Who's Zooming Whom? Attunement to Animation in the Interface

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A number of references in the Human–Computer Interaction literature make the common-sense suggestion that the animated zooming effect accompanying the opening or closing of a folder in the Apple Macintosh graphical user interface aids in a user's perception of which window corresponds to which folder. We examine this claim empirically using two controlled experiments. Although we did not find a statistically significant overall difference resulting from the presence or absence of the zooming effect, a post hoc analysis revealed a highly significant interaction between the experience of users with the Macintosh user interface and the zooming effect. This individual difference suggests that users may become attuned to the informational content of the zooming effect with experience.

Introduction

While the design of user interfaces has often relied on guidelines drawn from practice and ''look and feel,'' the field of Human–Computer Interaction (HCI) has sought to derive principles for design from cognitive theories of human information processing. The motivation for this work is to provide a more reliable basis for designing interfaces than common-sense or intuitive appeal. For example, the Goals, Operators, Methods, and Selection Rules (GOMS) model of Card, Moran, and Newell (1983) is a well-known formalization of the production rule approach to modeling cognition. This approach has achieved modest success, particularly in the analysis of interfaces for repetitive, non-discretionary tasks, although it has been argued that a strong theory of HCI cannot be drawn from this approach (see Landauer, 1995).

As interface developments increase the range of options for design, and hypermedia applications support a form of interaction based on pointing and clicking, users frequently open and close windows of information in rapid succession. In the studies detailed below, we examine the effect of the presence and absence of the zooming effect displayed when a folder is opened or closed in the Macintosh user interface. This effect carries the information that a particular window is associated with a particular folder on the Macintosh desktop. In some other windowing systems, the default behavior, when an icon is opened into a window or a window is closed into an icon, does not include such an effect.

Common-sense suggests that such animation is likely to be useful, as indicated by several writers. For example, Baecker and Small (1990) state:

> The outline zoom that accompanies the opening (and closing) of an icon orients the user to the location and origin of the new window that appears on the desktop. This is particularly helpful in a crowded environment. If the new window were to appear without the opening zoom, it would be more difficult for the user to determine that he had indeed opened the correct icon. The closing zoom assists in informing the user where he was working before he started the process that has just been completed. (Baecker & Small, 1990, p. 259)

May and Barnard (1995) assert: ''Salient information or objects should not just appear or disappear from the screen,'' and cite as a rare commercial application of this phenomenon the Macintosh Finder, where windows ''zoom'' in and out of their parent folder or application icons. (p. 30) Chang and Ungar (1993) make reference to the absence of such an animated effect accompanying the opening of a window, stating that in some windowing systems, ''Much of the screen changes suddenly and without indication of the relationship between the old state and the new state.'' (p. 45)

It is possible to derive broad theoretical support for these contentions. For example, the ecological, or Gibsonian, approach to perception/action research (Gibson, 1986) provides a framework upon which we can begin to conceptualize the process of interaction (Vicente &

Rasmussen, 1990). This approach emphasizes the shaping forces of environments in influencing cognition and has been employed by Vicente and Rasmussen to develop a framework for interface design called Ecological Interface Design (Vicente & Rasmussen, 1992). One output from this line of research is the view that temporally extended events in the environment are fundamental sources of stimulus for the perceptual system. Living organisms become attuned to various events that are specified by trajectories through time. As such, animation in the interface is likely to afford benefits to users seeking to identify locations and spatial arrangements.

One could make a similar case for animation within the more traditional information processing model of cognition (Eysenck, 1983) where the information provided by movement could be viewed as ''extra'' data for a perceiver to work on. The differences are subtle, but for ecological psychologists, animation would be more than extra data, it would be fundamental to cognition. While it is not our intention to resolve this issue, both perspectives seem to suggest that animation might be a useful addition to the user interface.

However, despite these assertions of the enhanced usability brought by the inclusion of this feature in the interface, and its continued inclusion (indeed, elaboration, in Apple's planned Copland interface) in the Macintosh interface, there is a paucity of empirical studies investigating these assertions. The following studies explore this territory. It was hypothesized that enabling the zooming effect will increase the subjects' memory association between folders and windows, and/or the speed with which they accomplish tasks that require knowledge of this association. In so saying, these experiments are tests of a common-sense interpretation of the value of temporal extensions in interface design (a necessarily conservative approach that seems justified given the history of failure associated with other common-sense ideas of good interface design, e.g., Grudin, 1989).

