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# Evaluating spacing of practice effects on the learning of shortcut keys

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# EVALUATING SPACING OF PRACTICE EFFECTS ON THE LEARNING OF SHORTCUT KEYS

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# ABSTRACT

## EVALUATING SPACING OF PRACTICE EFFECTS ON THE LEARNING OF SHORTCUT KEYS

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Using shortcut key commands to decrease computer mouse use is being recommended by ergonomists and organizations such as The New York Committee for Occupational Safety and Health. This is primarily because mouse use has been shown to be a contributing risk factor in developing muscular skeletal disorders. One issue that arises is how to best train people on shortcut keys. This study evaluated spacing of practice (massed practice versus distributed practice) on a shortcut key training protocol to determine if one type of practice increases shortcut key memorization more effectively than the other. The researcher found no significant difference in shortcut key memorization between the distributed practice group and the massed practice group. The researcher found a significant effect for time of test and a significant interaction between time of test and spacing of practice.

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## Introduction

### *Computer Mouse Usage and Muscular Skeletal Disorders*

In 1968, Douglas Engelbart introduced the mouse as an input device for computer use (Conner, 2003; Bellis, 2003). The mouse revolutionized how humans interact with computers. Rather than memorize function keys and macros in order to operate their computers, computer users could simply 'point and click' with their pointing devices. It is certain that the mouse offers a very productive way to interface with the computer. Karlqvist, Hagberg and Selin (1994) found that production was increased and the number of errors decreased when a mouse was used rather than a keyboard for a correction task. Computer users at home and at work embraced the mouse as an essential tool for interacting with the computer. From graphic artists to office assistants, people are using mice more continuously and more frequently than keyboards (Aarås, Fostervold, Ro, Thoreson, & Larsen, 1997).

However, after 20-plus years in the marketplace, the widespread use of the mouse has revealed costs as well as benefits in economic and ergonomic terms (Rempel, Jacobson, Brewer & Martin, 2000). Like the keyboard, the mouse has been linked to the development of muscular skeletal disorders (Cook, Burgess-Limerick, & Chang, 2000; Cooper & Straker, 1998; Fogleman & Brogmus, 1995). The leading risk factors associated with the development of muscular skeletal disorders are hypothesized to be the repetitive nature of work, prolonged constrained postures, static and forceful exertions, mechanical pressure, and duration of work (Armstrong, Radwin, Hansen, & Kennedy, 1986; Cook et al., 2000; Marras & Schoenmarklin, 1993). There is substantial evidence indicating that use of the mouse is a major factor for muscular skeletal disorders for workers and employers. An increased incidence of injury, escalating workers' compensation claims, and decreased productivity from lost work time are some of the possible effects.

Placement of the mouse, wrist postures, and mousing techniques are identified in the literature as factors for developing mouse related injuries. Karlqvist et al. (1994) found that mouse operators had long periods of awkward or strenuous working postures as compared to non-mouse operators and that they spent a larger amount of time with wrist ulnar deviation than computer users who worked without a mouse (i.e., keyboard only). Marcus, Gerr, Monteilh, Ortiz, Gentry, Cohen, Edwards, Ensor, and Kleinbaum (2002) found an increased risk for hand and arm symptoms and disorders when the mouse was used with $> 5°$ radial wrist deviation.

Increased shoulder flexion and external rotation have been observed in mouse users versus keyboard users (Cooper & Straker, 1998; Karlqvist et al., 1994). Increased mouse use over keyboard use has been shown to increase static positioning in computer-aided design (CAD) work (Byström, Hansson, Rylander, Ohlsson, Källrot, & Skerfving, 2002). Individuals with various disabilities have found the mouse more difficult to use than the keyboard (Trewin & Pain, 1999).

Specific research on the effects of using the mouse is prevalent in the literature. Different kinds of mouse designs have been tested and all of the pointing devices studied were found to have similar carpal tunnel pressure and wrist posture (Keir, Bach, & Rempel, 1998). In addition, research has shown that mouse users work with more extreme postures of the shoulders as compared to keyboard users (Cooper & Straker, 1998; Karlqvist et al., 1994).

Individual typing and mousing styles have been found to play an important role in the stress of forearm muscles during video display terminal work, and researchers have recommended that training should be a part of employee orientation protocols (Paul, Menon, & Nair, 1995). Substantially different interindividual muscle loading has been observed in computer mouse users (Cooper & Straker, 1998; Byström, et al., 2002). Higher muscular stress is suggested to be a risk factor in the development of muscular skeletal disorders, and any risk reduction efforts should acknowledge pre-existing differences between video display users (Paul et al., 1995).

The following methods have been suggested to ameliorate muscular skeletal disorders in mouse users (Cooper & Straker, 1998): (a) position, (b) use of alternative devices, (c) use of forearm support, (d) use of speech recognition software, and (f) increased use of the keyboard.

*Shortcut Keys*

Shortcut keys are either a key combination or an individual key (e.g., a tab key) that cause a specific cursor position or other screen operation to occur. The cursor control keys move the cursor and include the End, Home, Page Up, Page Down, Backspace and the arrow keys. The arrow keys move the cursor up, down, right and left. Shortcut key combinations include the use of Ctrl or Alt keys in conjunction with other keys. For example, *Ctrl+B* (the control and "B" keys pressed simultaneously) in Microsoft Word™ or Excel™ will bold text; *Alt+A* will highlight all text.

Early software, such as WordStar™ and XyWrite™, developed before the use of the computer mouse, required computer users to learn shortcut keys to be able to operate the software (Bellis, 2003). As the mouse became a key input device and the primary tool used to operate newer software, people forgot (or never learned) how to use shortcut keys. Many WordStar™ commands still exist in today's software; *Ctrl+X*, *Ctrl+C*, and *Ctrl+V* are prime examples. Other shortcut keys are ubiquitous in major software applications, including Microsoft Word™, Excel™, and Outlook™.

One strategy for decreasing mouse use and increasing keyboard use is increasing the use of shortcut keys. Some ergonomic specialists and organizations such as The New York Committee for Occupational Safety and Health are currently recommending use of shortcut keys for computer users (Stamatis, 2004). Performance Based Ergonomics, Inc., a San Francisco-based company that specializes in typing retraining, offers a class named "Avoiding the Mouse Trap" which, as part of the curriculum, instructs participants on the use of shortcut keys.

Increased use of shortcut keys minimizes the need for mouse use and allows computer users to keep their arms positioned closer to the midline of the body, as is ergonomically recommended. Use of these keys can also increase speed and productivity (Borland, 1997; Bott, 2000). Increased use of shortcut keys is probably not as effective for individuals whose work requires them to predominantly use the mouse (e.g., graphic artists). However, these individuals could still benefit from knowing the shortcut keys in their email management software (e.g., Microsoft Outlook™) and in the word processing programs they use for letter writing and other document-generating tasks.

The majority of research regarding pointing devices focuses on the design of the computer mouse, mouse placement, postural issues, and muscle loading, and not on alternatives (e.g., using shortcut keys). Extensive research on pointing devices exists today because mouse use is ubiquitous even though it is suspected to be a strong risk factor in muscular skeletal disorders (Cook, et al., 2000). Direct manipulation interfaces, which usually entail the use of a pointing device, have become the dominant interface paradigm (Mayhew, 1992). Thus, mouse use continues to be a key component in computer interface design.

There is very limited research comparing use of the mouse to keyboard use (Byström et al., 2002). However, the majority of these studies recommend keyboard use over mouse use for injury prevention, especially for heavy mouse users, like CAD operators (Byström et al., 2002). Research on shortcut keys may also be lacking because they require training to learn and their use is not as intuitive as the use of the mouse. Because of the ubiquitous nature of mouse use, today's computer users will require specific training if they are going to be able to use shortcut keys more extensively.

*Training Approaches for Increasing Shortcut Key Use*

Instructor led training has been used to teach individuals shortcut keys at the City of Sunnyvale and is a part of the training offered to companies by Performance Based Ergonomics, Inc. They offer a 90-minute class named "Avoiding the Mouse Trap" throughout the San Francisco Bay Area. The class includes an instructor led training done in a traditional classroom setting in a computer lab. These trainings include written handouts for participants to take with them following the training. Instructor led training is considered to be an effective training method that is both time- and cost-effective (Brown, 2001).

Computer based training is another common training method in today's business setting. Training programs can be web based or run from an instructional CD-ROM. Computer based learning can decrease the cost of training and give the learner greater control (Brown, 2001). However, greater control is not necessarily better, since research shows that employees working on their own without an instructor may choose to not finish computer based training and may not spend adequate time with the course (Brown, 2001; Desai, Richards, & Eddy, 2000).

Mastery learning methodology has been shown to be one of the most successful teaching methodologies (Krank & Moon, 2001). It focuses on essential, need to know information and skills that can be used immediately (McIntosh & Sullivan, 2000). Mastery learning can include interactive, instructor led presentations, reading printed materials, self-paced computer assisted programs, or a combination of these (Krank & Moon, 2001). One of the specific techniques used in mastery learning is the use of questions. Higher level questions can be used to get people to think more effectively and promote learning (Brothen & Wambach, 2000). The use of questions that have no penalty in computing the final score increases motivation and allows individuals to learn from their mistakes (Garver, 1998).

BrainX software, which was developed by five learning experts, is software that automates expert learning strategies like spaced learning, self-evaluation, and on-demand assistance in the form of hints and explanations (Barth, 2001). It is used primarily by students in order to prepare for tests and to learn any type of material. Individuals using BrainX can do so on multiple occasions (i.e., distributed practice). The software is engaging, uses principles of mastery learning methodology (including the use of questions), can be used by individuals on a self-paced basis, and may result in cost savings. Finally, the software can be beneficial in increasing individuals' practice time. Practice and time on task are two recognized important components of learning (Bell & Kozlowski, 2002; Brown, 2001).

Individuals using BrainX can do so on multiple occasions (i.e., distributed practice). Distributing practice is one of the ways to achieve what is known as a spacing effect. The spacing effect occurs when there is a certain lag from the first occurrence of an item to a second occurrence. The alternative, massed practice, occurs when the second occurrence of an item immediately follows the first one. Distributed practice sessions over several days or weeks have long-term advantages that have been demonstrated consistently for more than 100 years (Bjork, 1994; Toppino, Hara, & Hackman, 2002). The spacing effect has been shown to increase learning over chunked or massed distributed information (Bahrick, Bahrick, Bahrick, & Gahrick, 1993; Mizuno, 1997; Russo & Mammarella, 2002; Shebilske, Goettle, Corrington, & Goettl, 1999).

*Objectives of This Study*

Computer users, if trained on shortcut keys, could use shortcut keys to minimize mouse use and may decrease their risk of developing mouse related muscular skeletal disorders. Research is needed to understand how to best train computer users on shortcut key use.

The primary objective of this study was to compare the spacing effect, i.e., distributed practice, to massed practice in computer based training given to participants following an instructor led training. The computer based practice sessions were supported by the use of BrainX software and were used to help participants learn shortcut keys. All training was conducted in a computer lab setting. The training protocols were selected for their practicality and cost-effectiveness as well as their potential to be effective. Results from this study may help ergonomists, employers, and employees understand which training protocols may be most effective for computer learning of shortcut keys.

The Null Hypotheses formulated for this study were:

1. Spacing of practice will not affect the Rogers Shortcut Key Tests.
2. Time of test will not affect the Rogers Shortcut Key Tests.
3. Spacing of practice and time of test will not interact to affect the Rogers Shortcut Key Tests.

The researcher expected to see an improvement from the initial administering of the Rogers Shortcut Key Test scores when it was given again one week after all training for both massed and distributed practice groups, since both included instructor led training and the BrainX computer based training.

*Importance of the Study*

There is little experimental research regarding how to best train computer users on shortcut keys. Computer mouse use is increasing as a "window interface" becomes more and more prevalent (Cook, 2000). Windows™ based software programs tend to encourage non-keyboard computer input device use rather than keyboard use (Karlqvist & Hagberg, 1994). This research study was conducted to determine if the spacing effect (i.e., distributed practice) with the use of computer based training is beneficial for increasing retention of shortcut keys. If this simple, low cost method can be developed to enhance shortcut key training, then computer users everywhere can learn how to use shortcut keys to decrease overall mouse use. Shortcut key training could be incorporated into the ergonomic programs of organizations that have computer training centers or could be done onsite at individual workstations. It is postulated that if more people become more knowledgeable about shortcut keys, then software companies will be more inclined to incorporate keyboard shortcuts directly into their software.

*Definition of Terms*

BrainX software. Computer based training software that allows individuals to highlight key concepts on a website, in a book, or on a printed document to be stored and organized for later retrieval. The application then helps them review the information and test themselves on the content to prepare for exams.

Computer based training. Computer based training is any course of instruction whose primary means of delivery is a computer.

Distributed practice. Distributed practice is a series of practice sessions that have some type of break between sessions. This type of practice is also known as interlesson practice and is considered to be a type of spacing effect.

Instructor led training. Instructor led training or instructor based training is any course of instruction whose primary means of delivery is an instructor.

Massed practice. Massed practice, also known as chunked practice, is a series of practice sessions that are given consecutively with no substantial breaks between sessions. It is also known as massed presentation.

Muscular skeletal disorders (MSD). MSDs include disorders of soft tissue, muscles and skeleton. They occur most often due to repeated forceful exertions and/or awkward non-neutral postures of the body over time.

Repetitive strain injuries. Repetitive strain injuries are sometimes called overuse strain injuries and are a considered to be a muscular skeletal disorder or a cumulative trauma disorder. These injures can involve any tendon or muscle injury resulting from overuse, usually in the hand, wrist, or arm. Injury may be caused by any combination of repetitive, unaccustomed, or prolonged movements, forcefulness, or an awkward position (often due to bad ergonomics). The symptoms are pain, tingling, weakness, numbness, swelling, cracking, stiffness, or reduced coordination.

Shortcut keys. Shortcut keys are either a group of key combinations or an individual key such as a tab key that cause a specific cursor position or other screen operation to occur.

Spacing effect. The spacing effect occurs when there is a certain lag from the first occurrence of an item to a second occurrence versus having the second occurrence of an item follow the first one immediately ("massed presentation"). This lag time can be minutes to days to even months.

# Review of Literature

To best understand why shortcut keys may be beneficial in decreasing mouse use and possibly the incidence of muscular skeletal disorders, relevant material on muscular skeletal disorders, postural issues, and mouse-related research are reviewed in this chapter. In addition, research on training and learning is reviewed, since the goal of this study is to determine if a difference exists between distributed practice and massed practice for memorizing shortcut keys.

The review of literature focuses on five areas of research: 1) general research on muscular skeletal disorders, repetitive strain injuries and their diagnosis, 2) postural issues, 3) computer mouse and mouse positioning research, 4) muscle loading and 5) training and learning.

## *Muscular Skeletal Disorders and Repetitive Strain Injuries*

Disorders involving the neck and upper extremities were described as an occupational disease as early as 1713 (Winkel & Westgaard, 1992; Armstrong, Fine, Goldstein, Lifshitz & Silberstein, 1987). Muscular skeletal disorders related to repetitive tasks account for more than 50% of all occupational illnesses in the United States (US Department of Labor, 1998). The prevalence of work related upper extremity muscular skeletal disorders (e.g., tendonitis, epicondylitis, and Carpal Tunnel Syndrome) reported in America appears to have increased dramatically during the last ten years (Gustafson & Hagberg, 2003). Snook, Vaillancourt, Ciriello and Webster (1995) began with the premise that muscular skeletal disorders are associated with a combination of risk factors, and they went on to study repetition of motion, force of exertion, and type of motion (posture) as the three primary risk factors of muscular skeletal disorders. They investigated the interplay and interrelationships of these factors. The researchers found that the combination of these risk factors govern the work experience in relationship to duration of work, repetition of work, wrist flexion motion (power grip), and maximum acceptable torque applied to these various physical actions. Their study indicated that the factors governing work performance and the risk of muscular skeletal disorders are very complex and interrelated. Furthermore, they concluded that solutions to muscular skeletal disorders would never be simple.

Ranney (1993) developed a detailed assessment methodology to allow a precise diagnosis that could then be used to establish the cause of muscular skeletal disorders and formulate prevention strategies. He concluded that diagnoses of muscular skeletal disorders and repetitive strain injuries were really statements of causation rather than true medical diagnoses. Ranney (1993) found that specific diagnosis allowed for appropriate treatment and prevention. He designed a specific protocol for development of a complete diagnosis. These included physical examination, muscle tenderness, pain on resisted activity, and tendon and neurological assessment. Ranney (1993) concluded that unless the causative factors are known, little can be done to prevent re-injury and that early treatment is always more effective, long lasting, and prevents prolonged periods away from work.

The most common repetitive strain injury diagnosis in both the scientific literature and public media has focused on Carpal Tunnel Syndrome, since these injuries often result in severe disability and because there are more objective diagnostic tests for nerve impairments than for tendon disorders (Armstrong et al., 1987; Wilson & Sevier, 2003).

Other common neurological diagnoses include the following: median nerve compression at the elbow as well as in the wrist, Cubital Tunnel Syndrome, which involves ulnar nerve compression at the elbow (at the heads of the two flexor carpi ulnaris), and Radial Tunnel Syndrome, where the radial nerve may be compressed as it passes through the superinator muscle (Rempel, Harrison, & Barnhart, 1992; Ranney, 1993; Wilson & Sevier, 2003). Another neurological diagnosis is Thoracic Outlet Syndrome, which involves nerve compression of the thoracic outlet area. The symptoms can include pain, paraesthsias, numbness, and early fatigue in the upper limb (Sallstrom & Schmidt, 1984).

Common tendonitis diagnoses include: De Quervain's Syndrome (tendonitis of the thumb), Lateral epicondylitis (tennis elbow), and tendonitis of the wrist. For tendonitis the diagnostic indicator is localized tenderness over the tendon that is involved (Rempel et al., 1992).

