PRECISE, PERSONALIZED PERFORMANCE: Designing Notifications and Adaptations to Address Pointing Problems

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1 Abstract

The Internet should be accessible to all people. However, computers are frequently ill-equipped to handle the unique needs of users with varying abilities. People who find it difficult to use a pointing device, like a mouse, may find it frustrating to use a computer. Many factors, such as age, physical impairment, or fatigue, can affect pointing performance and pointing device use. Notifications and adaptations may offer personalized assistance to people that find it difficult to complete pointing tasks. However, the design of these tools must not outweigh their convenience.

We conducted a study with 12 younger adults to test a Chrome Extension prototype. This prototype detects pointing performance, notifies the user of any problems, and provides assistance. We asked the younger adults for feedback on our designs and to discuss what they liked and disliked. We found they preferred notification with functionality attached. They were also interested in data about their performance. In addition to this study, we have designed and developed new adaptations to address cursor loss and menu slips, both common pointing problems. These have been integrated in prototype for future work. In the future we will focus on both adaptations and notifications and address potential solutions for specific pointing problems.

2 Introduction

The Internet is a valuable resource, and will only become more so as more people get access. Unfortunately, web navigation is frequently difficult for individuals with pointing problems. Web adaptations and notifications for pointing problems offer a remedy.

2.1 Pointing Problems

Pointing problems are issues that make it difficult to use pointing devices, like a mouse or track pad. Common pointing problems include slipping off targets [6] or missing links [4]. There is no single cause for pointing problems. They may be due to physical symptoms of an illness, natural consequences of aging, or momentary lapses of coordination from fatigue [2]. It is common across all ages, but most prevalent in older adults [8]. Individuals with motor difficulties frequently have pointing problems. If the impairments are due to age or an illness like Parkinson, a user's pointing problems may intensify as motor skills deteriorate. [3].

2.2 Adaptations and Notifications

Adaptations and Notifications offer potential solutions. Adaptations modify an existing system, like an interface, to make it easier to use. Notifications deliver information or alert the user to changes, whether those changes are part of the system's behavior or the user's behavior.

Previously, both of these tools have been used to create more effective interface. Studies have indicated a notification must hit within a certain range of disruption for a user to notice the information, yet not be too annoyed to ignore it. [7]. Gajos, Wobbrock and Weld used adaptations to generate GUIs personalized to the abilities of impaired users. [1].

However, to be useful, a tool's design must not outweigh their convenience, or else the user will be discouraged from using it [5]. Keeping the goal of increased usefulness in mind, we examined these aspects separately. Firstly, we conducted a study testing younger adults' receptiveness to different notification designs and collecting their preferences. Secondly, we designed and built adaptations to address cursor loss.

3 Notification Study

This was an exploratory study testing participants' preferences for notification design. It grew out of preliminary work with older adults and those with pointing problems [2].In those studies, notifications were used but they were not the focus. However, we found the designs of the notifications were interfering with the real purpose of the study. Therefore, this study intended to explore participants' receptiveness to different types of design styles.

Younger adults were used for two reasons. Firstly, they established a baseline for pointing performance. In general, younger adults have fewer pointing problems. Secondly, collecting answers from multiple groups, both young and old, with and without pointing problems, will help us understand what constitutes a useful solution for pointing problems for all users.

3.1 Methods

This study was run with 12 younger adults (18-34). There were seven males, five females

Of the 12, three reported occasional pointing problems.

Users first filled out a background questionnaire on pointing problems they may have had. Next, they were shown the designs. The designs were built into a Chrome Extension Prototype (Fig. 1).

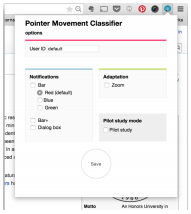

Figure 1: Extension Panel

Participants were asked to navigate Wikipedia so they could see each design as it would appear while browsing. The participants were first shown all three designs in sequence and filled out a questionnaire on how visible and understandable they were. Next, the researcher showed them each design individually and asked for their opinions on it. The researcher took notes on the participant's answers.

3.2 Designs

The participants were shown three design styles: Bar (fig 2), Bar + (fig 3), and the Pop-up (fig 4). The Bar is a subtle alert.

Figure 2: Bar Alert

These notification styles presented different levels of information and distraction to the user. It is designed to be non-intrusive. It drops down from below the toolbar as a line of color; it depends on the user knowing beforehand how to interpret it. In many ways, the Bar + is similar to the Bar: it is also designed to drop from the task bar and not to disrupt the user's browsing.

