Comparative Voting Performance of Reading Disabled Voters

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ABSTRACT

Although legislation now protects the rights of voters with special needs, no one has previously evaluated how different electronic voting systems affect the performance of the reading disabled community. Results of this initial study, evaluating three current systems, proved surprising and inform how future voting interfaces may potentially be improved for the population at large. Subjects with undiagnosed reading disabilities exhibited the highest error rate, however, those with previously diagnosed reading disabilities significantly outperformed the control group when using full-faced systems. By contrast, the previously diagnosed group performed worst when using standard-sized Direct Record Electronic (DRE) systems. We attribute this observable difference to the coping techniques that those with known disabilities have learned to get through everyday life. These allowed them to interact effectively with the full-faced system, which orients users but does not guide them through the process. Such strategies proved useless on DREs, which guide users through the process but provide no means for them to orient themselves. We conjecture that a hybrid design, incorporating the advantages of both systems, will benefit all users.

ACM Classification: H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

General terms: Design, Human Factors, Performance, Experimentation

Keywords: voting, reading disabilities, accessibility, user interfaces, compensation mechanisms.

INTRODUCTION

The rights of voters with special needs are now protected by law. This legislation is a mandate to accommodate those with disabilities during the interaction design of voting machines. Attempts have been made to show how ballot variations affect users of different educational backgrounds [1]. Improvements to audio voting are also in progress [2]. However, no one has previously evaluated how voting interfaces affect the learning-disabled community although approximately one out of every seven voters in the United States falls into this category.

By definition, the term "learning disabilities" refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, writing, reasoning, spelling, or mathematical abilities. These disorders are intrinsic to the individual and presumed to be caused by central nervous system dysfunction. Although a learning disability may occur concomitantly with other handicapping conditions (i.e., sensory impairment, mental retardation), social and emotional disturbances or environmental influences (i.e., cultural differences, insufficient or inappropriate instruction, psychogenic factors) it is not the direct result of those conditions or influences.[3]

Most people with learning disabilities can be most easily be identified as having reading[4]. We set out to discover how various types of electronic ballot interfaces affect reading-disabled versus non-reading disabled voters' abilities to correctly mark selections. Voting interfaces present special design challenges because when a voter confronts a ballot the complexity of an election and its issues is reduced to a simple choice of labels that must be recognized and selected. The act of making these selections is therefore entirely disconnected from the meaning of the choices.

VOTING EQUIPMENT

We focused our study on comparing recent incarnations of Direct Record Electronic (DRE) voting technologies, which include touch screens and full-faced LED (light-emitting diodes) feedback systems. Touch screen systems, which present only a few races per screen, guide users through the voting process. Full-faced systems, which evolved from the original lever machines of the late nineteenth century, present all races and selections simultaneously, but do not provide alert-style feedback to prevent common mistakes such as undervotes, i.e. choosing fewer than the total number of races.

Although other voting companies were contacted, only Electronic Systems and Software allowed us to use and provided machines for our study. We tested the currently available iVotronic DRE System with a 15-inch color touch screen Liquid Crystal (LCD) Display; the V2000 Full Faced Electronic System; and the prototype iVotronic LS Full Faced DRE with a massive high-resolution display.

SUBJECT SELECTION

Reading Disabled subjects were located by advertising and professional contacts. Organizations, such as the International Learning Disabilities Association, local unions and universities helped distribute flyers and informed their members of the study. In addition, we placed an ad in the *New York Post* to obtain both RD and Control subjects. At no time did the NYVS simply contact potential subjects. All subjects were required to be registered voters and received the same $25 honoraria for completing the study. A reading test given during the study differentiated subjects into the categories of learning-disabled and non-learning-disabled. Therefore, subjects were not informed that they had been selected because of this classification. That is, at no time were subjects told that they were in an experimental vs. control group.

TESTING PROCEDURE

The study was conducted at a standard polling location in Manhattan on May 24, 2004. Actual voting conditions were recreated as much as possible but with a few modifications. Poll workers hired for the test were located through the League of Women Voters and all had prior election experience. To avoid tainting the results, we used the ballot from the Erie County 2000 election because our New York City-based test subjects were unlikely to have voted on it or be previously familiar with its issues and candidates.