Rempel et al. (1994) while investigating the effect of wrist extension on carpal tunnel pressure, found that the mean carpal tunnel pressure increased with wrist extension. Marcus et al. (2002) found there was a higher risk of musculoskeletal symptoms and disorders when the following occurred:

- When the mouse wrist has radial deviation.
- When hours typing increases from 20 hours per week to 40 hours per week.
- When age is greater than 40 years.

- When gender is female.

This study found that there is a lower risk of developing musculoskeletal symptoms and disorders when the keyboard "J" key is farther than 12 cm from the table edge (arms supported out in front of body, resting on the work surface).

*Postural Issues*

Perhaps the most common arm posture observed in mouse users is the "resting" wrist posture. This is similar to what is considered to be the "lazy" style of keyboarding. When the user's wrist is in a resting position on a standard mouse pad, wrist extension is often observed. Wrist extension with mouse use is common and with the trackball it has been found to be even more substantial (Karlqvist, Bernmark, Ekenvall, hagberg, Isaksson & Rosto, 1999).

Sitting work posture has been studied extensively. One detailed study of sitting work posture found that whole spine flexed sitting posture led to higher levels of static activity in several neck and shoulder muscles than posture with a straight and vertical spine. This flexed spine sitting posture led to higher static activity levels than posture with slightly backward-inclined thoraco-lumbar spine sitting (Schuldt, Ekholm, Harms-Ringdahl, Nemeth & Arborelius, 1986). In a more recent study on sitting posture, a backward-leaning trunk position was noted to decrease trapezius muscle activity (Villanueva, Sotoyama, Jonai, Hisanaga, Takeuchi & Saito, 1996).

Further research that focused on neck and head position found that increased neck extensor tension occurred when there was a significantly greater angle of flexion. This study determined that documents positioned flat on a table to the right or left of the monitor led to the greatest levels of muscle tension, while documents positioned between monitor and keyboard or in place of monitor produced the lowest muscle tension (Hamilton, 1996).

Jensen, Rfinsen, Sotgaard and Christensen (2002) found that the association between mouse use and shoulder symptoms was significant when the group of call center employees (who had minimal mouse use) were excluded from their analysis of computer users. More severe upper torso pain and stiffness were associated with a keyboard position that was higher than the subject's elbows. Increased keyboard height and poor back support significantly increase pain in the shoulder, neck, and upper back and increase muscle activity (Faucett & Rempel, 1994; Karlqvist et al., 1999; Ryan & Bampton, 1988; Sauter, Schleifer & Knutson, 1991).

A study on the effect of mouse location on seated posture was done without EMG analysis and concluded that there was no significant discomfort associated with any of the three mouse locations studied (Dowell & Gscheidle, 1997). They did not control for upright versus reclining positions, and as a result some subjects preferred to recline while others sat upright. They also performed a short mousing task of only twenty-five minutes for each of the three locations. Because this task was time limited to twenty-five minutes it may not have been long enough to elicit muscle discomfort in the subjects. Of the two factors, time and tension, involved in static load muscle fatigue, the level of fatigue (measured as the amount of rest necessary for recovery) increases more rapidly for time rather than for tension (Hamilton, 1996; Onishi, Sakai & Kongi, 1982; Corlett, Wilson, &

Manenica, 1980). Another study on mouse design by Keir et al. (1998) found similar carpal tunnel pressure and wrist positioning in all three pointing devices studied.

Research on arm positions concluded that arm abduction led to higher levels of muscular activity in the upper back and neck (Cooper & Straker, 1998; Karlqvist et al., 1999; Schuldt et al., 1986). Villanueva et al. (1996) found that a backward-leaning trunk posture led to decreased trapezius muscle activity in some subjects. Based on this research, the ideal VDT work set-up would include the worker in a slightly backward reclined posture working on a height-adjustable work surface that curved around the worker's torso, providing forearm support for his or her keyboarding or mousing tasks. This position may be similar to the position found to be beneficial in the study by Gerr, Marcus, Ensor, Kleinbaum, Cohen, Edwards, Gentry, Ortiz & Monteilh (2002), which found having the arms out in front of the body, supported on the work surface, to be most beneficial. Lochridge (1998) concluded that most American workers are provided with furniture that is designed for an upright posture only, primarily due to space limitations.

Wrist ulnar deviation has been found to be a significant predictor of arm discomfort (Hunting, Laubli & Grandjean, 1981; Karlqvist et al., 1994; Marcus et al., 2002; Sauter et al., 1991). Flexion and extreme extension of the wrists has been associated with development of tenosynovitis of the flexor and extensor tendons in the wrist and with Carpal Tunnel Syndrome (Armstrong, Martin, Franzblau, Remple, & Johnson., 1995).

*Computer Mouse and Mouse Positioning Research*

Scientific literature on pointing devices in relationship to muscular skeletal disorders is now quite extensive. In the past, few studies have linked the use of a computer mouse to musculoskeletal problems (Cooper & Straker, 1998). Jensen et al. (2002) analyzed over 2579 full time employees to evaluate musculoskeletal symptoms and duration of computer and mouse use. They found the association between shoulder symptoms and mouse use was significant. Computer users who used the mouse for at least half of the work time as compared to intensive computer use without a mouse (call center employees) had significantly more hand and wrist symptoms.

Increased mouse use over keyboard use led to an increase in static positioning in computer-aided design (CAD) work (Byström et al., 2002). They compared a CAD program that utilized the mouse more frequently than a keyboard to another program that was more keyboard-intensive and required less mouse use. They concluded that using the keyboard more frequently is recommended to induce more movement and decrease the extremely constrained CAD work which is traditionally very mouse intensive. Trewin and Pain (1999) discovered that the majority of participants with various disabilities found the mouse difficult to use. Many preferred to decrease their mouse use and tried to avoid using it as much as they could. When computer users were studied performing a tracking task under time pressure, the keyboard was greatly preferred over the mouse (Jorgensen, Garde, Laursen, & Jensen, 2002).

Computer mouse use continues to increase and can account for up to two-thirds of computer operation time depending on the task performed and the software used (Cooper & Straker, 1998; Johnson, Dropkin, Hewes & Rempel, 1993). Fogleman and Brogmus (1995) investigated computer mouse use and muscular skeletal disorders to determine the magnitude of the problem. They studied the records of the Liberty Mutual Group from 1986 to 1993 to determine how many reported claims were related to the mouse. They found that workers' compensation claims were often not detailed enough to arrive at the specific cause of the claim. The brief narrations often did not differentiate between general computer related muscular skeletal disorders claims and mouse-specific claims. However, their evaluation of the data led to the conclusion that computer mouse muscular skeletal disorders had been increasing rapidly.

Gerr et al. (2002) found that when the mouse wrist had radial deviation there were increased musculoskeletal symptoms and disorders. Karlqvist et al. (1994) concluded that keeping the mouse positioned within the span of the forearm on the desk is recommended. The researchers also concluded that a shorter keyboard might be the ergonomic solution for narrow-shouldered people. However, this study did not use any alternative keyboards.

Mouse-related studies have shown that operating the mouse without forearm support increases the load on the trapezius muscles (Aarås, Fostervold, Ro, Thoreson & Larsen, 1997; Bystöm et al., 2002; Cooper & Straker, 1998; Karlqvist, et al., 1999). A large amount of interindividual variation in muscle load has been found in mouse users (Cooper & Straker, 1998; Karlqvist et al., 1999).

*Training and Learning*

The goal of training is to produce long-term learning and to optimize the transfer of training to the post-training environments (Bjork, 1994). Mastery learning methodology has been shown to be one of the most successful teaching methodologies (Krank & Moon, 2001). It focuses on essential, need to know information, and skills that can be used immediately (McIntosh & Sullivan, 2000). Mastery learning can include interactive, instructor led presentations, reading printed materials, self-paced computer-assisted programs, or a combination of these (Krank & Moon, 2001). One of the specific techniques used in mastery learning is the use of questions. Higher level questions can be used to get people to think more effectively and promote learning (Brothen & Wambach, 2000). Mastery learning has been found to increase participants' learning (Krank & Moon, 2001).

*Instructor led training*. Instructor led training is considered to be an effective training method that is both time- and cost-effective (Brown, 2001). It enables the instructor to help motivate trainees by encouraging appropriate behavior (McIntosh & Sullivan, 2000). Motivation is seen as crucial to learning and is sometimes assessed prior to initiation of training (Stevens & Fiske, 1995). Instructors have the ability to ask participants questions during training. Oral questioning during instructor led sessions has been found to increase participants' learning (Ralph, 1999).

Using a traditional one-time instructor led training for shortcut key training may limit the participants' ability to learn many shortcuts (Croasmun, 2003). One alterative is the use of distributed practice sessions for learning shortcut keys. This type of practice can be done in the traditional classroom setting (more time consuming and costly) or with the use of computer based training. Distributed practice sessions over several days or weeks have long-term advantages (Bjork, 1994; Toppino et al., 2002).

Researchers (Shebilske et al., 1999) defined interlesson spacing as minutes to hours between training sessions and intralesson spacing as seconds to minutes between presentations of items within a particular study session. They studied interlesson spacing (10 day spaced versus 2 day massed practice) and task-related processing during a complex skill acquisition. They did not study the effect of items spaced and repeated within the same study session. They found in experiment 1 that the participants in the distributed interval group performed better than the participants in the massed group that had no intervals between practice levels. This was especially evident when retention and transfer were tested one week post training. Experiment 2 contrasted 25-minute inter-lesson activities. One was an arithmetic task and the other a task-relevant elaboration task designed to give participants additional learning material on the topic they were studying. The elaboration group did better than the group that did the arithmetic task.

Bahrick, Bahrick, Bahrick, and Bahrick (1993) used intervals of 14, 28, and 56 days to test the spacing effect. They found that longer intersession intervals lead to a slight decrease in acquisition but had greater retention. Thirteen retraining sessions spaced at 56 days was able to produce retention similar to 26 sessions spaced at 14 days. Retention was tested at 1, 2, 3, and 5 year intervals. This was a nine-year study in all and involved the learning of a foreign language. Because the study only had four participants, the results should be considered interesting but not definitive.

Glover, Bullock, and Dietzer (1990) found that by inserting a delay after reading an advanced organizer (with introductory material presented with a high level of abstraction, generality, and inclusiveness) retention of the material was increased. They studied various task-related processing in a second experiment and found no significant difference in the scores of participants in the distraction and unsupervised conditions. These two groups significantly recalled more material than participants in the rehearsal condition, the immediate condition, or the control condition.

Russo and Mammarella (2002) assessed the presence or absence of a spacing effect in a yes/no recognition memory task for words and non-words after incidental learning focusing the attention of the participants to structural and graphic features of targets. Half of the participants were given words as targets, and half were given target non-words. They found that only in the non-word condition was a reliable spacing effect observed. The researchers noted that the lack of spacing effect in the word condition may have been due to a lack of repetition, which other studies have indicated is necessary (Russo & Mammarella, 2002).

Toppino et al. (2002) studied whether the spacing effect could be found when studied material consists of lists of words sampled from a single semantic category. They found that the spacing effect in free recall can occur with homogeneous lists depending on the number of items (lag) separating spaced repetitions. The longer lag time did not generate a spacing effect, while the shorter lags between spaced repetitions did. Mizuno (1997) found that for spaced learning to be more effective than massed learning, there needs to be repeated practice that includes the same series of items even if they are numerous and warned that this may be hard and boring.

Though the research on the spacing effect is extensive, no specific explanation of the spacing effect has gained general acceptance (Dempster, 1996; Toppino et al., 2002). Though research does not often distinguish between the spacing of items during a specific testing or study session versus the spacing effect of time with sessions being typically a day or even several weeks apart, a review of the research shows that different theories appear more frequently depending on whether the spacing effect being discussed is intralesson or interlesson spacing. There is limited differentiation in much of the research on the spacing effect between items that are spaced during the same training lesson (intralesson spacing) versus spacing of items over hours or days (interlesson spacing) (Shebilske, Goettle, Corrington, & Day,1999).

The two areas that appear most relevant to the interlesson (i.e., distributed practice) spacing effects are the benefits of sleep (for interlesson sessions that have a night of sleep between sessions) and Bjork's proposal (1994) that the act of retrieving information is itself a potent learning event. Bjork (1994) proposed that longer interlesson intervals promote memory processing by actually increasing short-term memory difficulties. By increasing the interlesson time period the retrieval strength (current ease of access) is lowered, and this hinders performance on practice tasks in the short run, but facilitates the growth of storage strength and enhances long-term memory (Shebilske et al., 1999).

Interlesson studies that include a night of sleep between sessions like the design in this study may benefit from the effects of REM (rapid eye movement) sleep. The function of sleep remains unknown despite an ever-increasing understanding of various related sleep functions including thermoregulation, brain detoxification, and tissue restoration (Maquet, 2001). Sleep has been shown to be beneficial in learning and memory retention though the extent of this role remains hotly debated (Stickgold, 2003). Peigneux, Laureys, Delbeuck, and Maquet (2001) reviewed sleep and memory research and found that there are four primary experimental techniques used to test the hypothesis that sleep leads to memory consolidation: (1) the effects of sleep deprivation following training, (2) the learning that takes place after post-training sleep periods, (3) the effects of within sleep stimulation on the sleep pattern and overnight memories, and (4) the reactivation of neural structures during various stages of sleep that were engaged in the process of learning during waking hours. Note that this last experimental technique has been used primarily in animal research rather than in humans, due to the more invasive type of technique needed to study brain activity. The researchers concluded that the studies they reviewed did indeed suggest that REM and non-rapid eye movement (NREM) sleep stages could benefit memory processes.

Walker, Brakefield, Seidman, Morgan, Hobson, and Stickgold (2003) found that participants in a motor skill learning study showed a much larger improvement with a behavioral skill acquisition following a night of sleep that was greater than additional rehearsal time alone could have produced.

Ficca, Lombardo, Rossi, and Salzarulo (2000) found that morning recall of verbal material was impaired after a night of disturbed sleep cycles, whereas it was not impaired after a night with preserved sleep cycles. They tested both REM and NREM sleep cycles and found no difference in the group that had decreased NREM sleep. Colin, Morais, and Kerkhofs (1999) found that REM sleep benefited an explicit memory task (recognition) but not an implicit memory task (word stem completion). However, the researchers point out that due to their small sample size of 10 subjects, their results need to be confirmed by a larger population size.

*Computer based training.* Increased use of computer based training is often seen in businesses today. Computer based training programs can be web based or run from an instructional CD-ROM. Computer based learning can decrease costs and give the learner greater control (Brown, 2001). Greater control is not necessarily better, since research shows that an employee working on his or her own without an instructor may choose to not finish computer based training and may not spend an adequate amount of time with the course (Brown, 2001; Desai et al., 2000). Williams and Zahed (1996) found that participants who took computer based training had greater retention of material one month post training versus those who were given a traditional lecture.

Desai et al. (2000) found that individuals preferred instructor based learning over computer based learning. However, their study population included many adults who had little computer experience. Studies with students as participants have found a strong preference for computer based learning, especially in the beginning phases of the learning process (Greiner, 1991; McKinnon, Nolan, & Sinclair, 2000).

While there is much research on the use of computer based training in university and higher education, there has been less research done in the vocational setting (Sambrook, Geertshuis, & Cheseldine, 2001). Sambrook et al. (2001) argue that as internet and computer use at home increases there will be more and more computer based programs and a need to develop computer based programs that are engaging and efficient in enhancing learning, knowledge acquisition, and skills development.

Williams and Zahed (1996) conducted a vocational computer based training study and found that participants who took the computer based training had greater retention of material one month post-training versus those who were given a traditional lecture. They used a repeated measures (pretest X two posttests) design with two groups (traditional lecture versus computer based training). They used the Computer Anxiety Index (CAIN) for those in the computer based training and found that there was no correlation between computer anxiety and learning. They also found no correlation between educational level and learning. Their groups consisted of both college and high-school-only graduates. There was no significant difference between the two groups on satisfaction with the training experience.

Brown (2001) evaluated how individual differences affect learning when computer based training is utilized. The study was performed at a Fortune 500 manufacturing firm and consisted of 78 technical employees. The training was strictly computer based (i.e., no live instructor), and the course material included quizzes with multiple choice and short answer questions. Extensive individual characteristics were measured to determine the employees' level of goal orientation. The researcher looked at high and low self-efficacy traits in individuals and found that (as expected) individuals with low efficacy had shorter practice time than individuals with high levels of self-efficacy. They were surprised to find that age, education, and computer experience were not strongly associated with learner choices. They concluded that individual differences did not predict practice and time on task effectively.

*BrainX software*. BrainX software, which was developed by five learning experts, is software that automates expert learning strategies like spaced learning, self-evaluation, and on-demand assistance in the form of hints and explanations (Barth, 2001). It is used primarily by students in order to prepare for tests and to learn any type of material. Individuals using BrainX can do so on multiple occasions (i.e., distributed practice). The software is engaging, uses principles of mastery learning methodology (including the extensive use of questions), and can be used by individuals on a self-paced basis, and may result in cost savings. Mastery learning and the use of questions have been shown to be very effective in increasing learning (Brothen & Wamback, 2000; Krank & Moon, 2001). The use of questions that have no penalty in computing the final score increases motivation and allows individuals to learn from their mistakes (Garver, 1998). BrainX is designed to allow individuals to score their own tests and utilizes questions to enhance learning. Brothen and Wamback (2000) studied the use of factual study questions to guide reading and promote mastery learning. The participants in this study who completed 96% of the study question assignments scored high, while those who did not did poorly on their quizzes. The use of questions is also known sometimes as the testing effect. Kuo and Hirshman (1996) investigated the testing effect and determined that superior leaning occurred from testing. They used a four-factor within subject design. Trial type (study versus test) was manipulated for four intervening trials. Both the study and test trials were self-paced and conducted individually with the material (a total of 64 three-item lists divided into 16 sets of 12 words each) presented on a computer screen. After completing all 64 experimental lists, a retention interval of five minutes occurred. Participants were asked to write down all the names of the U.S. states during this time. Then a free-recall test was given and participants were asked to recall and write down all the previously presented words they could remember. The result of the experiment was test trials produced better performance than the study trials.