Figure 3: Bar+ Alert

However, the Bar + does not depend on the user having prior knowledge. It has text explaining both why it has appeared and what options the user has, as well as buttons the user can press to execute an action.

The Dialog Box, or Pop-up, is deliberately distracting. When the criteria for deployment is detected, (in this case, small hyperlinks), the dialog box appears in the middle of the page. The user has to address it.

Figure 4: Dialog Box

Like the Bar +, it has text describing why it appeared and what the user's options are. Unlike the Bar +, it cannot be ignored; the user must either click an option or exit the notification to resume browsing.

3.3 Results

This study had two types of responses: closed responses, where the participant selected an option from a list of choices,

and open-ended responses, where the participant gave their opinions. The closed responses were categorized by their answer and graphed. To interpret the open-ended responses, two researchers made an initial pass through the answers, noting frequent themes and phrases. The researchers combed through the responses several more times, coding the responses for the selected themes. The researchers checked their code choice with each other to avoid bias. Once the responses were coded by theme, the users were categorized.

We found users prefer designs with explicit instructions and immediate options. Each participant was asked what design appealed to them the most. Out of the Bar, Bar +, and Dialog Box, 5 participants preferred the Bar + and the 7 preferred Dialog Box (Fig.5). No participant chose the Bar.

Figure 5: Notification Preferences of Younger Adults

When the participants were asked why they chose one over the other, we found there was not one single attribute in either notification that made participants choose one way or the other. However, we discovered in their responses common concepts that influenced their choices. These concepts were how familiar the notification seemed, and the level of information it presented.

3.4 Familiarity

Past experience with similar designs affected how participants perceived the current notification designs. How they chose depended on how they experienced the prior design. This manifested itself in several ways. Sometimes the location of the notification recalled a design a user had seen previously. One participant suggests how to improve the Dialog Box's effectiveness. They suggest moving it to the "lower-right corner" since the lower-right corner contains "more-important" alerts, like the battery status alert. Their response indicates the user is keyed into the location of expected alerts. If a design is familiar and comfortable to them; they know where to look. In other situations, users reject familiar designs if it reminded them of ad-ware. One user rejected the Bar + because "bars at the top of pages remind [them] of ads" (Y7). Again, the user knows where to expect certain types of information. However, this user expects

this space to present spam. Future work should avoid these associations. This will be difficult, since the associations are based on an individual user's history.

In both scenarios, participants appeal to past experience while browsing to justify why they accepted or rejected a design.

3.5 Information

Younger adults (n = 9) want information about their pointing performance. The type of information they wanted varied. Participants were asked if they wanted raw performance data, or if they would prefer the data returned as suggestions on how to improve.

