _____

ID NUMBER:_____

DATE:_____

TRAINING EFFECTIVENESS EVALUATION SURVEY

The attached survey is meant to serve two purposes:

1. To obtain information about your reaction to the written materials, "Ergonomics and VDT Use," that you received.
2. To evaluate the effectiveness of these materials.

Feel free to consult the written material as you complete this survey. However, if you have NOT yet read these materials, please do NOT complete this survey until you have done so.

When you have completed this survey, please return it in the enclosed envelope to:

Joyce Cameron
c/o _____

Using the enclosed envelope and the unique ID number provided on your form will help assure the confidentiality of your reply.

Completed surveys should be returned by Monday, September 18, 1995.

ID NUMBER:_____

DATE:_____

PART I: EVALUATION OF MATERIALS

In order to assess the value of the written materials you received, please complete the following by circling the number which corresponds to your level of agreement with each of the following statements.

		Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1.	The information was mostly new to me	1	2	3	4	5	6
2.	I believe I could use the information to make adjustments to my workstation.	1	2	3	4	5	6
3.	The quality of the written information was excellent.	1	2	3	4	5	6
4.	The material made me more aware of the connection between work-related discomfort and how I do my job.	1	2	3	4	5	6

Please continue with the next page of this survey.

PART 2: YOUR EVALUATION AND SUGGESTIONS FOR IMPROVEMENT

Please write your responses to the following questions on the lines provided.

5. What do you consider to be the strong point of the written materials you received.

_____

_____

6 What information did you need that was not provided in the written materials you received?

_____

_____

7. What information did you get in the written materials that was not useful?

_____

_____

8. What would you add to make the written materials better?

_____

_____

Please evaluate each of the following section of the "Ergonomics and VDT Use" materials by circling the number which corresponds to your level of agreement with each of the following statements.

9. The information in the section entitled "Chairs" was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

10. The information in the section entitled "Keyboard" was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

11. The information in the section entitled "Screen Placement and Viewing Specifications" was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

12. The information in the section entitled "Ergonomic Pauses" was very useful to me.

Decidedly Agree	Substantially Agree	Slightly Agree	Slightly Disagree	Substantially Disagree	Decidedly Disagree
1	2	3	4	5	6

PART 3: WHAT CHANGES HAVE OCCURRED SINCE YOU RECEIVED THIS WRITTEN MATERIAL?

For each question in Part 3, please place an "X" in the box associated with "**YES**" or "**NO**," and complete the follow-up questions on the lines provided.

13. Was you discomfort reduced by your use of the information provided?

[ ] **YES.** *On the lines to the right, please specify the location (e.g., right wrist, left shoulder, lower back) of the discomfort that was reduced.* _____ _____

[ ] **NO.**

14. Did you make any changes to your workstation as a result of the written material you received?

[ ] **YES.** [ ] **NO.**

On the lines below, please describe the changes you have made to your workstation, OR describe why you did not make changes to your workstation.

_____

_____

_____

Please continue with the next page of this survey.

15. Were there any changes which you wanted to make to your workstation, but that you could not make? [ ] **YES.** [ ] **NO.**

*If **YES**, please describe the changes you would have like to make and why you were unable to make them.*

_____

_____

_____

PART 4: GENERAL COMMENTS

16. Please write any additional comments that you feel would help to improve the written material you received.

_____

_____

Thank you for taking the time to complete this survey.

When you have completed this survey, please return it in the enclosed envelope to:
Joyce Cameron
c/o _____

ID NUMBER: _____

DATE: _____

BEFORE YOU BEGIN, please fill in the date at the top of this page. Then, work through this packet completing each part in turn. Please do not return to a previously completed part to modify your responses in any way. Your first reactions are most valuable to us

FOLLOW-UP SURVEY PACKET FOR OFFICE COMPUTER OPERATORS.

As you know, discomfort and injury among office computer operators are a growing concern for many people, and the purpose of the study in which you are participating is to evaluate training programs for office computer operators. To date, your cooperation in this study has been extraordinary and we look forward to receiving the information which you will provide to us by responding to the questions in this survey packet. This information will be available only to the researchers, and will be used only for scientific, statistical purposes. It will not be possible for people other than the researchers to identify the responses made by a particular participant.

As in the past, to assure the confidentiality of your responses, each survey is identified only by the ID number which has been used on the other surveys that you have completed.

The attached survey has six parts, and asks about:

PART 1: Your individual experience with work-related discomfort.
PART 2: Your knowledge about work-related discomfort, workstation adjustment, and typing/keying technique.
PART 3: Your experience with work-related body-part discomfort. (For example, have you, or others you know, experienced work-related body-part discomfort? If so, where have you experienced this discomfort? How severe is it? How frequently does it occur? How long does it take to go away?)
PART 4: You, your job, and your work area.
PART 5: Your keyboard and its use.
PART 6: Recent changes in your job.

Thank you for helping in this study.

ID NUMBER: _____

DATE: _____

PART 1: YOUR INDIVIDUAL EXPERIENCE WITH WORK RELATED DISCOMFORT

Part 1 of this survey asks for information about your individual experience with work-related discomfort. Please answer each question as accurately as you can. All of your responses will be treated confidentially.

QUESTIONS 1 - 4 ASK ABOUT YOUR INDIVIDUAL EXPERIENCE WITH WORK-RELATED DISCOMFORT.

