

# VOTE-BY-PHONE: AN INVESTIGATION OF A USABLE AND ACCESSIBLE IVR VOTING SYSTEM

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**Abstract:** One of the main goals of the Help America Vote Act (HAVA) was to ensure that voters with disabilities could vote independently. However, the current state of most voting methods does not allow for independent voting for everyone. In response to this issue, we tested a remote IVR voting system developed by Holmes and Kortum (2013), with an added audio speed adjustment feature and synthetic voice to increase usability and accessibility, especially for visually impaired voters (Piner, 2011). The focus of this research was to examine the viability and usability of the IVR voting system as an accessible voting platform for visually impaired voters. The system was tested by users with and without visual impairments, and usability was measured using the three ISO 9241-11 usability metrics (ISO 9241-11, 1998) of efficiency (time to complete a ballot), effectiveness (accuracy), and satisfaction (subjective usability). Results indicate that the IVR voting system could be a viable voting alternative to other established voting methods, with similar performance among sighted and visually impaired users.

**Keywords:** voting, accessible, usability, IVR, universal design.

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## Introduction

The Help America Vote Act (HAVA) and the Voting Accessibility for the Elderly and Handicapped Act were enacted to help preserve the rights to vote privately and independently and to access polling locations for those with disabilities (United States Government, 47th Congress, 2002; United States Government, 98th Congress, 1984). Even with these acts in place, voters with disabilities continue to have lower voter turnout rates than those without disabilities (Schur, 2013). Amongst those with disabilities, voter

turnout is lowest for those with visual, motor, or cognitive impairments (Schur, 2013). These low turnout rates are likely due to the increased likelihood of facing obstacles in the voting process, including travel to and navigation within a polling location, and reading or seeing the ballot (Schur, 2013). These obstacles affect at least 35 million American citizens with disabilities and therefore must be addressed in order to help preserve their right to vote (Houtenville, Brucker, & Lauer, 2014).

In light of these issues, this paper evaluates a novel remote voting system with a purely auditory interface that could help alleviate some of the difficulties in voting for the disabled, especially the visually impaired. The study used an interactive voice response (IVR) system that was designed to be highly usable and accessible, particularly for visually impaired or blind voters (Holmes & Kortum, 2013). While vote-by-phone systems have been investigated before, they have not been tested for usability, which could be a large component of successful implementation (Burg, Kantonides & Russell, 2009; Mazurick & Melanson, 2004). The goal of the assessment was to evaluate this system for its viability as a voting method and its usability for both visually impaired and sighted users.

## **Background**

As of 2008, 73% of polling locations had one or more obstacles that could impede access to voting areas for those with disabilities (United States Government Accountability Office, 2009). Though nearly all polling locations have accessible voting machines, 23% of voting stations with accessible voting systems offered less privacy than non-accessible voting stations (United States Government Accountability Office, 2009).

According to Schur (2013), traveling to a polling location is another challenge for those with disabilities. This obstacle can be avoided by utilizing remote voting methods, but the current remote voting standard in the US still presents problems for the disabled. Voting by mail is the primary way citizens can cast their ballot without traveling to a polling place (Ellis, Navarro, Morales, Gratschew, & Braun, 2007). With this method, ballots can be lost in the mail and either not received on time or at all (Ellis, Navarro,

Morales, Gratschew, & Braun, 2007). Perhaps more importantly, mail-in ballots are usually paper ballots, where voters must mark their selections on physical ballot. This type of ballot can create a barrier for voters with visual disabilities, as these voters may have difficulty reading or even seeing the paper ballot. Overcoming this difficulty often requires the voter to trust someone to help them complete the ballot, negating their private and independent vote. Even if the ballot were to be requested with larger, more easily readable text, that also has the potential to lead to reduced privacy when voting (Norden, Creelan, Munoz, & Quesenbery, 2006) since it allows other in the room to more easily see how the voter is marking the ballot. Voters with cognitive impairments may not be able to fully understand complex instructions written on the ballot and voters with fine motor impairments could have trouble physically filling out the ballot (Tokaji & Colker, 2007).

### Interactive Voice Response Systems

IVR systems allow interaction between users and computers via DTMF (touch-tone) inputs (Brandt, 2008). IVR systems have generally garnered a negative reputation due to the unsatisfying experiences many people have with the systems, with most of this dissatisfaction stemming from poor interface design (Brandt, 2008). However, by closely following the recommendations and research found in the current literature, it is possible to create a highly usable IVR interface that can increase the efficiency and perceived usability of these systems (Killam & Autry, 2000; Schumacher, Hardzinski, & Schwartz, 1995).

IVR systems can provide accessible interfaces for a broad range of physical disabilities (Brandt, 2008). Telephones can be purchased to match many different levels of physical ability, by using simple design elements, such as larger buttons for visual and fine motor impairments. Also, the purely audio interface of IVR systems is considered ideal for those with visual impairments (Laskowski, Autry, Cugini, Killam, & Yen, 2004). Norden, Creelan, Munoz, and Quesenbery (2006) noted that Vote-by-Phone systems show their greatest strength as accessible interfaces because they could allow voters to complete a ballot remotely. Voters could cast their ballots at home using

their own telephones configured with any accessible features needed. Voters would also not be required to travel to polling locations, which, as noted earlier, can be a difficult task for many disabled voters having to arrange for transportation to polling locations (Norden, Creelan, Munoz, & Quesenbery, 2006).

