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Comparison of Relative Versus Absolute Pointing Devices

Kent Norman
Kirk Norman

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Kent L. Norman
Department of Psychology, University of Maryland, College Park, MD
Kirk D. Norman
Information Systems, University of Maryland Baltimore Campus, MD
Contact: klnorman@umd.edu

ABSTRACT

In this study, a relative pointing device was compared with two different absolute pointing devices. Participants used a Wii Remote™ controller with the Wii MotionPlus™ attachment in three different configurations of motion sensing: Relative (6-axis: 3-axis accelerometer and 3-axis gyroscope), Camera Absolute (camera only), and Stabilized Absolute (camera + 6-axis). Twenty-four participants were given a series of movement tasks based on Fitts' test to complete at three different distances. In terms of information throughput, pointing accuracy, and user preference, relative pointing was clearly superior to absolute pointing, even when absolute pointing included stabilization.

INTRODUCTION

Pointing has always been a basic mode of communication between people; it is one of the first ways that infants communicate with caregivers. Today, computer interface designers are using it as a fundamental mode of communication between users and computers. The mouse, the trackball, the touchpad and the joystick are all devices used for pointing at locations or objects on the screen. All of these are relative pointing devices in the sense that one uses them to move the cursor from a starting point to an ending point, and there is no direct mapping between the device and the X, Y location on the screen. If the mouse reaches the edge of the mouse pad, the user can pick it up, put it back in the center of the mouse pad, and continue. Touch screens, light pens, and stylus boards are absolute pointing devices because there is a direct correspondence between the location of the pointing device and the cursor location.

Figure 1 – Loop™ Pointer

Figure 2 – The Wii™ Remote with MotionPlus™ attachment.

There are advantages and disadvantages to both approaches. Relative pointing allows the application of algorithms to transform the relationship between the location of the pointing device and the cursor. For example, the gain between device motion and cursor motion can be changed, and this gain will be independent of the distance from the screen. In addition, nonlinear pointer ballistics can adjust the speed of the cursor so that for large distances the cursor can speed up and for fine movements it can slow down. The cursor can also be bounded by the perimeter of the screen or by active edges that do not allow the cursor to go across them.

On the other hand, absolute pointing takes advantage of a highly learned direct mapping between the hand and the location on the screen that involves kinesthetic or proprioceptive cues from the body that map to external screen locations.

A considerable literature on this topic has developed for computer interfaces with relatively small screens (e.g., Sears & Shneiderman, 1991). However, in the past few years, pointing has been extended to large, wall-sized screens, video projectors, and large, flat panel television screens (Vogel & Balakrishnan, 2005). Relative pointing devices, such as the Loop™ pointer developed by Hillcrest Laboratories, have the advantage that an indirect mapping allows for settable and dynamic gain adjustments. Direct pointing devices such as touch screen interfaces prove to be impractical since users would have to get up and walk to the screen's location to input a choice. Devices that attempt to simulate a laser pointer, such as the Nintendo Wii Remote™ that uses a camera to establish a direct relationship between the device and the screen location, may have an initial psychological/proprioceptive advantage, but may ultimately be less efficient than relative pointing devices.

In this study, we compared three different configurations of the same pointing device, a Nintendo Wii Remote™ with the MotionPlus™ attachment. This device provides an absolute reference using an infrared camera with a resolution of 128 x 96 (8x sub-pixel analysis gives a 1024x768 resolution) and two infrared LEDs mounted on a sensor bar located on the top of the television set. In addition, the remote contains a 3-axis gyroscope to measure angular velocity, and a 3-axis accelerometer to measure linear acceleration. Configuration A (Relative) used only the six axes of the inertial sensors and represented relative pointing. Configuration B (Camera Absolute) used only the camera information and represented absolute pointing. Configuration C (Stabilized Absolute) used a combination of the camera and inertial information to generate an absolute pointing device with the same resolution and tremor cancellation as the Relative configuration. Comparisons were based on Fitts' tests and user ratings and preferences.

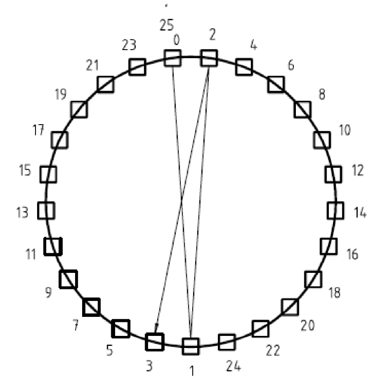

Figure 3 – Pattern of the Multidirectional Fitts' Task for ISO 9241-9 B.6.2.2 Standard.

METHOD

Participants

Twenty-four participants were recruited from the University of Maryland, College Park community using email lists and bulletin boards. They were primarily staff, faculty, and graduate students. They ranged in age from 20 to 58, with 12 males and 12 females. They were paid $50 for participating in sessions that lasted between 75 and 90 minutes.

Procedure

After signing a consent form, participants filled out a demographics survey and a survey on prior experience with pointing devices as shown in Appendices A and B. The order of the pointer configurations was counterbalanced across participants. To help participants remember the pointer configurations, red, clear, and black sleeves were put over the Wii Remote™. The type of pointing represented by red, clear or black was consistent for all participants, but the order of the pointer configurations was varied across participants. Participants spent about three minutes becoming familiar with each of the pointer configurations by playing a game of Solitaire on the television screen.

