Technical Report

Meta-Analysis of Preference for Split versus Standard Keyboards: Findings from 1972 to 1993

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May 11, 1995

TR54.899

Unclassified

Boca Raton, Florida

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ABSTRACT

A recent literature review of human factors studies of split keyboards through 1993 indicated very little consistency in outcomes among the experiments. This report presents a meta-analysis on the results of six experiments that investigated preference for standard versus split keyboards. This analysis revealed that user preference across the studies is in favor of standard rather than split keyboards.

Introduction

A recent literature review of human factors studies of split keyboards from 1926 to 1993 (Lewis, 1994) indicated very little consistency in outcomes among the experiments. Analyses of the variant outcomes suggested a significant relationship between split-keyboard inventorship and participants' unqualified preference for split keyboards. There appeared to be no relationship between experimental control of chair height or keyboard height and preference for split keyboards. Additional analyses (Lewis, 1995) indicated no significant relationship between prior standard typing experience or the amount of split keyboard experience and the outcomes of split keyboard experiments.

The review, however, did not include a meta-analysis of the experimental outcomes. For most dependent variables reviewed, it was not possible to conduct a meta-analysis due to insufficient statistical detail in the reports of the experiments. An exception to this was the information provided for keyboard preference. The purpose of this report is to document a meta-analysis of preference for split versus standard keyboards using the results of experiments conducted from 1972 to 1993.

Meta-analysis is relatively new to the literature of human factors, with only one having appeared in Human Factors (Damos, 1993), although the psychological literature includes hundreds of meta-analyses. Meta-analysis refers to a variety of statistical techniques for analyzing a body of separate but similar studies. Some techniques require as input estimates of effect sizes, and others use the observed significance levels of the reported statistical tests (Rosenthal and Rosnow, 1991). A recent Monte-Carlo comparison of effect size versus probability level methods found that unweighted combined significance tests gave results quite similar to those of a test based on weighted combinations of effect sizes, and, when variances are known, are equivalent to sample-size weighted means of sample effect sizes (Hedges, Cooper, and Bushman, 1992). The use of meta-analysis has been controversial (Mann, 1990), but the nature of the controversy has centered more on the merits of meta-analyses relative to traditional literature reviews than on the statistical foundations of meta-analysis (Hoyle, 1993; Mann, 1990; Schmidt, 1992).

Method

To track down appropriate references, the keywords for a series of electronic searches were SPLIT or ALTERNATIVE or ERGONOMIC with KEYBOARD or KEYBOARDS. The first electronic sources were four databases from the IBM Infogate service: Compendex, IBM Internal Reports and Patents, Inspec and ISI. The second set of electronic sources was from the Florida Atlantic University (FAU) library: ACM Computing Archives (1982-1992), Sociofile (1974-1991), NTIS (1980-1993), Science Citation Index (1991), PsychLit (1974-1993), Dissertation Abstracts (1861-1993),

Periodical Abstracts (1991-1993), Applied Science and Technology (1983-1993), Engineering Compendex (1980-1993), Social Science Index (1980-1993), Medline (1966-1993) and the Federal Documents Catalogue. In addition, all the indexes in the human factors books at FAU were searched for the keywords. The third source was our internal library, which includes Human Factors (1958-1993) and the Human Factors Conference Proceedings (1972-1992). Finally, the list of target references was completed by backtracking through the lists of references in the materials acquired in the first week of the search, ordering references from FAU's interlibrary loan department as required.

The final list (available in Lewis, 1994) included 44 references. Six papers from the split keyboard literature included data relevant to statistical tests of preference for split versus standard keyboards and provided enough detail for inclusion in a meta-analysis (Brigham and Clark, 1986; Douglas and Happ, 1993; Jahns, Litewka, Lunde, Farrand, and Hargreaves, 1991; Kroemer, 1972, Experiment 2; Lopez, 1993; Nakaseko, Grandjean, Hünting, and Gierer, 1985). The inclusion criteria for this meta-analysis were that the paper describe an experiment in which participants used both a split and a standard keyboard, had an opportunity to express their unqualified keyboard preference, and either reported the outcome of a statistical test or provided enough information to evaluate the outcome with a binomial test.

