

**The Impact of Ballot Type and Voting System on Voting Errors**

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The 2000 presidential election ushered in new awareness and concern about how Americans cast their votes. In reaction, Congress passed the Help America Vote Act of 2002 and many states and localities purchased new voting systems, revamped their procedures for updating voter registration records, and revisited a number of issues related to election administration and the voting experience. Researchers responded primarily by assessing the merits and shortcomings of different voting systems, ranging from computerized systems to those that rely on paper ballots. Their efforts have provided important insights into voting technology. Nevertheless, the systems themselves are only part of what voters confront when attempting to cast their votes. Voters also need to negotiate their way across a ballot. Whether a series of names and images programmed on a touch screen or printed on a piece of paper, the ballot has the potential to influence voters' abilities to cast their ballots as intended. When voting systems differed greatly—with some demonstrably poor and others new and largely untried—it made sense to focus heavily on the systems themselves. Now that the poorer systems—especially various kinds of punch cards—have been set aside, it makes sense to focus on ballot design, which has received much less attention.

Ballots are important to study for a number of reasons. First, ballots are the main thing voters see once they begin the voting process. Second, there is a large variety of ballot layouts, options, and tasks (more than the number of voting systems), and these can influence the voting process. For example, ballot-related issues, such as candidate order and straight-party options, give advantage some candidates over others (Krosnick et al. 2003). Perhaps more important, certain types of ballots are believed to be associated with more voter errors than others (Wand et al. 2001, Frisina et al. 2008). The so-called “butterfly” ballot exemplifies this (Wand et al. 2001). Third, the impact of ballot design on voter errors may be conditioned by the voting system on

which the ballots are programmed, resulting in the same type of ballot working effectively on one style of voting system, but not another. Finally, if some groups of voters make more errors on certain types of ballots or ballot-voting system combinations than others, then issues of fairness and equality in the voting booth come into play. In sum, as political scientists reported over 100 years ago (Allen 1906; Beard 1909), ballot-related issues can complicate the lives of election officials, politicians, and voters.

We assess the impact of ballot design on voter accuracy using data from a field study that enables us to associate individuals' prerecorded voting intentions with the votes they actually cast on two of the most dissimilar voting systems currently in widespread use—a touch screen system and a paper ballot system with precinct-based optical scanning (opscan). To isolate the effects of ballot designs on voter accuracy we programmed each voting system with two of the most common types of ballots: a standard office-bloc ballot and an office-bloc ballot with a straight-party feature. Our study focuses on the frequency of voter errors, focusing on unintentional undervoting (failing to select a candidate when one intended to vote for a candidate) and the extent to which voters cast ballots for unintended candidates or ballot measures—the most serious type of error one can make and the one that is most difficult to detect.<sup>1</sup> We also consider who makes various types of errors. Given that our research is concerned with the behavior of individuals when they encounter voting interfaces, our study is informed, in part, by the usability literature (also known as human factors psychology and industrial design). These studies typically assess systems in terms of “learnability,” efficiency, “memorability,” errors, accuracy, speed, and user satisfaction (Nielsen 1994, 2003).

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<sup>1</sup> For simplicity, throughout the text we refer to this type of error as a wrong candidate error. As we discuss later, our research design allows us to separate intentional undervotes from unintentional undervotes.

## **The Impact of Ballots on Voter Accuracy**

Voter accuracy has almost never been studied. Indeed, it is impossible to do so *in situ* because of ballot secrecy laws and practical considerations involving recording what happens in the voting booth. Nevertheless, there are reasons to believe that ballot design can make a considerable difference.