Over 97% of US households have DTMF (touch-tone) telephones, which is the primary interface for IVR systems (US Census Bureau, 2011). Because telephone access is ubiquitous and low cost telephones are readily available, the use of telephone-based IVR voting systems would not require the deployment of additional equipment to voters and would be cost effective to implement at polling locations.

Another advantage of IVR system interfaces is that they can be easily ported to other voting methods or technologies that use “prompt and response” interfaces (Brandt, 2008). This means that building a voting interface for the telephone and a graphical computer interface, for example, will be relatively cost effective since they share much of the same interaction structure. Further, because of the simplified nature of most IVR interactions, it is possible that other technologies may see performance improvements if a successful IVR system interaction design is implemented.

IVR systems have been successfully implemented for voting in both the laboratory and in the field in actual election settings. Holmes and Kortum (2013) demonstrated that an IVR voting system performed comparably to other voting methods and was considered subjectively usable by participants. A form of voting by phone was implemented in New Hampshire and Vermont elections. This instantiation of a vote-by-phone system did not permit remote voting, but instead allowed voters to use telephones at the polling locations to cast their ballot (Norden, Creelan, Munoz, & Quesenbery, 2006). Though the benefits to voting remotely were not available to the voters, the advantages of having a non-visual interface still remained for those with visual impairments, allowing for private and independent voting.

## Study 1 - Testing the IVR System with the General Voting Population

Holmes and Kortum (2013) developed and tested an IVR voting system to assess its usability and determine its general viability as a voting medium. This system was fitted with a user adjustable audio speed feature to increase its accessibility specifically for blind voters according to recommendations put forth by Piner (2011), Asakawa, Takagi, Ino, & Ifukube (2003), and Theofanos & Redish (2003). Although the system was shown to be usable and to perform comparably to other voting methods, the sample population, comprised solely of college undergraduates, limited the generalizability of the results.

In this study, we addressed the sample limitation in Holmes and Kortum (2013) by testing the system with the general voting population. The goal of this study was to further evaluate the general usability of the accessible IVR voting system and its viability to as a voting system with the general voting population. We also examined the utilization of the speech-rate accessibility feature to determine whether it would prove useful to sighted individuals and if it positively impacted overall usability.

### Method

#### Participants

135 subjects (65 females and 70 males) were recruited from the general Houston population. The participants had normal or corrected to normal hearing, and ranged in age from 19-65 years, with an average age of 36.54 ( $SD = 12.82$ ). Subjects were compensated \$25 for their participation.

#### Design

The study was a mixed design with one within-subjects variable and one between-subjects variable. The within-subjects variable was ballot type. Subjects voted on both the IVR voting system and a standard paper bubble ballot where a vote is made by filling in a small circle, or "bubble", next to a candidate in a race or choice on a proposition. The between-subjects

variable was the 2-level information condition, which determined how subjects voted. Subjects were randomly placed in either a directed-voting condition or an undirected-voting condition. Participants in the directed condition were given a sheet of paper, called a slate, that instructed them how to vote in each race and proposition. Those participants who were placed in the undirected condition were given a voter's guide, similar to the [League of Women Voters' guide](#), which details the political stance of all candidates as well as arguments for and against each proposition on the ballot. Participants in the undirected condition were allowed to vote freely. After casting their votes, participants in the undirected voting condition were given an exit interview, which assessed their voting intent for each race and proposition on the ballot.

The three measures of usability (efficiency, effectiveness, and satisfaction) as defined by the International Organizations for Standardizations recommendation ISO 9241-11 (ISO, 1998) served as the dependent variables. Efficiency reflected how long subjects took to complete a ballot.

Effectiveness captures how accurately participants made their intended selections on the interface, and was measured by error rate. In the undirected condition, errors were determined by comparing subjects' selections on the two ballots, IVR and bubble, with their answers on the exit interview. Selections that matched on two out of the three methods were considered to reflect the subjects' actual voting intent. Selections that deviated from two matching selections were considered an error on the method with the differing selection. For example, there are two major political parties in the US, the Republican Party, and the Democratic Party. If a participant selected the Republican Party candidate in the Presidential race for both the IVR voting system and the exit interview, but voted for the Democratic Party candidate on the bubble ballot, then this would count as an error on the bubble ballot. In the directed condition, selections deviating from the slate were counted as errors. Error rate was calculated by taking the total number of errors on a ballot and dividing it by the total number of possible errors on the ballot.