Brain-X software can be used to test specifically for the spacing effect or distributed practice effect since an individual can take any session any time. The software is also beneficial in increasing individual's practice time. Practice and time on task are two recognized important components of learning (Bell & Kozlowski, 2002; Brown, 2001).

# Method

*Overview*

Computer users were trained to use shortcut keys in an instructor led classroom setting. With each trainee, the training session was followed by one of two modes of practice: distributed or massed. Each practice mode was supported by the use of BrainX software and was used to learn shortcut keys. The software was administered with either (a) four massed practice sessions done back to back all on the same day, or (b) as distributed practice sessions with the first session given the first day and one consecutive session done each additional day for a total of four days.

The training protocols were selected for their practicality, cost-effectiveness, and their potential to be effective. Both computer based learning and instructor led training can decrease the cost of training and be effective (Brown, 2001). Supervising the computer based training ensured that the participants would complete all the study sessions. Research shows that employees working on their own without an instructor may choose to not finish computer based training and may not spend an adequate amount of time with the course (Brown, 2001; Desai, Richards, & Eddy, 2000). By using BrainX software, practice time was increased. Practice and time on task are two recognized important components of learning (Bell & Kozlowski, 2002; Brown, 2001). In addition, the use of questions in both the instructor led training and BrainX computer based sessions was utilized to increase learning and motivation. The use of questions that have no penalty in computing the final score increases motivation and allows individuals to learn from their mistakes (Garver, 1998). Pretraining and post training test scores were analyzed for statistical and practical significance.

*Participants*

Participants were volunteers from the Santa Clara Water District. The District's regular or interim employees were allowed to participate in this study. Office assistants and managers were asked to volunteer to participate in the study. Volunteering participants were assigned to either condition based on their schedule and therefore were not randomly assigned. This was done because many employees of the District have alternating Fridays or Mondays off and therefore could not attend the distributed practice session. The types of employees working in the alternating Fridays or Mondays off are the same as those in the district who work a regular Monday through Friday shift. Volunteers with alternating Fridays or Mondays off were placed in one of the two massed training sessions.

Prior to the training, participants were sent a Background Questionnaire (Appendix A) and the Rogers Shortcut Key Test (Appendix B) to identify their baseline knowledge of shortcut keys. Participant privacy was strictly maintained by using numbers to identify participants. Original documents with names were locked and stored by the experimenter at a remote location.

*Instruments*

*Background Questionnaire.* The Background Questionnaire (Appendix A) consisted of 11 questions regarding educational level, computer and Microsoft Word™ experience, daily computer time, physical discomfort, workers' compensation history (if any), and level of motivation. The Background Questionnaire's questions were later analyzed to assess the similarities between the two groups with respect to computer and Microsoft Word™ experience, daily computer time, and level of motivation and physical symptoms. In addition, the results of the Background Questionnaire were analyzed in order to determine whether the level of education, computer experience or motivation may have affected the percentage of increase in test scores. Motivation was assessed by asking the participants how they rated their own motivation level, with 1 indicating a low level of motivation, 2 indicating a moderate level of motivation, and 3 indicating a high level of motivation (see Appendix A).

*Rogers Shortcut Key Test*. The Rogers Shortcut Key Test (Appendix B) as well as a Rogers Short Test (Appendix C) was developed for this study. The material developed consisted of primary shortcut keys that work in Microsoft Word™. This was done in order to keep the material appropriate for the participants and to help control the study. Three shortcut key experts were consulted for content validity. They reviewed all of the shortcut key material in the study and helped select shortcut keys that were considered to be the most valuable and easiest to use (i.e., the most intuitive). They also assessed the wording of test questions and the BrainX material. The Rogers Shortcut Key Test consisted of 28 questions with five different options for the answer: (a) Ctrl + ______, (b) Alt + ______, (c) Function _____, (d) Other ______, and (e) a check box that said "Don't know" below each question. There was only one right answer for each question, and the raw score was the number of items on the test (i.e., 28). This test was given two weeks prior to any training (pretraining) and own week after all training sessions (one week post training).

*Rogers Short Test*. The Rogers Short Test (Appendix C) consisted of 12 questions that were taken from the longer Rogers Shortcut Key Test and utilized the same format. This test was given immediately prior (as the pretest) and right after the instructor led training (as the posttest) to assess for training similarity between all training sessions.

*BrainX software*. BrainX software, which is software that automates learning strategies such as spaced learning, self-evaluation, and on-demand assistance, was utilized in this study. It was used for both the massed and the distributed practice sessions following the instructor led training. BrainX software was used to test for the spacing effect (i.e., to determine whether distributed practice was substantially more beneficial than massed practice), and to increase practice time and help participants learn additional shortcut keys. Material from the Rogers Shortcut Key Test was used to develop the BrainX material used in the study. The first BrainX practice session had 12 questions (see Appendix D); the second session had 18 questions (including the original 12 questions from the first session). The last two sessions had 29 questions.

The main control with BrainX was the procedure in which it was used. All participants were instructed to go through each session following these steps: (a) review all material of each current session in the BrainX software, (b) take a BrainX practice test (see Appendix D) presented by BrainX, and (c) take a session review test (see Appendix D) also presented by BrainX. Additional study tools regarding each session's questions was added in the BrainX "Explanation" sections (see Appendix D) and in the "Answer Hint" sections that participants were allowed to use if needed. These study tools were designed to help participants identify the correct answer to each question. Verbal Instructions (Appendix E) on how to use BrainX software were developed for the instructor led training. In addition, Basic BrainX instructions (Appendix F) that have been developed by BrainX software were used as written handouts for the instructor led training.

*PowerPoint™ presentation.* A PowerPoint™ presentation (Appendix G) was developed for the instructor led training. The material developed used the principles of mastery theory (emphasizing demonstrations and a questioning approach). The course material was designed to be relevant to the participants, practical in substance, and engaging. This presentation covered shortcut key use, the reasons it is necessary to have a healthy typing style, and proper hand and finger positioning while typing shortcut keys (e.g., it is important to avoid the awkward positions that result when one tries to reach certain key combinations with one hand).

*Computer workstations.* Each participant had an adjustable chair and adjustable keyboard tray with a freestanding central processing unit (CPU) and monitor, standard keyboard, and a mouse. Participants had the opportunity to adjust the keyboard trays and chairs if they wished to, but no specific ergonomic modifications were made.

### *Procedure*

*Overview.* Approval from the Human Subjects Board was obtained from the office of Graduate Studies and Research at San Jose State University prior to the beginning of the experiment (see Appendix H). Once participants had expressed interest in participating in the study, they were contacted in order to determine which training would work best for them based on their availability and work schedule. They were then sent a packet that had the Background Questionnaire (Appendix A) and the Rogers Shortcut Key Test (Appendix B), as well as general information about the training (i.e., time and location and general instructions). Participants either mailed the Rogers Shortcut Key Test and Background Questionnaire back to the investigator or brought it to the first day of training. Participant privacy was strictly maintained by using numbers to identify participants. Original documents with names were locked and stored by the experimenter at a remote location.

The Rogers Shortcut Key Test scores (pretraining) were assessed to determine participants' baseline knowledge of shortcut keys and were later evaluated to determine if any participant had a score of 70% or better. Participants with scores in this range would have had their data excluded from the study, since these participants would not have benefited substantially from this study's training protocol. However, none of the participants had a score of 70% or better on the Rogers Shortcut Key Test (pretraining), so all participants' test scores were analyzed in this study.

All participants were given four practice sessions supported by BrainX software in either a massed format (on the same day of the instructor led training) or in a distributed format (one session per day starting on the day of the instructor led training). Before any of the training sessions, participants were asked to review and sign a written consent form (Appendix I) that discussed the study's requirements, risks and the compensation they were to receive for participating in the study. All participants were also given a copy of the BrainX software as part of their compensation and a list of shortcut keys (Appendix J). In addition, they were entered into a raffle to win a $100.00 VISA gift card that would be awarded to one participant upon completion of the study. The experiment was conducted in a computer lab at the Santa Clara Water District.

*Instructor led training*. Training presentation and materials were developed with the principles of mastery theory (emphasizing demonstrations and a questioning approach) used to design and conduct the training. The course material was designed to be relevant to the participants, practical in substance, and engaging. Specific verbal instructions (Appendix K) for the instructor led training were developed. The instructor led training and all BrainX computer based practice sessions (see Appendix D for an example session) were conducted in a computer lab. Each participant had exclusive access to a single computer. The instructor used a PowerPoint™ presentation (Appendix G) that was projected at the front of the training room. This presentation covered shortcut key use, the reasons it is necessary to have a healthy typing style, and proper hand and finger positioning while typing shortcut keys (e.g., it is important to avoid the awkward positions that result when one tries to reach certain key combinations with only one hand). The instructor demonstrated shortcut key usage in order to increase individual learning and participants' motivation. Participants were instructed on approximately 14 shortcut keys during the 45-minute instructor led training session. The instructor led training began with the administration of the Rogers Short Test (Appendix C) and a brief introduction stating that the purpose of the study was to look at the use of shortcut keys as a computer tool. No reference to the spacing effect was made in order to prevent biased behavior.

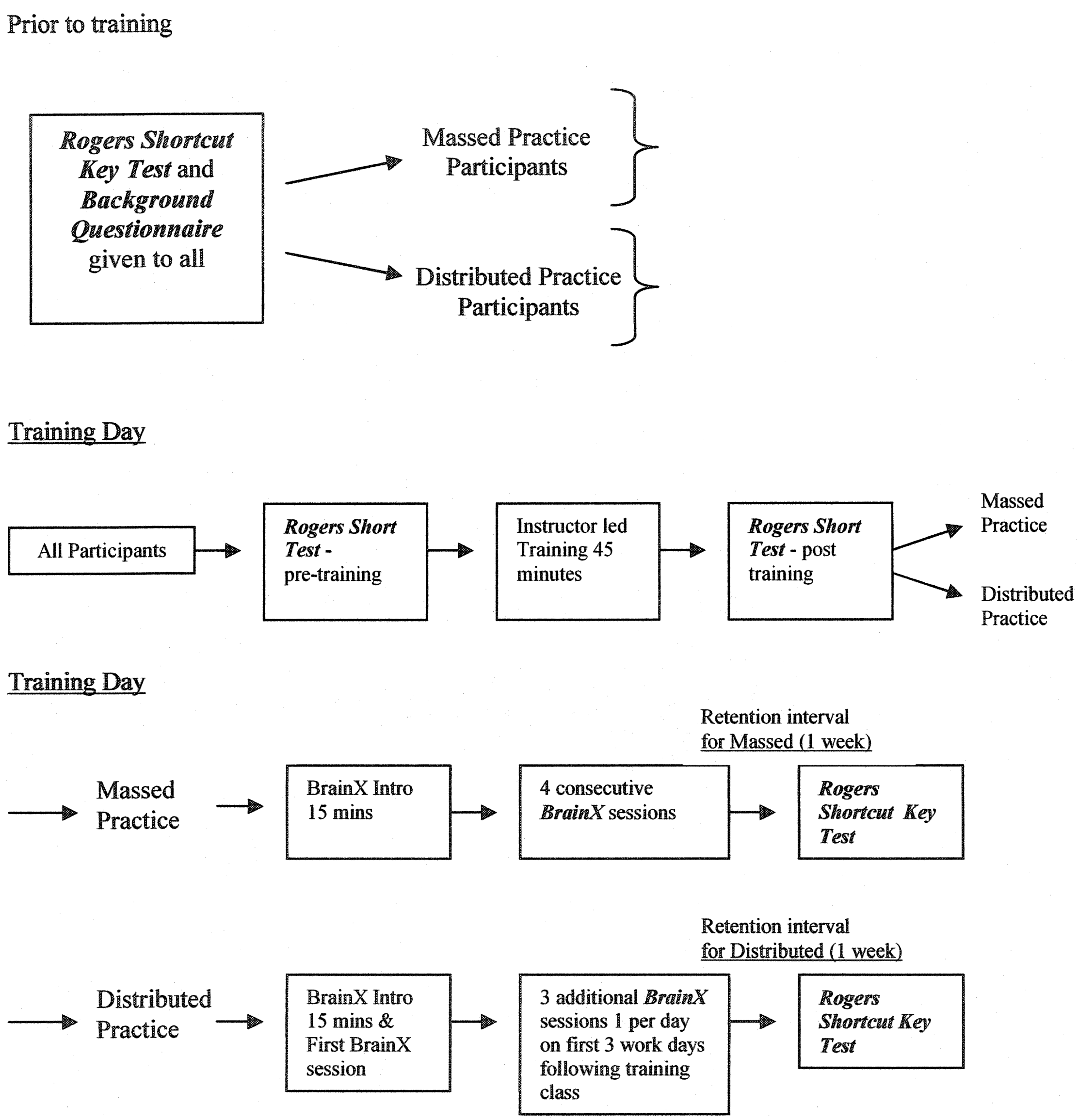



Figure 1. The study's procedural steps for the experiment with specifics regarding all steps in the selection, training and testing of all participants, and differences between the two conditions defined.

*Massed practice condition.* Two separate but identical instructor led training sessions were held for 14 participants of the massed practice condition. The first session had eight participants and the second had six participants. Participants took the training in a computer lab that had 10 computer workstations. The training began with the administration of the Rogers Short Test (Appendix C) followed by a 45-minute instructor led training on shortcut keys. After the instructor led training, participants were given the Rogers Short Test (Appendix C). They were then given a 15-minute introduction to BrainX software followed by a 5-minute break. Next, the four BrainX sessions were completed consecutively without breaks or interruptions. One week after training and the practice sessions, the massed practice participants returned to take the Rogers Shortcut Key Test (Appendix B).

*Distributed practice condition.* Two separate but identical instructor led trainings (identical to one another and also to the trainings provided to the massed practice participants) were given to 13 participants who comprised the distributed practice group. There were 10 participants in the first session and three participants in the second session. Like the massed practice groups, these two groups took the Rogers Short Test before and after the instructor led training. They were then given a 15-minute introduction to BrainX software and a short break. The participants returned and took the first BrainX session in the computer lab, which ended their training schedule for that day. They returned to the computer lab at the same time for the next three days, completing all four BrainX practice sessions. One week after the fourth and final BrainX session, they returned to take the Rogers Shortcut Key Test.

*Design*. The study incorporated a 2x2 repeated measure with a between subject variable (practice schedule) and a within subject variable of time of test. The between subject variable was manipulated following an instructor led training. The dependent variable was the test scores from the Rogers Shortcut Key Tests (Appendix B).

*Analysis*

The means of all test scores were calculated from the Rogers Short Test (pretraining) from the Rogers Short Test (post training) in both the distributed and massed practice groups. These were further analyzed by ANOVA to test for variance and to determine if one practice group learned more shortcut keys than the other. In addition, the interaction between spacing of practice and time of test was tested by ANOVA.

In order to assess the similarity of the four training sessions and the similarity between each of the instructor led trainings (which were designed to be exactly the same in each session), The means from the Rogers Short Test scores (pretraining) and the Rogers Short Test Scores (post training) of each instructor led training were compared to each other and analyzed by ANOVA. Descriptive statistics on the Background Questionnaire (computer experience, Microsoft Word™ experience, motivation) were calculated to check the data and determine any trends.

# Results

There were 27 participants (26 female and 1 male) between the ages of 27 and 63 (M = 44.25). There were 13 participants in the distributed practice group and 14 participants in the massed practice group. The average age in the distributed practice group was 44.77 years and the average age in the massed practice group was 43.73. Three participants in the massed practice group failed to list their age and therefore their age demographics could not be included in the analysis.

*Background Questionnaire*

Analysis of the data collected from the Background Questionnaire was conducted to assess the similarity of the massed and distributed practice groups as well as to assess for any trends. Education level, years of computer experience, years of Microsoft Word™ experience, and motivation were compared between the two conditions by analyzing their frequencies (Table 1).

The level of education among the distributed group participants was as follows: 7.7 % had high school only, 53.8% had some college, 23.1% had a bachelor's degree, and 15.4% had a master's degree. The level of education among the massed group participants was as follows: 0% had high school only, 57.1% had some college, 35.7% had a bachelor's degree, and 7.1% had a master's degree. The years of computer experience were distributed across less than 10 years experience and greater than 10 years experience. The distributed groups' participants had 23.1% with less than 10 years of computer experience and 76.9% with greater than 10 years of experience. The massed groups' participants had 21.4% with less than 10 years of computer experience and 78.6% with greater than 10 years of experience.

Table 1

*Results from the Background Questionnaire with frequencies from both groups*

| | | Distributed % | Massed % |
|---|---|---|---|
| Education Level | | | |
| | High School | 7.7 | |
| | Some college | 53.8 | 57.1 |
| | Bachelor's | 23.1 | 35.7 |
| | Master's | 15.4 | 7.1 |
| Years of computer use | | | |
| | Less than 10 years | 23.1 | 21.4 |
| | Greater than 10 years | 76.9 | 78.6 |
| MS Word™ experience | | | |
| | 1 – 4 years | 15.4 | 21.4 |
| | 5 – 9 years | 61.5 | 42.8 |
| | 10+ years | 23.1 | 35.7 |
| Motivation level | | | |
| | Medium | 30.8 | 42.9 |
| | High | 69.2 | 57.1 |
| Age | | M | M |
| | | 44.8 | 43.73 |

Microsoft Word™ experience was broken down into the following categories: 1 – 4 years, 5 – 9 years, and 10+ years. The distributed practice group had 15.4% of its participants in the 1 – 4 years category, 61.5% in the 5 – 9 years category, and 23.1% in the 10+ years category. The massed practice group had 21.4% of its participants in the 1

– 4 years category, 42.8% in the 5 – 9 years category, and 35.7% in the 10+ years category.

