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PVA RESEARCH FOUNDATION
FINAL PROGRESS REPORT

APPLICANT INSTITUTION: Koester Performance Research

GRANTEE: **Heidi Horstmann Koester**

CO-INVESTIGATOR: **None**

PROJECT TITLE: Adjusting Computer Mouse Settings Automatically to Accommodate User Needs

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Guidelines:

Completion of this report is required by our office no later than 60 days after the end date of your grant. Please send **one** copy by mail to the Foundation. Provide a brief answer for all the information requested. Please retain the question headings and limit your report to 5 pages. You may attach to this document any additional material you wish: manuscripts, reprints/copies of publications, conference programs, and/or grant products that have resulted from this project. We also request copies of photos that might be appropriate for inclusion in our Annual Report, our monthly magazine (PN), our Web site, or other publications. Photos should be high resolution, 300 d.p.i. or better, and in color. If any additional publications result from this project after the submission of this report, please forward them to the Foundation at that time.

This report is your opportunity to relate to us the outcome of your PVA Research Foundation project. The final report is read by the Director and Associate Director of Research and Education and the Board of Directors. Upon approval of your report by PVA Research Foundation staff, the final 10% of your grant (initially withheld) will be sent to you.

- **Please briefly describe the goals/specific aims of the project. Did your project reach its target audience?**

As stated in our original proposal, the goals of this project were as follows:

> The purpose of this project is to develop a software tool for the automatic configuration of mice and other pointing devices. This software will accommodate the needs of people with physical impairments, leading to improved productivity and comfort during computer use. To accomplish this goal, we will achieve the following objectives:
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> **Objective #1: Develop a prototype software program.**
> Task 1. Develop & validate methods of gathering necessary data about a user's pointing device, under natural conditions, i.e., during regular computer use rather than during a prescribed test activity.
> Task 2. Develop & validate methods of processing the raw user data so it can be used as input to decision algorithms that recommend input device settings.
> Task 3. Design and implement a basic prototype that communicates recommendations to the user and allows the user to respond.
> **Objective #2: Evaluate the software with computer users who have physical impairments.**
> Task 4. Demonstrate effectiveness of the software's recommendations for initial input device settings, in a single-session protocol.
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> **Test of Feasibility**: We must show that our software recommends appropriate configuration settings that will significantly increase pointing performance for subjects, by 30% or more.

The target population for this work includes people who have upper extremity impairments that affect their ability to use a standard computer mouse. These may be individuals who can use a standard mouse, but with difficulty, or people who cannot physically use a mouse and require an alternative pointing device such as a trackball or head-controlled mouse. There are a number of conditions that can cause these impairments, including spinal cord injury/disease, cerebral palsy, and traumatic brain injury.

We were able to reach this target audience in our effectiveness study, which involved 12 individuals with upper extremity impairments. Six women and six men participated, and diagnoses included multiple sclerosis, spinal cord injury, cerebral palsy, and stroke. Using our prototype software, these individuals improved their overall performance with their pointing device by 29.3% (significant at p=.028). This is within 1 pp of our goal of a 30% enhancement.

- **Was the project completed as originally intended? If not, please explain.**

Yes, we completed all objectives and tasks listed above.

- **Please describe the most significant results/conclusions obtained during this study and their relevance to individuals with spinal cord injury or disease.**

We successfully built prototype software that monitors user activity during performance of regular computer tasks and recommends appropriate Windows mouse settings to meet the user's specific needs. This software runs continuously in the background, so it does not require any time or effort on the part of the user. The current settings that it recommends are the mouse gain (sensitivity), the double-click time, and the double-click distance.

We measured the effect of our AutoIDA software on user pointing performance in an ABA study. In the two A conditions, participants used the default Windows settings; in the B condition, they used the settings recommended by our software. AutoIDA recommended at least one setting change to all 12 participants. Pointing performance was measured using Compass software, configured to present a series of 32 single- and 16 double-click target acquisition trials in each condition. The dependent variables were:

1. Trial Time: total amount of time from when a target was presented until the user successfully clicked or double-clicked within it.
2. Clicks: the number of clicks required per trial.
3. Entries: the number of times the mouse cursor entered the target per trial.
4. Error-free Trials, %: the percentage of trials successfully completed without any extra clicks.