Half of the participants were given a written explanation of the three pointing configurations, and half were told nothing. The written explanations were as follows:

> The Red Pointer is a relative pointing device with high resolution. With relative pointing, it is all about amount of movement, where you start and where you stop, not about the actual direction. So you can actually have the device turned away from the screen and it will still work. You will also notice that the cursor stops at the border of the screen so it is never lost. If you turn the pointer too far in any direction you can re-center it by pushing it against a border.
>
> The White Pointer is an absolute pointing device. An absolute pointer is like a laser pointer. It must be directed at the screen and if it is not, the cursor will be lost. You might have to wave the pointer around sometimes to see the cursor back on the screen.
>
> The Black Pointer is also an absolute pointing device but uses additional gyroscopic information so that it has higher resolution and less jitter.

An HP 42-inch LCD HDTV set at a resolution of 1366 x 768 was mirrored to an Acer laptop running Windows® XP. The laptop communicated with the Wii Remote™ using Bluetooth, and a custom application processed the sensor and camera data using Freespace® motion technology. Freespace MotionStudio was used to log the motion and sensor data and to present the tasks to the participants. A Wii Ultra Sensor Bar was used with the Wii Remote™ camera. For configuration A (Relative) the gain was set to match the gain used by the Loop™ pointer. Participants were seated in an ergonomic swivel office chair.

The first task was a multidirectional Fitts' test. Circles with diameters of 26, 34, 42 and 50 pixels (1.73, 2.26, 2.80 and 3.33 inches) were displayed in a circular pattern around the screen. The circular pattern was shown with four different diameters: 2, 7.5, 13.0, and 18.5 inches. Figures 3 and 4 show the pattern for this task. Each test consisted of 36 trials. Participants were instructed to be as fast and as accurate as they could and to use the same strategy consistently throughout the study. The

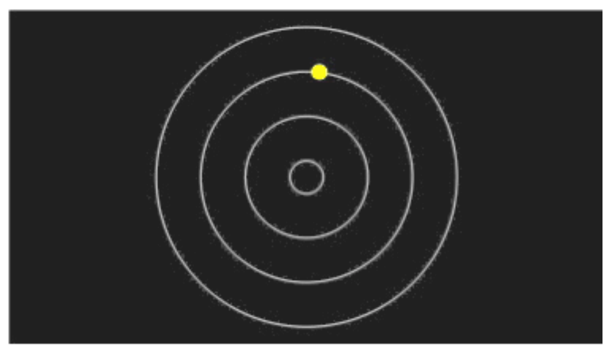

Figure 4 – Screen shot of the Multidirectional Fitts' Task

task was repeated at 6 feet, 9 feet, and 12 feet from the screen, in that order.

The second task was a screen edges Fitts' test, in which the circles appeared at the edges of the screen. There were 100 targets with a diameter of 19 pixels (1.3 inches) each. The distance between the targets was fixed so that there were 25 trials each of four different distances. This task was only run at 9 feet from the screen. For both tasks, the Wii Remote™ was configured so that either the A or B button could be used to select the target.

The final task was a casual browsing task for about three minutes with each configuration. The task was to use the Kylo™ browser to look for things of interest. After using each configuration, participants filled out a survey on the device; and at the end, they indicated their rank order preference for the three configurations: A (Relative), B (Camera Absolute), C (Stabilized Absolute). Appendix C shows this survey.

Experimental Design

A split-plot, spf-222.33, factorial design (Kirk, 1995) was employed. The between-subjects factors were gender (male, female), age (younger 20-39, older 40-58), and instructions (none, some). The within-subjects factors were pointer configuration, and for the Multidirectional Fitts' task, distance (6, 9, and 12 feet). There were three participants per cell in the between-subjects factorial design with counterbalancing of pointer configuration varying across participants.

RESULTS

Overall the mean age of the participants was 39 with a range from 20 to 58 years of age. The mean age of the males was 38 and the mean age of the females was 40. Five of the participants were left-handed and 19 were right-handed. Most of the participants spent between 4 and 12 hours per day on the Internet.

Pointing Survey

Figure 5 shows the results of the survey on pointing experience. Unless indicated, participants did not differ due to gender or age on their ratings. By far, participants were most comfortable with the mouse over the touchpad and touch screen ($t(23) = 4.25$, $p < .001$; $t(23) = 4.24$, $p < .001$). Younger participants were more comfortable with the touchpad than older participants were. ($F(1,19) = 11.61$, $p < .01$). Participants were fairly comfortable with the TV remote and channel navigation, but not with the Wii Remote™. Younger participants expressed higher proficiency in moving video game characters around than older participants did ($F(1,19) = 6.01$, $p < .05$), and more use of

