USER ASSESSMENT OF STANDARD AND REDUCED-SIZE NUMERIC KEYPADS

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As technology improves, portable computers become smaller and more compact. A clear design challenge is to provide a system that is as compact as possible without degrading system usability. The keyboard is still the primary input device for compact computers. Previous research has indicated that reduced key spacing adversely affects skilled typing. Therefore, a portable computer system should provide a keyboard with full-sized keys in the primary typing area. The purpose of this study was to determine if reducing key size and spacing adversely affects the usability of a numeric keypad. Skilled keypad operators compared a standard-size numeric keypad to two keypads that had reduced center-to-center key spacing. One of these keypads achieved its reduction primarily by reducing the key spacing. The other reduced both key size and spacing. (Note that the small changes in key size and spacing have little effect on the overall device dimensions of a numeric keypad.) Operators typed numbers faster with and preferred the standard keypad over the keypad with both reduced key size and key spacing. If a numeric keypad is offered as part of a portable computer, every effort should be made to provide full-sized keys. If reduced key spacing is unavoidable, wide keys are preferable to narrow keys.

OBJECTIVE

The objective of this study was to determine if a numeric keypad could be reduced in size without degrading the performance of the keypad for skilled keypad operators. As technology improves, portable computers become smaller and more compact. A clear design challenge is to provide a system that is as compact as possible without degrading system usability. The keyboard is still the primary input device for compact computers. Previous research has indicated that reduced key spacing adversely affects skilled typing. Kennedy and Loricchio (1987) compared standard and reduced-size keyboards. The standard size keyboard had 19 mm spacing in both the horizontal and vertical dimensions. The reduced size keyboard had 19 mm horizontal spacing and 15 mm vertical spacing. The keyboards were identical except for the difference in vertical key spacing. Although there were no significant differences in typing speed or error rate, users significantly preferred the keyboard with 19 mm spacing over the keyboard with 15 mm spacing. They indicated that they believed that the full-size keyboard was easier to use and was the keyboard they would choose to purchase.

This research (Kennedy and Loricchio, 1987) indicated that a portable computer system should provide a keyboard with full-sized keys in the primary typing area. Based on this information, it is reasonable to hypothesize that reducing the size of the numeric keypad would show similar results. Because there are relatively few keys on a numeric keypad, small reductions in key size and spacing of a numeric keypad do not result in very large reductions in the overall dimensions of the device. However, if the reductions have no effect on user performance or preference, then the reduction in key spacing and size would help the design goal of making the portable as compact as possible. The purpose of this study was to determine if reducing key size and spacing adversely affects the usability of a numeric keypad. To test this hypothesis, skilled keypad operators compared three commercially available numeric keypads.

METHOD

Participants

Fifteen participants were recruited from a temporary-help employment agency. All but one participant had experience using spreadsheet applications on a computer. Experience with spreadsheets ranged from two months to more than four years. Six had more than four years of experience, five had from one to three years experience, and three had less than one year of experience. Seven participants had college degrees, six had completed some college courses, and two had high school education. All participants said they could use a numeric keypad without looking at the keys.

Keypads

The layout of the numeric, add, and clear keys was the same on all three keypads. These were the only keys used by the participants. Table 1 shows the key size and spacing for these keypads. The keypads were categorized by two characteristics: center-to-center key spacing (18 mm or 16 mm); and width of the key cap (wide or narrow). The keypads are referred to as "18" (18 mm spacing), "16W" (16 mm

spacing, wide keys), and "16N" (16 mm spacing, narrow keys).

Table 1. Key Dimensions

	Key spacing		Key size	
Keypad	Horiz.	Vert.	Width	Height
18	18	15	14	10
16W	16	12	14	9
16N	16	15	10	10

Procedure

Pairs of Latin squares (Lewis, 1989) were used to counterbalance the order in which the participants used the keypads and stimulus sets. Participants received five minutes of practice on each keypad. Each participant used all three keypads to add a set of numbers. Each set consisted of 100 five-digit numbers. The numbers were arranged in 25 rows, with four numbers in each row. The participants' task was to add the four numbers in each row and to write the sum in the space beside each row. Participants' scores were the number of sums calculated during a seven-minute period. After completing the addition task with all three keypads, participants ranked the keypads in order of their preference.

RESULTS AND DISCUSSION

Tables 2, 3 and 4 show the results for the dependent variables of preference, input rate, and error rate. A Friedman test (Hollander and Wolfe, 1973) indicated a significant difference in preference among the keypads ($X^2(2) = 8.93$, $p < .05$). Distribution-free multiple comparisons based on the rank sums (Hollander and Wolfe, 1973) showed that the 18 keypad was significantly preferred over the 16N keypad ($p < .05$). Analyses of variance were used to analyze typing speed and errors. Keypad type had a significant effect on typing speed ($F(2,14) = 3.02$, $p < 0.06$). Participants typed significantly faster with the 18 keypad than with the 16N keypad (Duncan range test, $p < .05$). There were no significant differences in error rates ($F(2,14) = 1.96$, $p = 0.16$).

Table 2. Mean Preference Ranks

Multiple Comparisons		
18 keypad	16W keypad	16N keypad
1.40	2.13	2.47

Note: Means connected by a line are not significantly different at the .05 level.

Table 3. Mean Input Rate (keystrokes/minute)

Multiple Comparisons		
18 keypad	16W keypad	16N keypad
79.75	76.18	73.29

Note: Means connected by a line are not significantly different at the .05 level.

Table 4. Mean Error Rate (incorrect calculations/minute)

Multiple Comparisons		
16W keypad	18 keypad	16N keypad
0.33	0.29	0.15

Note: Means connected by a line are not significantly different at the .05 level.

CONCLUSIONS

Skilled keypad operators compared a standard-size numeric keypad to two keypads that had reduced center-to-center key spacing. One of these keypads achieved its reduction primarily by reducing the key spacing. The other reduced both key size and spacing. (Note that small changes in key size and spacing have little effect on the overall device dimensions of a numeric keypad.) Operators typed numbers faster with and preferred the standard keypad over the keypad with both reduced key size and key spacing. If a numeric keypad is offered as part of a portable computer, every effort should be made to provide full-sized keys. If reduced key spacing is unavoidable, wide keys are preferable to narrow keys.

REFERENCES

Kennedy, P.J., and Loricchio, D.F. (1987). Key space and user productivity. In *Abridged Proceedings of Poster Sessions of the Third International Conference on Human-Computer Interaction (page 48).* New York, N.Y.: Elsevier.

Hollander, M. and Wolfe, D. A. (1973). *Nonparametric statistical methods.* New York, NY: John Wiley.

Lewis, J.R. (1989). Pairs of Latin squares to counterbalance sequential effects and pairing of conditions and stimuli. In *Proceeding of the Human Factors Society 33rd Annual Meeting*, Santa Monica, CA: Human Factors Society.