Several real-life cases indicate the influence of ballot design on voter behavior. The most well-known is the butterfly ballot used in Palm Beach County, Florida in 2000, in which statistical analyses convincingly indicate that a substantial number of voters, enough to alter the outcome, cast a ballot for Reform party candidate Pat Buchanan when they intended to vote for Democrat Al Gore (Wand et al. 2001). More recently, in the 2006 congressional election in Florida's 13<sup>th</sup> district, the ballot was programmed on a touch screen system in such a way that it is the likely cause of more than 18,000 voters failing to cast a vote in one portion of a competitive election (Frisina et al. 2008); with just 369 votes separating the candidates, the layout of the ballot on the touch screen system surely influenced the outcome. Likewise, in a very different setting, Lausen (2007, 21) demonstrates how altering the design of the ballot for a lengthy list of candidates in a Chicago judicial retention election decreased dramatically the number of voters who failed to vote. In New York State, long-standing anecdotal evidence suggests that that voting for multiple judicial candidates and for ballot questions is problematic due to the ballot format on its lever machines. Recent systematic analysis of full-face ballots bolsters this conclusion (Kimball and Kropf 2007).

An analysis of ballots by Niemi and Herrnson (2003) revealed numerous features that could lead to confusion and possibly error. One of their primary observations is that instructions for voting can be confusing, especially as they relate to more complex tasks, such as voting for

more than one candidate in a multi-candidate election or voting for an “exception” after using a straight-party option. Rotating ballot order is done in some jurisdictions precisely because it is widely believed that candidates listed first for a given race are favored. Recent research has also demonstrated that ballot style can influence the number of votes that go unrecorded (Kimball and Kropf 2005; Bullock and Hood 2003; Wattenberg, et al. 2000).

It is clear that straight-party options alter voting habits, though how much they alter voters’ intentions is not easy to determine. Straight-party options on ballots were motivated primarily by partisan interests. They were originally designed to discourage voters from splitting their tickets or from failing to vote for offices below the top of the ticket (Rusk 1970). In this respect, the features have been a success. Most voters who use them cast their votes for candidates of one party (Campbell and Miller 1957; Rusk 1970). In some cases, however, these ballots have become victims of their own success. Illinois Republicans, for example, believed the use of straight-party ballots in their state made it too easy for Democrats to vote for Democratic candidates all the way down the state’s lengthy ballot. When they took control of the legislature and governorship, they removed the straight-party feature from Illinois’s ballots (Kimball, Owens, McLaughlin 2002). Currently, 15 states have ballots that feature some form of straight-party feature.

The introduction of touch screen and precinct-based optical scan voting systems has the potential to increase the complexities associated with some ballots and decrease those associated with others. Switching voting systems has the potential to confuse voters in simple voting situations, and is even more likely to confuse voters when trying to perform more complex tasks, such as using a straight-party option or voting in elections designed to select more than one candidate. When such changes occur, there is potential for confusion even among voters who

have previously performed these tasks. Such problems may be mitigated by voting systems with review screens that warn voters should they undervote in a multi-candidate election or that move the voter down the ballot to nonpartisan offices or ballot questions once they have used a straight-party feature. While the introduction of new voting systems has the potential to increase the complexities voters encounter when using certain ballots, certain features may have the potential to overcome some of the weaknesses attributed to the systems. Thus, it is important to test ballot effects on different voting systems.

### **Methodology**

In the field study described below, we tested two ballot formats with long histories of use: a standard office-bloc ballot, which lists all of the candidates for one office together, and an office-bloc ballot with a straight-party feature, which is similar to a standard office-bloc ballot in all respects, except that it allows an individual to cast all of his or her votes for candidates running in partisan contests through one action. To assess the generalizability of the findings across different voting systems, each ballot was tested on the two most widely used types of systems: a touch screen voting system (the Diebold AccuVote-TS) and a paper ballot system with precinct-based optical scanning (the ES&S Model 100). These voting systems are among the most dissimilar in use. Touch screen systems, which make up the bulk of the 38 percent of the systems used by voting public in 2006, feature an interface similar to those of ATMs commonly used in banking. Paper ballot/opscan systems, used by roughly half of all voters, are similar to multiple choice (fill-in-the-oval) forms used in testing and for forms used by government and private industry (Election Data Services 2006).

#### *Ballot Styles and Voting Systems Tested<sup>2</sup>*

Voting on a standard office-bloc ballot using an opscan system is fairly straightforward.

