The Association between Computer Typing Style and Typing Speeds

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The association between computer typing style and typing speed

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Typing styles vary among keyboard users; however few studies have investigated the association between typing style and typing speed. The purpose of this paper is to describe the differences in typing speed between typists who rarely assume extreme postures of the wrist, hands, and fingers with typists who often assume extreme postures. The paper also examines the association between other typing behaviors, such as using a wrist support, and typing speed. Forty computer users were videotaped while typing a standardized text. Their typing postures were rated using the Keyboard Personal Computer Style instrument (K-PeCS). One-way ANOVA's were used to compare typing speed between the rating levels of several items on the K-PeCS. Results suggest that those who frequently isolate their 5th digit are significantly faster than those who always isolate their 5th digit. Subjects who "float" their wrists, translate their wrist/hands, do not change pronation angles, use moderate to high force, and use more digits appear to type faster than those who do not.

Keyboard users have developed a variety of typing styles to more efficiently access their keyboards. Touch typing is one style that has long been taught as a method to increase typing speed. The touch typing method advocates specific postures and actions; typists are taught to "float" their wrists above the desk (Cook, Burgess-Limerick, & Papalia, 2004a) with fingers over a "home row." They learn to strike each key with a specific finger, eventually developing motor memory of where the key is in relationship to the home row. This allows the typist to type without looking at the keys, which is assumed to increase speed and efficiency. An expert touch typist can easily achieve 50 words per minute (Hales et al., 1994) and even 100 wpm. Those who are not trained in touch typing use a style often referred to as "hunt and peck." These self-taught typists use two or three fingers per hand, and may look for each key as they are typing. They are generally slower than a touch typist, typing approximately 10-30 wpm (Brandis & Straker, 2005).

These two methods appear to produce large differences in typing speed. It would seem, therefore, that typing speed is related to the postures and actions assumed during typing. Despite this apparent relationship, no research has examined whether postures or other typing behaviors are associated with differences in typing speed. Research examining typing speed and postures has primarily focused on alternative keyboards (Marklin, Simoneau, & Monroe, 1999; Zecevic, Miller, & Harburn, 2000). In these studies, differences in typing speed are assumed to be related to the presence of the alternative configuration of the keyboard, rather than the postures assumed during the task.

The purpose of this paper is to describe the differences in typing speed between those who rarely assume postures which place their wrist, hands, and fingers into extremes of posture with those who often perform these types of postures. This paper also examines other typing behaviors associated with touch typing, including the use of a wrist support, the magnitude of force, changes in pronation, the number of fingers used, and hand displacement and their association with differences in typing speed. The hypothesis related to postural extremes is that those who less frequently assume extreme postures will have a faster typing speed than those who more frequently do. The hypothesis for other behaviors is that those behaviors specified in touch typing (i.e., floating wrist, no hand displacement, no changes in pronation, decreased force, and using more fingers) will be significantly faster than the opposite of those behaviors.

METHOD

Subjects

A convenience sample of forty computer users between the ages of 18 and 65 were recruited from the University of Pittsburgh faculty, staff, and students. Subjects had to be familiar with using a computer, but did not have to be expert typists to participate.

Instruments

Typing speed. Typing speed and accuracy were gathered using an online typing program, Typing Master Pro ™ (Typing Master Finland, Inc., Helsinki, Finland - http://www.typingmaster.com/index.asp?go=company), which presents a typing test for the keyboard user on the computer screen. The program provides cues to the keyboard user as to where they are in the text, and advances the text automatically as the keyboard user works through the paragraph. The program automatically measures speed and accuracy during the typing task. All typing was completed on a standard keyboard.

Video recordings. Video recordings of the subjects' hands were made during the typing task. Three views were obtained, one left hand, one right hand, and one overhead view of both hands together. The camera angles and distances were standardized.

Computer style. The frequency and type of postures of the wrists, hands and fingers as well as the other behaviors were obtained using an observational instrument, The Keyboard Personal Computer Style instrument (K-PeCS) (Baker & Redfern, 2005). The K-PeCS is a 19-item rating instrument that documents the frequency of stereotypical motions and postures that are used by computer keyboarders during routine typing tasks. Many of the items are divided into right and left side measurements, and for the finger postures, they are also broken down by digits 2 through 5.