We tested the hypothesis that performance with the AutoIDA settings is significantly better than performance with the Windows default settings, using paired t-tests at the 0.05 level. Performance with the Windows default settings was the average performance across both A conditions. Additionally, we counted the number of "full reversals" across the 12 participants. A full reversal occurred when performance with the recommended settings was at least 15% better than both trials with default settings; i.e., the B condition was 15% better than each A condition. Table 1 shows the results.

			B vs. A Difference				
Variable	**A**	**B**	**Avg**	**Min**	**Max**	**p-value**	**Full Reversals (N)**
Trial time (sec)	5.78	3.30	-29.29%	0.85%	-75.21%	.028	7
Clicks (N)	3.31	1.66	-27.11%	7.30%	-84.15%	.113	5
Entries (N)	2.28	1.53	-22.09%	14.88%	-65.15%	.037	3
Error-free Trials (%)	75.46	90.73	15.27 pp	-5.47	37.51	.005	4

Table 1. Pointing performance with recommended settings (B) as compared to default settings (A). Column A shows average of both A conditions; column B shows average of the single B condition.
% Difference = (B-A)/A*100, calculated for each subject, then averaged across subjects.

On average, the recommended settings significantly improved pointing performance for these 12 individuals. The effect on Trial Time, Entries, and Error-free Trials was significant at the 0.05 level. Trial time had the strongest effect, with recommended settings improving time by 29.3%, and 7 of 12 participants showing a full reversal.

While the impact was significant across the entire group, there was considerable variation in the effects for specific individuals. The largest effects were quite large, such as the 75% improvement in Trial Time observed for one participant. Four participants received little to no benefits, generally because their baseline pointing performance was already very good.

At the end of the session, participants completed a short questionnaire regarding the perceived usefulness of the AutoIDA software and how the future user interface of AutoIDA should be designed. Usefulness was rated on a scale of 1 (lowest) to 5 (highest), and the target was for participant responses to be significantly greater than 3.6 (Nielsen, 1993). Usefulness ratings averaged 4.25, significantly above the target level (p=.040). 10 of 12 participants wanted to be asked for approval before AutoIDA made any adjustments to their settings, although several also commented that they would give the software more autonomy once they got used to its recommendations. 10 of 11 responders stated that they had no concerns with something like this running on their computer and monitoring their keyboard and mouse actions, as long as it did not interfere with any other programs. Overall, the questionnaire results suggest that the target population sees a clear value in software like AutoIDA and would willingly use it to support more productive computer use.

This project is relevant because it furthers the PVA's mission by enhancing computer access for people with SCI/D. PVA's primary goal is to assist veterans with spinal cord injury or disease (SCI/D) in reentering mainstream society. Full participation in mainstream society today, especially for individuals with physical impairments, requires effective computer access. Computer access is one key to education and vocational success, and this project helps ensure that these individuals will have the effective computer access they need in order to pursue their educational and vocational goals. The project will also benefit individuals with SCI/D regardless of age, by enhancing computer access for leisure, social communication, and home management activities. Finally, this work will provide better access to computers outside the home, such as those in libraries or other public locations. This helps promote community participation and involvement and also gives individuals with SCI/D the flexibility to access any computer, any time, anywhere.

- **Have the findings in this grant resulted in any new work or projects for your institution?**

Yes. To provide a more complete system, we need to create similar software that can adjust the keyboard settings as well. We submitted a proposal for the keyboard work to the PVA Research Foundation, but it was not funded. However, we did receive funding from the TREAT Center to pursue the keyboard work on a more modest scale. Results from the new keyboard project, combined with this successful pointing project, could yield software that allows Windows to automatically adapt to user needs and improve both pointing and typing performance for people with physical impairments. We appreciate the PVA's support for this project.

Papers Published in Conference Proceedings:
The following papers related to this project were published in the RESNA 2012 conference proceedings and are attached to this report. Additional manuscripts are in preparation.

1. Koester, HH and Mankowski, J. (2012). Fully Automatic Adjustment for Double-click Settings. Proceedings of RESNA 2012 Conference, Baltimore, MD.
2. Koester, HH and Mankowski, J. (2012).Making Custom Keyboard and Mouse Settings Portable. Proceedings of RESNA 2012 Conference, Baltimore, MD.

Signature of Project Director: _____ Date: _____

PVA Research Foundation staff approval: _____ Date: _____