To complete these questions, place an "X" in the "box" associated with your desired response like this, **[X].**

1. Do you have any work-related discomfort which you attribute to your job as a computer keyboard operator?

   [ ] **YES.** *Please go on to question #2.*
   [ ] **NO.** *Please go on to question #5 which is on the next page.*

2. How would you rate the OVERALL SEVERITY of your current, work-related discomfort?

   [ ] MINIMAL DISCOMFORT (discomfort is present, but I can ignore it)
   [ ] SLIGHT DISCOMFORT (discomfort is present, and I can't ignore it)
   [ ] MODERATE (discomfort affects ability to work and to concentrate)
   [ ] SEVERE (discomfort affects not only ability to work, but also many activities of daily living)
   [ ] INTOLERABLE (discomfort makes work and activities of daily living nearly impossible)

3. How would you describe the OVERALL FREQUENCY of your current, work-related discomfort?

   [ ] NOT VERY OFTEN (a few times a month or less)
   [ ] SOMETIMES (a few times a week)
   [ ] QUITE OFTEN (nearly every day)
   [ ] ALWAYS (if never goes away)

4. How would you describe the OVERALL DURATION of your current, work-related discomfort?

   [ ] NOT LONG (a week or less)
   [ ] MODERATELY LONG (more than a week, less than three months)
   [ ] A LONG TIME (more than three months; less than a year)
   [ ] A VERY LONG TIME (more than a year)

Please continue with Part 2 which begins on the next page.

PART 2: YOUR KNOWLEDGE ABOUT WORK-RELATED DISCOMFORT, WORKSTATION ADJUSTMENT, AND TYPING/KEYING TECHNIQUE

QUESTIONS 5 - 16 PRESENT STATEMENTS ABOUT WORK-RELATED DISCOMFORT, WORKSTATION ADJUSTMENT, AND TYPING/KEYING TECHNIQUE.

To complete the questions in Part 2 of this survey, circle "T" for "True" or "F" for "False" to indicate whether you believe the statement is "True" or "False."

5.	Experts know very little about the factors that contribute to work-related musculoskeletal disorders. Therefore, individual computer users can do very little, if anything, to avoid suffering from such disorders.	**T F**
6.	When using a keyboard, your hands and forearms should be in a reasonably straight line.	**T F**
7.	The location of your keyboard on your work surface has no effect on your comfort.	**T F**
8.	It doesn't matter whether you use fingers that are on the same, or different, hands when you use a combination of keys (e.g., SHIFT plus a function key, ALT + F, or CONTROL + C).	**T F**
9.	As long as the key goes down, it doesn't really matter how hard you strike the keys on the keyboard.	**T F**
10.	The distance between you and your keyboard is *not* particularly important.	**T F**
11.	The height of the monitor should be the same whether a person uses single vision or bifocal lenses.	**T F**
12.	When using a keyboard, the angle between your upper arms and your forearms should be about a right angle (90°).	**T F**
13.	The location of documents containing information for entry into your computer does *not* have any effect on discomfort.	**T F**
14.	Adjusting the tilt of your monitor screen helps reduce glare and reflection.	**T F**
15.	Operating a computer keyboard requires extensive use of small muscles.	**T F**
16.	The keyboard and monitor should be parallel with one another.	**T F**

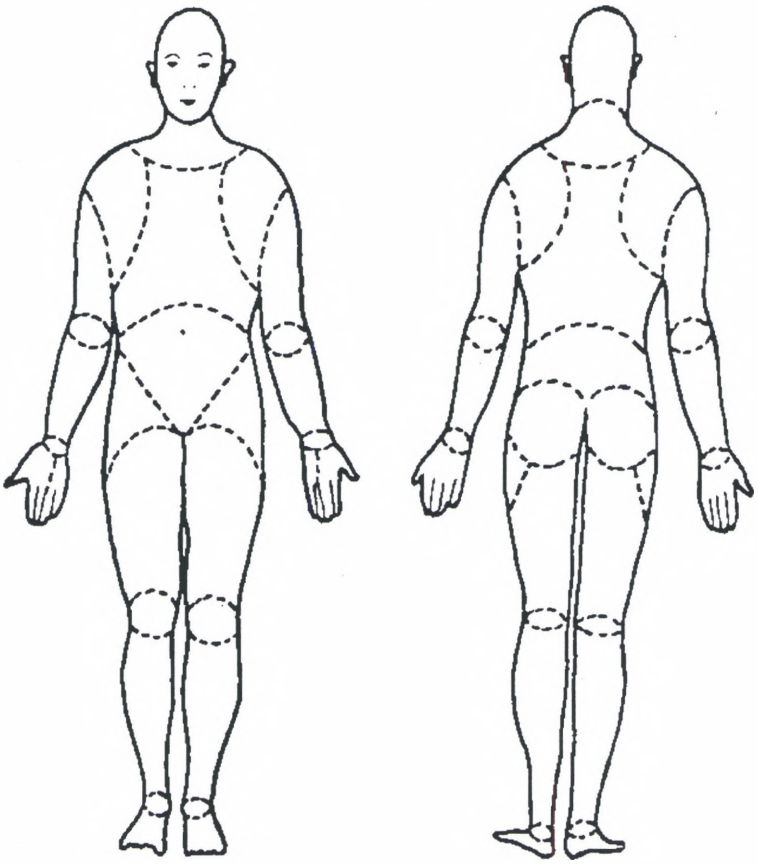
Please continue with Part 3 of this survey. It begins on page 3.

PART 3: YOUR EXPERIENCE WITH WORK-RELATED BODY-PART DISCOMFORT

Work-related activities can sometimes result in physical discomfort. For purposes of this part of the survey, consider that work-related body-part discomfort may include one or more of the following sensations: pain, tenderness, numbness, tingling, tension, fatigue, soreness, heat, cold, tremor, aching, burning, tiredness, cramping, stiffness, swelling, weakness, and loss of color.

This discomfort survey has two parts:

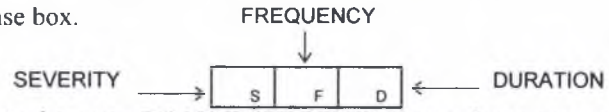
1. Diagrams of the front and the back of the body (see below) on which to locate and identify any current, work-related body-part discomfort.
2. Questions about your recent medical history and about any current medical treatment you are receiving for work-related body-part discomfort. These questions are located on page 6.



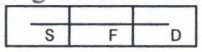
As in all the other parts of this survey, all information you provide will be kept confidential and will be used only for statistical, scientific purposes.