For all items, the rater observes the computer user and determines which criteria for each item best match the user's typing style. For this study, the items selected as independent variables were those that examined the postures and behaviors of the wrists, hands, and fingers. There were generally two types of ratings: some items were rated as occurring or not occurring, and some were rated by the frequency of the occurrence of a target posture. These frequency ratings were "never" (0% of the time), "occasionally" (1-30% of the time), "frequently" (31% to 99% of the time), and "always" (100% of the time)." The items of the former type were use of wrist support, hand displacement, (Baker, Cham, Cidboy, Cook, & Redfern, 2007), and whether the subject changed the pronation angle of the forearm. The items of the latter type were how often the subjects ulnarily deviated the wrist greater than 20 degrees, extended the wrist greater than 15 degrees, maintained the 5th or 1st digit in an isolated position, or hyperextended the 5th metacarpophalangeal (MCP) joint (Baker et al., 2007). Two additional items were also included. The amount of force used to activate the keyboard (rated as low and moderate to high) and the number of digits used to strike the keys per hand (rated as 3, 4, or 5). For all items but force, the right and left sides were evaluated separately.

The K-PeCS has been shown to generally have good to excellent reliability (Baker, Cook, & Redfern, submitted; Baker & Redfern, 2005), and has demonstrated content and criterion-related validity. For this study all observations were made from videotape.

Procedure

Typing tasks were completed in the laboratory. Subjects completed a demographic questionnaire which obtained information about computer use, including whether the subjects had ever had a touch typing course. All subjects were allowed to adjust the chair to a comfortable position, although the height of the keyboard was kept constant to make the videotape views standardized. Once subjects were satisfied with the computer set-up they typed from a standardized paragraph (a 4th grade reading level) for 20 minutes.

Data Analysis

Data processing. The overall speed of typing was obtained from the Typing Master Pro™ in words per minute (wpm). Accuracy was also documented.

Video recordings were digitized into video movies (clips) that had all three views (right hand, left hand, and overhead). A rater experienced in rating with the K-PeCS rated each clip twice, with at least one week between each rating. These two ratings were compared and discrepancies were identified. These discrepancies were re-rated to achieve agreement on each item.

Statistical analyses. Descriptive statistics were obtained for all demographic, dependent, and independent variables. The differences between typing speed, accuracy and adjusted typing speed for each level of each K-PeCS variable was assessed using a one-way ANOVA with the K-PeCS rating as the independent variable and the typing speed as the dependent variable. If significance was obtained, *post hoc* analyses were completed using Hochberg's GT2 to control for the unequal distribution of ratings for each item (Field, 2000). To fully understand the differences between the ratings for each item, the effect size Cohen's *d* (Rosenthal, 1994) was calculated between the ratings for each item. A Cohen's *d* is a standardized difference between the means in standard deviation units and can be interpreted using the following scale: a *d* between 0 and 0.19 is considered to be a negligible effect, a *d* between 0.20 and 0.49 is considered to be a small effect, a *d* between 0.50 and 0.79 is considered to be a moderate effect, a *d* between 0.80 and 0.99 is considered to be a large effect, and any *d* 1.00 and over is considered to be a very large effect (Tickle-Degnen, 2001).

RESULTS

Of the 40 subjects, 80% were female. The subjects' mean age was 29.2 (±11.1) and they reported an average of 5.2 (±2.4) hours per day of computer use. Mean typing speed was 50.4 (±15.7) wpm with a minimum speed of 30 wpm and a maximum speed of 95 wpm. Mean accuracy was 89.2% (±6.0) with a minimum accuracy of 71% and a maximum accuracy of 98%. Significant difference were found between the subjects for their overall typing speed, but not for accuracy except for right changes in pronation angle, where those who did change their pronation angle were significantly more accurate than those who did not (p = .01).

For typing speed, those who had taken a typing course had a significantly faster typing speed than those who had not (See Table 1). The effect of taking a typing course was very large (d = 1.04).

Table 1 – Difference in typing speed (wpm) for items of behaviors

Item	*n*	*Mean ±SD*	*Cohen's d*	*p*
Typing course				
yes	25	55.8 ±16.2	1.04	.004
no	15	41.3 ±9.9		
Uses wrist support (right)				
yes	21	43.6 ±11.1	1.22	.002
no	14	60.8 ±18.7		
Uses wrist support (left)				
yes	26	45.2 ±10.7	1.17	.003
no	12	61.3 ±20.3		
Hand/wrist displacement (right)				
yes	15	55.9 ±14.7	0.58	.09
no	25	47.0 ±15.7		
Hand/wrist displacement (left)				
yes	9	59.4 ±17.8	0.76	.05
no	30	47.8 ±14.5		
Force				
low	9	41.2 ±5.6	0.83	.05
mod/high	31	53.0 ±16.7		
Changes pronation angle (right)				
yes	13	43.5 ±10.7	0.69	.05
no	27	53.7 ±16.8		
Changes pronation angle (left)				
yes	9	40.2 ±5.24	0.93	.03
no	31	53.3 ±16.6		
Number of digits (right)				
3	7	39.1 ±4.74	3 v. 4 = 0.60	
4	13	45.2 ±12.9	4 v. 5 = 0.82	.007
5	20	57.6 ±16.6	5 v. 3 = 1.37*	
Number of digits (left)				
3	8	37.3 ±5.6	1.29	.004
4	30	54.7 ±15.7		