The polling place was divided into three sections: Greet and Education (GE), which contained a desk manned by two workers, another set of tables with the reading test and a waiting and learning area, with newspapers, voter guides and other election materials; Voting, which had four different curtained machines set up as for an election and chairs for queuing voters; and Post-Test with a check-out desk.

When subjects arrived at the polling location they checked in. Poll workers explained why we were conducting the study and what we were asking participants to do. This included learning enough about the candidates and issues on the ballot to make informed decisions; taking a 5-minute reading comprehension test; voting on two different machines; and completing a post-test questionnaire before collecting their honorariums. A poll worker then asked each voter to sign an informed consent form and offered to explain its conditions.

Each participant received a signed copy of the form and was reminded that it contained the researchers' identifications and addresses. Subjects then received a card with three letters on it indicating which voting machines to use. These numbers were generated from a random permutation of the numbers 1,2,3, and 4 as part of the Latin-squares method of statistical analysis that we used.

Subjects were sent to the learning area to educate themselves about the ballot before voting at a first machine. Then, each took a reading test. In addition to assessing subjects for possible learning disabilities, this activity distracted them from the their first voting experience. After the test, subjects were given a coffee/water break before voting on a second machine. Then, they were interviewed about their experience and given their honorariums.

RESULTS

Abbreviations Key:

- **RD** = Reading Disabled (with diagnosis) subjects.
- **RD Control** = RD Control subjects we tested to be reading disabled
- **Control** = all control subjects
- **MC** = control subjects whose average IQ matched the LD group.

Table 1: Errors Per Ballot.

	RD	RD Control	Control	MC
LS	3.3	5	4.55	3.4
V2000	2.5	3.4	3.9	4.5

iVotronic	6.45	4.3	5	4.7

Table 2: Mean Time to Complete Ballot.

	RD	RD Control	Control	MC
LS	6:56	6:16	4:12	4:56
V2000	5:30	4:16	4:57	5:21
iVotronic	7:00	7:10	4:22	4:00

Table 3: Races Left Blank Per Ballot.

	RD	RD Control	Control	MC
LS	4	4.08	4.8	2.8
V2000	2.76	3	5.43	4.25
iVotronic	1.9	1.27	1.64	0.2

Table 4: Self-Reported Discomfort.
scale of 1-5; 1 = least comfortable.