INSTRUCTIONS

As you complete this part of the work-related body-;art discomfort survey, please read the descriptions of discomfort *very* carefully (see below). Then complete this part of the survey as honestly and as accurately as you can. for each body part where you CURRENTLY experience work-related-body-part discomfort, write a number from the SEVERITY scale in the left-hand (s) response box, a number from the FREQUENCY scale in the middle (F) box, and a number from the DURATION scale in the right-hand (D) response box.



For each body part where you DO NOT CURRENTLY experience any work-related-body-part discomfort, fraw a horizontal line through all three boxes of the three-part rating box, like this:



SEVERITY SCALE

How much does this discomfort affect your ability to work and to engage in activities of daily living (e.g., eating, dressing)/

-- = ***NO DISCOMFORT***
1 = ***MINIMAL*** (discomfort is present, but I can ignore it)
2. = ***SLIGHT*** (discomfort is present and I cant' ignore it)
3 = ***MODERATE*** (discomfort affects my ability to work and to concentrate)
4 = ***SEVERE*** (discomfort affects not only my ability to work, but also many of my activities of daily living)
5 = ***INTOLERABLE*** (discomfort makes work and activities of daily living nearly impossible)

FREQUENCY SCALE

How often do you experience work-related body-part discomfort?

--= ***NEVER***
1 = ***NOT VERY OFTEN*** (a few times a month or less)
2 = ***SOMETIMES*** (a few times a week)
3 = ***QUITE OFTEN*** (nearly every day)
4 = ***ALWAYS*** (it never goes away)