The voter uses a pen or pencil to fill in the oval or circle (or, alternatively, completes a broken arrow) next to the name of each candidate or position on a ballot question he or she intends to support. When the ballot is filled out, the voter slides it into a paper feeder in jurisdictions that have optical scanners on site. This provides immediate feedback about overvoting (voting for more candidates than is allowed for a given office).<sup>3</sup> Voters choosing to correct a flawed ballot can fix each error as it is reported by repeating the process until the ballot no longer contains any overvotes. From the paper feeder the ballot drops into a large ballot box resembling a safe. Like other opscan systems, the Model 100 has no review screen on which voters can check the accuracy of their selections, though of course they can take a second look at the ballot before inserting it into the paper feeder.

Voting on an office-bloc ballot with a straight-party feature on a paper ballot opscan system is similar except that the first box on the ballot, labeled “STRAIGHT PARTY VOTING,” lists the names of all of the parties whose candidates are listed on the ballot. Each party has an oval next to it. A voter who wishes to vote for every candidate affiliated with one party simply has to fill in the oval next to the name of that party. The voter can then skip every partisan office and proceed to those portions of the ballot that list nonpartisan elections and ballot questions. The voting tabulator will count all of the votes for partisan races as votes cast for the party selected in the straight party voting bloc. Once the ballot is completed, the voter slides it into the optical scanner, as discussed above.

An individual who wishes to cast all but one vote for the candidates of a single party can

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<sup>2</sup> For a more complete description of the voting systems see Herrnson et al. (2008).

<sup>3</sup> Voters who cast overvotes are alerted by a warning tone and a brief text message to that effect (such as *too many votes—county commissioner*). These voters have the option of removing their ballot and replacing it with a new one (which is the prescribed procedure), erasing a filled-in oval where they overvoted (not prescribed because erasures can cause problems in reading the ballot), or pressing a button that activates the computer to accept the ballot as is, complete with overvotes. On the model used in our study, overvotes were reported one at a time, beginning with the

do so by filling in the oval for the intended party in the straight-party bloc and then voting for the lone preferred candidate who is not a member of that party by filling in the oval next to that candidate's name. Referred to as a straight-party vote with exception (Niemi and Herrnson, 2003), this action causes the voting tabulator to count all of the votes in partisan races as having been cast for candidates of the voter's preferred party with the exception of the race in which the voter selected a candidate of another party, who receives a vote for that election. Ballots that allow for straight-party voting with exception allow voters to use the straight-party feature and then cast as many exceptions to that preference as they desire.

Although the procedures for using the straight-party feature or voting straight-party with exception do not appear particularly complicated, our observations indicated that some voters were confused by them. Some filled in the oval next to their intended party and then filled in the oval next to the name of every candidate affiliated with that party. When all of the Republican ovals were filled in correctly this did not result in any votes having been cast for the wrong candidates or for no candidate at all, but it was an extremely inefficient way to vote and showed a lack of understanding on the part of the voter. Some other voters evidently assumed that filling in the oval for a particular party would result in their automatically voting for a candidate in every contest, including candidates in races for nonpartisan offices, and they skipped ahead to the ballot questions. Obviously, however, the straight-party option does not apply to nonpartisan elections. As a result, these voters unintentionally did not cast a vote in these contests.

Voting on a standard office-bloc ballot on a touch screen system, such as the Diebold AccuVote-TS, is a fairly straightforward process. Poll workers authenticate an access (or activation) card roughly the size of a credit card, which is designed to activate the system and to

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error appearing nearest the top of the ballot. Additional overvotes also are reported one at a time in the order in which they appear.

ensure that a voter casts only one ballot. Voting involves touching the screen to select candidates from whichever office or offices appear on the first screen; they then instruct the system to advance to the next office or offices by touching the appropriate virtual button (or target area) on the screen. The number of races shown on a given screen varies by the amount of space required to list all of the candidates for each race. After voters navigate their way through all of the offices and ballot questions (if any), a list of all of the voter's selections is presented. This review screen (or screens) shows for whom they voted in each race and indicates whether any races have been missed, including when fewer than the allowable number of candidates has been selected. If they wish, voters can change their voting decisions, and they can repeat the reviewing and changing process until they are satisfied with the entire ballot. At that point they touch the target area on the screen to cast the ballot.