Table 2

*Microsoft Word™ Experience in Distributed and Massed Groups*

| Microsoft Word™ Experience | 1 – 4 years | 5 – 9 years | 10+ years |
|---|---|---|---|
| Distributed Group | 15.4 | 61.5 | 23.1 |
| Massed Group | 21.4 | 42.8 | 35.7 |

Participants were also asked to rate their level of motivation as low, medium, or high. In the distributed practice group, 30.8% listed their level of motivation as medium and 69.2% listed their level of motivation as high. In the massed practice group, 42.9% listed their level of motivation as medium and 57.1% listed their level of motivation as high.

*ANOVA and the Rogers Shortcut Key Tests*

Three 2-way ANOVAs were conducted using SPSS 11.5 with the between subject variable schedule of practice and the within subject variable of time of test. In addition, ANOVA was used to test for interaction between the two independent variables. The dependent variable was the scores of the Rogers Shortcut Key Tests. The maximum raw score possible was 28 with one point per question. The first analysis done to test the schedule of practice variable was conducted in order to answer the first research question regarding whether there would be no difference in the scores of the Rogers Shortcut Key Tests in the distributed practice group versus the massed practice group.

As depicted in Figure 2 the mean score of the distributed group's Rogers Shortcut Key Test (pre training) was 10.08 and the mean score of their Rogers Shortcut Key Test (post training) score was 21.00. The mean score of the massed group's Rogers Shortcut Key Test (pre training) was 9.36 and the mean score of their Rogers Shortcut Key Test (post training) score was 17.5. The analysis of the mean values of both tests between the two groups (massed and distributed) did not show a significant effect for type of practice, $F(1,25) = 1.92$, non sig.

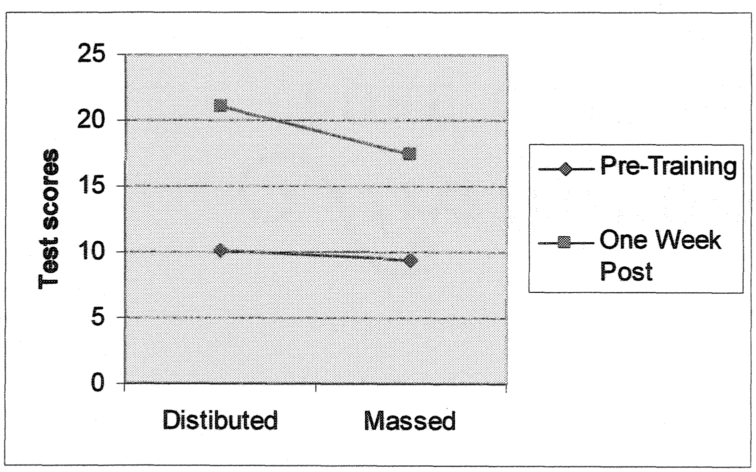



Figure 2. Test scores of Rogers Shortcut Key Tests pretraining and post training in distributed and massed groups.

The second analysis was done to answer the second research question regarding whether time of test will affect the Rogers Shortcut Key Test scores. Further, a significant time of test main effect was found $F(1,25) = 132.41$, $P < .05$. Depicted in

Figure 3, the means of the Rogers Shortcut Key Test scores for distributed groups' one week post training score (M=21.00, SD=5.13) and the massed groups' one week post training score (M= 17.7, SD=4.77) was significantly higher than the distributed groups' (M=10.08,SD=4.69) pretraining score and the massed groups' (M=9.36,SD=3.25) pretraining score.

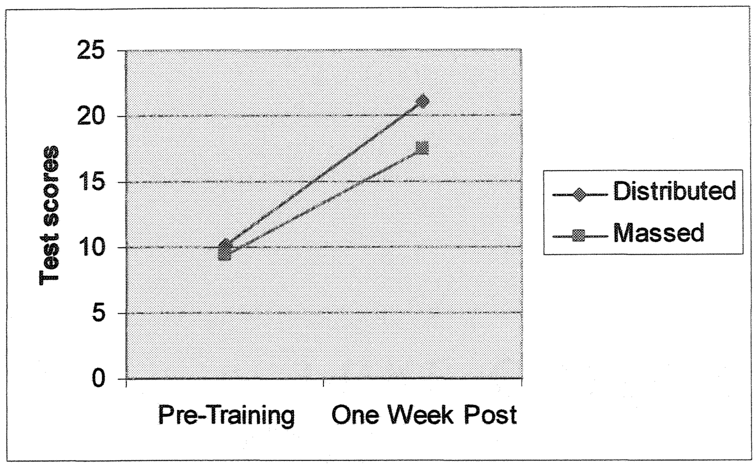



Figure 3. Test scores of Rogers Shortcut Key Tests for the pretraining time of test and the one week post training time of test for the distributed and massed groups.

The third analysis was done to test for interaction between the two independent variables of spacing of practice and time of test. This was done in order to see if there was an interaction of the two independent variables on the scores of the Rogers Shortcut Key Tests. The analysis of all of the means did show a significant effect for interaction between type of practice and time of test, $F(1,25) = 362.42$, $P < .05$. The variance table (see Table 3) indicates a large interaction between the spacing of practice and time of test. In addition, it indicates that training had a significant effect on time of test.

Table 3

Variance Table

| Source of Variation | SS | df | $M^2$ | F |
|---|---|---|---|---|
| Rows (Rogers Shortcut Key scores) | 1225.16 | 1 | 1225.16 | 132.41*** |
| Columns (Practice type between groups) | 60.02 | 1 | 60.02 | 1.92 |
| Interaction (Practice type versus shortcut key scores) | 11312.16 | 1 | 11312.16 | 362.42*** |
| Within (Massed versus distributed within group) | 26.05 | 23 | 1.13 | 2.82 |
| Total | 12623.39 | 26 | | |

*Supplemental Analysis*

In order to assess whether the instructor led training was consistent for all four sessions, a one-way ANOVA was conducted on the raw score change in the Rogers Short Test (post training) from the Rogers Short Test (pretraining) for all four sessions (two distributed and two massed). The mean for the raw score change for the distributed first session was 3.00. The mean for the distributed second session was 2.33. The mean for the raw score change for the massed first session was 3.63. The mean for the massed second session was 3.67. There was no significance ($p < .05$) in the means of any of the four sessions.

*Summary of Analysis*

The main condition of schedule of practice was not significant. The main condition of time of test was significant and the dependent variable of test scores was affected by this within subject variable. There was a significant interaction between the two independent variables spacing of practice and time of test. There was no significance ($p < .05$) in the mean scores of the Rogers Short Tests between any of the four instructor led sessions.

# Discussion

The purpose of this study was to evaluate the influence of schedule of practice (massed versus distributed) on the learning of shortcut keys. Distributed practice sessions over several days or weeks have long-term advantages (Bjork, 1994; Toppino et al., 2002). Participants received instructor led training followed by the BrainX practice sessions in either a massed or distributed format. Both of these training protocols used principles of mastery learning, primarily with the use of questions in order to increase learning. Questions can be used to get people to "think" more effectively and promote learning (Brothen & Wambach, 2000). In order to assess shortcut key knowledge gain and retention, the Rogers Shortcut Key Test was given two weeks prior to any training and compared to the Rogers Shortcut Key Test that was given one week after the completion of all the BrainX practice sessions. The test scores from both pre training and post training tests were compared with two-way ANOVA.

The hypothesis stating that spacing of practice will not affect the Rogers Shortcut Key Test was supported by the results of the test scores. Therefore, the null hypothesis stating that spacing of practice will not affect the Rogers Shortcut Tests was accepted. The second hypothesis stating that time of test will not affect the Rogers Shortcut Tests was not supported by the results of the test scores. Test scores indicated that learning of shortcut keys did occur. Therefore the null hypothesis was rejected.

The hypothesis that there would not be an interaction between spacing of practice and time of test on the Rogers Shortcut Key Tests was not supported by the results of the study and the null hypothesis was therefore rejected. The source for the interaction is unclear since the main effect of massed versus distributed was not significant. Time of test had a strong effect on the dependent variable of test scores and may be primarily responsible for the interaction.

In regards to the fact that the spacing of practice did not have a significant effect on test scores, one factor that may have affected the study is the fact that the massed practice group had a larger percentage of individuals with more than 10 years of Microsoft Word experience (35.7%) than the distributed group (23.1%). The higher baseline knowledge of Microsoft Word™ could have made the learning process easier for participants in the massed condition. A likely reason is that Microsoft Word™ uses a substantial number of shortcut keys and anyone with knowledge of Microsoft Word™ most likely will know many of them. Two participants in the massed practice group had a substantial gain; they learned 15 new shortcut keys (a 54% increase) from the training and the BrainX practice sessions.

Another factor that may have affected the results of the study is that the retention time of one week may not have been long enough to show a significant difference between the spacing of practice effect. However, past research by Shebilske et al. (2000) found that participants in the distributed interval group performed better than the massed group when retention and transfer were tested one week post training. On the other hand, Bahrick et al. (1993) found that retention improved with longer intersession intervals which included sessions that were spaced at 56 days.

Since both the massed and distributed group had the instructor led training as well as BrainX sessions, the instructor led training may have affected the results of the test scores. The instructor led training was given just one week prior to the final administering of the Rogers Shortcut Key Test. Instructor led training is considered to be an effective training method that is both time- and cost-effective (Brown, 2001). Some of the learning may have occurred from this training especially since the Rogers Shortcut Test was given only one week after this training.

In order to assess that the instructor led trainings were similar supplemental analysis was done by comparing the means of each one of the four training sessions to all of the other sessions by ANOVA. Results indicated that each of the four instructor led training sessions were similar in nature. Therefore, the results of the primary analysis that looked at the Rogers Shortcut Key Test scores of the distributed and massed groups should be valid and perhaps indicates that the study had internal validity. Why this study did not get a significant main effect for spacing of practice is unclear and needs to be researched further. The spacing effect has been shown to increase learning over chunked or massed distributed information (Bahrick et al.,, 1993; Mizuno, 1997; Russo & Mammarella, 2002; Shebilske et al., 1999).

Since only 12 shortcut keys were used in the instructor led training this cannot account for all of the learning that occurred, as evidenced by the scores of the Rogers Shortcut Key Test (one week post training). Because BrainX software was used to teach all 28 shortcut keys and test scores increased significantly from the first time the Rogers Shortcut Key Test was given (pre training) to the final time it was given (one week post), the BrainX software, along with the instructor led training, appears to have been significant for teaching participants shortcut keys.

To better understand the time on test variable as well as the spacing of practice variable and how the two interact, future research is needed. A future study that utilizes just the four BrainX software study sessions without the instructor led training would help to understand the specific effects of using this software. Evaluating training in which participants received just the instructor led training and a list of shortcut keys to study for one week on their own without any controlled practice sessions or without the aid of BrainX software would also help determine how strong of an effect the instructor led session has on learning.

Results from this study indicate that both training protocols (instructor led training combined with either a massed versus distributed practice session presented by BrainX software) are effective training protocols for the learning of shortcut keys. There was no control group in this study, since it was assumed that participants would learn some shortcut keys from any training.

The limitations of this study included the small number and variety of participants (including only having one male participant). Another possible limitation may have been the way in which the participants were selected, since they were not assigned to groups randomly. Further experimentation on this topic may include more participants from a wider background of professional fields, vary the length of shortcut key lists to be learned, and vary the setting (e.g., have the BrainX sessions at individual's workstations rather than a computer lab).

In summary, distributed practice sessions presented by BrainX software were not significantly more effective in training individuals on shortcut keys than massed practice sessions presented by BrainX software. Massed practice sessions presented by BrainX may perhaps be as effective as distributed sessions and could be beneficial in teaching shortcut keys to computer users.

# REFERENCES

Aarås, A., Fostervold, K. I., Ro, O., Thoreson, M., & Larsen, S. (1997). Postural load during VDU work: A comparison between various work postures. *Ergonomics,* 40, 1255-1268.

Armstrong, T. J., Fine, L. J., Goldstein, S. A., Lifshitz, Y. R., & Silverstein, B. A. (1987). Ergonomics considerations in hand and wrist tendonitis. *The Journal of Hand Surgery,* 12A, (5), 830-837.

Armstrong, T. J., Martin, B. J., Franzblau, A., Rempel, D. M., & Johnson, P. W. (1995). Mouse input devices and work-related upper limb disorders. In A. Grieco, G. Molteni, B. Piccoli & E. Occhipinti (Eds.), *Work and display units* (pp. 375-380). Elsevier Science B. V.

Armstrong, T. J., Radwin, R.G., Hansen, D.J., & Kennedy, K.W. (1986). Repetitive trauma disorders: Job evaluation and design. *Human Factors,* 28, 325-336.

Bahrick, H. P., Bahrick, L., Bahrick, A. S., & Gahrick, P. E. (1993). Maintenance of foreign language vocabulary and the spacing effect. *Psychological Science,* 4, (5), 316-321.

Barth, S. (2001). Worker, teach thyself: A personal learning manager puts employees in charge of their education. Retrieved September 26, 2004 from http://www.destinationkm.com/articles/default.asp?ArticleID=320.

Bell, B., & Kozlowski, S. (2002). Adaptive guidance: Enhancing self-regulation, knowledge, and performance in technology-based training. *Personnel*

*Psychology,* 55, (2), 267-307.

Bellis, M. Inventors of the modern computer: The history of the computer mouse and the prototype for windows – Douglas Englebart. (n.d.). Retrieved June 26, 2003, from http://inventors.about.com/library/weekly/aa081898.htm

Bjork, R. (1994). Memory and metamemory considerations in the training of human beings. In J. Metcalfe & A. P. Shimamura (Eds.). Metacognition: knowing about knowing (pp. 185-205). Cambridge, MA: MIT Press.

Borland, R. (1997). Microsoft Word 97. Redmond, Washington: Microsoft Press.

Bott, E. (2000). Using Microsoft Office 2000. Indianapolis: Que/Macmillan Computer Publishing.

Brothen, T., & Wambach, C. (2000). Using factual study questions to guide reading and promote mastery learning by developmental students in an introductory psychology course. *Journal of College Reading,* 30, 158-165.

Brown, K. (2001). Using computers to deliver training: Which employees learn and why? *Personnel Psychology,* 54, (2), 271-297.

Byström, J. M., Hansson, G., Rylander, L., Ohlsson, K., Källrot, G., & Skerfving, S. (2002). Physical workload on neck and upper limb using two CAD applications. *Applied Ergonomics,* 33, (1), 63-74.

Colin, C., Morais, J., & Kerkhofs, M. Implicit memory and REM sleep: A pilot study. *Sleep and hypnosis: an international journal of sleep, dream, and hypnosis.* 1, (2), 82-87.

Conner, M.. (2003). Doug Engelbart's revolution. Retrieved June 26, 2003, from http://www.learnativity.com/engelbart.html

Cook, C., Burgess-Limerick, R., & Chang, S. (2000). The prevalence of neck and upper extremity musculoskeletal symptoms in computer mouse. *International Journal of Industrial Ergonomics.* 26, (3), 347-356.

Cooper, A., & Straker, L. (1998) Mouse versus keyboard use: A comparison of shoulder muscle load. *International Journal of Industrial Ergonomics.* 22, 351-357.

Corlett, N., Wilson, J., & Menenica, I. (1986). Ergonomics of working postures: Models, methods and cases. *Proceedings of the First International Occupational Ergonomics Symposium.* Zadar, Yugoslavia, April 15-17 1985. London: Taylor and Francis.

Croasmun, J. (2003). Got a pain from mousing around? Ergonomist wants to help. Retrieved November 12, 2003, from http://www.ergoweb.com/news/detail.cfm?id=834.

Desai, M., S., Richards, T., & Eddy, J. P. (2000). A field experiment: instructor-based training vs. computer-based training. *Journal of* Instructional Psychology, 27, 239-244.

Dempster, F. (1996). Distributing and managing the conditions of encoding and practice. In E. L. Bjork & R. A. Bjork (Eds.), *Memory* (pp. 317-344). San Diego: Academic Press.

Dowell, W. R., & Gscheidle, G. M. (1997). The effect of mouse location on seated posture. In Salvendy, G., Smith, M. J., & Koubek, R. J. (Eds.). *Design of Computing Systems: Cognitive Considerations.* Elsevier, NY, 607-610.

Faucett, J., & Rempel D. (1994). VDT-related musculoskeletal symptoms: Interactions between work posture and psychological work factors. *American Journal of Industrial Medicine,* 26, 597-612

Ficca, G., Lombardo, P., Rossim L., & Sarzarulo, P. (2000). Morning recall of verbal material depends on prior sleep organization. *Behavioural Brain Research, 112, 159-163.*

Fogleman, M., & Brogmas, G. (1995). Computer mouse use and cumulative trauma disorders of the upper extremities. *Ergonomics,* 38, 2465-2475.

Garver, K. (1998). A computerized approach to mastery learning: Helping community college students make the grade in anatomy. *Journal of College Science Teaching.* 28, (2), 94.

Gerr, F., Marcus, M., Ensor, C., Kleinbaum, D., Cohen, S., Edwards, A., Gentry, E., Ortiz, D. J., & Monteilh, C. (2002), A prospective study of computer users: Study design and incidence of musculoskeletal symptoms and disorders. *American Journal of Industrial Medicine,* 41, 221-235.

Glover, J., Bullock, R., & Dietzer, M. (1990). Advance organizers: Delay hypotheses. *Journal of Educational Psychology, 82, (2), 291-297.*

Greiner, J. M. (1991). Interactive multimedia instruction: What to do the numbers show? *Proceedings of the Ninth Annual Conference on Interactive Instruction Delivery, 100-104.*

Gustafsson, E., & Hagberg, M. (2003). Computer mouse use in two different hand positions: Exposure, comfort, exertion, and productivity. *Applied Ergonomics,* 34, 107-113.