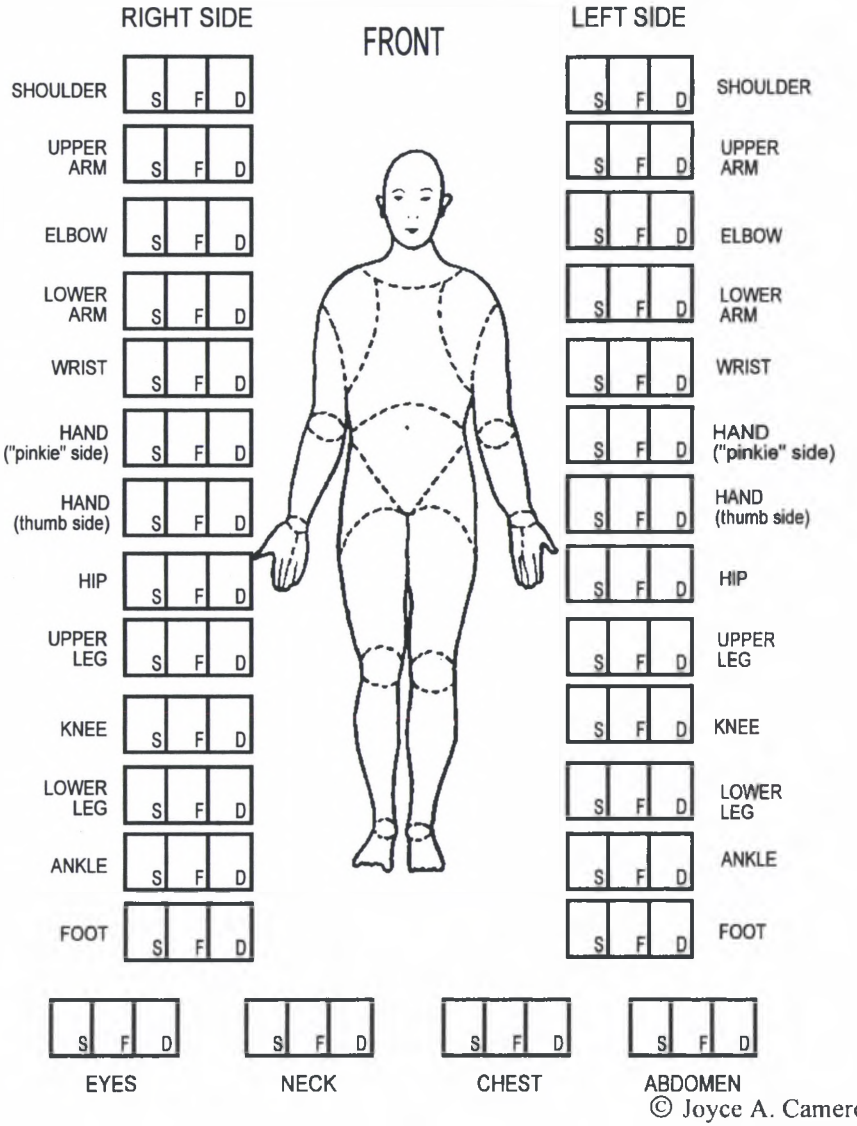
DURATION SCALE

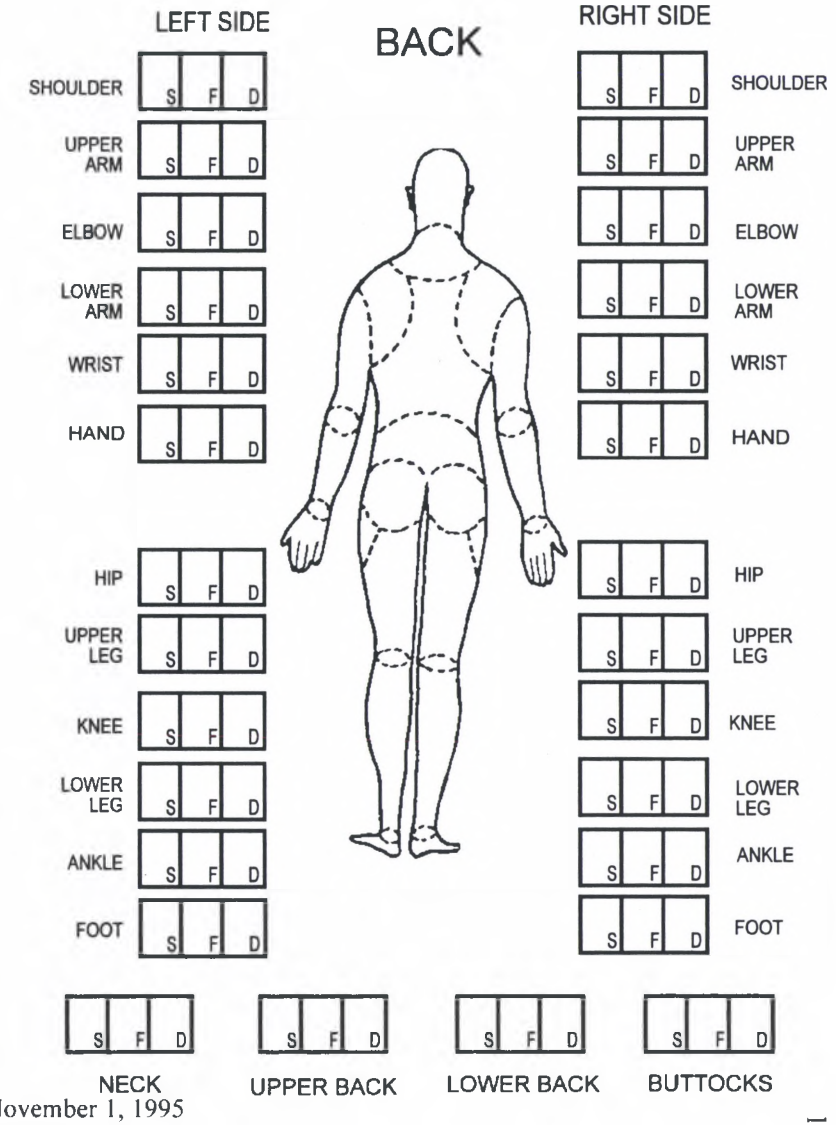
How dong does this work-related body-part discomfort last when it occurs?

-- = ***I DO NOT HAVE ANY DISCOMFORT***
1 = ***IT DOESN'T LAST LONG*** (my discomfort usually goes away as soon as I stop what seems to cause it, or shortly thereafter)
2 = ***IT LASTS SEVERAL HOURS*** (my discomfort usually goes away with hours of stopping the activity that seems to cause it)
3 = ***IT LASTS OVERNIGHT*** (my discomfort usually does not go away over night)
4 = ***IT RARELY GOES AWAY*** (my discomfort may go away over weekends, and it usually goes away over vacations)
5 = ***IT DOESN'T GO AWAY***

EXAMPLE

A computer operator uses a keyboard for 5 or 6 hours a day. By the end of the day, this person usually ends up with a lot of tension and soreness in his/her neck. This discomfort is annoying, but does not really affect work performance. It also seems to go away overnight. However, this person is concerned because it has continued for over a year. This person would complete the response boxes describing his/her neck using a "2" for severity, a "3" for frequency, and a "2" for duration as shown below.





QUESTIONS 17 - 20 ASK ABOUT YOUR EXPERIENCE WITH WORK-RELATED-BODY PART DISCOMFORT

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X]*, or write your response on the line(s) provided.

17. Since the first large *group* meeting in which you completed and returned survey for this study, have you gone a physician about one or more of the areas of work-related discomfort you have identified on this questionnaire?

    [ ] **YES.** *Please continue with this question.*
    [ ] **NO.** *Please go on to question #18.*

    *If **YES**, were you given a diagnosis?*

    [ ] **YES.** *Please continue with this question.*
    [ ] **NO.** *Please go on to question #18.*

    What was the diagnosis? →

    _____ ↑

    What body part(s) was/were affected?

    _____

18. Have you gone to any other type of health professional (e.g., chiropractor, massage therapist, physical therapist, etc.) about one or more of the areas of work-related body-part discomfort that you have identified on this questionnaire? [ ] **YES** [ ] **NO**

19. Are you currently taking over-the-counter drugs for the discomfort you have identified? [ ] **YES** [ ] **NO**

20. Are you currently taking prescription drugs for the work-related discomfort you have identified? [ ] **YES** [ ] **NO**

Please continue with Part 4 of this survey. It begins on page 7.

PART 4: YOU, YOUR JOB, AND YOUR WORK AREA

Part 4 of this survey asks questions about you, your job, and your work area. Please answer each question as accurately as you can, and be assured that your responses will be kept confidential and available only to the researcher.

QUESTIONS 21 - 32 ASK FOR INFORMATION ABOUT YOU AND YOUR CURRENT JOB.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

21. On average, how many hours per week do you work at your current job in this company?
    - [ ] less than 10
    - [ ] 11 - 19
    - [ ] 20 - 34
    - [ ] 35- 40
    - [ ] 41 - 50
    - [ ] more than 50

22. Do you use glasses, or contact lenses, when working at the computer?
    - [ ] **YES**. *Please continue with this question.*
    - [ ] **NO**. *Please go on to question # 23.*

    *If **YES**, have you obtained new glasses as a result of the training and/or written information you received?*
    - [ ] **YES**. *Please continue with this question.*
    - [ ] **NO**. *Please continue with this question.*

    *If **YES**, have you changed prescriptions as a result of the training and/or written information you received?*
    - [ ] **YES**. *Please go on to question # 23.*
    - [ ] **NO**. *Please go on to question # 23.*

23. Do you use a mouse when you use your computer?
    - [ ] **YES**. *Please continue with this question.*
    - [ ] **NO**. *Please go on to question # 28.*

    *If **YES**, did you begin using a mouse after the date on which you received training and/or written information on workstation adjustment?*
    - [ ] **YES**. *Please go to question # 24.*
    - [ ] **NO**. *Please go on to question # 26.*

24. Which hand do you use to operate your mouse?
    - [ ] right hand
    - [ ] left hand

25. Which mouse button do you use the most?
    - [ ] right mouse button
    - [ ] left mouse button
    - [ ] other (please specify)

    _____

26. During your typical work day, what percentage of the time you spend using a mouse is devoted to each of the following tasks: (Please make sure that your percentages add up to 100%.)