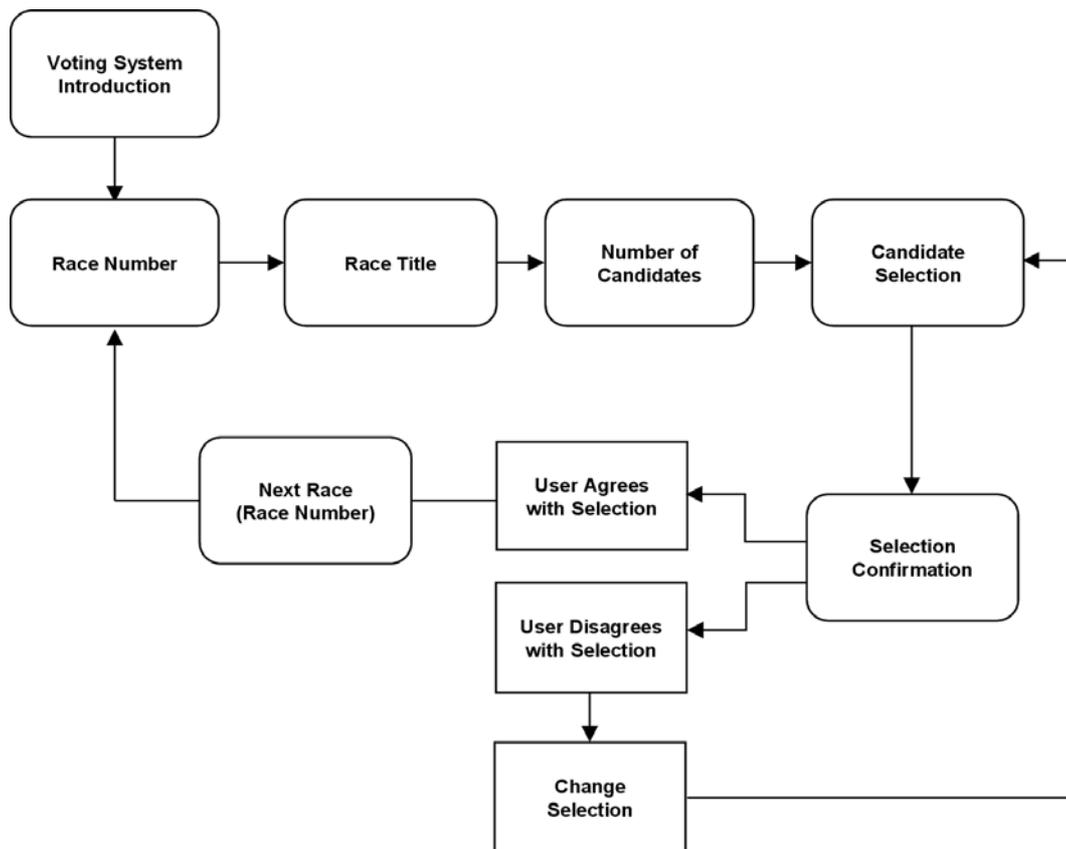
The System Usability Scale (SUS) was used to assess the subjective usability of the system, representing the satisfaction metric. It is a ten item, Likert scale survey scored from 0 (poor) - 100 (excellent) (Brooke, 1996). It has been demonstrated to be an effective measure across a wide range of interface types (Bangor, Kortum & Miller, 2008), making it ideal for use in this study of different voting technologies.

## Materials

The IVR voting system was a serial representation of the ballot used in studies by Everett et al., 2008, Byrne et al., 2007, Everett et al., 2006, and Greene et al., 2006. The paper bubble ballot used the same ballot as well. The ballot contained 21 races at the national, state, county, and non-partisan (without political affiliation) level and 6 propositions from various state or county ballots.

The IVR employed a male synthetic voice, as recommended by Piner (2011). The system provided general instruction on the use of the IVR, and then presented each of the races in turn. The IVR utilized an in-line confirmation method, rather than an end of ballot review. After making a selection, the voter was asked to confirm the selection. If they were satisfied with the selection, the system moved on to the next race. If they were not satisfied with the selection, the system returned to the list of candidates for the current race to allow the user to make another selection. Figure 1 shows the basic operational flow of the IVR.

Figure 1. Basic flow of the IVR interaction



The IVR system also employed a speed adjustment system that allowed users to change the rate of speech without distortion. The feature was configured to allow users to slow or speed the system audio in 10% increments to a maximum of +/- 50% at any time throughout the voting process. To control this feature, users pressed "7" to slow the audio and "9" to speed the audio in accordance with Schumacher et al.'s (2000) usable IVR design guidelines. Those guidelines suggested that the IVR should have directional metaphors consistent with the common stereotypes and keypad layout.

A section 508 (Rehabilitation Act of 1973, 1973) compliant telephone was used to complete the ballot on the IVR voting system. The system logged ballot completion times, user responses, and audio speed adjustment usage.

### Procedure

Subjects placed in the undirected condition were given a voter's guide, modeled on the League of Women Voter's guide, which contained information about every candidate and proposition. Participants could

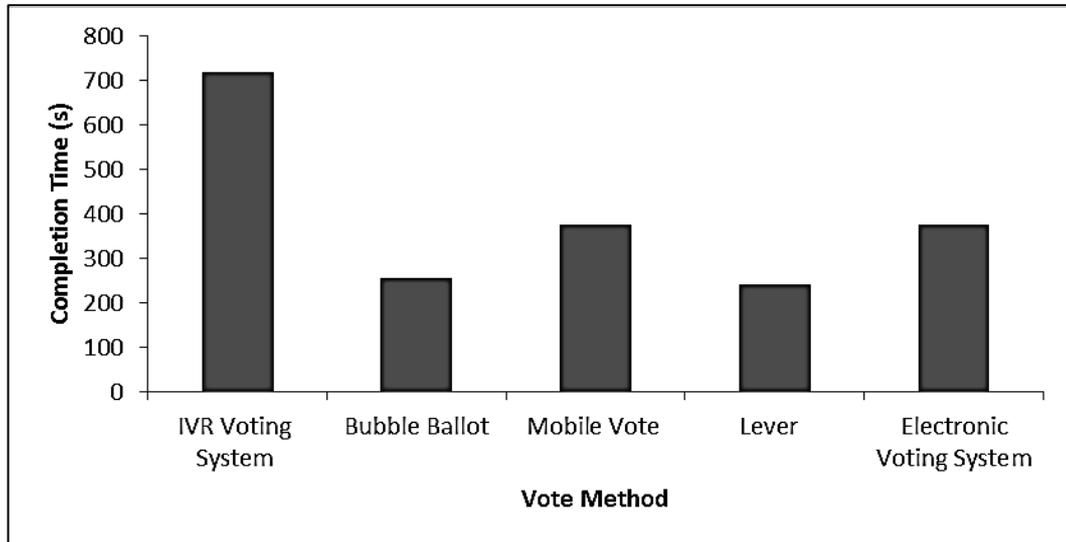
decide whether or not they wished to use the guide to make their voting selections. Participants in the directed condition were randomly given a voting slate that contained either a majority of Democratic or Republican candidates. The ordering of the voting methods was counterbalanced. Immediately after voting with a particular method (paper or IVR) participants rated their satisfaction using the System Usability Scale survey.