Experiment 1

In the first instance, subjects were required to perform a search task involving opening and closing of multiple windows seeking a target match.

Method

Subjects. Ten graduate students (5 female, 5 male), from Indiana University and Georgetown University, volunteered to participate in this study. Five of the subjects were regular (daily) users of Apple Macintosh computers, but all 10 subjects knew how to use a mouse to open and close folders.

Materials. Nine different displays were created on a Macintosh ''desktop.'' Each display was similar, consisting of six folders arrayed along the bottom of the screen, and six folders arrayed along the right side of the screen (Fig. 1). This configuration was chosen because informal observations of typical Macintosh desktops showed that users would commonly place often-used folders in those positions. Folders were numbered from 1 to 12, beginning in the bottom-left corner, and ending in the top-right corner.

Each of the 12 folders opened into a window, displayed in a random location on the screen, containing a single file. Nine categories of words were used to generate names for the files: Months, fonts, Macintosh programs, Macintosh control panels, computer companies, male names, female names, academic disciplines, and sports. All of the files in a given display were given names from the same category. Two of the files, in each display, were given identical filenames. These matched pairs were selected at random, with the only constraint being that they were not placed in adjacent folders.

These displays were presented on an Apple Macintosh IIci, with a 21-inch Radius color screen. Using a utility called 7Tuner1.7, two copies of the System 7.1 Finder and System files were created—one with the zooming effect enabled, the other with the zooming effect disabled.

Design and procedure. After a practice trial, subjects performed the task on the eight remaining displays grouped into four blocks of two, with order of display counterbalanced across subjects.

Subjects were seated individually in front of the computer, and shown the practice display. It was explained that each folder only contained a single file, and that the subject's task was to discover the two folders containing files with identical names. The subjects were instructed that they were to open only one folder at a time, i.e., they had to close each folder's window before opening the next folder. However, they were instructed to open both of the folders that contained files with identical names when they had found the match. Subjects were informed that their performance would be timed, and that they would be asked to recall the folder in which specific files were located, but that their primary goal was to locate the match as quickly as possible.

Before each trial, subjects were told from what category the filenames were generated, e.g., ''months of the year.'' Timing of the task, by stopwatch, began when a subject clicked on a folder, and ended when the two folders with matching files were both visible on the screen. A record of every folder the subject opened and closed while searching for a match was also kept. Finally, after each trial, the subject was presented with a list of the names of all of the files in the display, and instructed to write the numbers of the folders in which the files could be found.

Results

Speed.[1] Mean time to open and close a folder in the zooming condition was greater (mean = 3.96 seconds,

[1] Data from one trial in the zooming condition, and one trial in the non-zooming condition, were discarded as a result of unexpected environmental distractions.