_____ % using menus

_____ % *pointing* and *clicking* on buttons or icons

_____ % *clicking* and *dragging* icons or objects

100 % of time using mouse

27. Do you use keyboard equivalents for some tasks that you could perform with a mouse?

[ ] **YES**. *Please continue with this question.*
[ ] **NO**. *Please go on to question #28.*

*If **YES**, please write the reasons(s) you use your keyboard instead of your mouse on the lines to the right.*

_____

_____

28. During your typical work day, WHAT PERCENTAGE OF THE TIME THAT YOU USE YOUR COMPUTER are you using the alphanumeric keyboard, the numeric keypad, and/or the mouse? (Please make sure that your percentages add up to 100%.)

_____ % primarily alphanumeric keyboard

_____ % primarily numeric keypad

_____ % primarily mouse

_____ % mouse and alphanumeric keyboard

_____ % both mouse and numeric keypad

_____ % all three: mouse, alphanumeric keyboard, and numeric keypad

100 % of time using keyboard and/or mouse

29. At work, how long do you typically sit without getting up?

[ ] less than half an hour
[ ] one half to one hour
[ ] one to two hours
[ ] more than two hours

30. How satisfied are you with your job?

[ ] very satisfied
[ ] satisfied
[ ] somewhat satisfied
[ ] dissatisfied
[ ] very dissatisfied

31. Do you work at another paying job?

[ ] **YES.** *Please go on to question # 32.*
[ ] **NO.** *Please go on to question # 33.*

32. Do you use a computer keyboard and monitor at this other job?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #33.*

*If **YES**, how many additional half-hours per week do you use a computer at this other job?*

_____ . additional half-hours per week

QUESTIONS 33 - 39 ASK FOR INFORMATION ABOUT YOU AND YOUR WORK AREA.

To complete these questions, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

33. How comfortable is the current set-up of your workstation (desk/table, chair, keyboard, and monitor)?

[ ] very comfortable *Please go on to question #34.*
[ ] reasonably comfortable *Please go on to question #34.*

If you checked "somewhat comfortable" or "not very comfortable," please use the lines to the right to explain what you believe makes your workstation uncomfortable.

[ ] somewhat comfortable *Please continue with this question.*
[ ] not very comfortable *Please continue with this question.*

_____

_____

34. Has the location of your work area changed since you completed the first questionnaire for this study? That is, have you moved to a new floor or to a new location on the same floor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #35.*

*If **YES**, are your MONITOR, KEYBOARD, and DOCUMENTS in the same relative position in both your old and your new work areas? (e.g., your monitor is to your left in both your old and your new work areas).*

[ ] **YES.**
[ ] **NO.**

35. Have there been any changes in the equipment available in your workstation (desk/table, chair, keyboard, monitor, etc.) since you completed the first questionnaire for this study?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #36.*

*If **YES**, please list the equipment that has been changed (e.g., different chair), or removed, from your workstation on the lines to the right.*

Changed:_____

_____

Removed:_____

_____

36. Have you personally added anything (e.g., cushion, foot rest) to modify your workstation since you completed the first questionnaire for this study?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #37.*

*If **YES**, please specify the item(s) added on the lines to the right.*

_____

_____

37. Have you used the adjustment capability (e.g., turned a knob, lifted a lever, etc.) of one, or more, of the major components of your workstation (desk/table, chair, keyboard, and/or monitor) since you completed the first questionnaire for this study?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #38.*

*If **YES**, how often do you use the adjustment capability of one, or more, of the major components of your workstation?*

[ ] I use it several times each day
[ ] I use it every day
[ ] I use it almost every day
[ ] I used it within the last month
[ ] I used it within the last 6 months
[ ] I used it about a year ago
[ ] I used it more than a year ago

38. Do you use the adjustment capability of some component of your workstation once a day or more?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #39.*

*If **YES**, please specify the component(s) you adjust daily on the lines to the right.*

Components adjusted daily:_____

_____

*If **YES**, what are your reasons for using the adjustment capability of your workstation daily? (Please check all that apply.)*

[ ] other people share my workstation
[ ] I can not get comfortable
[ ] to perform different tasks
[ ] to use different equipment
[ ] to change position
[ ] other (please specify below)

_____

39. Is there a sufficient range of adjustability in your workstation?

[ ] **YES.** *Please go on to question # 40.*
[ ] **NO.** *Please continue with this question.*

*If **NO**, what part of your workstation would you like to be able to adjust? (Please write your response on the lines to the right.)*

_____

_____

QUESTIONS 40 - 45 ARE ABOUT THE CHAIR YOU SIT IN WHEN USING YOUR COMPUTER.

To complete question 40, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

40. Does your chair provide you with any adjustment capabilities? That is, can you change, or move, any part (e.g., seat, back rest) of your chair?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question # 41.*
[ ] **DON'T KNOW.** *Please go on to question # 41.*

*If **YES**, please list the features that are adjustable on the lines to the right.*

_____

_____

To complete questions 41 - 43, place an "X" in the "box" preceding the word YES or NO in the left column labeled "SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED . . ." Then, if you answered "NO," please complete the right column labeled "If NO, WHAT WAS YOUR REASON FOR NOT CHANGING?" by circling the number that goes with your response.

	SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED. . .		***If NO*, WHAT WAS YOUR REASON FOR *NOT* CHANGING?**				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
41.	the height of the SEAT of your computer chair?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
42.	the position of the BACKREST of your computer chair up or down?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
43.	the position of the BACKREST of your computer chair forward or backward?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

To complete questions 44-46, place an "X" in the "box" associated with your desired response like this, **[X].**

44. Does your chair have arm rests?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #45.*

If YES, do the arms of your chair prevent you from sitting at the distance you would like when using your keyboard?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

If YES, do the arms of your chair prevent you from sitting at the distance you would like when writing on your work surface/desktop.

[ ] **YES.**
[ ] **NO.**

45. Is there about two inches of clearance between the back of your knees and the front of your chair when you sit at your computer?