	RD	RD Control	Control
LS	3	1.86	2.25
V2000	2.91	1.8	2.23
iVotronic	2.5	2	2.5

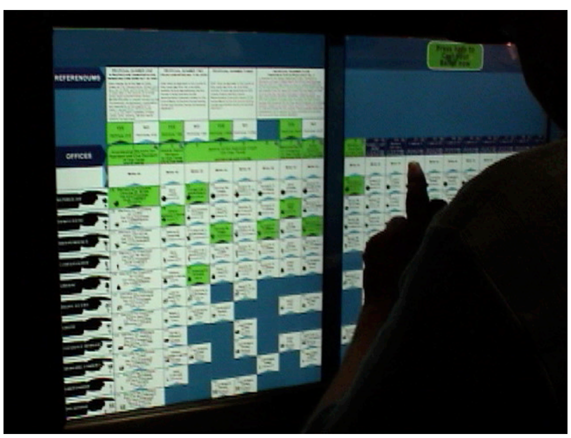

Fig. 1. Voter voting on the LS Machine

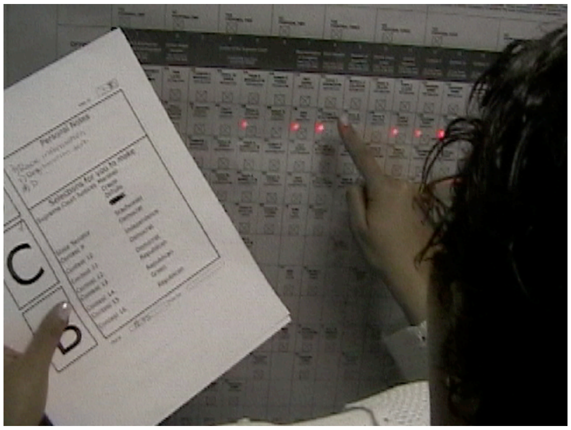

Fig. 2. V2000

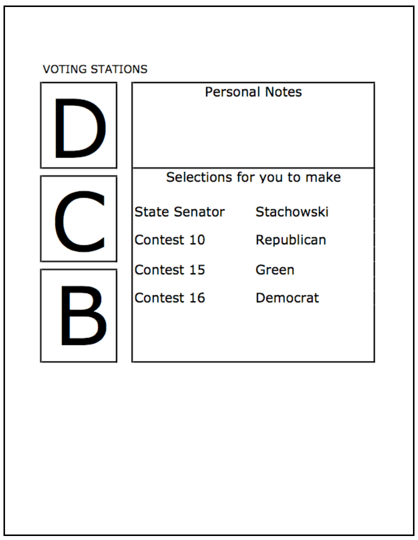

Fig. 3. Example Palm Card

Analysis

Diagnosed learning-disabled subjects achieved significantly lower error rates on full-faced machines than they did on the standard DRE machine: 3.3, 2,5 vs 6.5 for LS, V2000 and iVotronic, respectively. Undiagnosed RD voters exhibited a higher error rate (5 vs. 4.3, LS vs. iVotronic), showing that they found the full-faced systems slightly more difficult.

We were concerned by the poor performance of standard control subjects on all the systems. The IQ test results showed that the average IQ of controls was significantly lower than that of the diagnosed learning-disabled voters. Therefore, we broke higher scoring control subjects into a group whose average IQ matched that of the diagnosed RD voters. Matched control subjects exhibited the lowest error rate on the LS machine and left significantly fewer races blank on all machines when compared to normal controls (Table 3).

One of the more striking differences between groups was the level of self-reported discomfort about particular systems that they noted on the post-test questionnaire. Voters with undiagnosed learning disabilities were consistently uncomfortable. Those with diagnosed conditions reported significantly less discomfort when voting on full-faced machines.

Finally, we were concerned with the high error rate on ballots, which ranged from five to as many as nine races per ballot for some group/machine combinations. Either the voters were incapable of using our palm cards effectively and accurately recording their intent or they ignored them and what they were doing. Using video capture, we watched voters fill out ballots, realize errors, and react to the machines. Only one voter reacted violently when a machine (the LS) was hanging. In a few cases, we saw voters complete the entire ballot without looking at the palm card, selecting the same row of candidates for every race. Because these subjects clearly did not comply with the conditions of the experiment, we disqualified their ballots from our analysis. We are convinced that the differential in error rates indicates a true difference in voters' abilities to successfully and accurately vote.

Clearly, forcing users to take action on each screen encourages them to vote on more races. This study does not establish whether these additional decisions are intentional or random. All subjects, significantly reduced undervotes but increased their total completion time when using page-by-page DRE systems. The full-faced system appears to provide a significant time advantage, which will allow for a higher throughput of voters.

CONCLUSION

Different technologies clearly provide distinct benefits for certain groups. Full-faced ballots are more effective for those without undiagnosed learning disabilities. The intuitive nature of a full-faced ballot is easier to vote on for most non-RD subjects and allows them to complete their ballots more quickly and with fewer errors. In addition, diagnosed RD subjects are able to use the grid structure of the full -faced ballot to orient themselves when voting, while they do not have this orientational benefit on the page-by-page DRE.

FUTURE WORK

The promise of electronic voting machines is not only the ability to accurately and repeatedly count votes but also the possibility of empowering previously disenfranchised populations to vote successfully. We plan to use the protocol developed for this study to test various new user interfaces aimed at taking the orientation-aiding advantages of the full-faced systems and combining them with the guided nature of page-by-page DREs. The resulting system will be less confusing for voters and permit them to accurately record their intent.

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