* = *post hoc* p is significant

Generally significant differences were found for items which examined if an action occurred or did not occur (Table 1). Those who used a wrist support were significantly slower than those who did not and this effect was very large (d = right 1.22, left 1.17). Those who displaced their hands while typing were significantly faster than those who did not on the left only. Moderate effect sizes were found for both sides (d = right 0.58, left 0.76). Individuals who used low force while typing were significantly slower than those who used high force (d = 0.83). Subjects who changed their pronation angle were slower than those who did not. Although the effect was larger on the left (d = 0.93) than the right (d = 0.69).

Table 2 - Difference in typing speed (wpm) for items of posture.

Item	*n*	*mean*		*Cohen's d*	
Right ulnar deviation > 20° (p = .77)					
N	14	52.5	±16.4	N v. O = 0.05	O v. F = 0.37
O	14	51.7	±16.3	N v. F = 0.41	O v. A = 0.29
F	8	45.9	±15.2	N v. A = 0.34	F v. A = 0.41
A	4	47.0	±15.9		
Right ulnar deviation > 20° (p = .26)					
N	18	55.4	±16.4	N v. O = 0.74	O v. F = 0.46
O	7	44.3	±11.3	N v. F = 0.22	O v. A = 0.00
F	6	51.5	±21.1	N v. A = 0.74	F v. A = 0.22
A	8	44.3	±11.9		
Right wrist extension > 15° (p = .13)					
N	10	46.8	±10.5	N v. O = 0.77	O v. F = 0.57
O	10	59.3	±22.1	N v. F = 0.22	O v. A = 1.14
F	16	49.6	±13.8	N v. A = 0.78	F v. A = 0.22
A	4	40.0	± 4.2		
Left wrist extension > 15° (p = .33)					
N	13	52.6	±16.4	N v. O = 0.34	O v. F = 0.79
O	7	58.7	±20.5	N v. F = 0.45	O v. A = 0.75
F	11	45.6	±14.2	N v. A = 0.38	F v. A = 0.45
A	8	47.1	±11.2		
Right 5th isolation (p = .02)					
N	9	46.3	± 9.0	N v. O = 0.85	O v. F = 0.37
O	11	54.7	±10.7	N v. F = 0.92	O v. A = 1.17
F	9	60.6	±22.0	N v. A = 0.49	F v. A = 0.92*
A	11	40.9	±13.0		
Left 5th isolation (p = .04)					
N	11	46.7	± 9.3	N v. O = 0.46	O v. F = 0.43
O	11	51.6	±11.8	N v. F = 0.77	O v. A = 1.34
F	12	58.3	±21.6	N v. A = 1.03	F v. A = 0.77*
A	6	37.8	± 7.4		
Right 1st isolation (p = .49)					
N	29	51.6	±17.1	N v. O = 0.66	O v. F = 1.10
O	4	41.3	± 5.9	N v. F = 0.06	O v. A = n/a
F	5	50.6	±10.6	N v. A = n/a	F v. A = n/a
A	1				
Left 1st isolation (p = .70)					
N	17	51.7	±18.8	N v. O = 0.26	O v. F = 0.01
O	8	47.3	±12.9	N v. F = 0.25	O v. A = 0.65
F	7	47.4	±13.2	N v. A = 0.24	F v. A = 0.25
A	7	55.9	±13.7		
Right 5th MCP hyperextension (p = .07)					
N	15	50.8	±14.9	N v. O = 0.23	O v. F = 0.13
O	8	54.0	±12.5	N v. F = 0.31	O v. A = 1.83
F	10	56.1	±19.8	N v. A = 1.16	F v. A = 0.31
A	7	37.0	± 5.5		
Left 5th MCP hyperextension (p = .16)					
N	11	50.5	±18.2	N v. O = 0.09	O v. F = 0.45
O	13	51.7	±10.6	N v. F = 0.40	O v. A = 0.78
F	8	58.4	±21.9	N v. A = 0.78	F v. A = 0.40
A	7	40.0	± 5.6		

N-never; O-occasionally; F=frequently; A-always; * = *post hoc* p is significant

Subjects who used more digits while typing were significantly faster than those who did not, and this effect was very large for both hands (*d* = right 1.37, left 1.29).