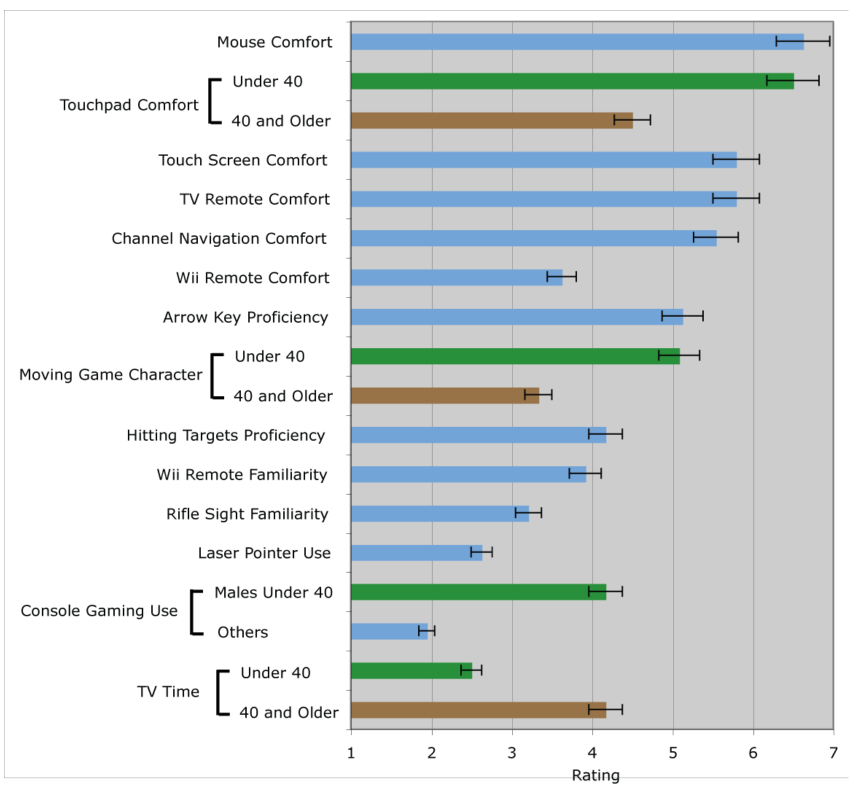

Figure 5 – Results of the pointing survey (Error bars are the 95% confidence interval around the mean).

gaming consoles ($F(1,19) = 5.20$, $p < .05$) than older participants did. On the other hand, older participants spent more time watching television than younger participants did ($F(1,19) = 5.38$, $p < .05$). Finally, with respect to the three absolute pointing devices, familiarity with the Wii Remote™ was moderate, familiarity with a rifle sight was lower, and use of laser pointers was very low.

Fitts' Throughput

The data from the Fitts' task were used to calculate values of throughput based on the ISO 9241-9 standard (for more information, see Douglas, Kirkpatrick, & MacKenzie, 1999; ISO, 1998; Schapira & Sharma, 2001).

Values were calculated as follows: First the effective target size was calculated for each circle size (see Figure 6). The method of computing effective target size was based upon ISO 9241-9, but was extended to two dimensions. For each target size, all of the clicks were analyzed relative to the circle center. Let x_i and y_i be the x and y coordinates of click i relative to the center of target i and N be the total number of clicks at that target size. First, the mean was subtracted

$$\overline{X} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

from each x coordinate

$$\hat{x}_i = x_i - \overline{X}$$

and the same was done for the y coordinates.

Next, the squared distance was computed for each value

$$w_{eff} = 4.133 \cdot \sigma_{2d}$$

Then the 2d deviation was calculated:

$$\sigma_{2d} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} d_i^2}$$

Finally, the ISO recommended factor was applied to get the effective width

$$w_{eff} = 4.133 \cdot \sigma_{2d}$$

Given the effective width, the index of difficulty I_i for a given trial with a distance of d_i is:

$$I_i = \log_2\left(\frac{d_i}{w_{eff} + 1}\right)$$

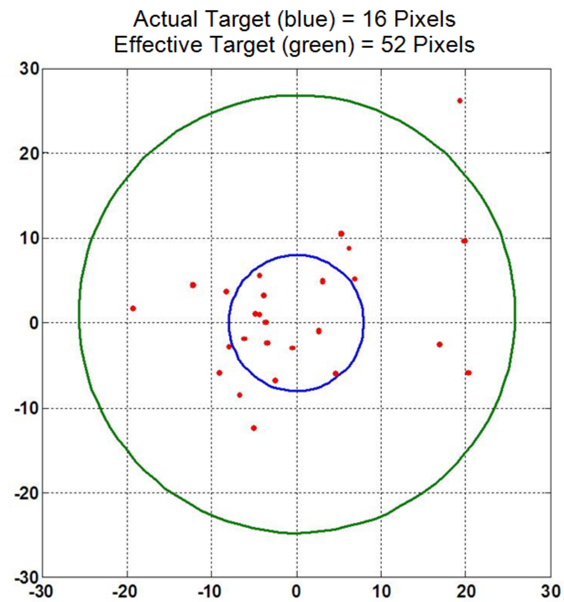

Figure 6 – Effective target size.

If the participant accidentally double clicked the A or B button or clicked very far from the target, the trial was removed. Double clicks were defined as a second click within 0.1 seconds of the first click. Invalid clicks were defined as clicks that are a distance away from the target of more than three times the radius of the circle. One participant had so many invalid clicks, that the data from Fitts' task had to be dropped from the analysis.

As illustrated in Figure 7, the data were plotted in two dimensions: index of difficulty and movement time. Since trials were designed to have four levels of difficulty, the data was clustered into four groups. The black vertical lines are the divisions between the clusters. For each cluster, the average value in both time and difficulty was used as the representative point.

These points are shown as squares on the plot. Finally, a linear fit was applied to these four points. The red dotted lines show the estimate of the standard deviation of the error in the linear fit. The throughput is then the inverse of the slope of the fit line. Plots for all of the participants and tasks exhibited a good fit, except for one task (Multidirectional at 12 feet for the Stabilized Absolute Configuration) for one participant whose data had been clustered into three rather than four groups.