## Results

The usability metrics collected on IVR voting performance were evaluated and directly compared with those of the paper bubble ballot. We also compared IVR performance with performance measures collected in usability studies of other voting technologies that used the same ballot as this study to better understand how the IVR system fares against other common voting methods. These additional technologies included lever machines, prototypical electronic voting systems and an experimental application that allows people to vote on their smartphone as studied in Everett et al., 2008, Byrne et al., 2007, Everett et al., 2006, and Greene et al., 2006.

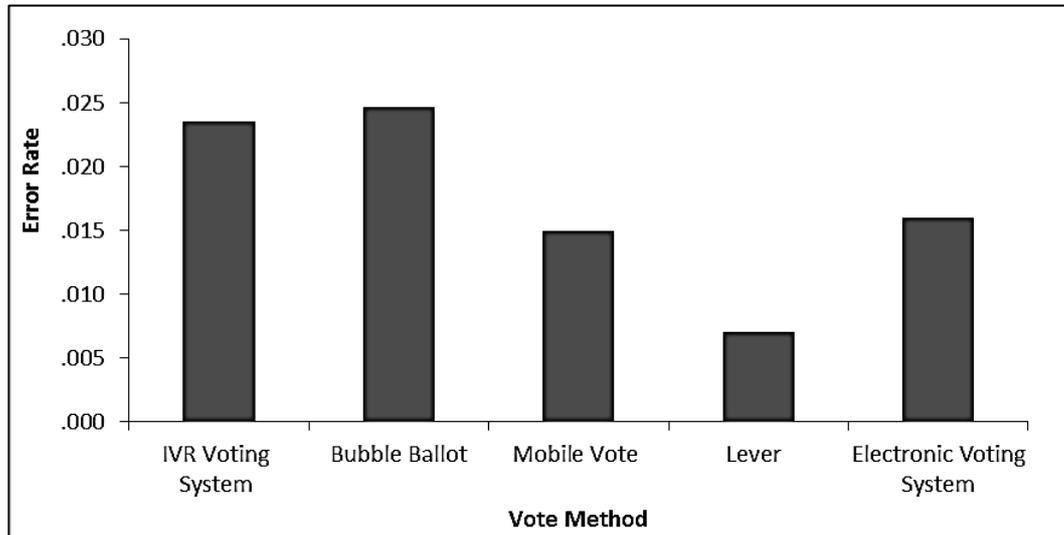
**Efficiency.** The average ballot completion time across the information conditions for the IVR voting system was 719.90 seconds ( $SD = 251.28$ ), which is approximately 12 minutes. This time was noticeably longer than that of the bubble ballot and times of other voting methods from previous studies (data collected from Everett et al., 2008, Campbell, B., et al., 2010, and Greene et al., 2006) as seen in Figure 2.

Figure 2. Total ballot completion time comparison of the IVR voting system with various voting methods.



Effectiveness. Six subjects were removed from this analysis due to their error rates being above 15% on both the IVR voting system and the bubble ballot, indicating a lack of understanding or non-compliance of the experimental task (Byrne, Greene, & Everett, 2007). The IVR voting system's error rate was .023 ( $SD = .054$ ), while the bubble ballot's error rate was .025 ( $SD = .067$ ). There was no evidence supporting a difference between the error rates of the two voting methods,  $F(1, 128) = .03$ ,  $p = .86$ ,  $MSE < .01$ . Figure 3 displays a comparison of the IVR voting system and bubble ballot error rates to error rates from other voting methods (Everett et al., 2008; Campbell, et al., 2010; Greene et al., 2006).

Figure 3. Comparison of error rates between the IVR voting system and other voting methods.



Error was also examined on a by ballot basis (see Table 1), meaning that a ballot either contains one or more errors or does not. Approximately 25.6% of ballots contained at least one error on the IVR. About 21.7% of bubble ballots contained one or more errors.