[ ] **YES.** *Please go on to question #46.*
[ ] **NO.** *Please continue with this question.*
[ ] **DON'T KNOW.** *Please go on to question # 46.*

*If **NO**, how much clearance is there?*

[ ] less than 1 inch
[ ] more than 3 inches

46. Is there enough clearance for your legs and feet when you sit at your computer?

[ ] **YES.** *Please go on to question #47.*
[ ] **NO.** *Please continue with this question.*

*If **NO**, in which dimension(s) do you need more room? (Please "X" all that apply.)*

[ ] I need more up/down clearance between the tops of my thighs and the bottom of the surface on which my keyboard rests.
[ ] I need more side-to-side clearance for my legs and feet.
[ ] I need more forward/backward (in/out) clearance for my legs and feet.

QUESTIONS 47 - 49 ARE ABOUT YOUR KEYBOARD

To complete questions 47 - 49, place an "X" in the "box" preceding the word YES or NO in the left column labeled* "SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED . . ." *Then, if you answered "NO," please complete the right column labeled "If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?" *by circling the number that goes with your response.

	SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED. . .		***If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?**				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
47.	the HEIGHT of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
48.	the SIDE-TO-SIDE? location of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
49.	the FORWARD/ BACKWARD location of your keyboard?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

QUESTIONS 50 - 59 ARE ABOUT YOUR MONITOR

To complete question 50, place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

50. Does your monitor provide you with any adjustment capabilities? That is, can you change, or move any part (e.g., the tilt, the swivel, or the brightness/contrast) of your monitor?

[ ] **YES.**
[ ] **NO.**
[ ] **DON'T KNOW.**

To complete questions 51 - 56, place an "X" in the "box" preceding the word YES or NO in the left column labeled* "SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED . . ." *Then, if you answered "NO," please complete the right column labeled "If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?" *by circling the number that goes with your response.

	SINCE YOU RECEIVED TRAINING AND/OR WRITTEN INFORMATION ON WORKSTATION ADJUSTMENT HAVE YOU CHANGED. . .		***If NO,* WHAT WAS YOUR REASON FOR *NOT* CHANGING?**				
			It didn't need changing	It is too difficult	It is not adjustable	I don't know how	I didn't think about it
51.	the forward/backward TILT of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
52.	the side-to-side SWIVEL of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
53.	the BRIGHTNESS/ CONTRAST of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
54	the HEIGHT of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
55	the SIDE-TO-SIDE location of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5
56	the FORWARD/ BACKWARD location of your monitor?	[ ] **YES.** [ ] **NO.**	1	2	3	4	5

To complete questions 57 - 59, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

57. Is the distance to your computer screen comfortable for viewing?
[ ] **YES.**
[ ] **NO.**

58 Is the brightness/contrast of your monitor screen adjusted so it is comfortable for viewing?
[ ] **YES.**
[ ] **NO.**

59 Do you notice glare/reflection on your monitor screen when you work?
[ ] **YES.**
[ ] **NO.**
[ ] **DON'T KNOW.**

QUESTIONS 60- - 62 ARE ABOUT OTHER EQUIPMENT YOU MAY HAVE IN YOUR WORKSTATION

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X], or write your response on the line(s) provided.

60. Since you received training and/or written information about workstation adjustment, have you acquired a document holder?
[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #61.*

*If **YES**, what percentage of the time that you are using your computer do you use your document holder?*
_____ % of the time that I am using my computer

61. Since you received training and/or written information about workstation adjustment, have you acquired a wrist rest?
[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #62.*

If YES, do you use the wrist rest when you use your computer?
[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #62.*

If YES, what percentage of the time do you LEAN on the wrist rest?
[ ] 0 - 24 percent of the time
[ ] 25 - 49 percent of the time
[ ] 50 - 75 percent of the time
[ ] 76 - 100 percent of the time

62. Since you received training and/or written information about workstation adjustment, have you acquired a footrest?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #63.*

If YES, do you use this footrest when you use your computer?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please go on to question #63.*

If YES, what percentage of the time do you use your footrest?

[ ] 0 - 24 percent of the time
[ ] 25 - 49 percent of the time
[ ] 50 - 75 percent of the time
[ ] 76 - 100 percent of the time

QUESTIONS 63 - 72 ARE ABOUT POSITIONING *YOURSELF* AT YOUR COMPUTER KEYBOARD AND MONITOR.

To complete these questions, place an "X" in the "box" associated with your desired response like this, [X].

63. Since you received training and/or written information about workstation adjustment, do you habitually check the position of your torso with respect to your keyboard?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your torso with respect to your keyboard?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your torso with respect to your keyboard?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

64. Since you received training and/or written information about workstation adjustment, do you habitually change your position if you find that the position of your torso with respect to your keyboard is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move keyboard up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the keyboard where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

65. Since you received training and/or written information about workstation adjustment, do you habitually check the position of your arms and hands with respect to your keyboard?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your arms and hands with respect to your keyboard?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your arms and hands with respect to your keyboard?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

66. Since you received training and/or written information about workstation adjustment, do you habitually change your position if you find that the position of your arms and hands with respect to your keyboard is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move keyboard up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the keyboard where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

67. Since you received training and/or written information about workstation adjustment, do you habitually check the position of your torso with respect to your monitor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your torso with respect to your monitor?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your torso with respect to your monitor?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

68. Since you received training and/or written information about workstation adjustment, do you habitually change your position if you find that the position of your torso with respect to your monitor is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move monitor up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the monitor where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

69. Since you received training and/or written information about workstation adjustment, do you habitually check the position of your head and eyes with respect to your monitor?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** how often do you check the position of your head and eyes with respect to your monitor?*

[ ] each time I start to use my computer
[ ] at least once each day
[ ] other (please specify)

_____

*If **NO,** do you ever check the position of your head and eyes with respect to your monitor?*

[ ] when I think about it
[ ] when it doesn't seem right
[ ] other (please specify)

_____

70. Since you received training and/or written information about workstation adjustment, do you habitually change your position of you find that the position of your head and eyes with respect to your monitor is unsatisfactory in some way?