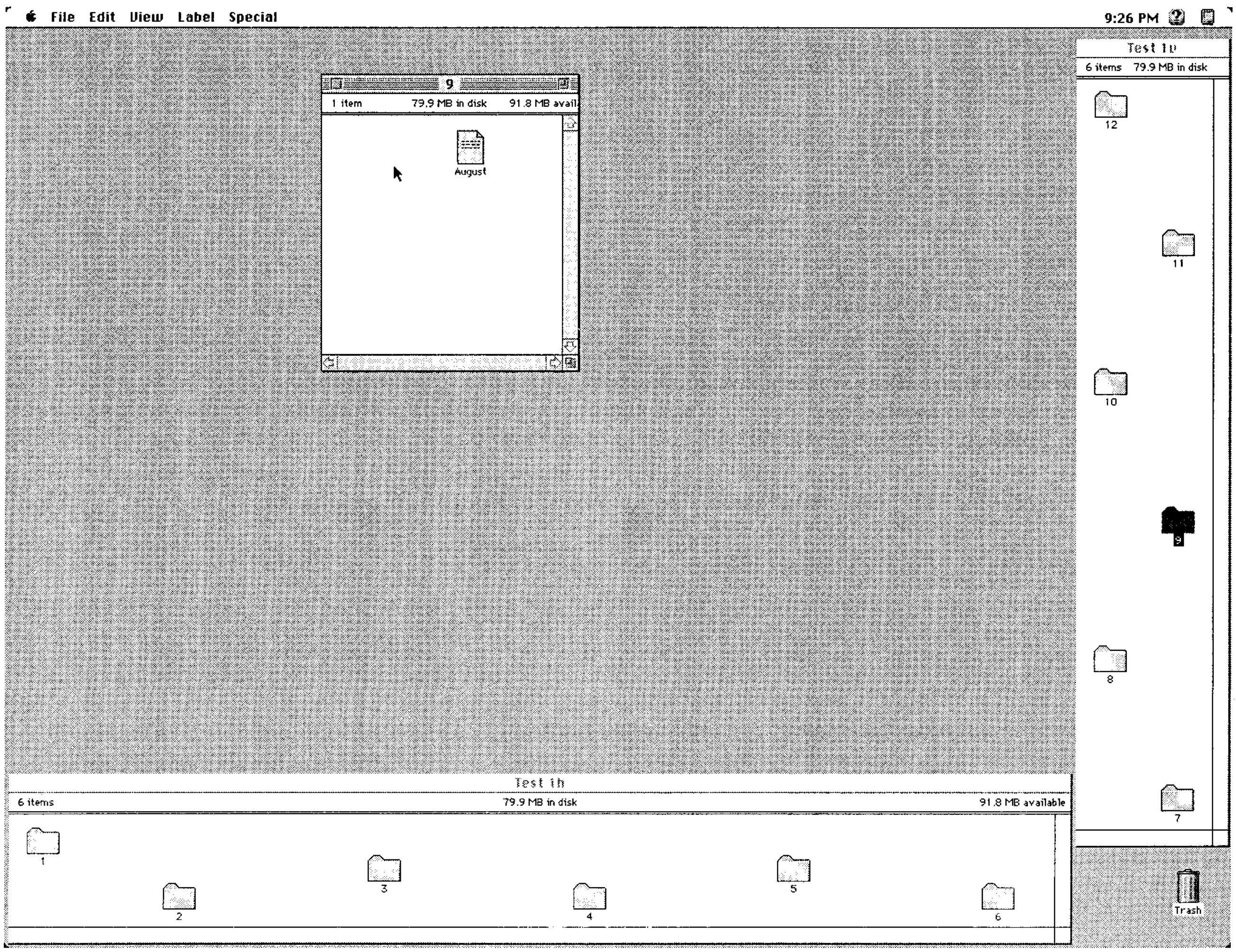

FIG. 1. Screen shot of example display.

SD = 0.67) than in the no-zooming condition (mean = 3.87 seconds, SD = 0.6), although the difference does not reach statistical significance ($F(1) = 0.77$, $p = 0.388$).

Number of folders required to find match. Using the record of folders visited, the number of folders the subject visited after they have seen the matching files was calculated. If the subject had perfect memory for location, then the minimum number of folders required to find the matching folder would have been one [i.e., when the first matched (second seen) item was noted, the subject would then select the folder containing the first seen item of the pair]. With less than perfect memory, the subject would need to search for the matching target, and the number of folders required to find a match would increase. The results are shown in Table 1.

TABLE 1. Number of folders required to find match.

Number of folders opened	Zoom enabled	Zoom disabled
Per task—mean (SD)	3.26 (3.23)	3.72 (3.97)
Total—mean (SD)	12.44 (4.01)	13.0 (4.76)

Although the mean number of folders required to find a match was greater in the non-zooming condition, this difference was not statistically significant ($F(1) = 0.24$, $p = 0.626$).

Distance to first response during trial. As a measure of memory for location, we calculated the distance in ordinal location from the first folder opened after the subject had seen a match, to the folder which actually contained the matching file. Hence, the minimum value of this statistic, given that a subject has perfect memory for location, is zero. If the subject selected a folder adjacent to the correct folder, than this statistic will be scored a one. It should be noted that this is not a direct spatial measure but an ordinal one. With zoom enabled, the mean distance was 1.67 folders (SD = 2.74) compared to a mean of 1.41 (SD = 2.01) in the zoom disabled condition ($F(1) = 0.32$, $p = 0.58$).

Post-trial memory. Users were given a sheet with the names of all the files and were asked to write the numbers of the folder in which the files were located. We calculated the ordinal distance (as above) from reported location to the actual location of the folder visited immediately after the subject visited the first of the matching pair of folders.