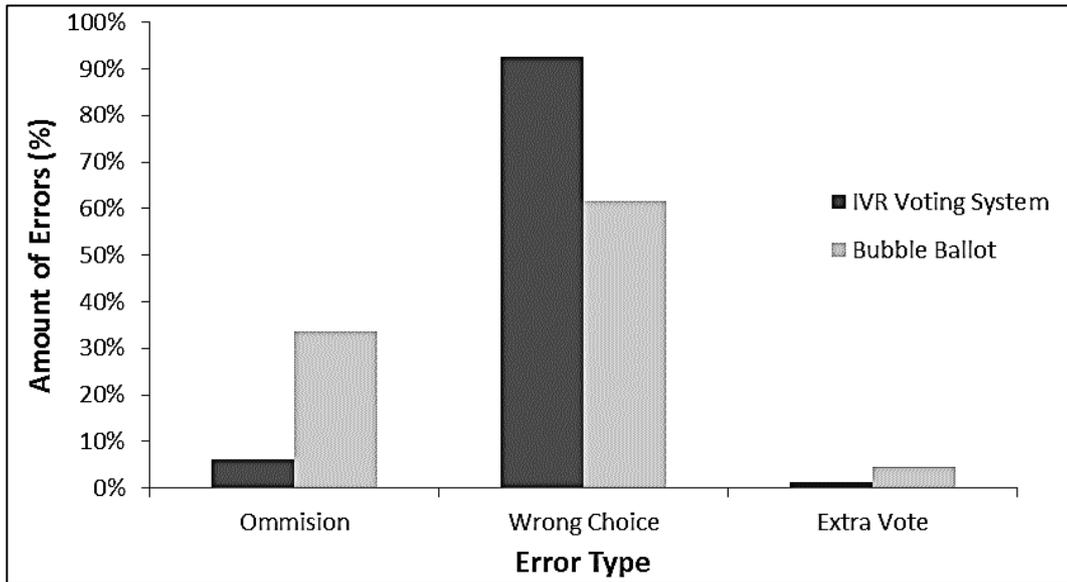
Table 1. Frequency of ballots with and without errors

	No Errors	Errors
IVR Voting System	33	96
Bubble Ballot	28	101

There were three types of errors that subjects made during the experiment. Omission errors occur when there is no selection made when the intent was to make a selection. Wrong choice errors occur when the selection made is not the one that was intended. Lastly, extra vote errors occur when a selection is made when the intent was not to make a selection in a race.

The bubble ballot elicited the most omission and extra vote errors, while the IVR voting system produced the highest count of wrong choice errors. The percentage of each type of error committed for the IVR voting system and bubble ballot is shown in Figure 4.

Figure 4. Number of each type of error committed within the IVR voting system and bubble ballot.



**Satisfaction.** The IVR voting system received an average SUS score of 84.41 ( $SD = 14.48$ ), while the bubble ballot scored approximately 4 points lower at 80.43 ( $SD = 16.15$ ). The two scores were reliably different (see Figure 5),  $F(1, 134) = 5.12, p = .03, MSE = 208.97$ . Figure 6 depicts a comparison of SUS scores of the IVR voting system with other voting methods from previous studies by Everett et al., 2008, Campbell, et al., 2010, and Greene et al., 2006.

Figure 5. Boxplot comparing SUS scores for the IVR voting system and bubble ballot.

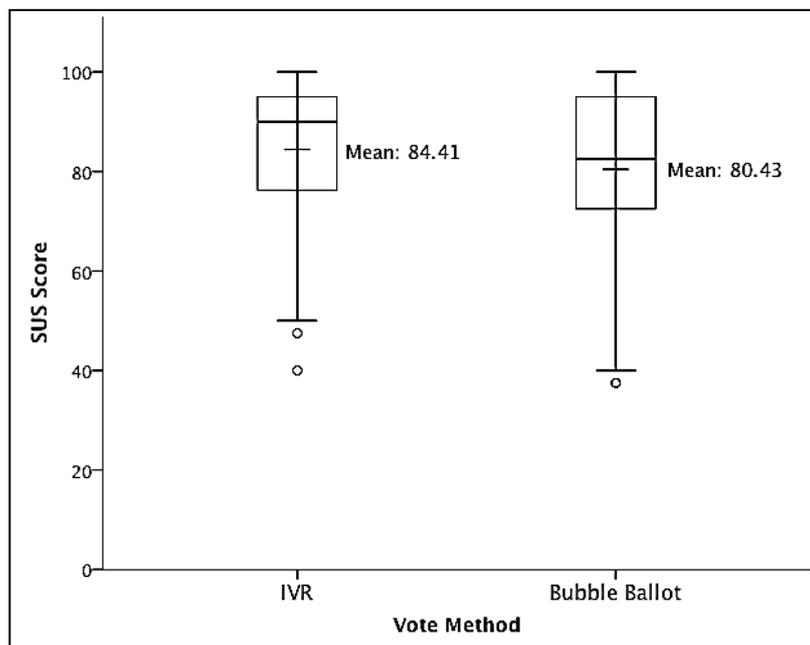
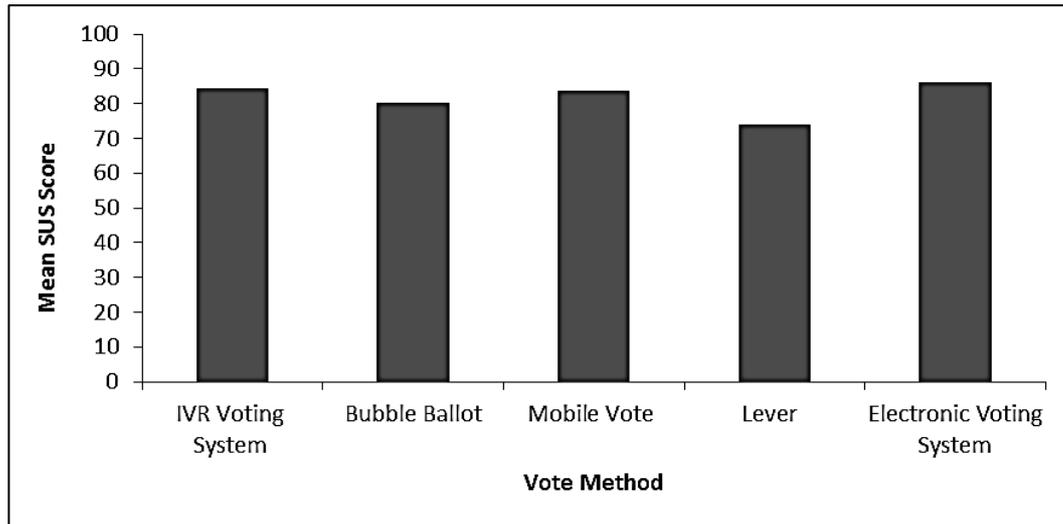