Voting on an office-bloc ballot with a straight-party feature on a touch screen is quite similar. However, instead of initially presenting the first race on the ballot, the system provides a box that lists the name of every party that appears on the ballot and instructs the voter that by touching the screen next to a given party name he or she can vote for all of the candidates of that party. Voters who choose this option and touch the target area to advance are automatically moved down the ballot to the first nonpartisan election. They can then vote for the nonpartisan elections and ballot questions that remain on the ballot. Voters who choose not to use the straight-party option are instructed to touch the screen to move them to the next page, where they begin voting for the first of the partisan elections. Voters who wish to vote straight-party with exception can either change a vote by paging back through the ballot and changing their vote when they arrive at the specific election or by navigating to the race of interest by selecting the race when they reach the review screen at the end of the ballot.

## *Hypotheses*

Our focus is on the impact of ballots on voter errors. However, we recognize that other factors can interact with ballots to produce fewer or more errors. These include performing tasks that are more complex than voting for one candidate for one office and the background characteristics of voters.

Our first set of hypotheses, focusing on ballot design, are premised on one of the main tenets of the usability research literature: systems with simple, straightforward end-to-end designs, involving fewer steps, providing confirmation of one's actions and system-based help are more effective than systems that have added complexity, require extra actions, and do not provide assistance with cognitive tasks (Nielsen 1994, 2003).

Hypothesis 1: Voters commit fewer errors in simple situations, such as voting for one candidate for one office, on a standard office bloc ballot than on an office bloc ballot with a straight-party feature.

Hypothesis 1a: Fewer wrong candidate errors occur when using the standard office bloc ballot than when using an office bloc ballot with a straight-party feature.

Hypothesis 1b: Fewer undervotes occur when using the office bloc ballot with a straight-party feature than when using the standard office bloc ballot. This occurs because the straight-party feature simplifies the voting process by automatically casting votes in all partisan elections.

Hypothesis 2: When using the office bloc ballot with a straight-party feature, changing a vote on the partisan portion of the ballot results in more wrong candidate errors in comparison to more simple tasks, including changing a vote on the non-partisan portion of the ballot. On the touch screen system voters either have to figure out how to navigate back from the nonpartisan races to the partisan races, or wait until they reach the review screen and navigate from there. In addition

to memory failure, and issues with navigation, the voter has to figure out the process of changing the vote which involves first deselecting the initial choice and then selecting the new choice. On the opscan system the voter can simply fill in the appropriate bubble to vote straight-party with exception. While seemingly simple, the voter may not be aware of this possibility and might be led to erase the straight-party selection and fill in each race individually, which can lead to errors.

Hypothesis 3: Voters commit fewer undervotes when voting for two candidates in a partisan election on an office bloc ballot with a straight-party feature than on a standard office bloc ballot because the straight party feature enables the voter to complete all of the votes for partisan offices in one action.

Our second set of hypotheses is concerned with the abilities of voters' possessing different background characteristics to navigate successfully their way through the different ballots on each of the two voting systems. The hypotheses draw from the usability literature and the literature on the digital divide, which posit that individuals with certain background characteristics, including the elderly and less educated, have more difficulty performing complex tasks, including using computers (Riviere and Thakor 1996; Kubeck et al. 1996). After providing an overview of voters' error rates, we focus on the impact of voters' backgrounds on the number of wrong candidate errors and undervotes. We focus on these errors because they are the only errors common to both voting systems on which the ballots are programmed. We do not test for errors that can only be committed on only one system, such as voting for more candidates than allowable, making stray marks, or tearing a ballot a ballot on a paper ballot/opscan system or screen freezes caused by dragging a finger down the screen or other equipment failures on the touch screen system.

Hypothesis 4: Voters who have low levels of computer usage, less education, and are older, will commit more wrong candidate errors when using the ballot with a straight-party feature. The same is true for minorities and those who have not previously encountered the voting systems.<sup>4</sup>

Hypothesis 5: Voters who have low levels of computer usage, less education, and are older, will commit more undervotes than other voters when using the ballot with a straight-party feature.

The same is true for minorities and those who have not previously encountered the voting systems.