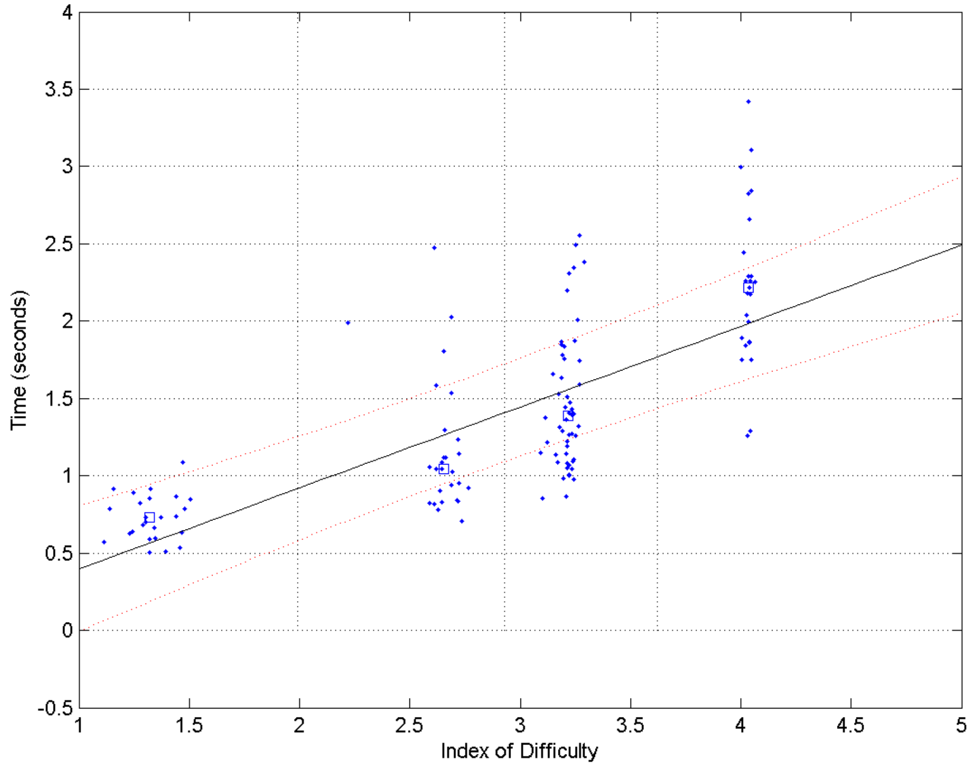

Figure 7 – Fitting slope for throughput with movement time as a function of difficulty.

Figure 8a shows the mean results for the Multidirectional task for the three pointer configurations. The pointer configuration had a significant effect ($F(2,28) = 32.34$, $p < .001$), with Camera Absolute having the worst throughput ($F(1,28) = 42.98$, $p < .001$), Stabilized Absolute having better throughput and Relative having the best throughput ($F(1,28) = 6.63$, $p < .05$). Distance did not have a significant effect overall and is not shown in Figure 8a.

Overall, throughput did not depend on age or explanation given, but it did depend on gender, with females outperforming males (mean female = 3.76, +/- .031, mean male = 3.13 +/- .32, 95% confidence interval, $F(1,14) = 9.27$, $p < .01$). There were some higher-order interactions with instructions, gender, and pointer configuration, but they did not appear to be meaningful.

Throughput for the Screen Edges task differed significantly due to pointer configuration ($F(2,30) = 10.45$, $p < .001$), with Camera Absolute being worst, Stabilized Absolute in between, and Relative being best as shown in Figure 8b.

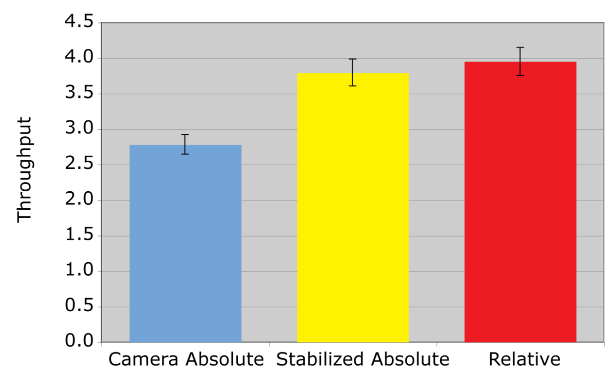

Figure 8a – Throughput for the Multidirectional Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

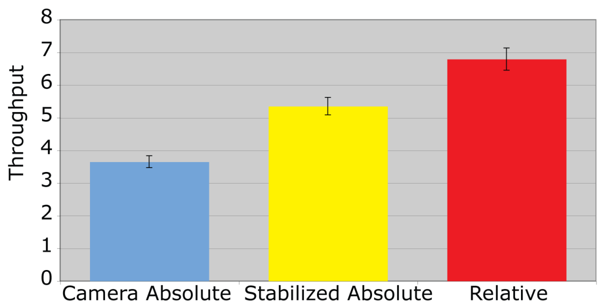

Figure 8b – Throughput for the Screen Edges Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

Speed of hitting targets (1/movement time) in the Multidirectional task varied as a function of pointer configuration ($F(2,46) = 9.38$, $p < .001$) but not with distance. Figure 9a shows that the Camera Absolute configuration was slightly faster than both the Stabilized Absolute and the Relative configurations.