Figure 6. Comparison of SUS scores between the IVR voting system and other voting methods.



**Audio Speed Adjustment Usage.** Approximately 37% of subjects utilized the speed adjustment feature. When the audio speed adjustment feature was used, average ballot completion time was 607.06 ( $SD = 213.43$ ) seconds compared to the non-use average of 786.28 seconds ( $SD = 249.22$ ).

## Study 2 - Testing the IVR system with the Visually Impaired Voting Population

The second study extended the results from study 1 by testing the IVR voting system with users from the general population who were legally blind. The performance of visually impaired and sighted users in their use of the system was then compared. This analysis is important since the system is intended to equally support both sighted and visually impaired users in their vote casting efforts.

### Participants

19 (11 females, 8 males) legally blind subjects were recruited from the general Houston population. These participants reported normal or corrected to normal hearing, and had an average age of 43.47 years ( $SD = 15.81$ ). Participants were compensated with a \$25 e-gift card for their participation.

## Design

The same design as Study 1 was used, with the exception of the information and ballot type conditions. Because the participants were visually impaired, we only used the directed condition and did not have them complete a bubble ballot. The voting slate was verbally administered to subjects prior to voting, and the experimenter collected satisfaction data from the SUS using a verbal protocol as well. A participant's visual status (sighted or legally blind) was the between-subjects variable used when comparing sighted and visually impaired subjects. To allow for direct comparison between sighted and visually impaired subjects, only data from the 67 subjects in the directed condition in Study 1 were used.

## Materials

The same materials in Study 1 were utilized, with the exception the use of a Section 508 compliant telephone. Subjects used their personal telephones to complete the study since the study was conducted remotely.

## Procedure

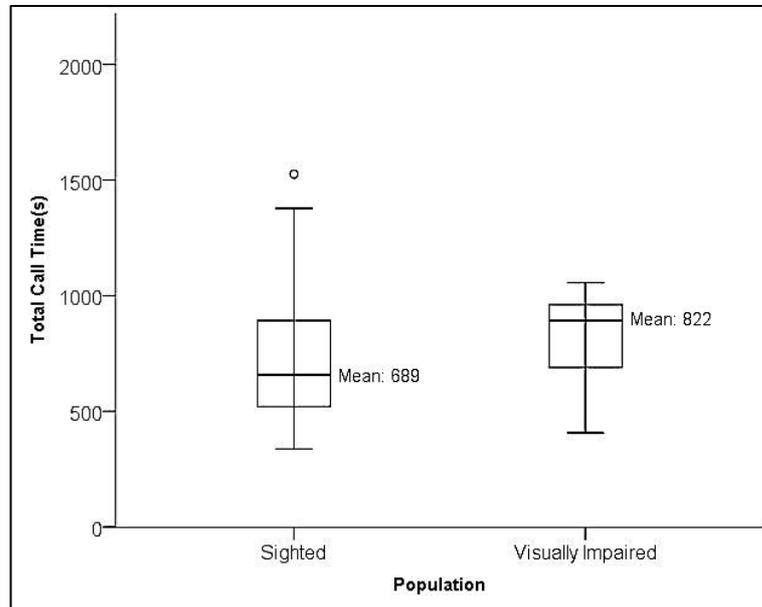
A modified version of the procedure from Study 1 was used in order to accommodate testing with visually impaired subjects. Participants were asked to call into the laboratory at a specified appointment time from any touch-tone telephone to participate. Subjects were given a simplified verbal slate, instructing them to vote for all Democrats, skipping races that did not have a Democratic candidate and non-partisan races, and to vote "no" on all propositions.

## Results

**Efficiency.** The average ballot completion time for visually impaired users was 822.16 seconds ( $SD = 201.83$ ), which is approximately 14 minutes. Average voting time for sighted users was 689.00 seconds ( $SD = 206.10$ ), or approximately 11 minutes and 30 seconds. The total ballot completion times were significantly different,  $F(1, 84) = 6.23$ ,  $p = .01$ ,  $MSE = 42,104.08$ .