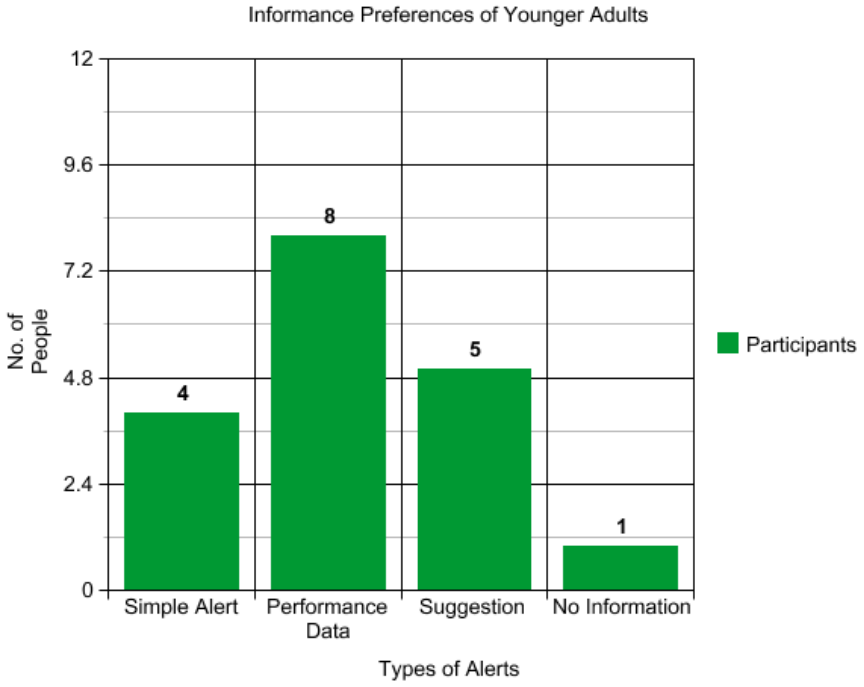

Figure 6: Information Preferences of Younger Adults

The participants what asked what sorts of information alerts they would prefer. Most (n=8) wanted performance data, some (n=5) wanted suggestions for improvement. Several users (n =4) mentioned that the suggestion for improvement was "not useful" unless it offered option to improve. For example, a notification suggests that the user has been missing links and not only suggests they zoom in, but has a button the user could press to do so. Others (n=4) wanted a simple alert, so they would know "an adaptation had taken place" (Y7). Only one participants wanted no information at all (Fig. 6). This departs from prior studies with older adults, who largely did not want performance

information.

When asked what sort of information they would like, one user wanted to know "How often [they] miss-clicked a link. How often [they] have to click an item for it to respond to my clicks ... [Knowing this] would help [them] better use a pointing device" (Y10).

This statement suggests that knowing a little more about one's self and one's ability, even if it is in terms of raw data, like missed clicks, can help one improve apart from the computer. It makes one aware of one's abilities and problems, should they have them.

3.6 Discussion

Past experience affects the preferences of younger adults. Therefore, future work must consider conventional notifications styles and what emotions they evoke. Given that users seem sensitive to malware concerns, how can notification design evoke more trust?

Younger adults want data. How should notifications present data? This study suggests they want unvarnished performance data. This departs from studies with older adults, which found they do not like to be reminded of their performance, especially if their performance lacks.

The overall purpose of this study is to create an AUI for those with motor difficulties. Consider a patient with a degenerative motor disease like Parkinson's. How should data be presented when the general trend is a decline? This study indicates a desire for performance feedback, but future work will have to examine how to express the feedback in a way that is sensitive and satisfactory across user groups.

4 Adaptation Study

In addition to conducting the notification studies, I built a mouse adaptation to accommodate cursor loss while web browsing as part of my DREU internship. Although notifications and adaptations may work in tandem with each other, this part of my internship focused less on conceptual designs and more on technical questions.

The adaptation is implemented as a Chrome Extension. It is written in JavaScript and HTML/CSS. It offers the user two options to prevent cursor loss: a constant adaptation that increases the cursor's size, and an idle adaptation that causes the cursor to pulse or glow when the user is idle. Both are meant to make the cursor more visible on the page and harder to lose.

4.1 Cursor Loss

Cursor loss can occur when a user loses track of the pointer's position on the screen. It is a common pointing problem across user groups [3]. Finding the

cursor again may be annoying and time consuming. Furthermore, user with motor difficulties may have difficulty regaining the cursor [9].

4.2 Preliminary Work

The idea for a cursor loss extension already existed when I joined the project. During the first week, I discussed directions the adaptation could take and was given some preliminary sketches (Fig. 7). This sketch is for the "pulse" adaptation, which adds a webkit CSS animation behind the cursor. Prior to this experience, I had never used JavaScript or HTML, so the first two weeks, I studied the languages. Then I began building the extension in earnest.

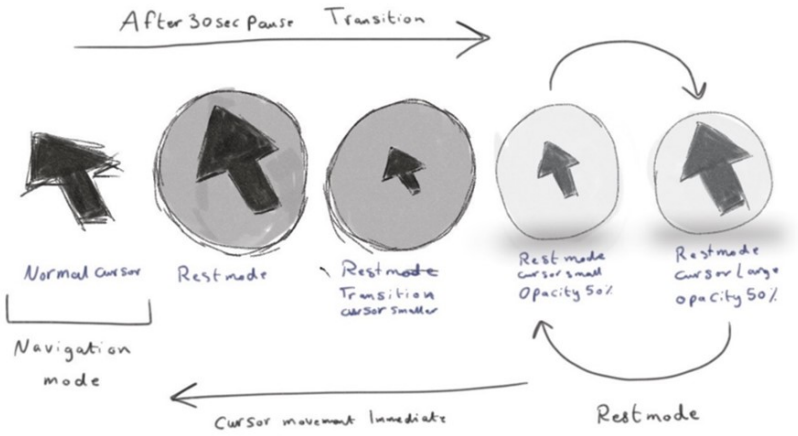

Figure 7: Preliminary design of "pulse" animation

4.3 The Extension

The adaptation is for web browsing specifically. It is built in a Chrome Extension using Javascript and HTML/CSS. The extension offers a drop-down panel that gives the user two adaptation options: "Constant" or "Idle".