Subjects more accurately reported the location of the folder when zooming was enabled (mean (SD) = 3.93 (5.42)) rather than disabled (mean (SD) = 5.2 (5.95)). Although not significant statistically ($F(1) = 1.51$, $p = 0.229$), the difference is in the hypothesized direction.

Clearly, the simple provision of the zooming effect is not a straightforward benefit to users, as seems to have been assumed in the literature. From a design perspective, the general preference for zooming suggests it may be worth keeping for most users, but at a theoretical level, the reasons for retaining or advocating its use are not so clear.

In post-task interviews, none of the subjects reported having noticed the zooming windows effect appearing and disappearing. This would seem to indicate that whatever effect the presence or absence of the zooming event has on cognition, there is little conscious awareness of it.

It became clear that subjects were employing a variety of mnemonic techniques in order to improve their probability of succeeding at the task. All subjects reported that they had begun rehearsing either the names of the various files, or the first letter in each filename, as they proceeded through a trial. The use of numbered folders also enabled subjects to use numbers as cues for memorization. The variability in subjects' ability to use these techniques could have swamped the lower-level perceptual effect we were attempting to study. In fact, much of the variability in the samples was accounted for by large individual differences.

In order to pursue this issue further, a revised methodology was developed and further data collected. In the following experimental design, a less cognitively complex task involving a higher rate of presentation was employed to prevent the effective deployment of higher-level memorization strategies. If zooming effects were likely to have any effect on user cognition, such a task was more likely to expose them.

Experiment 2

Method

Subjects. A total of 26 students at Indiana University volunteered to participate in this study, 13 male and 13 female.

Materials. Forty different displays were created on a Macintosh desktop. Each display was similar, consisting of four folders arrayed along the right side of the screen (Fig. 2). This configuration was again chosen as this is the default location for new folders created on the Macintosh desktop. The names of the folders were concealed.

Each of the four folders in a display opened into a window, displayed in one of the four equally-sized quadrants of the screen not used to display the four folders. These displays were presented on an Apple Centris 610, with a 12-inch color screen. As before, two versions of the experimental folders were created.

Design. Each subject was tested on all 40 displays. The displays were grouped into four blocks of 10, alternating between ''zooming enabled'' and ''zooming disabled.'' Order of presentation was counterbalanced across all subjects.

Procedure. Subjects were seated individually in front of the computer. For the first two blocks of 10 displays, the four folders in each display were opened in random order. The experimenter then pointed to one of the opened windows and asked the subject to which folder that window corresponded.

For the second two blocks, the trials began with the four folders already opened into four windows, one in each quadrant. The four windows were closed in random order. The experimenter then pointed to one of the folders, and asked the subject in which quadrant the corresponding window had been displayed.

Results

Subjects performed both tasks with greater accuracy, and less variance, when the zooming effect was enabled (see Table 2). However, as before, these differences are not statistically significant at the $p < .05$ level.

In order to explore these differences further, several post-hoc analyses were performed. Subjects could be distinguished in terms of their experience with Macintosh computers (half of the subjects reported that 50% or more of their uses of personal computers were of a Macintosh). Therefore, incorporating Macintosh experience as a factor operationalized in this manner enabled a three-way ANOVA (zoom × task × user) to be performed. The results indicated that the subject's experience with Macintosh systems is a significant factor in performance (Table 3).

The interaction between type of user and zooming effect was highly significant, accounting for 48% of the variance in the sample. Figures 3 and 4 show the mean accuracy for each user type in both tasks.

In the opening tasks, Macintosh users were more accurate than non-Macintosh users when zooming was enabled (mean 6.23 compared to 4.77), while the opposite relationship held in when zooming was disabled (mean 4.69 to 5.08).

For the closing task, a similar relationship held. Macintosh users were more accurate when zoom was enabled (mean score = 5.08 compared to 4.15) but less accurate when zoom was disabled (mean score = 4.38 compared to 4.62). Post-hoc tests indicate that the difference between Macintosh users performance with zoom enabled or disabled is significant for the opening task (one-tailed $t = 3.397$, $df = 24$, $p = 0.001$).