Fewer significant results were found when examining the frequency of extreme postures, although the effect sizes for many of these comparisons often fell into the moderate to very large range (Table 2). Only for 5th digit isolation was there a significant difference in typing speed between the rankings. *Post hoc* analyses revealed that the difference lay between those who frequently isolated their 5th digit and those who always isolated their 5th digit. This effect was moderate to large (*d* = right 0.92, left 0.77).

DISCUSSION

Overall, those who had taken a touch typing course were significantly faster than those who had not taken a touch typing course, and the effect of taking a touch typing course was very large, suggesting that touch typing is a very efficient method of data entry

Only one item, which looked at 5th digit isolation, was significant for extremes of posture. For this item *post hoc* analyses found that those subjects who frequently isolated their 5th digit were significantly faster than those who always isolated their 5th digit. This result may relate to the number of fingers used for typing; those who always isolate their 5th digit only use 4 digits which was found in this study to be associated with slower typing speeds. In examining the effect sizes for this and items which approached significance, however, an interesting trend was observed. There was a large to very large effect size between those ratings which compared never or occasional extreme postures with frequent or constant extreme postures. These effect sizes suggest that those individuals who maintain extreme postures tend to be slower typists. Possible explanations for this effect are that extremes of posture may slow down individuals as they have to move a greater distance to access the keys. Extremes of posture may also indicate a level of stiffness in the joint which requires more time to overcome. While this study does not prove that having an extreme position causes a slower typing speed, it does suggest that there is a difference in speeds when these extreme postures are present.

Most individual items which examined behaviors recommended in touch typing courses were significant and had a moderate to very large effect on typing speed. Subjects who had taken a touch typing course, floated their hands (i. e. did not use a wrist rest), did not change their pronation angle and used more fingers typed faster than those who did not suggesting that recommendations made in touch typing courses do increase speed. Those who displaced their hand/wrist more often were significantly faster on the left and borderline significantly faster on the right, with a moderate effect size for both (*d* = right 0.58; left 0.76). This suggests that moving the hands to reach the keys, rather than keeping the hands still over the home row is also a faster method.

Touch typist are instructed to use a light snapping motion to strike the keys to improve speed. This study suggests that those who use high force are significantly faster typists. This faster speed may represent an unavoidable response to the utilization of the control strategies for finger movement during touch typing as described by Dennerlein, Mote, and Rempel (1998). They reported that a burst of flexor activity, which is essentially unchecked by extensor activity, causes the finger to strike and activate the key. As a person moves faster, the ability to regulate the flexor burst may become more difficult, resulting in increased keying forces.

The fact that floating the hands makes typists significantly faster may cause a problem for keyboard users. Several studies suggest that using support reduces EMG output and discomfort of the neck (Cook, et al., 2004a; Cook, Burgess-Limerick, & Papalia, 2004b; Rempel et al., 2006), but this study finds that workers are significantly faster when they are unsupported and can displace their hands. Workers may not want to reduce productivity which may happen if they add a wrist support. Human factors personnel who recommend support should examine forearm support which may still allow some "floating" to occur.

It is interesting to note that these postures and behaviors had no significant effect on accuracy, except for changing pronation, which caused a significant increase in accuracy. Changing pronation seems to be a behavior used by "hunt and peck" typists to "peek" under their hands to look for keys. The ability to accurately see keys, while slowing down movement, would increase accuracy.

Limitations. This was a convenience sample, and we did not recruit and equal number of males and females. Further research with a more equal distribution by gender might provide different results. It is unusual to get such high effect sizes with statistically non-significant results. The distribution of the rankings for the K-PeCS was very unequal and small throughout the study, and the variances were very high. This would have affected the significance levels, causing the potential for Type II errors. Because of the potential for the study to be underpowered we provided the effect sizes for all comparisons, both significant and non-significant, so that readers could more easily examine the associations between postures and typing speed. These large effect sizes suggest that further research with a larger sample is needed to fully understand if the results reported here are truly non-generalizable or actually represent Type II error.

CONCLUSION

This study suggests that differences in typing speed are associated with different typing styles. Those individuals with more extreme postures and those with characteristics unrelated to touch typing tend to type slower than those who have postures and behaviors advocated in touch typing. Further study is needed to fully understand these differences, and to identify how personal typing style affects typing speed. In addition research is needed to assess how posture and typing speed influence the development of musculoskeletal disorders.

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