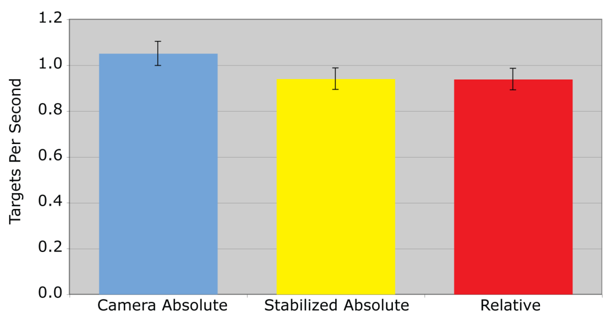

Figure 9a – Speed of hitting targets in the Multidirectional Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

However, for the Screen Edges task requiring the user to move the cursor longer distances across the screen, the Relative configuration was faster than either the Camera Absolute or the Stabilized Absolute configurations as shown in Figure 9b ($F(2,46) = 7.68$, $p < .001$).

The number of errors also varied with pointer configuration. The Camera Absolute configuration resulted in the most errors,

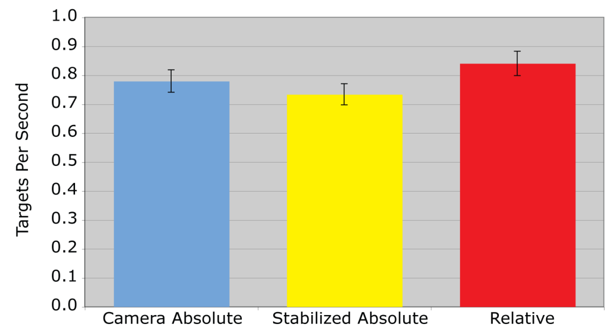

Figure 9b – Speed of hitting targets in the Screen Edges Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

Stabilized Absolute was second, and Relative resulted in the least errors for the Multidirectional Task ($F(2,46) = 62.42$, $p < .001$) and the Screen Edges task ($F(2,46) = 111.38$, $p < .001$).

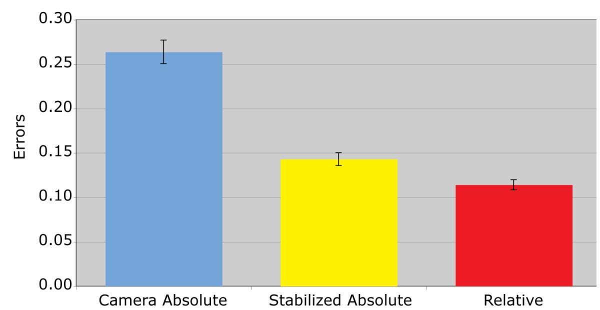

Figure 10a – Errors in the Multidirectional Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

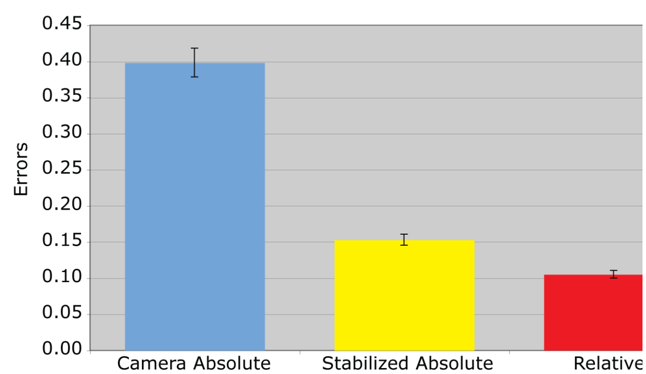

Figure 10b – Errors in the Screen Edges Task as a function of pointer configuration (Error bars are the 95% confidence interval around the mean).

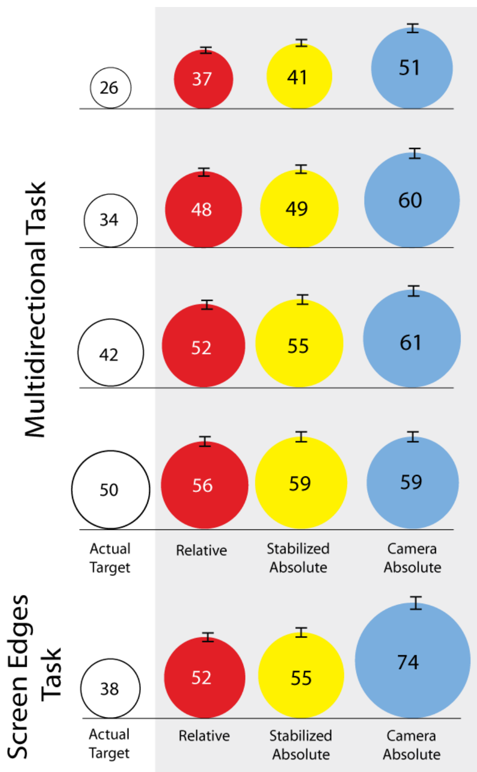

Figure 11 – Effective size of the target as a function of pointer configuration (Error bars are the 95% confidence

An effective width of the target was calculated for each circle size (26, 34, 42, and 50 for the Multidirectional task and 38 for the Screen Edges task) as described above. This measure indicates the precision for hitting the target. For all but the largest size target, the Camera Absolute configuration resulted in the largest, most inaccurate measurement, and the Relative configuration the smallest, most accurate measurement, as shown in Figure 11 ($F(2,46) = 32.36$, $p < .001$ for 26; $F(2,46) = 41.56$, $p < .001$ for 34; $F(2,46) = 9.47$, $p < .001$ for 42; $F(2,46) = 1.27$, $p = .30$ for 50; $F(2,46) = 52.27$, $p < .001$ for 38). Distance had a significant effect only for the smallest size target, with the effective size increasing with distance from the screen ($F(2,46) = 4.16$, $p < .05$).