### *Study Design*

The field study involved 1,540 participants who were recruited from university student bodies, faculty, and professional and maintenance staffs; office buildings; upscale and downscale shopping malls; senior citizens' facilities; and community centers located in urban and suburban areas in Maryland, Michigan, and New York (for more information on the participants see Herrnson et al. 2008).<sup>5</sup> After receiving a brief orientation to the project, participants were asked to read a voter guide (or information booklet), either the one for use with a standard office bloc ballot or the one for use with the office bloc ballot with a straight-party feature. The voter guide resembled the nonpartisan sample ballots mailed to registered voters by election officials in some localities and published in some local newspapers. Voters frequently circle their choices on these samples and take them into the voting booth to aid them in voting. By recording their voting

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<sup>4</sup> The literature on the digital divide suggests African Americans are much less likely than whites or Asians to live in a home with a computer. Race is an important factor to consider given the role that it plays in the composition of U.S. political jurisdictions and the findings in the literature that behavioral outcomes differ by race. Studies relying on aggregate data to assess the impact of race are not consistent. Brady et al. (2001); Bullock and Hood (2002); Knack and Kropf (2003); Tomz and Van Houweling (2003); Kropf and Knack (2004); Alvarez, Sinclair, and Wilson (2004); and Kimball and Kropf (2006) show that African Americans are likely to commit more residual vote errors. Herron and Sekhon (2005) demonstrate that some of these "errors" are due to the strategic behavior on the part of some African American voters. Drawing on the effects of experiential learning from the usability literature, those who have experience voting on systems similar to those tested will commit fewer errors (Nielsen 1994; Grissom and Perlman 1995).

<sup>5</sup> In addition to the field study, we used an expert review and a laboratory study in which we videotaped 42 individuals casting a ballot. These studies helped in the development of hypotheses and interpretation of results.

decisions on a sample ballot and later using that ballot in the polling place, voters are able to cast their ballots without relying entirely on memory.

The ballot we used in the study looks like a ballot that individuals would encounter in the voting booth and was realistic in content and length.<sup>6</sup> It consisted of 18 offices and four ballot questions and contained most of the features that occur in ballots across the states—partisan and nonpartisan sections, federal, state, and local offices, multiple parties, an uncontested race, and races with two candidates to be elected. Real offices (president, governor, county sheriff, and so on) were used, with real party names in the partisan section. Fictitious names were created for the candidates, but we took care to include a mix of men and women as well as names that sounded as if they represented various national and ethnic backgrounds. Ballot questions were realistic—not especially intelligible nor obviously controversial. Wording on the ballots—such as the instructions to “vote for one” or “vote for no more than two”—were taken from real ballots. We used the same ballot to test all of the voting systems.

The guide we provided to voters included some descriptive information for the candidates for president, as well as for candidates for some state, local, and nonpartisan offices that appeared further down the ballot. Voters were instructed to circle the names of the candidates they had selected on the basis of the information provided. This procedure was used to make the election simulation fairly realistic, to engage voters at the onset, and to keep them attentive throughout the voting process. For some lower-level offices, voters were asked to choose among a number of candidates whose names were accompanied by only a small amount of descriptive information, such as the candidates’ party affiliation. By enabling voters to rely on partisanship, a standard voting cue that informs most individuals’ vote choices, particularly in down-ballot

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<sup>6</sup> We designed our ballot after reviewing ballots used between 1998 and 2000 that were collected from all 50 states.

racess, additional realism was introduced into the simulation.<sup>7</sup> Further authenticity was created by asking voters to choose two candidates for associate justice of the state supreme court and two candidates for state representative, as these are multi-candidate races in a number of states, and by providing voters with a summary paragraph for each of the four ballot issues that appeared at the end of the voter guide and on the ballot and asking them to circle “yes” or “no,” depending on their preferences. On the office bloc ballot, we also asked them to omit a vote for one down-ballot race, as many voters routinely do. Of course, using substantive information about candidates and issues, and employing a voter guide, takes time; in the interest in preventing the simulation from becoming too long, voters were instructed to simply vote for a pre-selected candidate for some offices.

Finally, we instructed voters to do some things in the voting booth that occur with varying frequency. We asked voters to vote for one candidate for an office and then change that vote to another candidate in order to simulate correcting an error and to imitate the behavior of individuals who test out new technologies, including voting systems, when encountering them for the first time.