Häkkinen, P. (2002). Challenges for design of computer-based learning. *British Journal of Educational Technology,* 33, (4), 461-469.

Hamilton, N. (1996). Source document position as it affects head position and neck muscle tension. *Ergonomics,* 39, 593-610.

Hastings, S., Woods, V. Haslam, R.A. & Buckle, P. (1981). Interviews and observation to investigate health effects from using Non-Keyboard Input Devices (NKID), *Proceedings of the IES 2000,* 569-572.

Hunting, W., Laubli, T.H., & Grandjean, E. (1981). Postural and visual loads at VDT workplaces, *Ergonomics,* 24, 917-931.

Jensen, C. Finsen, L., Søgaard, K., & Christensen, H. (2002). Musculoskeletal symptoms and duration of computer and mouse use. *International Journal of Industrial Ergonomics,* 30, (4), 265-275.

Johnson, P. E., Dropkin, J., Hewes, J. & Rempel, D. (1993). Office ergonomics: Motion analysis of computer mouse usage. *Proceedings of the American Industrial Hygiene Conference and Exposition.* Fairfax, VA: American Industrial Hygiene Association. 12-13.

Jorgensen, A. H., Garde, A. H., Laursen, B. & Jensen, B. R. (2002). Using mouse and keyboard under time and pressure: Preference, strategies and learning. *Behavior and Information Technology,* 21, (5), 317-319.

Karlqvist, L., Bernmark, E., Ekenvall, L., Hagberg, M., Isaksson, A., & Rostö, T. (1999). Computer mouse and track-ball operation: Similarities and differences in posture, muscular load and perceived exertion. *International Journal of Industrial Ergonomics.* 23, (3), 157-169.

Karlqvist, L., & Hagberg M. (1994). Ergonomic risk factors for musculoskeletal symptoms among civil engineers using computer mouse. *Proceedings of the Fourth International Scientific Conference: Work With Display Units.* Milan, Italy, 2-5 October 1994.

Karkqvist, L., Hagberg, M. & Selin, K. (1994). Variations in upper limb posture and movement during work processing with and without mouse use. *Ergonomics,* 37, 1261-1267.

Keir, P.J., Bach, J.M., & Rempel, D.M. (1998). Finger loading and carpal tunnel pressure: Differences between a pinching and a pressing task. *Journal of Orthopaedic Research,* 16, 112-115.

Krank, H. M., & Moon, C. E. (2001). Can a combined mastery/ cooperative learning environment positively impact undergraduate academic and affective outcomes? *Journal of College Reading and Learning,* 31, 195-217.

Kuo,T., & Hirshman, E. (1996). Investigations of the testing effect. *American Journal of Psychology,* 109, (3), 451-465.

Lochridge, E. Comfort, productivity, and the myth of "correct" posture. (n.d.). Retrieved July 20, 1998, from http://www.mindspring.com/metaguy/ essay.html.

Maquet, P. (2001). The role of sleep in learning and memory. *Science,* 294, (5544), 1048-1052.

Marcus, M., Gerr, F., Monteilh, C., Ortiz, D. J., Gentry, E., Cohen, S. Edwards, A., Ensor, C., & Kleinbaum, D. (2002). A prospective study of computer users: II. postural risk factors for musculoskeletal symptoms and disorders. *American Journal of Industrial Medicine,* 41, 236-249.

Marras, W.S., & Schoenmarklin, R.W. (1993) Wrist motion in industry. *Ergonomics,* 36, 341-351.

Mayhew (1992). *Principles and guidelines in software user interface design.* Englewood Cliffs, NJ: Prentice-Hall.

McIntosh, N., & Sullivan, R. (2000). Issues in technology-assisted learning environments. *Pharmaceutical Technology,* 24, 8-13.

McKinnon, D. H., Nolan, C, J. P., & Sinclair, K. E. (2000). A longitudinal study of student attitudes toward computers: resolving an attitude decay paradox. *Journal of Research on Computing in Education,* 32, 325-335.

Mizuno, R. (1997). A test of theeffectiveness and efficiency of the low-first method. *Japanese Journal of Psychology.* 68. (1), 1-8.

Onishi, N., Sakai, K., & Kogi, K. (1982). Arm and shoulder muscle load in various keyboard operating jobs of women. *Hum Ergol,* 11, 89-97.

Paul, R. D., Menon, K., & Nair, C. (1995). Individual differences in the activity of dominant forearm muscles during VDT work. *Proceedings of the Human Factors and Ergonomic Society 39th Annual Meeting,* 926-930.

Peigneux, P, Laureys, S., Delbeuck, X. & Maquet, P. (2001). Sleeping brain, learning brain: The role of sleep for memory systems. *Neuroreport,* 12, (18), A111-A124.

Ralph, E. G. (1999). Oral-questioning skills of novice teachers: ... any questions? *Journal of Instructional Psychology, 26, 286-297.*

Ranney, D. (1993). Work-related chronic injuries of the forearm and hand: Their specific diagnosis and management. *Ergonomics,* 36, 871-880.

Rempel, D. M., Harrison, R. J., & Barnhart, S. (1992). Work-related cumulative trauma disorders of the upper extremity. *JAMA,* 267, (6), 838-842.

Rempel, D., Horie, S., & Tal, R. (1994). Carpel tunnel pressure during keying. *Proceedings of the Marconi Keyboard Research Conference.* San Francisco, CA: University of California, Berkeley.

Rempel, D, Jacobson, M., Brewer, R., & Martin, B. (2000). Finger muscle activity during use of different pointing devices. *Proceedings of the IEA 2000/HFES 2000 Congress.* University of California – San Francisco and Berkeley, Ergonomics Laboratory, University of Michigan, Ann Arbor, Michigan.

Russo, R., & Mammarella, N. (2002). Spacing effects in recognition memory: When meaning matters. *European Journal of Cognitive Psychology.* 14, 49-59.

Ryan, A. G., & Bampton, M. (1988). Comparison of data process operators with and without upper limb symptoms. *Community Health Studies,* 20, 63-68.

Sallstrom, J., & Schmidt, H. (1984). Cervicobrachial disorders in certain occupations, with special reference to compression in the thoracic outlet. *American Journal of Industrial,* 6, 45-52.

Sambrook, S., Geerthuis, S., & Cheseldine, D., (2001). Developing a quality assurance system for computer-based learning material: Problems and issues. *Assessment & Evaluation in Higher Education,* 26, (5), 412-426.

Sauter, S.L., Schleifer, L.M., & Knutson, S.J. (1991). Work posture, workstation design, and musculoskeletal discomfort in a VDT data entry task. *Human Factors,* 33, 151-167.

Schuldt, K., Ekholm, J., Harms-Ringdahl, K., Nemeth, G., & Arborelius, U. P. (1986). Effects of changes in sitting work posture on static neck and shoulder muscle activity. *Ergonomics* 39, (12), 1525-37.

Shebilske W. L., Goettl, B. P., Corrington, K., & Goettl, B. P. (1999). Interlesson spacing and task-related processing during complex skill acquisition. *Journal of Experimental Psychology: Applied.* 5, (4), 413-437,

Snook, S. H., Vaillancourt, D. R., Ciriello, V.M., & Webster, B. S. (1995). Psychophysical studies of repetitive wrist flexion and extension. *Ergonomics,* 38, (7), 1488-1507.

Stamatis, B. (2004). Keyboard shortcuts may prevent injury. Retrieved April 9, 2004 from http://www.uft.org/?fid=145&tf=1404&nart=1329.

Stevens, L. E., & Fiske, S. T. (1995). Motivation and cognition in social life: A social survival perspective. *Social Cognition.* 13 (3), 189-215.

Stickgold, R. (2003). Human studies of sleep and off-line memory reprocessing. In P. Maquet, C. Smith, & R, Stickgold (Eds.), *Sleep and brain plasticity* (pp. 41-63). New York: Oxford University Press.

Toppino, T., Hara, Y. & Hackman, J. (2002). The spacing effect in the free recall of homogeneous lists: Present and accounted for. *Memory & Cognition,* 30, (4), 601-606.

Trewin, S., & Pain, H. (1999). Keyboard and mouse errors due to motor disabilities. *Journal of Human-Computer Studies,* 50, 109-144.

US Department of Labor (1998). Occupational injuries and illnesses in the United States by Industry, 1991. *Bureau of Labor Statistics Bulletin 2424.*

Villanueva, M. B. G., Sotoyama, M., Jonai, H., Hisanaga, J., Takeuchi, Y. & Saito, S. (1996). Adjustments of posture and viewing parameters of the eye to changes in the screen height of the visual display terminal. *Ergonomics,* 39, (7), 39-44.

Walker, M., Brakefield, T., Seidman, J., Morgan, A., Hobson, J. A., & Stickgold, R. (2003). Sleep and the time course of motor skill learning. *Learning and memory,* 10, (4), 275-284.

Williams, T. C., & Zahed, H. (1996). Computer-based training versus traditional lecture: Effect on learning and retention. *Journal of Business and Psychology,* 11, (2), 292-310.

Wilson, J. K., & Sevier, T. L. (2003). A review of treatment for carpal tunnel syndrome. *Disability & Rehabilatation,* 25, (3), 113-119.

Winkel, J., & Westgaard, R. (1992). Occupational and individual risk factors: Part

II - The scientific basis (literature review) for the guide. *International Journal of Industrial Ergonomics,* 10, 85-104.

Appendix A

**Background Questionnaire**

**Responsible Investigator(s):** Deidre Rogers, RN, CAE

**Title of Protocol:** Evaluation of Training on Shortcut Keys

Introduction: In order to select participants for this study we need prospective participants to complete the following demographic and research related information. If you are selected to participate in this study you will receive a consent form that describes the study in detail and compensation for your participation. Please circle your answers and fill in the blanks when appropriate. We estimate that participants will spend approximately 2 ½ – 3 hours total for this study and refreshments will be served on those days in which participants receive the bulk of the training or testing.

1. What is your educational level?
   a) High school ________
   b) High school & some college (list number of years) _______
   c) College (BS,BA) __________
   d) College (BS,BA) & some graduate level classes (list number of years) _________
   e) College (MS, MA, or equivalent - please describe) ________________________
   f) College (Ph. D) _________________________________________________
   g) Other (e.g., specialty licensing, vocational training, etc.) ____________________

2. How long have you used a computer?
   a) More than three years? _________________
   b) More than ten years? __________________

3. Are you familiar with M.S. Word? Yes/No How long have you used the software? ____

4. How long have you used a computer pointing device (e.g., computer mouse)?
   a) More than one year? ___________________
   b) More than three years? _________________

5. Describe your knowledge and level of proficiency with shortcut key use (i.e., Alt keys, Ctrl keys, etc.)
   a) Low
   b) Medium
   c) High (if high, please describe in more detail) ___________________________
   ____________________________________________________________________

6. How many hours per day do you average working on the computer for?
   a) 1 - 3 hours per day
   b) 4 hours per day
   c) 5 or more hours per day (please describe in more detail) ___________________
   ____________________________________________________________________

Participants Initials __________

8. What is your work shift and official Schedule (A, B, etc.)? ______________________
__________________________________________________

9. Have you had any recent physical discomfort in your arms, shoulders, neck or upper back?
If yes, please explain: ________________________________________________
__________________________________________________________________

10. Have you ever had a Workers' Compensation claim for problems relating to the before mentioned areas of the body (e.g. arms, shoulders)? Yes/No
If yes, please explain briefly: ____________________________________________
__________________________________________________________________

11. How would you rate your level of motivation at this time to learn shortcut keys (and decrease your overall mouse use)?

a) Low
b) Medium
c) High (if high, please describe in more detail) ___________________________
______________________________________________________________

**Thank you for completing this screening questionnaire. Please give us your name and the best way to reach you (phone, email). We will inform you if it is appropriate for you to participate in this study within two weeks.**

____________________________ ________________
Name Date

____________________________
Best way to get in touch

Appendix B

Your # __________

> Note: While there are separate specific keys on a keyboard for *Ctrl, Shift,* and *Alt,* there is **NO** specific key that is known as a "Function key". The term function key(s) refers to all the F keys (F1 – F12) that run along the top of your keyboard.

Rogers Shortcut Key Test

1. How do you highlight/select an entire document?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

2. Which shortcut key combination is used to bold highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

3. Which shortcut key combination allows you to italicize highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

4. Which shortcut key combination will allow you to save a document (or save any new changes or additions to a document you are working on)?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

5. Which shortcut key combination is used to copy highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

6. Which shortcut key combination is used to cut highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

7. What is the quick way to bring up a new blank document (using a shortcut combination)?

   Ctrl+__________ Alt+ __________ Function+ __________ Other __________ Don't know ☐
   Key Key Key

8. Which shortcut key combination is used to paste text?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

9. Which shortcut key combination will allow you to print a document?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

10. When you are in Microsoft Word and want to open a document, the quickest shortcut key combination is ___________.

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

11. Which shortcut key will allow you to "Save As"?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

12. Which shortcut key combination allows you to undo what you have just typed?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

13. Which shortcut key combination allows you to redo what you have just undone?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

14. Which shortcut key combination is used to underline highlighted text?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

15. How do you exit Microsoft Word and almost all other programs you have open?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

16. What shortcut key combination, will allow you to close a document in Microsoft Word (but keep the program open)?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

17. Which shortcut key do you use to minimize all open windows (i.e., programs)?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐

Key Key Key

18. Which shortcut key combination will allow you to toggle between programs (i.e., briefly view all open programs and documents) in all open programs?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

19. If you want to close any active command window (or cancel an action) you can type the ________ key.

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

20. Which shortcut key combination will allow you move the cursor one word to the left?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

21. Which shortcut key combination will allow you move the cursor to the beginning of the line?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

22. Which shortcut key combination will allow you move the cursor to the end of the line?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

23. How do you move the cursor to the beginning of the current document?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

24. How do you move the cursor to the end of the current document?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

25. If you want to highlight/select a word to the right of the cursor, which shortcut key combination would you use?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

26. Which shortcut key combination will bring up the File pop down menu in Microsoft Word?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

27. Which shortcut key combination will bring up the Font Dialog Box?

Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
Key Key Key

28. Which shortcut key combination will give you a Page Break?

Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
Key Key Key

Appendix C

# __________

Rogers Short Test

> Note: While there are separate specific keys on a keyboard for *Ctrl, Shift,* and *Alt,* there is **NO** specific key that is known as a "Function key". The term function key(s) refers to all the F keys (F1 – F12) that run along the top of your keyboard.

1. How do you highlight/select an entire document?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

2. Which shortcut key combination is used to bold highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

3. Which shortcut key combination allows you to italicize highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

4. Which shortcut key combination will allow you to save a document (or save any new changes or additions to a document you are working on)?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

5. Which shortcut key combination is used to copy highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

6. Which shortcut key combination is used to cut highlighted text?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

7. What is the quick way to bring up a new blank document (using a shortcut key combination)?

   Ctrl+__________ Alt+ __________ Function __________ Other __________ Don't know ☐
   Key Key Key

8. Which shortcut key combination is used to paste text?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

9. Which shortcut key combination will allow you to print a document?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

10. Which shortcut key combination allows you to bring up the Font "Dialog Box"?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

11. Which shortcut key combination will allow you to "Save As"?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

12. Which shortcut key combination allows you to undo what you have just typed?

Ctrl+_________ Alt+ _________ Function _________ Other _________ Don't know ☐
Key Key Key

Appendix D

# **BrainX Digital Learning System**

**Study Session of KnowledgeBase: Session 1**

**Record # 1**

**Question/Fact:**

How do you highlight/select an entire document?

**Answer:**

*Ctrl* & A

**Explanation:**

Highlights entire document (including any graphics).

**Record # 2**

**Question/Fact:**

What is the shortcut key combination used to bold highlighted text?

**Answer:**

*Ctrl* & B

**Explanation:**

Can be used to bold a word, a sentence, a selected piece of a document, or an entire document.

**Record # 3**

**Question/Fact:**

What is the quick way to bring up a new blank document (using the *Ctrl* key)?

**Answer:**

*Ctrl* & N

**Explanation:**

Use to bring up a blank new document in MSWord.

**Record # 4**

**Question/Fact:**

*Ctrl* & P will do what? __________.

**Answer:**

Print a document

**Explanation:**

Used to bring up your print menu, so you can print a document. You still can change number of items to be printed, select pages, etc. prior to printing.

**Record # 5**

**Question/Fact:**

Which shortcut key combination is used to **copy** highlighted text?

**Answer:**

*Ctrl & C*

**Explanation:**

Used to copy a selected portion or the entire document (if the entire document is highlighted/selected).

**Record # 6**

**Question/Fact:**

Which shortcut key combination is used to **cut** highlighted text?

**Answer:**

Ctrl & X

**Explanation:**

Can be used to cut selected portion of a document.

**Record # 7**

**Question/Fact:**

Which shortcut key combination is used to paste text that has been copied to the clipboard?

**Answer:**

*Ctrl & V*

**Explanation:**

Any thing you have copied in MSWord can be quicky pasted with this shortcut key command.

**Record # 8**

**Question/Fact:**

When you are in Microsoft Word and want to open a document, the quickest shortcut Key combination is ___________.

**Answer:**

*Ctrl* & O

**Explanation:**

Used to open a document when you already have MSWord open.

**Record # 9**

**Question/Fact:**

You can use the *Ctrl* &I shortcut key combination to ___________.

**Answer:**

*Italicize*

**Explanation:**

Used to italicize a selected item, selected text, or the entire document (if it is all highlighted/selected).

**Record # 10**

**Question/Fact:**

Which shortcut key combination will allow you to save the document (or save any new changes of a document you are working on)?

**Answer:**

*Ctrl* & S

**Explanation:**

Use to save a new document or to continually save as you add to a new document

**Record # 11**

**Question/Fact:**

Typing F12 allows you to ____________.

**Answer:**

Save as

**Explanation:**

If you want to save a document with a new name use the shortcut key F12 to do so.