[ ] **YES.** *Please continue with this question.*
[ ] **NO.** *Please continue with this question.*

*If **YES,** what changes do you usually make? (Please check all that apply.)*

[ ] move monitor up/down, right/left, in forward/backward
[ ] move seat of chair up/down
[ ] move chair right/left and/or forward/backward

*If **NO,** what are your reasons for not making some change? (Please check all that apply.)*

[ ] I can't get the monitor where I would like it
[ ] I can't get the chair seat high, or low, enough
[ ] I can't get the chair where I would like it
[ ] other (please specify)

_____

71. Was your work-related body-part discomfort reduced by your use of the information provided in the training and/or written materials you received?

[ ] **YES**. *Please continue with this question.*
[ ] **NO**. *Please go on to question #72.*

*If **YES**. please specify the location (e.g., right, wrist, left shoulder, lower back) of the discomfort that was reduced on the lines to the right.*

_____
_____
_____

72. Did you make any changes to your workstation as a result of the demonstration and/or written material you received?

[ ] **YES**. *Please continue with this question.*
[ ] **NO**. *Please continue with this question.*

*If **YES**, please describe the changes you have made to your workstation on the lines to the right.*

_____
_____

*If **NO**, please describe why you did not make changes to your workstation on the lines to the right.*

_____
_____

73. Were there any changes which you wanted to make to your workstation, but which you could not make?

[ ] **YES**. *Please continue with this question*
[ ] **NO**. *Please go on to question #74.*

*If **YES**, please describe the changes you would have liked to make and why you were unable to make them on the lines to the right.*

_____

_____

_____

_____

PART 5: YOUR KEYBOARD AND ITS USE

QUESTIONS 74 - 84 CONTAIN DESCRIPTIONS REGARDING KEYBOARD OPERATION

To complete these questions, please place an "X" in the "box" preceding the word NO or YES in the left column labeled " I HAVE HEARD OF THIS"* THEN, *if you answered "YES," please complete the right column labeled "I DO THIS" by circling the number that goes with the appropriate response.

NOTE: Some of the statements below reflect recommended practice, while others do not. Please be sure to read each statement carefully before responding.

		I HAVE HEARD OF THIS	*If you answered **YES**, please complete this column.* **I DO THIS**		
			YES	**I TRY TO**	**NO**
74.	The body should be centered opposite the "J" key.	[ ] **NO** [ ] **YES**	1	2	3
75.	The fingertips should be vertical over the keys of the home row (asdf jkl;)	[ ] **NO** [ ] **YES**	1	2	3
76.	The shoulders should be relaxed.	[ ] **NO** [ ] **YES**	1	2	3
77.	The wrists should be low but not touching the keyboard unit.	[ ] **NO** [ ] **YES**	1	2	3

78.	The body should be located a "handspan" from the keyboard.	[ ] **NO** [ ] **YES**	1	2	3
79.	The thumbnail should be at right angles to the spacebar.	[ ] **NO** [ ] **YES**	1	2	3
80.	The feet should rest on the floor.	[ ] **NO** [ ] **YES**	1	2	3
81.	Reach for desired keys, keeping other fingers in typing position over the keys of the home row (asdf jkl;)	[ ] **NO** [ ] **YES**	1	2	3
82.	The forearm should be parallel with the keyboard.	[ ] **NO** [ ] **YES**	1	2	3
83.	Use a quick sharp stroke to strike each key.	[ ] **NO** [ ] **YES**	1	2	3
84.	Use a down-and-in motion to strike the space bar	[ ] **NO** [ ] **YES**	1	2	3

PART 6: RECENT CHANGES IN YOUR JOB

To complete question 85 place an "X" in the "box" associated with your desired response like this,* [X], *or write your response on the line(s) provided.

85. Have you changed jobs since the first large group meeting at which you completed and returned the first questionnaire for this study?

[ ] **YES**. *Please continue with this questions and with the remainder of this survey.*
[ ] **NO**. *Please go on to question #92.*

*If **YES**, please write your current job title on the line to the right.* _____

*If **YES**, how many weeks have you worked at this new job?* |___|___| weeks

QUESTIONS 86-91 ARE ABOUT *YOUR NEW JOB*

86.. Before you begin the next few questions, we would like you to think back to your last typical work day *in this new job*. Assuming that your LAST WORK DAY was a TYPICAL WORK DAY, complete the schedule below by placing an "X" in the "box" to describe your activities during each half hour that you were at work. That is, during each half hour that you were at work were you involved doing "mostly computer work," or "mostly NOT computer work" (e.g., for most people, their lunch period would involve "mostly NOT computer work"). If your LAST WORK DAY was not a TYPICAL WORK DAY, please complete the schedule as if it had been a TYPICAL WORK DAY.

TIME	TYPICAL WORK DAY		TIME	TYPICAL WORK DAY	
	mostly computer use	mostly NOT computer use		mostly computer use	mostly NOT computer use
7:00	[ ]	[ ]	12:30	[ ]	[ ]
7:30	[ ]	[ ]	1:00	[ ]	[ ]
8:00	[ ]	[ ]	1:30	[ ]	[ ]
8:30	[ ]	[ ]	2:00	[ ]	[ ]
9:00	[ ]	[ ]	2:30	[ ]	[ ]
9:30	[ ]	[ ]	3:00	[ ]	[ ]
10:00	[ ]	[ ]	3:30	[ ]	[ ]
10:30	[ ]	[ ]	4:00	[ ]	[ ]
11:00	[ ]	[ ]	4:30	[ ]	[ ]
11:30	[ ]	[ ]	5:00	[ ]	[ ]
12:00	[ ]	[ ]	5:30	[ ]	[ ]

87. On the basis of the schedule you just completed, how many half hours of your typical work day included mostly computer work? (Just count the number of "X's" in the column labeled "mostly computer use.")

Typical work day: _____ half hours.

88. During your typical work day, WHAT PERCENTAGE OF YOUR TOTAL WORK DAY IS DEVOTED TO EACH OF THE FOLLOWING TYPES OF TASKS? (Please make sure that your percentages add up to 100%.)

_____ % computer tasks

_____ % telephone tasks

_____ % other tasks (please specify the tasks on the lines below).

_____

_____

100% of typical work day

89. During your typical work day, WHAT PERCENTAGE OF THE TIME THAT YOU USE YOUR COMPUTER is devoted to each of the following types of tasks? (Please make sure that your percentages add up to 100%.)