User Assessment of Pointers

Figure 12a shows the results for the survey items where a positive response (Agree) is desirable, and Figure 12b shows those questions where a negative response (Disagree) is desirable. In a number of cases an explanation of the pointing configurations made a difference in the ratings. The figures display two bars in cases where there was a statistically significant difference. The Relative and Stabilized Absolute configurations were rated significantly higher than the Camera Absolute

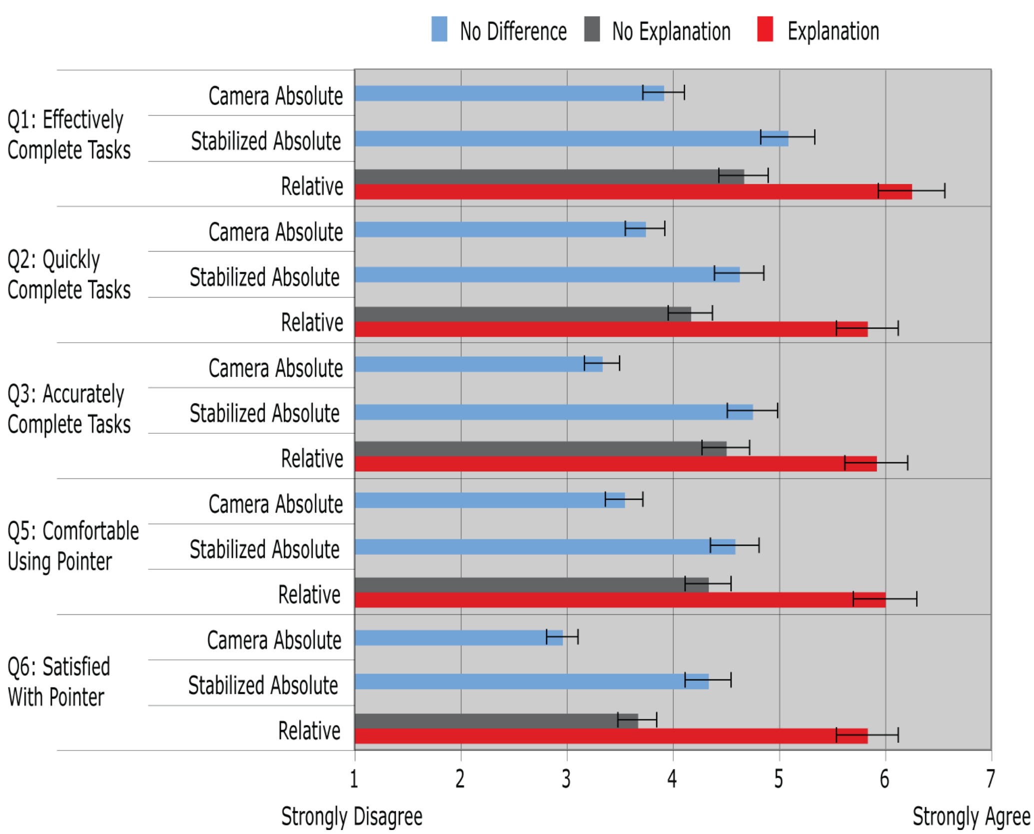

Figure 12a – User ratings of experience of the pointer configurations (Error bars are the 95% confidence interval around the mean)

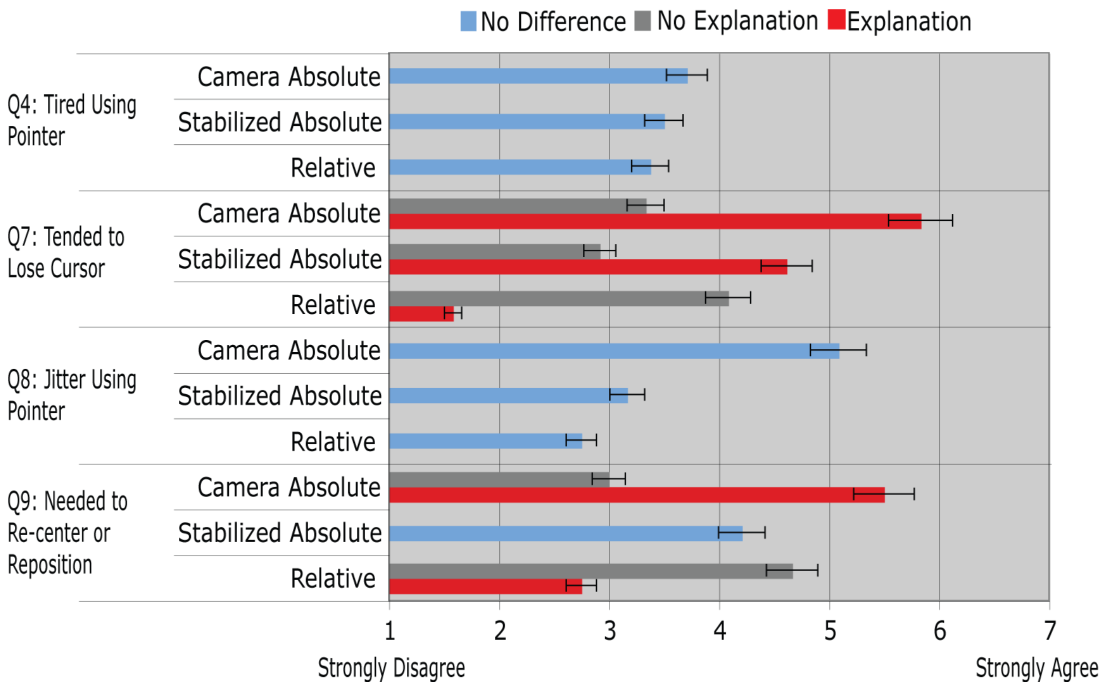

Figure 12b – User ratings of experience of the pointer configurations (Error bars are the 95% confidence interval around the mean).

