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Interviewer Reactions to Alternative Hardware for Computer-Assisted Personal Interviewing

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Abstract: This paper describes the results of laboratory-based tests examining interviewers' expectations and attitudes towards computer-assisted personal interviewing (CAPI), and their performance on four portable microcomputers differing in weight and mode of data entry (keyboard versus pad). This paper focuses specifically on the use of CAPI for interviews conducted while the interviewer is standing. Interviewers completed a series of tasks designed to determine what weight they could reasonably carry and/or hold in the course of their work. A series of mock CAPI interviews was conducted to measure performance using each of the computers. Finally, reactions to various features/components of the machines and feelings regarding the possible implementation of CAPI were obtained in a debriefing interview.

Key words: CAPI; laptop vs. handheld computer; keyboard vs. pad data entry; microcomputer ergonomics; interviewer expectations.

1. Introduction

Computer-assisted personal interviewing (CAPI) is an increasingly viable alternative for data collection in survey research. A number of survey organizations around the world already make use of this new technology (see for example Baker (1990), Bateson and Hunter (1991), Bernard (1989), Bradburn et al. (1991), Netherlands Central Bureau of Statistics (1987), Rothschild and Wilson (1988), Thornberry, Rowe, and Biggar (1991), Van Bastelaer, Kerssemakers, and Sikkel (1988)). Despite its increasing use, most publications on CAPI have only described feasibility tests, respondent reactions and particular applications. None previously have focused systematic research on alternative approaches to CAPI or on the possible effects of CAPI on aspects of the survey process such as the activities performed by the interviewer.

Interviewers are required to carry the CAPI microcomputer, to use the device in a wide variety of interviewing situations, to facilitate the transmission of data to a central location, and to care for the hardware. The reaction of the interviewer to CAPI is a critical element in the successful

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adoption of this technology. What we know about interviewers' reactions to CAPI, however, derives mainly from interviewer debriefings producing largely qualitative data (see Ingels, Mikros, and Cooke (1989) and Sebestik et al. (1988)). Various studies are in progress which may add more systematic evidence in the future (see Bradburn et al. (1991) and Statistics Sweden (1989)), but much of the knowledge we now have about the effect of this new method of data collection on the interviewer remains anecdotal in nature.

The anecdotal evidence has been sufficient to raise concerns about the possible effects of CAPI on the attitudes and behaviors of interviewers. A key concern identified in earlier studies (see NCHS and U.S. Bureau of the Census (1988), Sebestik et al. (1988)) is the physical demands on the interviewer resulting from the weight and bulk of the machines used. Additional concerns raised by interviewers include screen clarity, ease of data entry, battery life and other features of the CAPI hardware and software.

These concerns prompted a proposal for the series of laboratory-based studies described here to examine the effect of hardware features on interviewer reactions to CAPI. Although these studies may be limited in their generalizability to a full range of field settings, their utility lies in the potential for explicit comparisons of various CAPI features under experimentally controlled conditions.

2. Design of the Research

A series of tests was designed to address interviewers' reactions to and acceptance of CAPI technology within the context of the Bureau of Labor Statistics' (BLS) Consumer Price Index (CPI) surveys. Interviews for these surveys are relatively short (about 5 to 10 minutes) and are usually conducted while interviewers are standing at the sample addresses. In this respect, the CPI is somewhat atypical of many CAPI applications to date.

An evolving distinction in CAPI is that between interviews typically conducted sitting (using a laptop computer) and those usually conducted standing (using a handheld computer). The latter places more demands on the interviewer, and consequently also on the hardware requirements. This paper focuses on the application of CAPI for standing interviews.

Four computers were evaluated in this test, varying on two important dimensions – weight and entry mode. Entry mode may be by keyboard or by a keyboardless screen-based pad utilizing an electronic pen (stylus) or touchscreen. Two keyboard machines and two "pad" machines were evaluated to permit comparisons between "lighter" and "heavier" machines on the one hand, and between keyboard and pad machines on the other. These four computers will be referred to as LIGHT KEY, HEAVY KEY, LIGHT PAD and HEAVY PAD respectively.

The tests lasted about 90 minutes for each subject. Each test consisted of four parts: a self-administered questionnaire, physical tasks related to carrying and holding computers, use of a CAPI application, and a debriefing interview.

Each subject first completed a self-administered questionnaire covering the following issues: experience as an interviewer, health and stress issues, attitudes towards computers, experience with computers, expectations regarding CAPI, and background information.