**<u>Record # 12</u>**

**Question/Fact:**

Which shortcut key combination allows you to undo what you have just typed?

**Answer:**

*Ctrl & Z*

**Explanation:**

If you are typing and realize you have made a mistake, then strike Ctrl & Z to undo what you have just typed.

# Appendix E

## Verbal Instructions for BrainX 15 Minute Introduction

Comments: These instructions were given along with the second part of the power point presentation. How to open BrainX software will be the first portion and then the Basic BrainX Instructions (Appendix G) will be discussed in the exact order it comes in. The power point presentation will be used to describe what each BrainX screen will look like.

"Please click on 'Start' on the lower left hand portion of your computer screen."
"Click on 'All Programs' – then BrainX – and the Digital Learning System - You will see a menu box with six items listed – Click on the Digital Learning System."

"This will bring up this first slide.
(Point to Power Point Presentation)

The instructor will then describe how to use BrainX by focusing on the handouts that match the Power Point Slides.

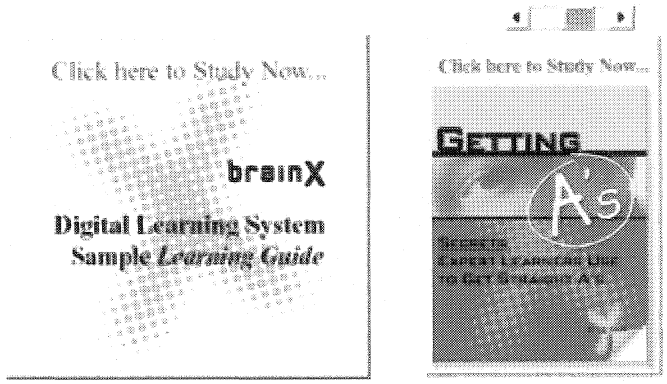
Then,

"You can use BrainX anyway you find helpful. Some people prefer to test themselves right away and repeatedly, while others may prefer to read through all the session's material from the question to the explanation. Please try to keep each session to 10 – 20 minutes or so. The earlier sessions have less material and should take less time. So the first session we expect to take about 7 – 10 minutes and the last session 20 – 25 minutes."

Appendix F

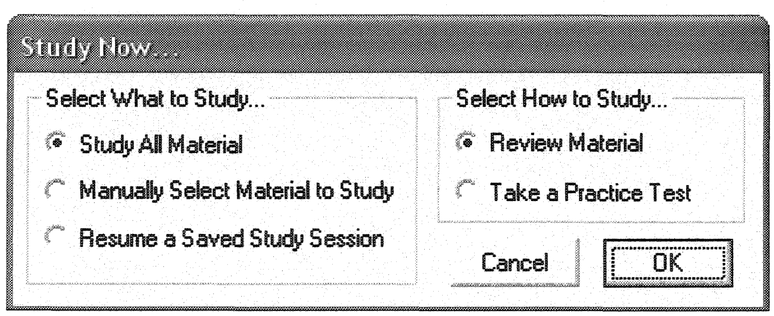
Basic BrainX Instructions (Handout)

1. **First Step** Choose and open a Learning Guide (**BrainX**), simply select/click on the picture in the middle of the screen. If you have more than one Learning Guide a scroll bar will appear above the pictures, use it to select the Learning Guide you would like to use, then click on the picture.




The Learning Guide will open and then you can select and open the chapter you would like to use. Open the appropriate chapter by double-clicking on it or right-click and select open from the pop-up menu. *Note: If any Learning Guide is a single chapter then that chapter will automatically open.*

2. **Review and Testing Option** Select Shortcut Keys on the main menu and double click. Then open the first session by double clicking on session 1. Once you have opened a Learning Guide chapter your study session can begin. At this point the program opens and displays the **"Study Now"** window.

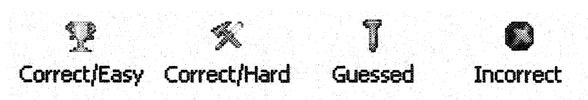



You now select from the options: **"Select What to Study"**, and **"Select H ow to Study"**. The default is to study all materials, either by the **"Review Material"** *(see #3 of this guide)* or **"Take a Practice Test"** *(see #4 of this guide)*. It is recommended that you initially review the material; however taking the practice test is equally beneficial as a starting point. After making your selections click the "**OK**" button.

3. **Review Overview** The review mode displays the question, answer, supporting information and mnemonic for each record/question. By using the arrow keys at the top of the screen you can easily move through each record, reviewing the questions. To exit the review mode click on the "**Done**" button.


This will return you to the screen with the list of records/questions.

4. **Testing Overview** If in Step #2 of the guide you choose "**Take a Practice Test**" then the Learning Guide opens the BrainX Digital Tutor and you immediately begin a practice test. The practice test is employed with the user performing a self-evaluation; by comparing your answer with the correct answer. After each comparison the user selects from the buttons on the top of the screen:
5.

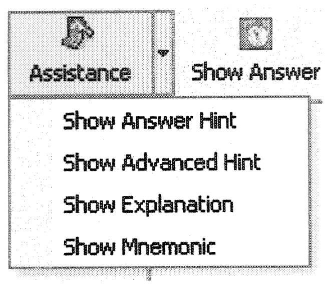



The practice test flows as follows:

a. You read the question
b. You decide on the answer
*At this point you can type the answer or just say the answer to yourself and then move to the "Show Answer" step.*
c. After you have decided on the answer then you select the "**Show Answer**" button, which will display the correct answer in the answer field.
d. Evaluate your answer - Select one of the four self-evaluation choices: **Correct/Easy, Correct/Hard, Guessed,** or **Incorrect**
*Example: If your answer was correct, but it was hard for you, then you would select the "Correct/Hard" button.*
e. After you perform the self-evaluation, the BrainX Digital Tutor automatically advances you to the next question. Just as in the Review session you can use the "**Previous**" and "**Next**" arrows to move to the previous or the next practice test question.

Once you have completed all the questions, or you are at a place where you wish to stop, you simply select the "**Done**" button on the top toolbar.

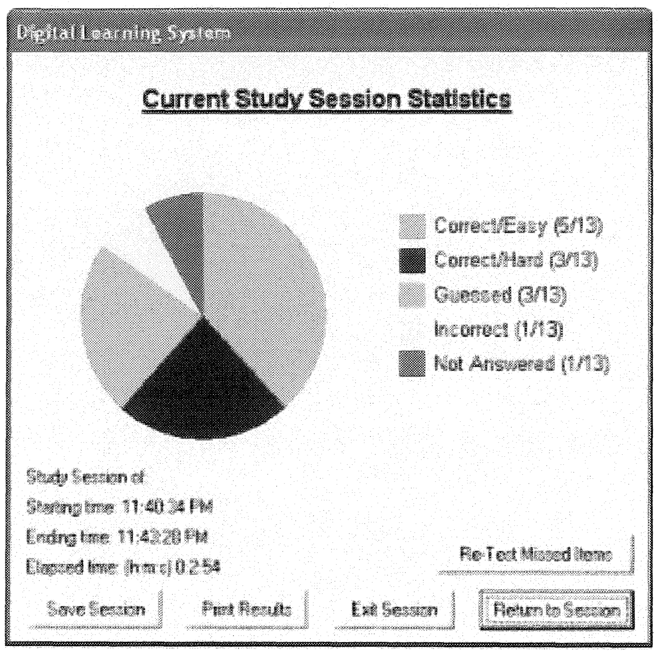
6. **Testing Assistance** The program provides "**Assistance**" to help you review, learn and retain the information in the testing mode. When selected, the "**Assistance**" button, located on the main toolbar, opens a drop down box with four types of assistance.
7.



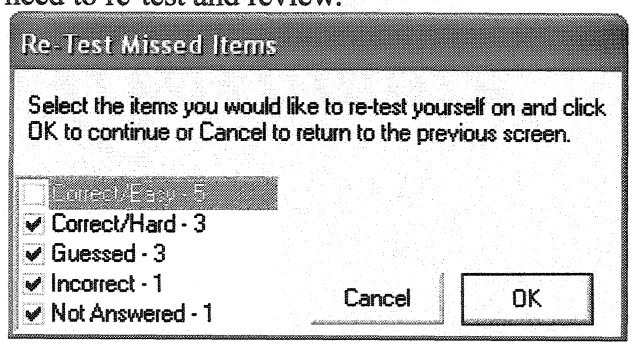

There are four levels of assistance available if the author created content for all of assistance items. The following are the available assistance items:

a. **Hint** - Progressive hints to the answer, improves retention and helps the brain remember the answer.
b. **Advanced Hint** - Defined by the author to assist the user in determining the answer.
c. **Explanation** - A detailed explanation of the answer, usually a portion of the text that developed the question and the answer.
d. **Mnemonic** - Provides a memory device used to retain complex strings of related material.

6. **Results** When you press the "**Done**" button in the testing mode, the program will provide graphical and numeric feedback and elapsed time on the current study session.




Based on learning theory research and in order to improve your performance, it is recommended that you press the **"Re-Test Missed Items"** button and select the items that you need to re-test and review.




Save this study session to continue at another time or print the study session for further review.

Press **"Exit Session"** to quit and then **"Close"** until you reach the opening page.

Appendix G

# Ergovera's Shortcut Key Class

Presented by Deidre Rogers, RN, CAE

## Why use shortcut keys?

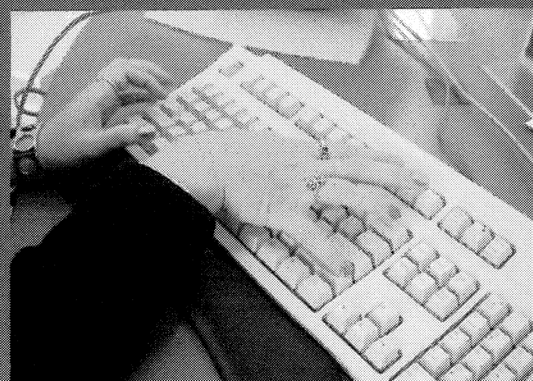
- To avoid overuse of the mouse which for many is an issue because of position and awkward postures.
- To increase overall efficiency.
- To save time.

## Why a healthy typing style is key?

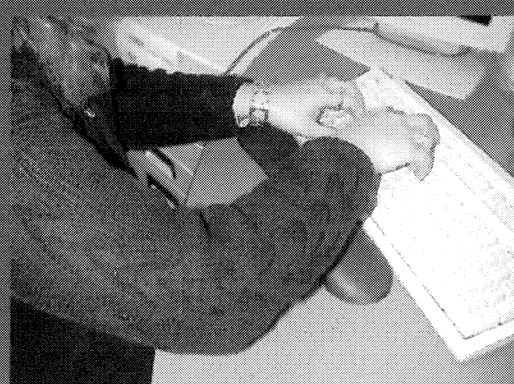
- Unhealthy typing styles do damage to wrists, forearms, and elbows.
- Prolonged bad habits lead to RSI (Repetitive Strain Injuries).
- How traditional touch typing can get you in trouble.

## Heavy Resting

## Pinky Use & Ulnar Deviation

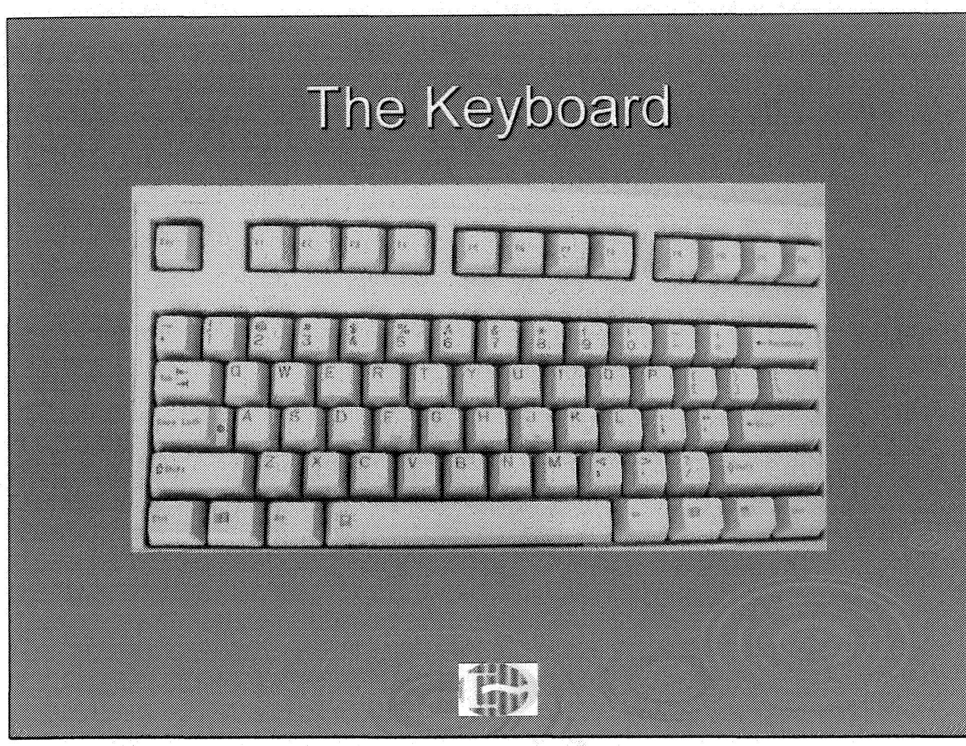


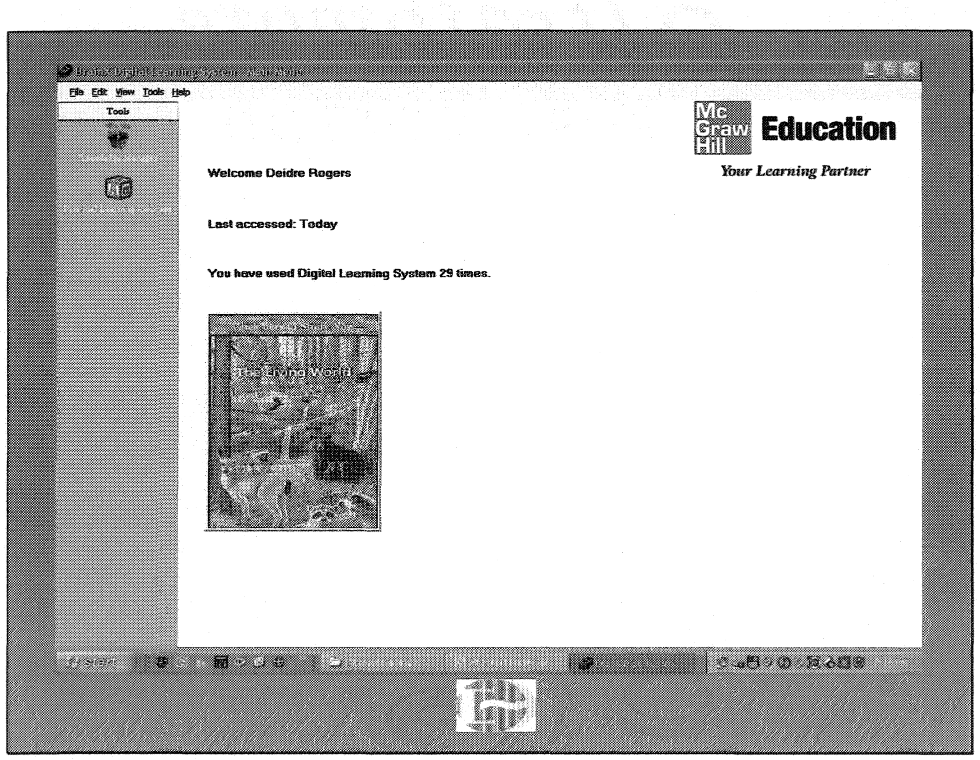
## Using Whole Arm Movements & A "Floating Wrist" Technique