configuration on whether they allowed participants to effectively, quickly, and accurately complete the task (p < .01 in each case). The Relative and Stabilized Absolute configurations did not differ from each other, but with an explanation the rating was significantly higher than without an explanation ($F(1,21) = 8.50$, $p < .001$; $F(1,21) = 8.40$, $p < .001$; $F(1,21) = 6.23$, $p < .05$; respectively).

There were no significant differences for ratings of getting tired with the device. However, for comfort and overall satisfaction, again, the Relative and Stabilized Absolute configurations were rated significantly higher than the Camera Absolute configuration (p < .01 in case). With an explanation, again, the Relative and Stabilized Absolute configurations did not differ from each other, but the rating was significantly higher than without an explanation ($F(1,21) = 6.71$, $p < .05$; $F(1,21) = 12.82$, $p < .01$).

Participants reported a loss of cursor at a higher rate with the Camera Absolute configuration than with the Relative configuration ($p < .05$). Giving participants an explanation of the pointer configurations had a significant effect. The explanation caused a significant increase in the rating of loss for the Camera Absolute and Stabilized Absolute configurations ($F(1,21) = 13.67$, $p < .001$; $F(1,21) = 4.73$, $p < .05$; respectively) and a significant decrease for the Relative configuration ($F(1,21) = 18.82$, $p < .001$). The explanation apparently made the participants more aware of the problem.

Participants reported significantly more jitter with the Camera Absolute configuration than with either the Relative or the Stabilized Absolute configurations ($p < .01$ in each case).

Finally, for re-centering the pointing device, overall there was no significant difference, but when explanations were given there was a significant increase for the Camera Absolute configuration ($F(1,21) = 13.51$, $p < .001$) and a significant decrease for the Relative configuration ($F(1,21) = 5.11$, $p < .05$). It is possible that participants did not really understand the explanation of what "re-centering" or "repositioning" the device meant.

When asked to rank first, second and third preferences, participants gave the Relative configuration the most points, with an average rank of 1.62. The Stabilized Absolute configuration was next with 1.75 points, and the Camera Absolute configuration was least preferred with an average rank of 2.62 points. The Relative and Stabilized Absolute configurations were statistically preferred over the Camera Absolute configuration ($p < .01$), but did not differ from each other.

DISCUSSION

Although absolute pointing would seem to have intuitive advantages over relative pointing, both performance data and user preferences favor relative pointing. When pointing at objects 6 to 12 feet away, participants usually extended the arm holding the device toward the screen, pointing the device as if it were a stick. This suggests that absolute pointing is more intuitive. However, relative pointing has technological advantages that absolute pointing does not have. Since movements are only relative to the current position of the cursor on the screen, they can be shorter than for absolute pointing, where the movement of the device has to go from an absolute position sometimes off the screen to an absolute position onscreen. In addition, relative pointing can take advantage of dynamic gain to speed up the movement for large distances and slow it down for small distances. Finally, relative pointing allows the user to hold or orient the device in ways that can be more comfortable than pointing at the screen, as one would have to do with an absolute pointer.

Data provided by the Fitts' Multidirectional task and the Screen Edges task revealed very large performance differences between the Camera Absolute configuration, using the Wii Remote™ with the infrared camera for positioning, and the Relative configuration, using Freespace motion technology. However, the smaller performance difference between the Relative and the Stabilized Absolute configurations indicates that a significant portion of this difference was due to the low resolution of the camera, which resulted in jitter and inaccurate pointing. Nevertheless, even after adding the positioning information for the MotionPlus™ attachment, the Relative pointing configuration was still superior to the Stabilized Absolute pointing configuration. While not as large, the differences in throughput, movement time, errors, and effective width significantly favored relative pointing.

Providing an explanation of the differences between the pointers did not have a direct or significant effect on performance, but it did have a very strong effect on the user experience for the Relative configuration. When users were given an explanation of how relative pointing worked versus how absolute pointing worked, they rated the Relative configuration significantly better on effectiveness, speed, accuracy, comfort and overall satisfaction. But without the explanation, relative pointing was rated about the same or slightly worse than the Stabilized Absolute configuration.

The practical implication of this counterintuitive result is obvious: use relative pointing for making selections on the television screen and provide an explanation of how relative pointing works.

However, a number of issues remain. There may be tasks in which absolute pointing is more desirable. For example, in video game applications, such as the genre of first person and rail shooters, when the game controller simulates a gun, it makes sense to simulate absolute pointing of the weapon at a target. However, in casual “pick up and play” games, it is not clear that absolute pointing is desired. Even in first person shooter games, relative pointing is common, allowing the player to move a gun sight displayed on the screen relative to the target. Relative pointing has the “quick draw” advantage of allowing the player to “shoot from the hip” rather than from an absolute shooting stance.

Posture of the user can also be important. In the current study, participants sat upright in an ergonomic swivel office chair. Informal observation revealed that many participants held the pointing device toward the screen with the arm partially or fully extended. Such a posture is required for absolute pointing, but not for relative pointing. Users of relative pointing devices can sit or recline in any position and need not worry about pointing the device directly at the screen. They only need to move it in a relative manner to change the position on the cursor. It is expected that with greater familiarity, users will minimize their effort to move the device and further maximize their efficiency hitting targets.