The carrying and holding tasks used two boxes designed for this purpose. The first, for the carrying task, contained nine removable 1-pound (0.45 kg.) weights, which allowed the weight of the case to be varied

between about 5 and 14 pounds (between 2.3 and 6.3 kilograms). The box for the holding task was approximately the same dimensions as the file folders typically carried by interviewers. This box contained nine removable 1/2-pound (0.23 kg.) weights, with the weight varying between 1.5 and 6 pounds (between 0.7 and 2.7 kg.). The carrying box was also equipped with a removable shoulder strap, and the holding box with a neck strap.

Subjects completed three tasks with each of the carrying and holding boxes. In one task, weights were increased from the lowest level, while in the other task, weights were decreased from the maximum level. The order of these two tasks was randomized. Finally, the desirable weight using the strap was determined. Subjects were asked to carry or hold each weight level for a few minutes to determine whether they would be comfortable with that weight in the course of their work. The weights judged most desirable from the increasing and decreasing tasks were then averaged for each subject.

In the third part of the test, subjects were asked to conduct a series of mock CAPI interviews, one on each of the four computers used. Short mock interviews were designed with three requirements in mind: (a) to have subjects perform a variety of data entry tasks, (b) to give subjects a brief demonstration of some of the features of CAPI, and (c) to be simple enough for subjects to use with minimal instruction. The mock interviews contained 13 questions familiar to the subjects.

Although every attempt was made to make the interviews equivalent across the various machines used, different input devices prevented these from being identical. Both the display of information on the screen and the method of selecting response options differed across machines. Thus, it cannot be determined whether differences in performance across the various machines are attributable to different input methods or to other differences in screen presentation and layout.

Subjects were requested to conduct each interview standing. If this was not possible (e.g., because the computer became too heavy), they were instructed to sit and operate the machine on their laps (as opposed to using a table). The researcher played the role of the respondent in each case, following a set script of responses. The order of use of the four machines was randomized to balance possible learning and fatigue effects. Following the mock interviews, subjects were asked a series of questions to elicit their reactions to various features of the machines used, and to CAPI in general.

3. Sites and Subjects

The tests were conducted during the winter of 1990 with a total of 70 subjects (BLS interviewers). Subjects were tested at seven of the bureau's regional offices. Neither sites nor subjects were randomly selected. However, regional office staff was requested to select a variety of interviewers from their region in terms of age, gender, physique, experience at BLS, and knowledge of computers.

The majority of subjects tested were female (86%). The subjects' ages ranged from 22 to 72 with a mean of 49.6 years. The subjects appear fairly typical of many field interviewing staffs. Not only are the vast majority of face to face interviewers female, but they also tend to be somewhat older persons. This is expected to affect the physical capacity of interviewers to handle various machines. This older group is also more likely than the general population to experience various health problems, and more likely to use corrective lenses, again

*Table 1. Percentage of subjects reporting physical problems**

	Experienced problem (%)	If yes, work related (%)
Neck	43	47
Shoulders	39	59
Arms	31	73
Wrists/hands	27	58
Upper back	20	64
Lower back	41	38
Legs	31	32

*Base of percentages in this and other tables is 70 subjects.

affecting their ability to deal with CAPI hardware.

Despite the inability to generalize to all interviewers and field situations, this study provides the opportunity to test some initial ideas and develop hypotheses regarding the potential effect of CAPI on survey interviewers. These tests elicit the initial subjective reactions of interviewers to certain aspects of the new technology. Such reactions may play a key role in interviewers' eventual acceptance of, or opposition to, CAPI.

4. Questionnaire Responses

A series of questions were included to obtain baseline measures of stress and health problems currently experienced and to examine the potential effect of CAPI on these issues. These questions were taken from Statistics Sweden (1989). Subjects were asked whether, over the past 12 months, they had suffered aches, pains, or any other types of problems with various parts of their bodies. For those who responded in the affirmative, they were asked whether they thought this problem was related to their data collection work.

One quarter of subjects reported no health problems, while 45% reported three or more problems. As shown in Table 1, neck, lower back, and shoulder problems are the most frequently reported by subjects. These could all be associated with, or aggravated by, the carrying of heavy loads. On average, in about half these cases, such problems were attributed by the subjects to their work as interviewers. This has two implications. One is that any examination of health problems potentially caused by CAPI should be interpreted in the context of existing levels of complaints. The question becomes whether CAPI will significantly increase the number or severity of health-related complaints already existing among interviewers. Second, given the relatively high levels of existing problems reported, the new technology could potentially be blamed for a variety of ailments that presently go unreported.