Constant increases the sizes by replacing the default cursor with a larger image of a cursor. The user has three sub-options: "Default", "Medium", and "Huge" (Fig. 8).

In the "Idle" option, the cursor remains the default, but an event listener is activated. This event listener wait for mouse movements, and times the seconds between them. If a user is idle for three seconds, a CSS animation is triggered behind the cursor. The user has options here too: they can choose a "pulse" or a "halo" animation.

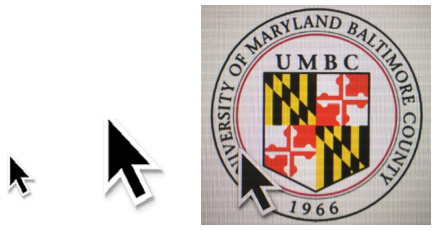

Figure 8: Cursor size options

4.4 Adaptation Discussion

This is only the prototype; it has not been tested on users. Future work will test these adaptations are at preventing cursor loss while minimizing distraction. With a mind for aiding web navigation and mitigating distraction, future work may also focus on adaptations that flatten menus or make small links more navigable.

5 Overall Discussion

Adaptations and Notifications complement each other, but to increase their effectiveness, we must consider them individually. The Notification studies suggest that different user groups want different things from a notification. For example, younger adults want lots of information; older adults want less. How can a notification system be designed that accommodates the needs of as many users as possible? Future work will work towards creating the most accommodating system.

However, a system must not only be accommodating but accessible; this is where adaptations are key. The prototype I built depended on the user clicking multiple times on small buttons to access the panel, the cursor options, the sub-options, etc. The target user group for these AUIs are the motor impaired. Even if the cursor adaptation proves useful, the set-up steps may be prohibitive for them. Yet users want options. Future work will have to consider how to execute an adaptation smoothly without assuming much about the user's preferences.

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References

[1] Krzysztof Z. Gajos, Jacob O. Wobbrock, and Daniel S. Weld. Automatically generating user interfaces adapted to users' motor and vision capabilities. In *Proceedings of the 20th Annual ACM Symposium on User Interface Software and Technology*, UIST '07, pages 231–240, New York, NY, USA, 2007. ACM.

[2] Amy Hurst, Jennifer Mankoff, and Scott E. Hudson. Understanding pointing problems in real world computing environments. In *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility*, Assets '08, pages 43–50, New York, NY, USA, 2008. ACM.

[3] Simeon Keates, Faustina Hwang, Patrick Langdon, P. John Clarkson, and Peter Robinson. Cursor measures for motion-impaired computer users. In *Proceedings of the Fifth International ACM Conference on Assistive Technologies*, Assets '02, pages 135–142, New York, NY, USA, 2002. ACM.

[4] Simeon Keates and Shari Trewin. Effect of age and parkinson's disease on cursor positioning using a mouse. In *Proceedings of the 7th International ACM SIGACCESS Conference on Computers and Accessibility*, Assets '05, pages 68–75, New York, NY, USA, 2005. ACM.

[5] Talia Lavie and Joachim Meyer. Benefits and costs of adaptive user interfaces. *Int. J. Hum.-Comput. Stud.*, 68(8):508–524, August 2010.

[6] I. Scott MacKenzie, Tatu Kauppinen, and Miika Silfverberg. Accuracy measures for evaluating computer pointing devices. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '01, pages 9–16, New York, NY, USA, 2001. ACM.

[7] McCrickard. Attuning notification design to user goals and attention costs. *Commun. ACM*, 46(3):67–72, March 2003.

[8] Karyn A. Moffatt and Joanna McGrenere. Slipping and drifting: Using older users to uncover pen-based target acquisition difficulties. In *Proceedings of the 9th International ACM SIGACCESS Conference on Computers and Accessibility*, Assets '07, pages 11–18, New York, NY, USA, 2007. ACM.

[9] SHARI TREWIN and HELEN PAIN. Keyboard and mouse errors due to motor disabilities. *International Journal of Human-Computer Studies*, 50(2):109 – 144, 1999.