_____ % typing/keying mostly words

_____ % typing/keying mostly numbers using the numeric keypad

_____ % making handwritten notes on paper

_____ % e-mail

_____ % other (please specify below)

_____

100% of time using computer for various tasks

90. During your typical work day, WHAT PERCENTAGE OF THE TIME THAT YOU USE YOUR COMPUTER is devoted to looking at the screen? at paper documents? at the keyboard? etc.? (Please make sure that your percentages add up to 100%)

_____ % looking at my screen

_____ % looking at paper documents laid flat on my work surface

_____ % looking at paper documents held up by a document holder

_____ % looking at my keyboard

_____ % other (please specify below)

_____

100% of time looking at work-related information

91. During your typical work day, WHAT PERCENTAGE OF THE TIME THAT YOU USE YOUR COMPUTER are you using the alphanumeric keyboard, numeric keypad, and/or the mouse? (Please make sure that your percentages add up to 100%.)

_____ % primarily alphanumeric keyboard

_____ % primarily numeric keypad

_____ % primarily mouse

_____ % both mouse and alphanumeric keyboard

_____ % both mouse and numeric keypad

_____ % all three: mouse, alphanumeric keyboard, and numeric keypad

_____

100% of time using keyboard and/or mouse

92. Before you turn in your completed survey, please check that you have completed all items, and complete any items that you may have accidentally skipped. Do NOT, however, modify any of your responses.

Thank you for taking the time to complete this survey.

APPENDIX G

OVERALL FREQUENCY OF DISCOMFORT SEVERITY RATINGS BEFORE INSTRUCTION

Body Part	0[1]	1	2	3	4	5	missing
Body parts in which 30 or more study participants reported some level discomfort (*i.e.*, at least 50% of the study participants reported some level of discomfort)							
Back Neck	8	14	17	13	6	0	1
Eyes	13	22	15	6	3	0	0
Lower Back	14	15	12	12	5	0	1
Upper Back	15	13	16	11	3	0	1
Front Neck	21	12	14	8	3	0	1
Right Front Wrist	23	17	12	5	2	0	0
Left Back Shoulder	25	13	17	4	0	0	0
Right Back Shoulder	26	12	16	5	0	0	0
Right Front Shoulder	29	13	14	3	0	0	0
Body parts in which fewer than 30 study participants reported some level discomfort (*i.e.*, at least 50% of the study participants reported some level of discomfort)							
Right Front Hand ("pinkie" side)	31	19	7	2	0	0	0
Left Front Wrist	32	13	10	2	1	0	1
Right Front Hand (thumb side)	33	16	8	1	1	0	0
Right Back Wrist	34	11	10	3	1	0	0
Left Front Shoulder	34	11	12	2	0	0	0
Buttocks	35	7	10	6	0	0	1
Right Back Hand	35	17	4	2	0	0	1
Left Back Hand	36	17	4	1	0	0	1
Left Front Hand ("pinkie" side)	36	16	7	0	0	0	0
Left Back Wrist	36	12	9	1	1	0	0

[1] NOTE:

DISCOMFORT SEVERITY RATING SCALE (Cameron, 1996)

Numerical Value	Descriptive Adjective	Behavioral Description
-- or 0	NO DISCOMFORT	
1	MINIMAL	"discomfort is present, but I can ignore it."
2	SLIGHT	"discomfort is present and I can't ignore it"
3	MODERATE	"discomfort affects my ability to work and to concentrate"
4	SEVERE	"discomfort affects not only my ability to work, but also many of my activities of daily living"
5	INTOLERABLE	"discomfort makes work and activities of daily living nearly impossible"

Body Part	0[1]	1	2	3	4	5	missing
Right Front Lower Arm	39	13	4	3	0	0	0
Left Front Hand (thumb side)	41	11	7	0	0	0	0
Left Front Lower Arm	43	12	3	1	0	0	0
Right Front Upper Arm	45	10	2	1	0	0	1
Right Back Elbow	46	9	1	2	1	0	0
Right Front Elbow	46	9	2	1	1	0	0
Right Front Knee	47	6	3	3	0	0	0
Left Front Elbow	48	8	1	2	0	0	0
Left Back Elbow	48	8	1	1	1	0	0
Right Back Lower Arm	48	7	3	1	0	0	0
Left Back Upper Arm	49	7	3	0	0	0	0
Left Back Lower Arm	49	6	3	1	0	0	0
Left Front Knee	49	6	2	2	0	0	0
Right Back Hip	49	5	3	0	0	0	2
Right Back Foot	49	6	2	0	0	0	2
Left Front Upper Arm	50	7	1	0	0	0	1
Right Back Upper Arm	50	7	2	0	0	0	0
Right Front Hip	50	7	2	0	0	0	0
Left Front Foot	51	7	1	0	0	0	0
Left Back Hip	51	5	2	0	0	0	1
Right Front Foot	51	6	2	0	0	0	0
Right Back Ankle	51	5	1	0	0	0	2
Left Front Hip	52	6	1	0	0	0	0
Left Front Ankle	52	6	1	0	0	0	0
Right Front Ankle	52	5	2	0	0	0	0
Right Back Knee	52	3	1	1	0	0	2
Abdomen	53	4	2	0	0	0	0
Left Front Lower Leg	53	4	1	1	0	0	0
Left Back Ankle	53	4	2	0	0	0	0
Left Back Foot	53	5	1	0	0	0	0
Right Front Upper Leg	53	5	0	0	0	0	1
Right Front Lower Leg	53	3	2	1	0	0	0
Right Back Upper Leg	53	2	2	0	0	0	2
Right Back Lower Leg	53	3	1	0	0	0	2
Chest	54	3	1	1	0	0	0
Left Front Upper Leg	55	4	0	0	0	0	0
Left Back Upper Leg	55	2	2	0	0	0	0
Left Back Knee	55	2	1	1	0	0	0
Left Back Lower Leg	56	2	1	0	0	0	0

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