Subjects were also asked whether they ever suffered from aching, tired or sore eyes in their work (43% said yes), or from headaches (23% said yes). The majority of subjects (83%) wear some form of corrective lenses (glasses or contact lenses) in their work, with 43% of all subjects wearing bifocals. Bifocals might present particular problems for CAPI interviewers, focusing as they do on the keyboard, screen, and respondent.

5. Carrying Task

To put the results for this task into perspective, the four machines used in the tests were weighed in their carrying cases with ancillary equipment (batteries and AC adapters). The typical carrying weights for these four machines are presented in Table 2.

In contrast, the mean weight comfortably carried by subjects was 7 lb. 12 oz. (3.52 kg.), with a standard deviation of 29 oz. (0.82 kg.). The average weight comfortably carried with the shoulder strap was 8 lb. 3 oz. (3.71 kg.). This is significantly

Table 2. Carrying weight of computer (with case, battery and adapter)

LIGHT KEY	7 lb. 0.5 oz.	3.19 kg.
HEAVY KEY	10 lb. 14.5 oz.	4.95 kg.
LIGHT PAD	6 lb. 6.0 oz.	2.89 kg.
HEAVY PAD	9 lb. 5.0 oz.	4.22 kg.

Table 3. Holding weight of computer (without case or adapter)

LIGHT KEY	4 lb. 4.0 oz.	1.93 kg.
HEAVY KEY	7 lb. 2.0 oz.	3.23 kg.
LIGHT PAD	5 lb. 8.5 oz.	2.51 kg.
HEAVY PAD	7 lb. 3.0 oz.	3.26 kg.

($p < .01$) higher than the mean weight carried without a strap. The majority of subjects (81%) said they liked the shoulder strap, and would use it at least some of the time. However, the general sentiment was that this should be optional. In other words, the computer should not be so heavy that a strap is required.

The subjects performed the weight tests before they used any of the four computers. A third of the subjects (36%) chose an acceptable weight for carrying that was less than the weight of the lightest computer tested. This raises the question whether acceptable weight levels should be based on some average measure or a minimum threshold.

It should also be remembered that the weight obtained was not based on actual interviewing, but on a brief simulation in an artificial environment. Given that subjects may well underestimate the weight they will be able to carry after a period of adjustment, these computers may be within the range that interviewers can reasonably be expected to *carry* in the course of their work. Whether they are light enough to permit use while standing and holding the machine is more doubtful.

6. Holding Task

The weight of the four computers as used in the mock interviews (using batteries rather than AC power) is found in Table 3.

The mean weight comfortably held by subjects was 3 lb. 10 oz. (1.64 kg.), with a standard deviation of 14 oz. (0.4 kg.). This is less than the weight of any of the four computers tested. Based on the weights held, only 14% of subjects would be able to hold the lightest of the four computers comfortably while interviewing.

Again, the external validity of these results could be questioned. Nevertheless, the weights determined in these tests give an indication of the range of comfort as expressed by interviewers. Based on a series of ergonomic studies in the early 1980s, Statistics Sweden (see Lyberg 1985) determined the ideal weight for a handheld CAPI computer to be 1 kg. (2.2 lbs.).

The average weight held with the neck strap was 3 lb. 15 oz. (1.79 kg.). This is significantly higher than the average weight held without the neck strap. However, when asked how they felt about the neck strap, 53% of subjects said they did not like it. Interviewers complained of looking foolish using the neck strap. In addition, the straps may interfere with the operation of the computer. A neck strap does not appear feasible to permit the holding of heavier loads while interviewing, but may be considered as an option for those interviewers who desire such additional support.

These findings raise some questions. Should decisions about the machine weight be based on some average measure (as reported above), or on some minimum threshold? Will interviewers adapt easily to the increased burdens associated with using a computer, or will health issues become a major concern? What weight will interviewers be prepared to tolerate in order to

Table 4. Preferred position during use of computer (in percent)

POSITION	LIGHT KEY	HEAVY KEY	LIGHT PAD	HEAVY PAD
Standing	81	62	81	77
Sitting	6	18	4	7
Standing, then sitting	13	20	14	16

maximize other features of CAPI, such as screen visibility, battery life, etc.?

7. Mock Interviews

7.1. Position of interviewer

The position chosen by the subjects for holding the computer while conducting each interview is presented in Table 4. Subjects were requested to stand if they could. Some sat immediately upon being handed the computer, while others began the interview standing, but sat down at some point during the interview.