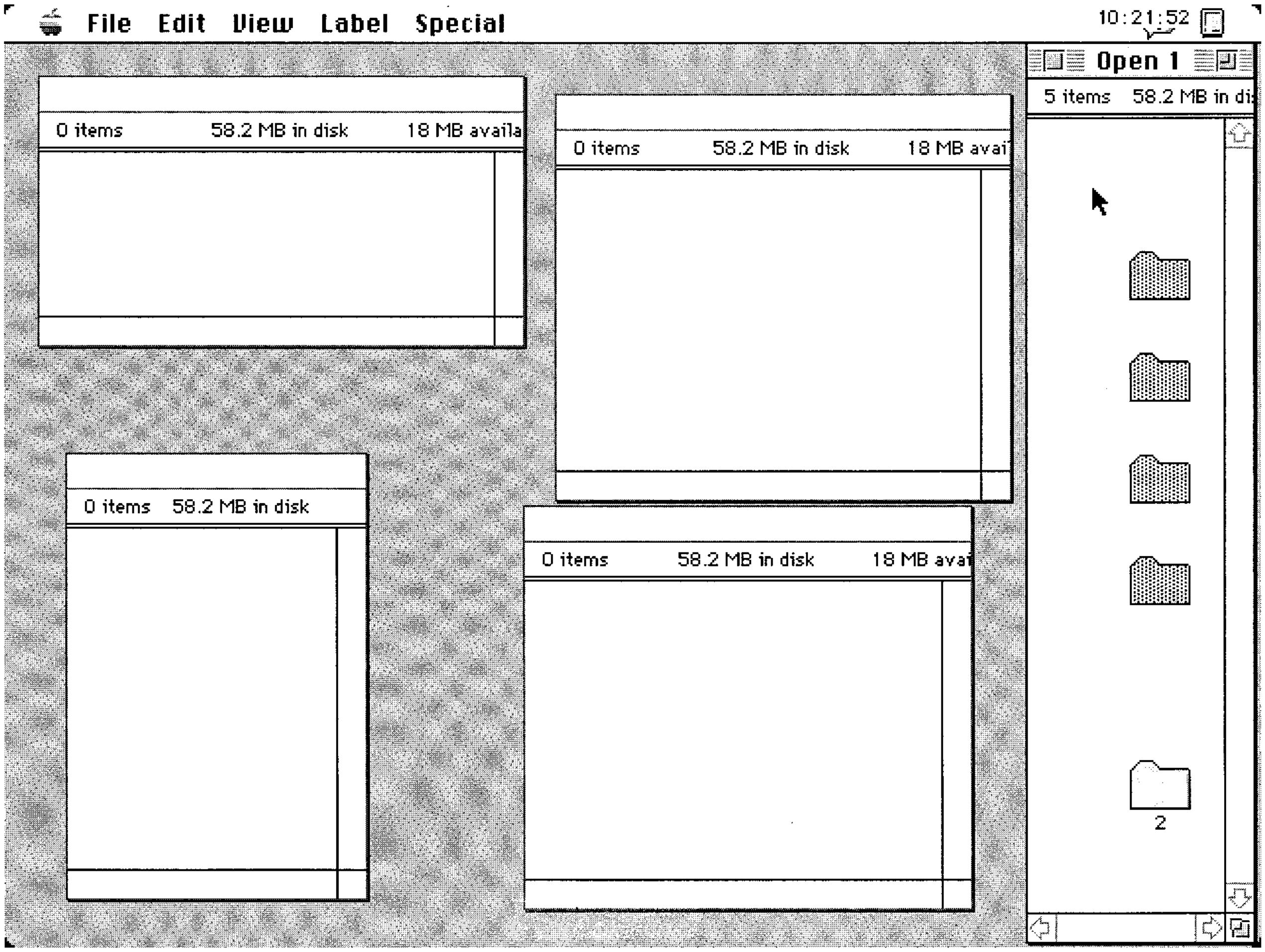

FIG. 2. Screen shot of example display.

Qualitative data. All subjects reported that the second ''closing'' task was more difficult than the ''opening'' task. The display time required to close four windows was less than the time required to open four windows. Clear preference for zooming enabled was obtained, 23 out of the 26 subjects (88%) reported preferring the zoom effect enabled rather than disabled.