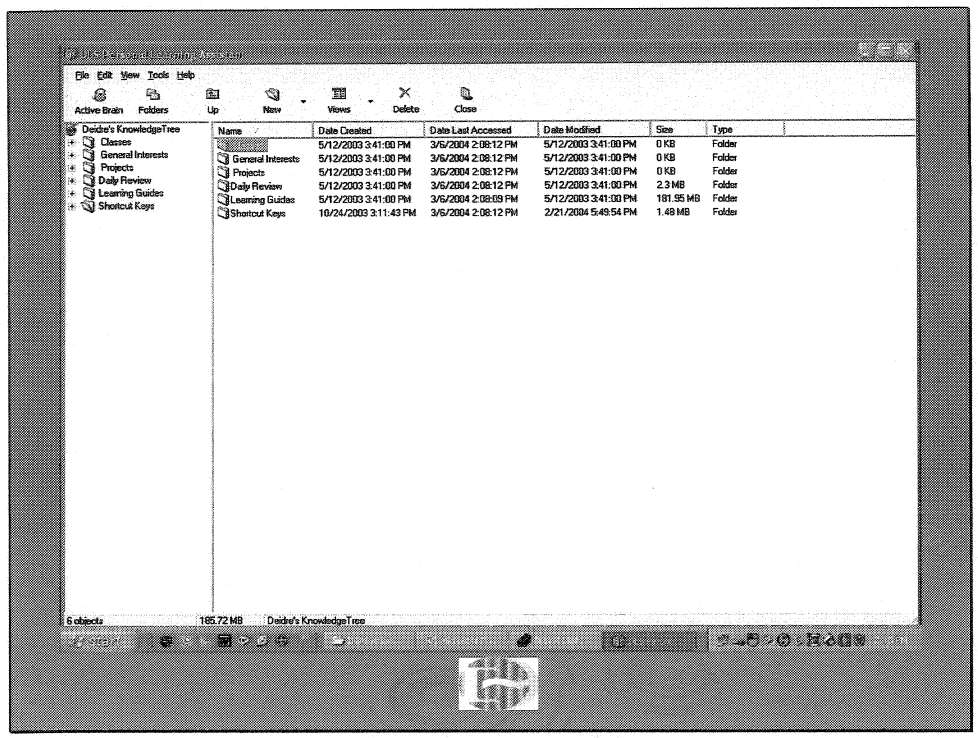


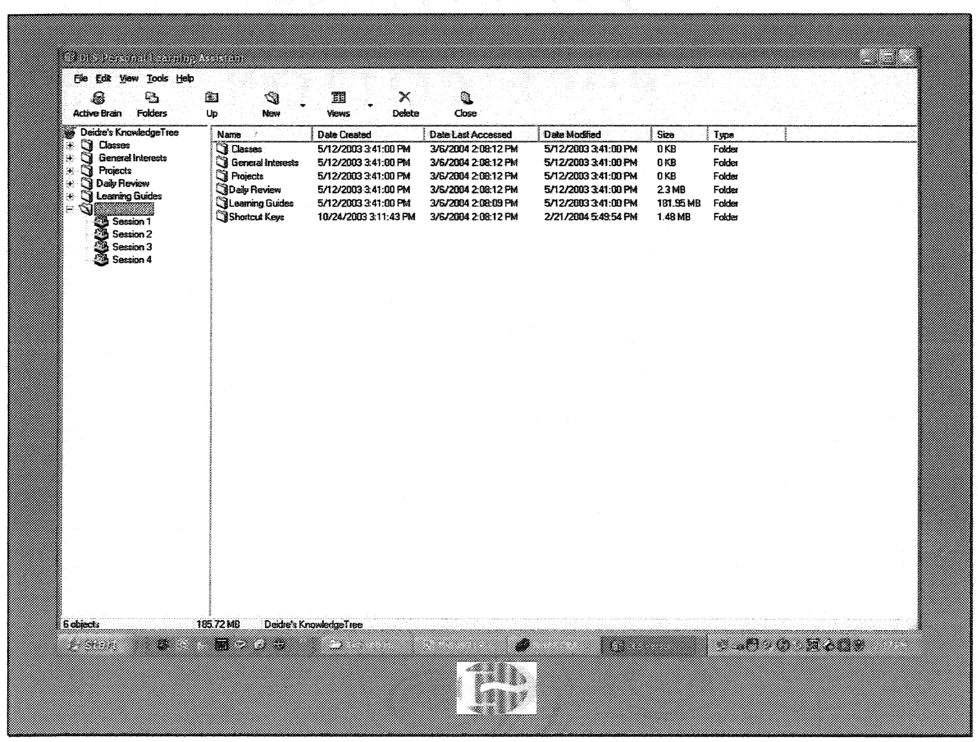
## Proper Shortcut Key Technique Using Two Hands

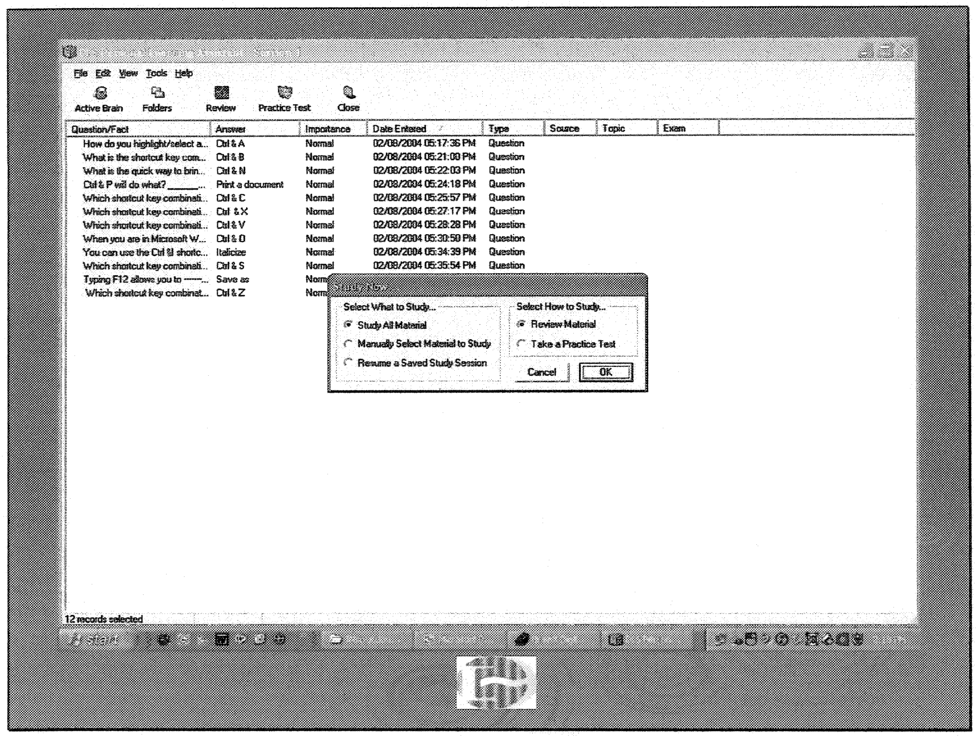
## Neck Positioning


The Keyboard

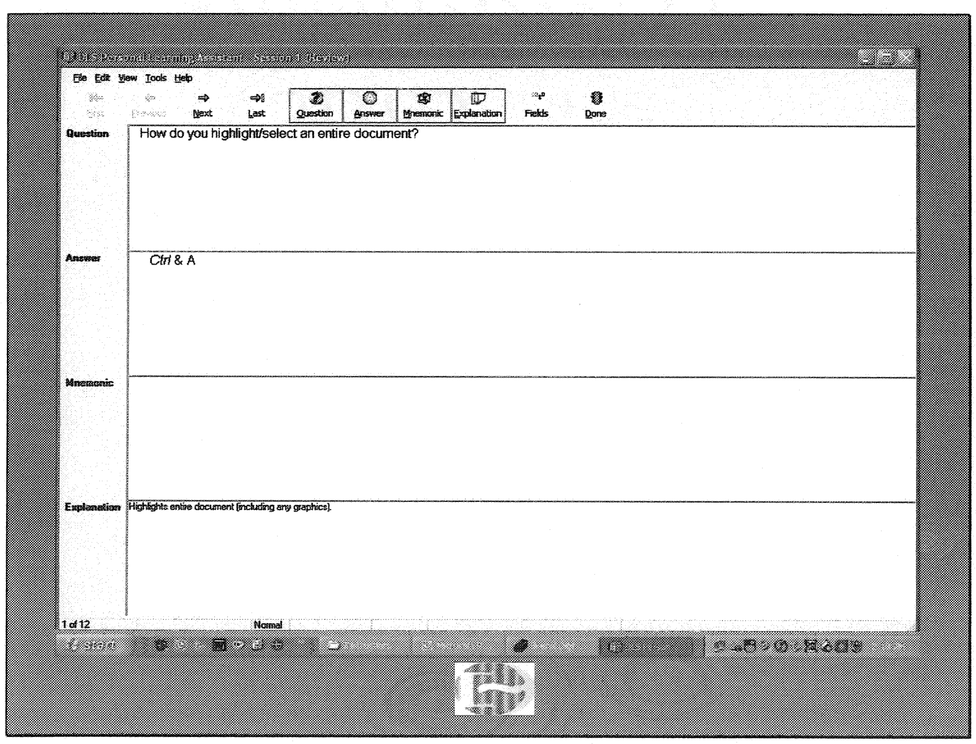

File Edit View Tools Help
Tools
Mc Graw Hill Education
Your Learning Partner
Welcome Deidre Rogers
Last accessed: Today
You have used Digital Learning System 29 times.
The Living World


File Edit View Tools Help
Active Brain
Folders
Up
New
Views
Delete
Close
Deidre's KnowledgeTree
Classes
General Interests
Projects
Daily Review
Learning Guides
Shortcut Keys
Name
Date Created
Date Last Accessed
Date Modified
Size
Type
General Interests 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 0 KB Folder
Projects 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 0 KB Folder
Daily Review 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 2.3 MB Folder
Learning Guides 5/12/2003 3:41:00 PM 3/6/2004 2:08:09 PM 5/12/2003 3:41:00 PM 181.95 MB Folder
Shortcut Keys 10/24/2003 3:11:43 PM 3/6/2004 2:08:12 PM 2/21/2004 5:49:54 PM 1.48 MB Folder
6 objects
185.72 MB
Deidre's KnowledgeTree

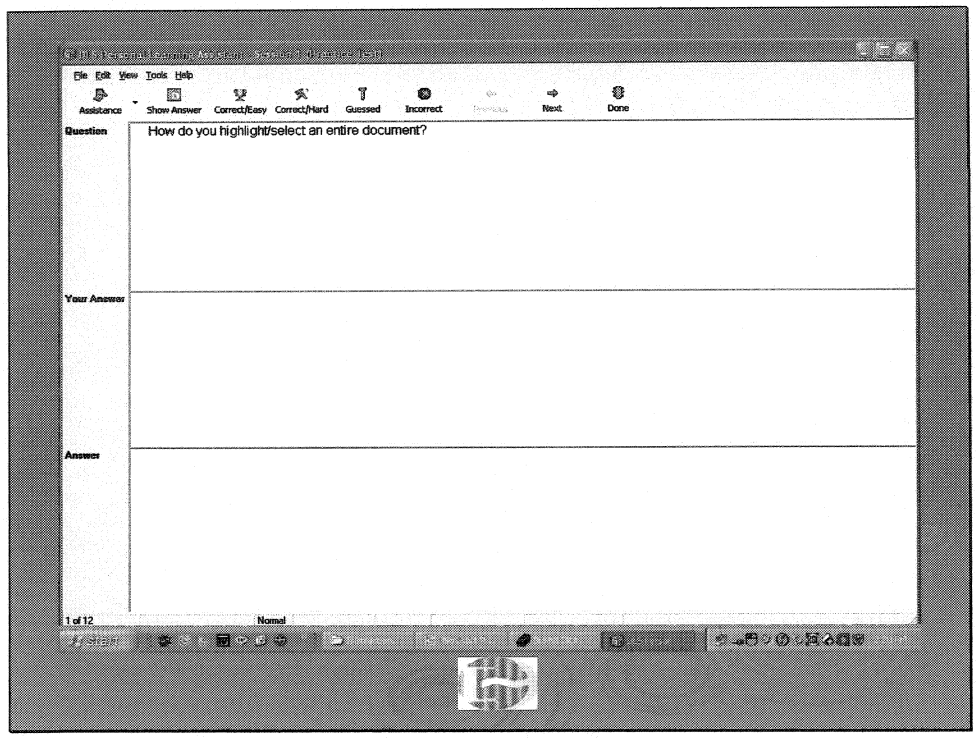

File Edit View Tools Help
Active Brain
Folders
Up
New
Views
Delete
Close
Deidre's KnowledgeTree
Classes
General Interests
Projects
Daily Review
Learning Guides
Session 1
Session 2
Session 3
Session 4
Name
Date Created
Date Last Accessed
Date Modified
Size
Type
Classes 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 0 KB Folder
General Interests 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 0 KB Folder
Projects 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 0 KB Folder
Daily Review 5/12/2003 3:41:00 PM 3/6/2004 2:08:12 PM 5/12/2003 3:41:00 PM 2.3 MB Folder
Learning Guides 5/12/2003 3:41:00 PM 3/6/2004 2:08:09 PM 5/12/2003 3:41:00 PM 181.95 MB Folder
Shortcut Keys 10/24/2003 3:11:43 PM 3/6/2004 2:08:12 PM 2/21/2004 5:49:54 PM 1.48 MB Folder
6 objects
185.72 MB
Deidre's KnowledgeTree

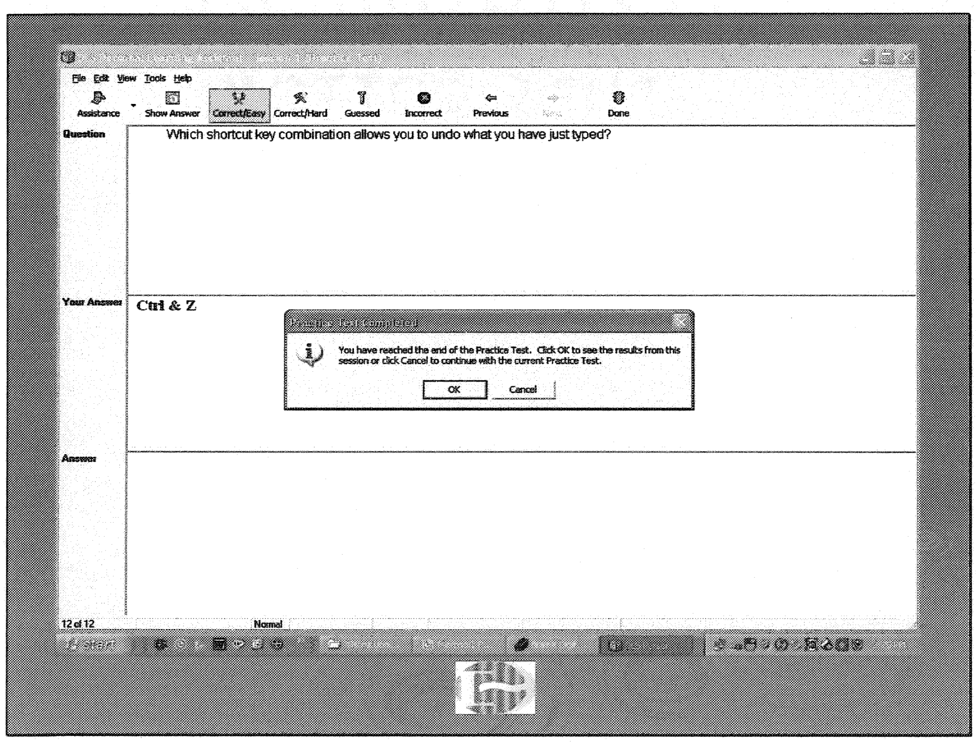


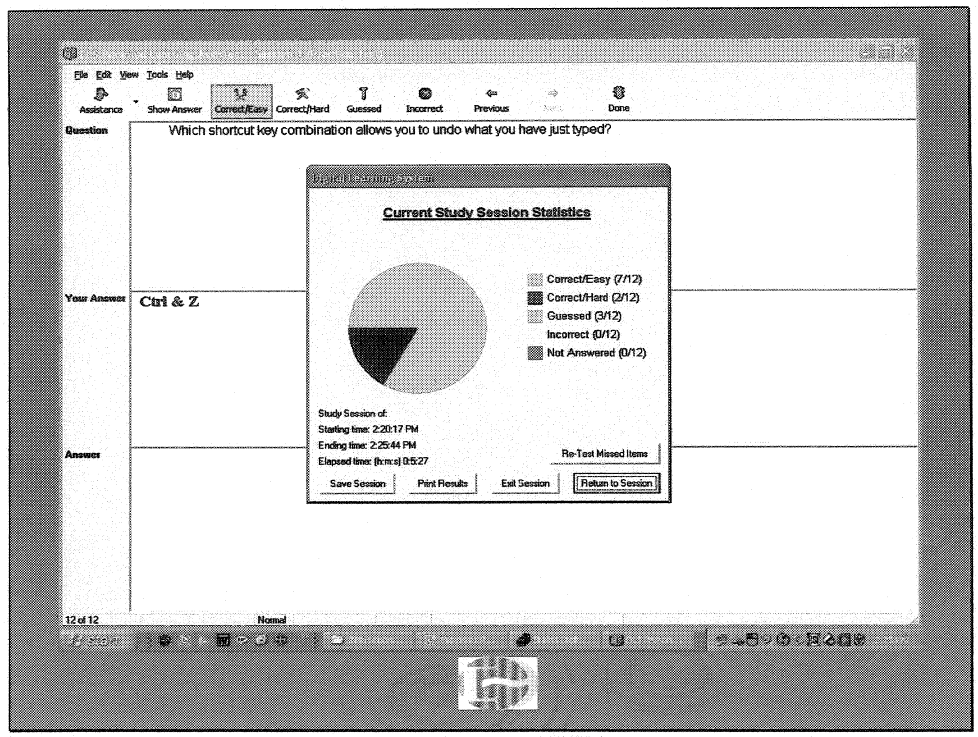
File Edit View Tools Help
Active Brain
Folders
Review
Practice Test
Close
Question/Fact
Answer
Importance
Date Entered
Type
Source
Topic
Exam
How do you highlight/select a... Ctrl & A Normal 02/08/2004 05:17:36 PM Question
What is the shortcut key com... Ctrl & B Normal 02/08/2004 05:21:00 PM Question
What is the quick way to brin... Ctrl & N Normal 02/08/2004 05:22:03 PM Question
Ctrl & P will do what? ______... Print a document Normal 02/08/2004 05:24:18 PM Question
Which shortcut key combinati... Ctrl & C Normal 02/08/2004 05:25:57 PM Question
Which shortcut key combinati... Ctrl & X Normal 02/08/2004 05:27:17 PM Question
Which shortcut key combinati... Ctrl & V Normal 02/08/2004 05:28:28 PM Question
When you are in Microsoft W... Ctrl & D Normal 02/08/2004 05:30:50 PM Question
You can use the Ctrl & I shortc... Italicize Normal 02/08/2004 05:34:39 PM Question
Which shortcut key combinati... Ctrl & S Normal 02/08/2004 05:35:54 PM Question
Typing F12 allows you to ------... Save as
Which shortcut key combinat... Ctrl & Z
Select What to Study...
Study All Material
Manually Select Material to Study
Resume a Saved Study Session
Select How to Study...
Review Material
Take a Practice Test
Cancel
OK
12 records selected