Despite the fact that all four computers weighed more than the average weight held by subjects in the first test, the majority were able to hold each of the computers while interviewing. However, only 59% of subjects were able to conduct interviews with all four computers while standing. Furthermore, those who stood throughout the test were not necessarily comfortable doing so. Many made comments about the weight of the machines. On average, the mock interviews involved a total standing time of less than 20 minutes. Whether subjects would be able to stand and hold these machines repeatedly throughout a full interviewing day cannot be determined from this brief test.

7.2. Length of interview

The time each subject took to complete the mock interview was recorded using the computers' internal clocks (Table 5).

Interviews on the keyboard machines were significantly ($p < .01$) faster than on the pad machines. This time difference could be attributable either to the novelty and unfamiliarity of the pad machines relative to the keyboard machines, or to inherent design differences between the two types of computers. Further testing is necessary to determine whether such differences disappear after prolonged use.

7.3. Error rates in mock interviews

The mock interviews were designed to test the use of various key combinations while operating the computer in a standing position. Given that the researcher (in the role of respondent) gave set responses to each question, the number of errors made in response to various questions could be determined. Three types of questions were included in the mock interviews.

a. Closed-ended questions

Six closed-ended questions (involving yes/no answers or choices from a list of responses) were included in the instrument. The percentages of subjects making one or more

Table 5. Average completion times for mock interviews by machine (in seconds)

Machine	Mean	Standard deviation
LIGHT KEY	171.2	42.9
HEAVY KEY	186.0	48.8
LIGHT PAD	228.0	60.2
HEAVY PAD	229.4	74.0

Table 6. Percentage of subjects making errors on three questions

	Own name	Respondent's name	Telephon number
LIGHT KEY	3	4	9
HEAVY KEY	8	5	14
LIGHT PAD	59	48	58
HEAVY PAD	29	31	31

errors on each of the machines are as follows: 20% on the LIGHT KEY, 17% on the HEAVY KEY, 13% on the LIGHT PAD, and 10% on the HEAVY PAD. Subjects tended to make slightly more errors when entering numbers on a keyboard than when selecting an item from a menu by pressing or tapping that item on a screen.

The findings on error rates should be treated with caution. The mock interviews were conducted without prior training on any of the four machines, and subjects were aware of the experimental nature of the tests. Thus they may have placed less emphasis on the accuracy of the responses recorded. Error rates will obviously differ greatly in a production environment. (For some indication of the level of entry errors that might be expected under production CATI (rather than CAPI) conditions, see Kennedy, Lengacher, and Demerath (1990).)

b. Numeric input

Three questions requiring numeric input (e.g., entering a dollar amount) were included. The percentages of subjects making one or more errors on these three questions on each machine are as follows: 7% on the LIGHT KEY, 12% on the HEAVY KEY, 43% on the LIGHT PAD, and 39% on the HEAVY PAD. In contrast to the closed-ended questions, subjects made significantly more errors on the two pad machines when asked to enter numeric information. On the LIGHT PAD this required writing the numbers in the box provided, while on the HEAVY PAD a row of numbers was displayed on the bottom of the screen and the subject had to tap in the response.

c. Alphanumeric input

Subjects were given three tasks requiring alphanumeric input. They were asked to enter their own names, and the name and telephone number of the "respondent." The percentages of subjects making errors on each of these questions appear in Table 6.

Incorrectly spelled names were regarded as errors, while mistakes in formatting or upper/lower case were not counted. The high error rate for the LIGHT PAD is indicative of the problems subjects had with the handwriting recognition. Not only did subjects make more errors on the two pad machines, but they also took more attempts to enter the information.

The trends for error rates for alphanumeric input parallel those for the open-ended questions requiring numeric input. When subjects are required to type or write in information, they perform worse on the pad machines than on the keyboard machines. However, this appears to be reversed when input requires the selection of an item already displayed on the screen.

The above results should be seen in relative rather than absolute terms. If these differences in error rates across machines persist after training and prolonged use, it may be prudent to base the choice of the

type of machine to use for CAPI on the kind of data that the interviewer will typically enter. For example, if the entry of a large amount of open-ended information is required, a keyboard machine may be more practical. On the other hand, if most of the data entered takes the form of closed-ended responses, a pad machine may be more feasible. It is important that further research be directed at whether or not these relative differences in errors and speed using different input devices persist after a period of use, and under varying conditions.

8. Debriefing Interview

Subjects were asked to rank six components of a CAPI machine in order of importance. A score of 6 was assigned to the most important component and 1 to the least important. Average rankings and the percentage of respondents ranking each component as most important are seen in Table 7. The importance of weight to interviewers is clearly evident from the responses to these two measures.