Subjects reported using a number of different strategies in order to improve their odds of successfully completing each trial. These strategies included: Numbering either the folders or the quadrants and attempting to memorize the order in which they were involved in the display; attempting to memorize the spatial sequence in which the folders and windows were involved in the display; and focusing one's attention on the spatially more compact group of folders, while using peripheral vision to observe the location of the relatively larger windows. In the reportedly more difficult closing task, several subjects abandoned all hope of correctly memorizing the entire sequence of events, and reportedly focused their attention on specific parts of the display (e.g., the first and last folders closed, or a specific folder), hoping that they would be queried first about one of those parts.

Discussion

Although the data did not indicate a clearly significant performance advantage for the zooming effect, our post-hoc findings suggest a significant interaction between the zooming factor and user experience. While we intend to conduct further analysis of this effect with experience on zooming interfaces manipulated a priori, it seems that

TABLE 2. Accuracy matching folders with windows.

	Opening		Closing	
Task—zoom	Enabled	Disabled	Enabled	Disabled
Mean (SD)	5.5 (1.86)	4.88 (2.41)	4.62 (1.77)	4.5 (1.84)

TABLE 3. ANOVA partial summary table for accuracy data.

Source of variation	SS	DF	MS	F	p
Within + residual	27.15	24	1	13	
Zoom	3.47	1	3.47	3.07	0.093
User by zoom	14.62	1	14.62	12.93	0.001

users of the Macintosh interface are more sensitive to the zooming effect.

Theoretically, we can understand the differential effect of the zooming factor on Macintosh users as a type of temporally-extended, information-bearing pattern to which they have become attuned through repeated exposure. The discovery of such attunements is characteristic of the ecological approach to psychology, which emphasizes the interaction between the organism and the environment, rather than just the abilities of the organism (Vicente, 1995). While our results do not directly resolve any debate between the ecological and information-processing approaches to perception research, they do illustrate the value of the ecological perspective in suggesting empirical examination of a neglected aspect of the interface.

In terms of interface design, it is clear that apparently advantageous features might not be enhancing performance as expected. Interface designers should adopt a cautious attitude to ''common-sense'' views of good design where there is little evidence to support their view. Researchers and theorists of HCI need to develop a more

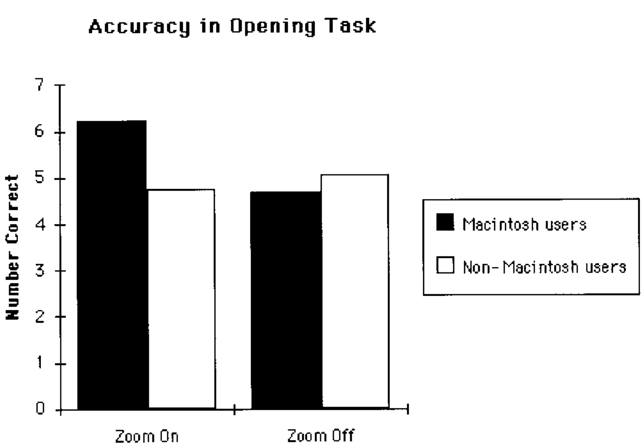

FIG. 3. Mean accuracy scores for users in opening task on both interfaces.

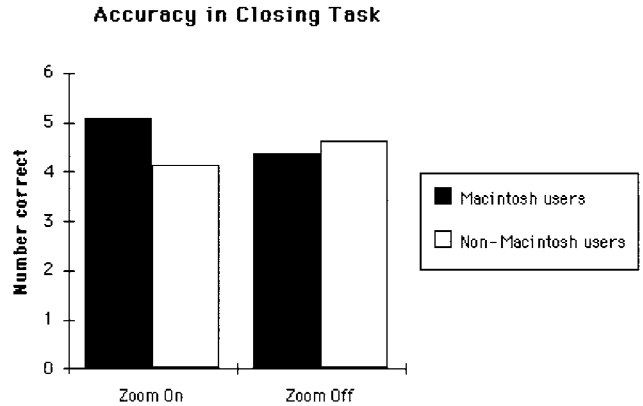

FIG. 4. Mean accuracy scores for users in closing task on both interfaces.

critical attitude to claims for the cognitive compatibility of animation in user interfaces. Further research could usefully explore the relationship between animation and experience.

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