It is interesting but not really surprising that females outperformed males on one of the pointing tasks. Studies on sex differences have generally found that females are slightly better at fine motor coordination and manual tasks that require dexterity than males (Anatasi, 1958; Maccoby & Jacklin, 1975). What this means is that females will be slightly better, faster and more accurate than males when selecting items on the television screen.

On the other hand, there were no significant differences due to age despite the expectation that older users might be slower and less accurate than younger users. This is encouraging because it means that older users are an appropriate market for pointing devices used with televisions.

Finally, knowing that relative pointing is superior may help to inform designers of new interfaces for the television. There may be ways of improving interface design for the television to further maximize the advantages afforded by relative pointing. Gain and acceleration of the pointer may be improved. Relative positioning of selectable items on the screen may be improved. Instructions on how to effectively use relative pointing may be developed to improve the user experience with the television. Additional research is, of course, needed to explore these and other issues about relative pointing.

REFERENCES

Anastasi, A. (1958). Heredity, environment, and the question “How?”. *Psychological Review, 65*, 197-208.

Douglas, S. A., Kirkpatrick, A. E., & MacKenzie, I. S. (1999). Testing pointing device performance and user assessment with the ISO9241, Part 9 standard. *Proceedings of the ACM Conference on Human Factors in Computing Systems - CHI '99*, pp. 215-222. New York: ACM.

ISO. (1998). Report number ISO/TC 159/SC4/WG3 N147: Ergonomic requirements for office work with visual display terminals (VDTs) - part 9 - requirements for non-keyboard input devices (ISO 9241-9). *International Organisation for Standardisation*.

Kirk, R. E. (1995) *Experimental Design: Procedures for the behavioral sciences (3rd Ed.),* New York: Brooks/Cole.

Maccoby, E. E., & Jacklin, C. N. (1975). *The psychology of sex differences*. Stanford University Press.

Schapira, E. and Sharma, R. (2001). Experimental evaluation of vision and speech based multimodal interfaces, *Workshop on Perceptive User Interfaces*, pp. 1-9.

Sears, A. and Shneiderman, B. (1991). High Precision Touchscreens: Design Strategies and Comparisons with a Mouse. *International Journal of Man-Machine Studies*, 34(4). 593-613.

Vogel, D. and Balakrishnan, R. (2005). Distant freehand pointing and clicking on very large, high resolution displays. In *Proceedings of the 18th annual ACM symposium on User interface software and technology*, Seattle, WA, USA, 33-42.

Appendix A: Demographics Survey

Pointing Study

Section 1: Demographic Information

1. In what year were you born: ______ (yyyy)

2. Gender: ○ Female ○ Male

3. Racial/Ethnic Identity (Check all that apply):

   ☐ African American

   ☐ Asian American
   ☐ Caucasian
   ☐ Hispanic
   ☐ Native American
   ☐ Other: ______

4. Current Situation:

   Student:
   ○ College Undergraduate
   ○ Graduate Student
   Employed:
   ○ Job Title/Position: ______
   ○ Other: ______

5. On average, how many hours a day do you spend on a computer including using the Internet?

   ○ 0-1 ○ 1-2 ○ 2-4 ○ 4-8 ○ 8-12 ○ More than 12 hours per day

6. Are you predominantly ○ left or ○ right handed:

7. Is there anything else that we should know about you for this study?

[Continue -->]

Appendix B: Pointing Survey

Section 2: Familiarity with pointing devices

1. How comfortable are you using a computer mouse?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

2. How comfortable are you using a touchpad on a laptop computer?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

3. Do you ever use a laser pointer for presentations?

Never 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very often

4. How familiar are you using a sight on a rifle?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very familiar

5. How comfortable are you using a touch screen to make selections?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

6. How good are you at using arrow keys to move a cursor around the screen?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very good

7. When playing video arcade type games, how good are you at hitting targets?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very good

8. When playing video games, how good are you at moving your character around?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very good

9. How much do you play video games using a console such as the XBox, Playstation, or Nintendo?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very much

10. How familiar are you with the Nintendo Wii Remote?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very familiar

11. How comfortable are you moving the cursor around using a Wii Remote?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

12. How much time do you spend watching television?

Very little 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very much

13. How comfortable are you at finding or navigating channels on the television?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

14. How comfortable are you using a television remote to select channels?

Not at all 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Very comfortable

15. How often do you get confused with left and right directions?

Never 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Frequently

Section 3: Comments

If there anything else that you would like to share about these topics, please type in the box below:

Continue -->

Appendix C: Pointer Evaluation

Pointer Impressions

1. I was able to effectively complete the tasks using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

2. I was able to complete the tasks quickly using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

3. I was able to accurately complete the tasks using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

4. My hand felt tired after using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

5. I felt comfortable using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

6. Overall, I was satisfied with how easy it is to use this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

7. I tended to lose the cursor with this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

8. There seemed to be jitter using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

9. I had to recenter or reposition the cursor using this pointer:

Strongly disagree 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ 6 ◯ 7 ◯ Strongly agree

10. Please explain how it felt to use this pointing device, and whether or not you preferred using it:

11. Please indicate your order of preference for the three pointers:

Most preferred
Middle
Least preferred

12. If there is anything else that you would like to share about this study, please type in the box below:

Continue -->