Subjects then ranked their preference for the three modes of data entry used. A score of 3 was assigned to the most preferred, and 1 to the least preferred. The average rankings and percentages of respondents ranking each mode as most preferred are in Table 8.

These responses indicate no clear preference for one mode of data entry over another. Subjects were also asked to compare the four computers on a variety of features. The percentages preferring each machine on each feature are presented in Table 9.

Table 7. Subject rankings of various components of computers

	Average ranking	Percent ranked most important
Weight	5.2	60
Data entry	4.4	29
Screen	3.8	7
Balance	3.5	4
Speed	2.6	0
Appearance	1.3	0

Table 8. Subject rankings of input modes

	Average ranking	Percent ranked most preferred
Keyboard	2.1	41
Light pen	2.0	33
Touchscreen	1.9	26

The two pad machines are preferred by 59% of subjects for data entry. Moreover, although subjects took longer to complete interviews on the two pad machines, these two machines were preferred over the keyboard machines for speed. The same is true for ease of use, despite the higher error rates for the two pad machines. These reactions point to the future potential of the pad machines given sufficient practice (and

Table 9. Preferences for computers in terms of various features (in percent)

Feature	LIGHT KEY	HEAVY KEY	LIGHT PAD	HEAVY PAD	NONE
Weight	73	3	23	1	0
Balance	40	6	40	14	0
Data entry	26	16	29	30	0
Screen	23	49	17	11	0
Speed	16	17	21	29	17
Ease of use	27	9	30	34	0
Overall appearance	51	19	16	13	1

improvement of the handwriting recognition software).

Subjects were asked to select which of the four machines they would choose to use in their work: 43% selected the LIGHT KEY, 9% the HEAVY KEY, 30% the LIGHT PAD, and 19% the HEAVY PAD. Of those who selected the LIGHT KEY, 80% mentioned weight as the reason for their choice. Of those who selected the LIGHT PAD, 67% mentioned the handwriting recognition or the use of the light pen, or both, while 77% of those selecting the HEAVY PAD mentioned ease of use as the reason for their choice.

It is clear from these responses (and from the selection of features above) that people prefer different machines for different reasons. No one machine among the four appears to meet all the needs of interviewers. Only 4% of subjects selected the same machine on all seven features listed in Table 9. The majority chose each of the machines at least once, again indicating that each computer has at least one feature on which it is preferred over the others.

9. Conclusions

This study has examined a number of issues relating to interviewers' reactions to the use of CAPI, particularly for interviews conducted while standing. It is clear that the weight of the computer is a key element in interviewer acceptance of CAPI. However, the choice of a CAPI machine will inevitably involve some trade-off or compromise. Certain features (screen, battery life, weight, price, etc.) may be valued at the expense of others (ruggedness, storage capacity, etc.). Recent developments make it likely that a computer light enough and small enough to satisfy these experimental subjects will soon be available (if one is not available by the time of publication).

No clear choice is apparent at this writing on the most suitable mode of data entry for CAPI. Neither the handwriting recognition nor touchscreen machine performed as well as "traditional" keyboard computers in terms of speed and errors. However, such differences could well disappear given sufficient familiarity with and training on these machines. Moreover, these technologies are still in their relative infancy. New developments should make these systems easier to use and less error-prone in the future. Furthermore, the choice of the appropriate method of data entry should depend in part on the type of information (closed-ended vs. alphanumeric) to be entered.

Pad machines may offer greater potential in terms of reductions in weight, improved balance and handling, and better eye contact. The question of the relative strengths and weaknesses of typing versus handwriting recognition, and touchscreen versus keyboard remains unresolved. Again, it seems wise to conduct further testing using various input modes and to evaluate new developments in such technology, before a decision is made regarding the best mode of data entry for specific CAPI applications.

Despite the difficulties experienced by subjects in these tests, the majority nevertheless held positive attitudes toward CAPI, and indeed looked forward to its introduction. Nevertheless, these tests raise certain questions for the future. As hardware developments solve weight problems and bring a greater variety of potential CAPI computers to the fore, attention will likely begin to turn to issues such as mode of input, screen design, and layout.

Thus far, issues of machine feasibility have been a predominant concern. As technical hurdles are overcome, the human aspects of the new technology may gain prominence. As the human interface between the researcher and the respondent,

the interviewer is expected to play a key role in the degree of success of this new method.

Given the progress of CAPI in recent years, the question has become less one of whether or not to adopt this new technology. Rather, the issue is which combination of hardware, software and procedures are most suitable for a particular application, and what effects such choices will have on data collection staff, respondents, and data quality.

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