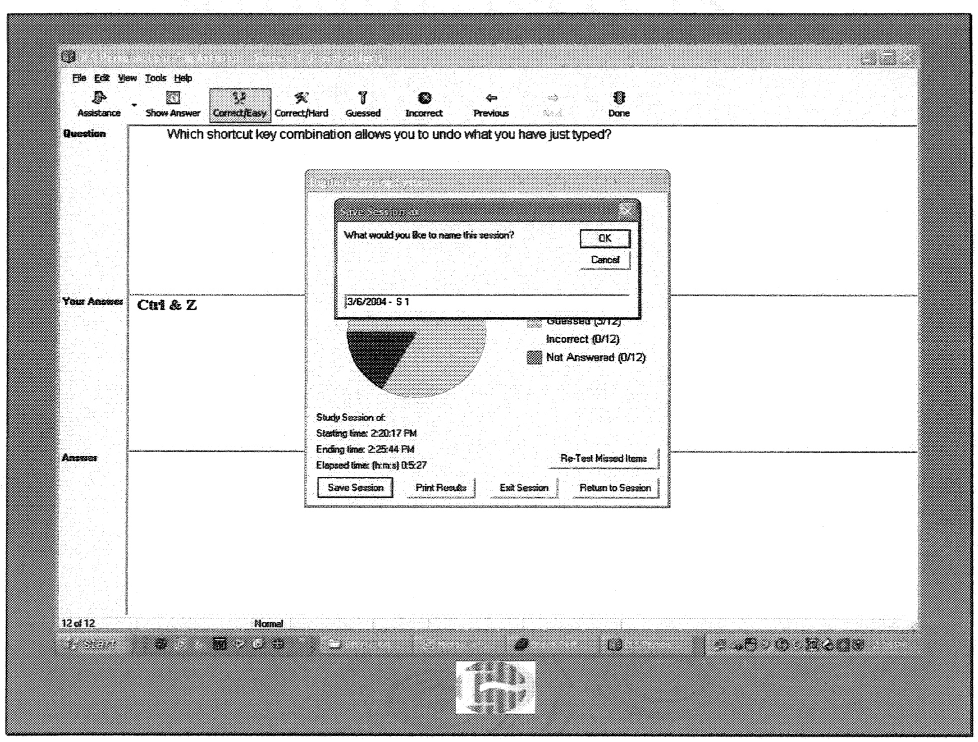



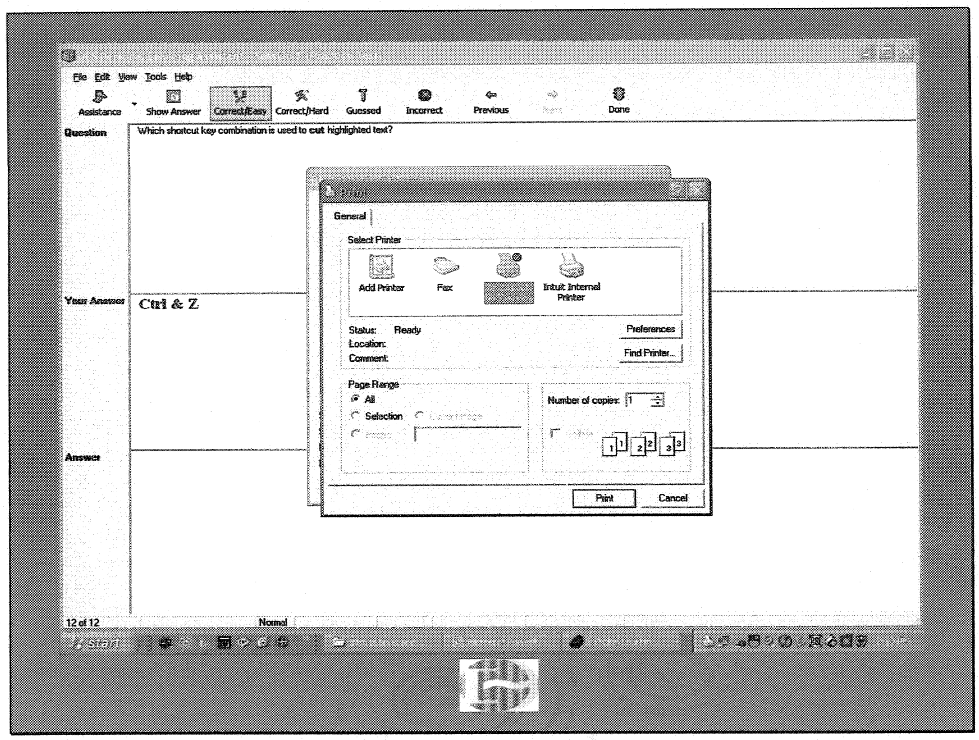
File Edit View Tools Help
Next
Last
Question
Answer
Mnemonic
Explanation
Fields
Done
Question
How do you highlight/select an entire document?
Answer
Ctrl & A
Mnemonic
Explanation
Highlights entire document (including any graphics).
1 of 12
Normal

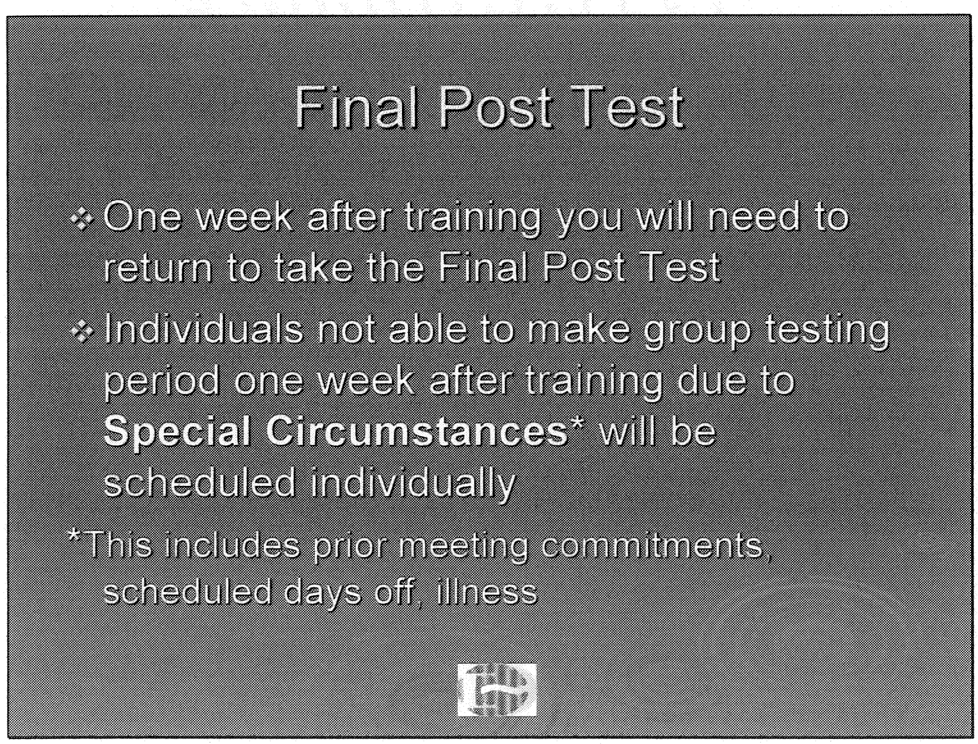

File Edit View Tools Help
Assistance
Show Answer
Correct/Easy
Correct/Hard
Guessed
Incorrect
Previous
Next
Done
Question
How do you highlight/select an entire document?
Your Answer
Answer
1 of 12
Normal


File Edit View Tools Help
Assistance
Show Answer
Correct/Easy
Correct/Hard
Guessed
Incorrect
Previous
Next
Done
Question
Which shortcut key combination allows you to undo what you have just typed?
Your Answer
Ctrl & Z
You have reached the end of the Practice Test. Click OK to see the results from this session or click Cancel to continue with the current Practice Test.
OK
Cancel
Answer
12 of 12
Normal


File Edit View Tools Help
Assistance
Show Answer
Correct/Easy
Correct/Hard
Guessed
Incorrect
Previous
Done
Question
Which shortcut key combination allows you to undo what you have just typed?
Your Answer
Ctrl & Z
Answer
Current Study Session Statistics
Correct/Easy (7/12)
Correct/Hard (2/12)
Guessed (3/12)
Incorrect (0/12)
Not Answered (0/12)
Study Session of:
Starting time: 2:20:17 PM
Ending time: 2:25:44 PM
Elapsed time: (h:m:s) 0:5:27
Re-Test Missed Items
Save Session
Print Results
Exit Session
Return to Session
12 of 12
Normal


File Edit View Tools Help
Assistance
Show Answer
Correct/Easy
Correct/Hard
Guessed
Incorrect
Previous
Done
Question
Which shortcut key combination allows you to undo what you have just typed?
Your Answer
Ctrl & Z
Answer
What would you like to name this session?
OK
Cancel
3/6/2004 - S 1
Incorrect (0/12)
Not Answered (0/12)
Study Session of:
Starting time: 2:20:17 PM
Ending time: 2:25:44 PM
Elapsed time: (h:m:s) 0:5:27
Re-Test Missed Items
Save Session
Print Results
Exit Session
Return to Session
12 of 12
Normal


File Edit View Tools Help
Assistance
Show Answer
Correct/Easy
Correct/Hard
Guessed
Incorrect
Previous
Done
Question
Which shortcut key combination is used to cut highlighted text?
Your Answer
Ctrl & Z
Answer
General
Select Printer
Add Printer
Fax
Intuit Internal Printer
Status: Ready
Location:
Comment:
Preferences
Find Printer...
Page Range
All
Selection
Number of copies: 1
Print
Cancel
12 of 12
Normal


Final Post Test
❖ One week after training you will need to return to take the Final Post Test
❖ Individuals not able to make group testing period one week after training due to **Special Circumstances*** will be scheduled individually
*This includes prior meeting commitments, scheduled days off, illness

San José State
UNIVERSITY

**Office of the Academic Vice President**

***Academic Vice President Graduate Studies and Research***

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E-mail: gradstudies@sjsu.edu
http://www.sjsu.edu

Appendix H

To: Deidre Rogers
11765 Edgewood Dr.
Felton, CA 95018

From: Pam Stacks, Pam Stacks
Interim AVP, Graduate Studies & Research

Date: April 27, 2004

The Human Subjects-Institutional Review Board has approved your request to use human subjects in the study entitled:

"Evaluating Schedule of Practice Effects on the Learning of Shortcut Keys."

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Pam Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subjects portion of your project is in effect for one year, and data collection beyond April 27, 2005 requires an extension request.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services that the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at (408) 924-2480.

cc: Dr. Louis Freund

Appendix I

San José State University
Department of Industrial & Systems Engineering
Room 283, Engineering Building
One Washington Square
San José, CA 95192-0085
Voice: 408-924-3301
Fax: 408-924-4040
E-mail: isengr@email.sjsu.edu
Website: http://www.engr.sjsu.edu

**Agreement to Participate in Research**

**Responsible Investigator(s):** Deidre Rogers, RN, CAE

**Title of Protocol:** Evaluation of Training on Shortcut Keys

1. You have been asked to participate in a research study investigating several training protocols that will be used to train computer users on shortcut keys in MSWord.

2. You will be asked to attend a 45-minute training class on shortcut keys followed by a 15-minute introduction to the use of BrainX software. One half of you will stay for an additional one hour session in which BrainX will be used to teach you additional shortcut keys, while the other half will do one session of BrainX software followed by 3 consecutive days worth of approximately 10-25 minute practice sessions with BrainX software. The training will be held at the computer training center. Prior to training and after the training you will be given written tests. One week after completing final training, you will be asked to return and take another written test. Refreshments will be provided.

3. There are no foreseeable risks or discomfort with this study and all participants will receive training on shortcut keys.

4. The benefit to you as a participant is that you will learn a computer-related skill that may make you more proficient and productive at the computer.

5. The results of this study may be published but no information that could identify you will be included.

6. The compensation for participation in the study will include a copy of BrainX software (which can help you study any subject you are trying to learn). All participants who complete the full study will be eligible to participate in a raffle to win a $100.00 Visa Gift Certificate.

Participants Initials __________

7. Questions about this research may be addressed to Deidre Rogers at (831) 335-8448. Complaints about the research may be presented to Kevin Corker, Professor, Industrial and Systems Engineering at (408) 924-3988. Questions about research subjects' rights or research-related injury may be presented to Iam Stacks, Interim Academic Vice President, Graduate Studies and Research, at (408) 924-2488.

8. No service of any kind to which you are otherwise entitled will be lost or jeopardized if you choose to "not participate" in the study.

9. Your consent is being given voluntarily. You may refuse to participate in the entire study or in any part of the study. If you decide to participate in the study, you are free to withdraw at any time without any negative effect on your relations with San Jose State University or with any other participating institutions or agencies.

10. At the time that you sign this consent form, you will receive a copy of it for your records, signed and dated by the investigator.

**The signature of a subject on this document indicates agreement to participate in the study.**

**The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject has been fully informed of his or her rights.**

___________________________________

Signature Date

___________________________________

Investigator's Signature Date

Participants Initials __________

| SHORTCUT | DESCRIPTION |
|---|---|
| Ctrl & A | Highlight all text |
| Ctrl & B | Bold |
| Ctrl & I | Italicize |
| Ctrl & U | Underline |
| Ctrl & C | Copy |
| Ctrl & V | Paste |
| Ctrl & N | Bring up new document (blank) |
| Ctrl & X | Cuts text |
| Ctrl & P | Prints document |
| Ctrl & O | Open documents (file control) |
| Ctrl & S | Save |
| F12 | Save as |
| Ctrl & Z | Undo (Clipboard command) |
| Ctrl & Y | Redo |
| Alt & Tab | Toggle all open documents/programs [Hold Alt and type Tab] |
| Ctrl & "left arrow key" | Move one word to left |
| Ctrl & "right arrow key" | Move one word to right |
| "End" | Moves curser to end of current line |
| "Home" | Moves the curser to the beginning of the line |
| Ctrl & "Home" | Moves curser to beginning of the document |
| Ctrl & "End" | Moves the curser to the end of the document |
| Alt & F | Bring up File menu |
| Alt & E | Bring up Edit menu |
| Ctrl & "left arrow key" | Moves cursor one word to the left |
| Ctrl & right arrow key" | Moves cursor one word to the right |
| Alt & F4 | Closes program (e.g., MSWord) |
| "Esc" | Closes any dialog box or menu; or cancels an action |
| "Flying windows key" & M | Minimizes all windows at a time |
| Ctrl & F4 | Closes open document (but not the program) * Same as Ctrl & W |
| Ctrl & W | Closes open document* Same as Ctrl & F4 |
| Ctrl& Shift & "right arrow" | Highlights/selects word to the right of the curser |
| Ctrl & Shift & "left arrow" | Highlights/selects word to the left of the curser |
| Ctrl & D | Brings up Font dialog box in Windows |
| Ctrl & "Enter" | Gives you a page break |

# Appendix K

## Verbal Instructions for Instructor Led Training

Comments: These instructions will be given after the first part of the Power Point presentation has been given (before the BrainX software has been introduced).

"Our primary focus will be on Microsoft Word. However many of these shortcuts work in Excel, Outlook and even software that is not part of Microsoft Office."

Bring up visual of keyboard layout or use a keyboard in class to point to Ctrl, Shift, Enter, Tab, Function keys, Right Click key, Arrow keys, Delete, Page Up/Page Down, and Home/End keys. Talk about the Alt key briefly.

Then ask participants to open the "Rogers Test Document" document on their desktops. Then ask them:

"Does anyone know the shortcut key combination used to select an entire document?"
Instruct them to go ahead and select the document (Ctrl & A).

"How about copying a document?"
Instruct them to go ahead and copy the document (Ctrl & C).

"What's the quickest way to bring up a new, blank document?"
Instruct them to do so (Ctrl & N).

"And if you want to copy the document onto your new document what shortcut key combination do you use?"
Instruct them to go ahead and do this (Ctrl & V).

"How would you save this document using shortcut keys?"
Instruct them to go ahead and do this (Ctrl & S).

"If you wanted to print the document what shortcut key would allow you to do this?"
Instruct them to type in the shortcut keys (Ctrl & P) but not to click "okay".

"How do you close a 'dialog box' like this with just one key?"
Use your "Esc" key.

"If you want to move to the very top of the document what shortcut key combination will allow you to do so?"
Try that (Ctrl & "Home").

"And if you want to go to the end of the document?"

(Ctrl & End).

"Go back to the top of the document with the use of Ctrl & Home and then use Ctrl & your right arrow key to move into text."

"Now key Ctrl & Shift & your right arrow key several times, this will allow you to select several words"

"Using shortcut key combinations, italicize and bold these highlighted/selected words" (Ctrl & I and Ctrl & B)

"Now use a shortcut key combination to cut these selected words."
(Ctrl & X)

"Let's say you have changed your mind, and you want these words back, which shortcut key allows you to do this?"
(Ctrl & Z)

"Now use your Ctrl and right arrow keys to move down approximately eight words or so."

"Use your Ctrl, Shift and left arrow keys together to select four words (to your left)."

"Using a shortcut key combination underline these four words."
(Ctrl & U).

"What shortcut key will allow you to Save As? This is a function key." "Do this and save the documents as 'Shortcut key practice 2'."

"If you want to open the File menu what Alt key shortcut key combination will allow you to do so?" (Alt & F)

"Practice using your down arrow key to go to 'Save As' - use of your arrow keys is an efficient way to move up and down these menus."

"What shortcut key combination will allow you to bring up the Font Dialog box?"
Ctrl & D

"Practice keying the tab key several times -- this allows you to move around in the opened sections of the Dialog Box. Ctrl & Tab will allow you to move between the different tab headings at the top of the Dialog Box. Try this a few times briefly."

"To close the Font Dialog Box simply hit the Esc key."

"So if you want to close Microsoft Word, how can you do this with a shortcut key combination?" "The clue is to use your Alt key and…" (Alt & F4)

"Finally, the last one for this instructor-based session is the Alt & Tab key combination. If you want to practice this you may need to open an additional program or document. Then type the Alt and Tab key and see what happens. This is a great way to toggle between documents or programs."