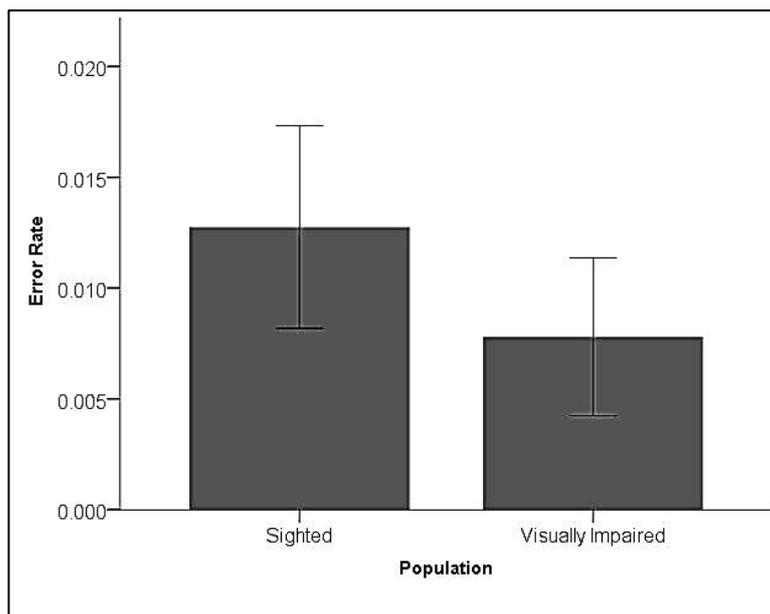
Figure 7 compares the total ballot completion time of sighted and visually impaired subjects.

Figure 7. Comparison of total ballot completion time between populations.



Effectiveness. The error rate of visually impaired subjects was .008 ( $SD = .016$ ), while sighted subjects' error rate was .013 ( $SD = .036$ ). No evidence supported a difference between the error rates of the two populations,  $F(1, 78) = .34$ ,  $p = .56$ ,  $MSE = .76$ . Figure 8 compares the error rates of sighted and visually impaired users on the IVR voting system.

Figure 8. Error rates of sighted and visually impaired users on the IVR voting system. Error bars represent +/-1 standard error.



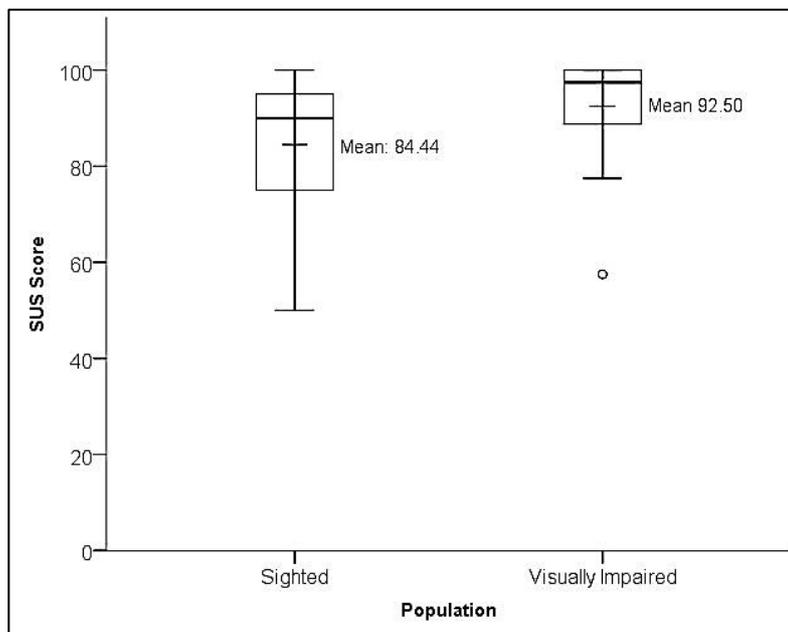
The by ballot error rate for the system was measured (see Table 2) for the visually impaired participants. Approximately 21% of ballots contained at least one error, equating to four ballots out of 19 containing errors. This number appears to compare well with by ballot error rate (25.6%) of sighted participants. Three ballots contained undervote errors, meaning no selection was made on races that required one. One ballot contained a wrong choice error, where a selection that did not coincide with the slate was made.

Table 2. Frequency of ballots with and without errors on the IVR voting system between populations

	No Errors	Errors
Sighted	33	96
Visually Impaired	4	15

Satisfaction. The average SUS scores from visually impaired subjects was 92.50 ( $SD = 10.74$ ) and 84.44 ( $SD = 14.14$ ) for sighted subjects. A Welch corrected ANOVA revealed that the SUS scores were reliably different,  $F(1, 37.58) = 7.18, p = .01, MSE = 181.82$ . Figure 9 depicts a comparison of SUS scores between the two populations.

Figure 9. Average SUS scores for sighted and visually impaired users.



Audio Speed Adjustment Usage. Approximately 26% of visually impaired subjects utilized the speed adjustment feature. Those who used the feature

had an average ballot completion time of 684.73 ( $SD = 294.58$ ) seconds, while those who did not complete their ballot in an average of 871.25 seconds ( $SD = 140.87$ ).

## Discussion

**Efficiency.** The IVR voting system is slower, in terms of ballot completion, than other voting methods. This is an expected result because of the serial nature of the interface; voters must listen to every candidate and every race if they are to complete the ballot fully, and visual scanning short-cuts cannot be utilized. Both sighted and unsighted users showed longer completion times, suggesting that the presence of a visual impairment was not the issue, but rather the exhaustive presentation of the information.