Results

Table 1 shows the preference results for each study. (For more detailed descriptions of the studies, see Lewis, 1994.) When the authors of the studies did not conduct their own statistical test, I conducted binomial tests to evaluate the experimental outcome. Using a method described by Rosenthal and Rosnow (1991), all the observed significance levels were converted to their corresponding Z-scores, as shown in Table 1. Note that the method requires the use of one-tailed probability levels. Results supporting the hypothesis that users prefer split keyboards received positive values, and those supporting the hypothesis that users prefer standard keyboards received negative values.

A meta-analysis of homogeneity demonstrated that the outcomes of the studies were significantly different (X^2=51.3, df=5, p=.00000048). Analyses that explore variables that could lead to these different outcomes appear in Lewis (1994; 1995). An unweighted meta-analysis to combine the observed significance levels of these six studies indicated that the overall outcomes strongly support the hypothesis that participants prefer standard to split keyboards (Z=2.569, p=.01). The tolerance of this result for future null results (resistance to the file drawer problem, described in Rosenthal and Rosnow, 1991) is considerable. There would have to be 77 unpublished studies with null results in researchers' file drawers before it would be reasonable to ascribe this overall result to the sampling bias created by the publication of only statistically significant findings.

Table 1. Summary of Preference Outcomes Reported in Split-Keyboard Experiments

Study	Description of Outcome	Type of Test	One-tailed Observed Significance Level	Z-Score
Kroemer (1972, Exp. 2)	17 of 19 participants who expressed a preference preferred the split keyboard.	Binomial	.00037	2.70
Nakaseko et al. (1985)	Comparing split and standard keyboards with similar rest areas, 16 of 25 participants preferred the split keyboard.	Binomial	.11	1.2265
Brigham and Clark (1986)	19 of 19 participants preferred the standard keyboard.	Binomial	.000038	-3.95
Jahns et al. (1991)	6 of 8 participants preferred the split keyboard.	Binomial	.14	1.0803
Douglas and Happ (1993)	Participants preferred the standard keyboard.	F-test	.0042	-1.9774
Lopez (1993)	Participants preferred the standard keyboard.	X^2-test	.00000015	-5.318

The test of homogeneity is $\Sigma(Z_i\text{-}E(Z))^2$, distributed as X^2 with K-1 degrees of freedom, where K is the number of studies.

The test of combined probabilities is $(\Sigma Z_i)/K^{1/2}$, distributed as Z, where K is the number of studies.

Discussion

Within the limits of the available experiments, meta-analyses of the outcomes of the split keyboard experiments demonstrated that user preference across the studies is in favor of standard rather than split keyboards, a finding that is strongly resistant to the file drawer problem. Considering results across the available literature, it is unlikely that users will tend to prefer split keyboards to standard keyboards. Instead, they seem to prefer standard keyboards.

Previous analyses (Lewis, 1994; 1995) have shown that there is no evidence that variables such as adjustment of chair height, adjustment of keyboard height, standard typing experience of participants, or amount of practice with the split keyboards systematically affected the outcomes of the experiments, which means that it is not currently reasonable to invoke any of these variables to explain the outcome of an experiment. The only situational variable that had a significant relationship with an experimental outcome was split keyboard inventorship with participants' preference for split keyboards (Fisher Exact Probability test, $p=.014$).

The reports of the outcomes of future split keyboard experiments should include a complete description of the statistical tests conducted to evaluate the results, including the test statistic, degrees of freedom, and the observed probability level to two significant digits. Including this level of statistical detail will allow future literature reviews to conduct more extensive meta-analyses than the current literature permits.

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