One large contributor to the lower efficiency of the IVR was that the IVR interface had a different form of review than the other forms of voting described here. In most voting methods, voters mark their entire ballot and then perform a check of those selections at the end of the voting process, immediately prior to casting the ballot. This type of vote reviewing significantly complicates the interface for an IVR system, because it would require that a user be able to navigate back and forth to a race to change or modify a selection if it was deemed incorrect during the review. In order to eliminate this significant interface complexity, the IVR system utilized an in-line review process. Immediately following the selection of a candidate, and acknowledgement of that selection, the IVR would ask the user to verify that selection. This verification took the form of a prompt that stated "In the race for the Senate, you voted for John Smith. If this is correct, press 1. If this is not correct, press 2". If a user made a mistake, pressing 2 would take them back to that race for the correction. The review prompt would be played again and, if the user was satisfied with their vote, they would move to the next race. This means that users were forced to review every single race by having it read back to them. This is in contrast to the typical skimming behavior exhibited by users during the review of their ballots. Paper ballots are often cast with little review at all (Herrnson et al., 2006), since there is not a formal review step in the process.

Even on electronic voting machines, where a voter is presented with a formal review screen that summarizes all of the selected votes and asks the user for confirmation, voters typically spend very little time (most spend less than 20 seconds) (Everett, 2006) on the review screen.

In the IVR, if the average review prompt is about 10 seconds in duration, this adds 270 seconds to the overall time across the 27 races. If we were to remove this forced review time from the analysis, IVR completion time would be much more similar to other voting systems.

Even though we can account for this extra time, the fact remains that IVR voting took longer than other forms of voting. However, this disadvantage may be counteracted with the fact that the IVR voting system does not necessarily require voters to travel to a voting location and wait in line to vote, which could translate into significant time savings for voters. Since visually impaired users took approximately 2.5 minutes longer to complete a ballot on the system than sighted users, the benefit of not incurring the previously discussed barriers of travel and ability to vote independently may outweigh the decreased efficiency for visually impaired voters (Schur, 2013).

The IVR system did employ a modified version of a standard feature that is common in commercially deployed IVR system: barge through. Barge through allows a user to make a selection at any time during the prompt presentation. This feature allows a user to make their selection immediately upon hearing it, thus reducing errors due to memory load. The IVR deployed here used a modified form of barge through, which forced the user to hear the race number and position (e.g. "Race 3 of 21", "You are voting for the US Senator"), but allowed them to make their selection any time after that. If they selected a candidate before all of the candidates had been read, the prompt would terminate, and the voter would be taken to the confirmation message. We measured the full run time for each race without barge through, called system time, to help determine the usage of the barge through feature. Use of this feature was significant as all races, for both sighted and visually impaired users, were on average faster than system time. The use of the feature reduced the average ballot completion time by 34.0% for sighted users and 24.9% for visually impaired users. This feature

was the only reason the ballot could have been completed in faster than system time, therefore is solely responsible for increasing efficiency in the system. It is an integral attribute to the system as it positively affects usability.

**Effectiveness.** There was no evidence supporting a difference between the error rates for ballot type and population. Due to that result, we could assume that the IVR voting system could perform well in the aspect of accuracy as a voting medium for both sighted and visually impaired users. It is worth noting that the error rates for both the bubble ballot and IVR voting system for sighted users seemed elevated compared to other voting methods, though statistical support of a difference could not be established due to lack of data from the previous studies for comparison. Increased error rates observed in this study for both the IVR and bubble ballot as compared to error rates for the two methods in past studies could be due to sample differences since both methods showed an increase. Regardless, the error rates for both methods are still considered to be very low.

**Satisfaction.** The IVR voting system had a higher average SUS score than the bubble ballot, suggesting that the IVR is more subjectively usable than the bubble ballot. It was also rated higher by visually impaired users than sighted users. Though the SUS scores for the bubble ballot and IVR voting system (blind and sighted participants) varied, they could all be considered 'Excellent' according to the adjective rating scale for the SUS (Bangor, Kortum, & Miller, 2009). This was a favorable outcome because it helps support the proposed viability and usability of the IVR voting system as a voting method for both sighted and visually impaired users. Despite of the longer voting times, the IVR voting system was still assessed to be on par with other voting methods in terms of subjective usability, furthering its stance as a universal voting medium for both sighted and visually impaired users.

**Audio Speed Adjustment Usage.** About 37% of sighted subjects and 26% of visually impaired subjects utilized the audio speed adjustment feature. The feature was implemented specifically to support visually impaired users, as they often have experience with increased rate text presentation through

their extensive use of screen reading technology on the personal computer. The fact that a third of the sighted users took advantage of the feature suggests that, like closed captioning on televisions, this feature has relevance as an interface feature across the population. The IVR is uniquely suited to provide a universally accessible voting interface as there is no separate accessible mode like you would find with some electronic voting systems in use today. Essentially, everyone who would use the IVR voting system could benefit from its accessible features.

Finally, it is important to note that this study only addressed the *usability* of the IVR voting system. Other issues, most notably security, were not intended to be evaluated in this study. If the IVR were to be used in a polling location, security concerns would be minimal. However, one of the stated strengths of the system is the ability of the IVR to be used virtually anywhere, which brings about additional security issues, including potential loss of privacy from interception of the voting session and coercion of the voter since the voter is not within the controlled environment of a secure polling station. These security issues would need to be addressed before the IVR voting system could be used in an in a real election, particularly if voters were allowed to vote remotely.

## Conclusions

The study strongly suggests that IVR voting platforms could be a potential option to help increase the ability of visually impaired users to participate in elections with the same privacy and self-reliance as other voters. At a minimum, this study has provided the first step in determining how the IVR stands as a remote and accessible voting system. Further research with larger numbers of visually impaired users, could help us better understand the performance of these systems in voting environments, and could have implications in the realm of voting accessibility.

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