Participants were directed to vote on one of the voting systems and to complete a questionnaire recording their reactions when finished. Then, they voted on another voting system. The number of participants for each type of ballot was roughly the same; each participant used the same type of ballot throughout the study.<sup>8</sup> Finally, participants concluded the study by completing a questionnaire to ascertain background information, such as their prior

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<sup>7</sup> On the importance of party identification as a voting cue, see a long line of research in political science, beginning with Campbell, Converse, Miller, and Stokes (1960). For a recent discussion, see Green, Palmquist, and Schickler (2002).

<sup>8</sup> Because we were only to obtain one voting system of each type and they needed to be reprogrammed in order to change ballot styles, we were unable to randomly assign participants to the two ballot types. However, both ballots were deployed in similar (and in many cases the same) locations to control for the possibility of systematic bias. Moreover, as shown later, the effects we find for the ballot remain in the presence of a variety of statistical controls.

voting experience, age, race, education level, and other relevant information.<sup>9</sup> Background information, the voter guides (which recorded voter intentions), actual votes cast, and reactions to the voting experience using each system were matched using the unique name cast for the write-in vote and some other identification numbers.<sup>10</sup>

### *Dependent Variables*

Our dependent variables, measuring different types of voter errors, expand on the residual vote, which has served as the basic metric for most studies of ballot and voting system effects. This measure, developed by scholars associated with CalTech/MIT Voting Technology Project, combines the number of overvotes, undervotes, and spoiled ballots into a single aggregate-level measure (see also Ansolabehere and Stewart 2005). The major strength of the measure is that it has provided a means to compare the performance of different voting systems and ballot designs across different jurisdictions. When coupled with data about the citizens residing in those jurisdictions, estimates can be generated that attempt to control for the impact of voters' background characteristics (Brady et al. 2001; Tomz and Van Houweling 2003; Herron and Sekhon 2005; Kimball and Kropf 2005). However, the residual vote is of limited use, especially with the development of touch screen voting. First, overvotes—a major component of the residual vote—have been rendered obsolete on touch screen systems and may be less likely to occur in jurisdictions that employ paper ballot opscan systems with precinct scanners. Second, studies suggest that the introduction of new voting systems that do not rely on punch cards or other flawed technologies in fact reduced the number of spoiled ballots (electionline.org, 2007). Third, undervotes are often intentional rather than an indication of error (e.g., Herron and Sekhon

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<sup>9</sup> More information about the voter guides and questionnaires is available at [www.capc.umd.edu](http://www.capc.umd.edu).

<sup>10</sup> All write-in names were of the same length (three-letter first name, four-letter last name) and were relatively simple. Voters who failed to enter a name that could be matched up with a booklet were excluded from the analysis.

2005). Finally, as is the case with all aggregate-level data analysis, analyses relying on the residual vote are subject to the pitfalls of the ecological fallacy.

Our study moves beyond the limitations of aggregate data and measures in a number of ways. It enables us to assess the impact of voting systems, ballot designs, and relevant voter traits—including computer usage patterns and other variables related to the digital divide—on voters’ abilities to cast their ballots as intended, while controlling for the voting systems on which they vote. Moreover, instead of relying on one measure comprising a variety of errors, we are able to pinpoint undervotes and votes cast for the wrong candidate. Note that the effects of voting for the wrong candidate are worse than failing to vote in a race altogether because one candidate inadvertently loses a vote and another receives it. We also measure the total number of errors made by an individual voter. This summary count enables us to make an overall evaluation of the impact of ballot style on voter accuracy.

### *Statistical Techniques*

After using descriptive statistics to provide an overview of the data and test some basic hypotheses, we perform two multivariate analyses: one for wrong candidate errors and one for undervotes. Because our dependent variables are counts, with an expectation for overdispersion, we use negative binomial regression rather than OLS or Poisson regression. Based on our hypotheses, we include measures of the age, education, race, computer use, ballot type, and previous experience with the type of voting system being used. We also include controls for partisanship, the order in which the individual voted on the particular voting system, and location of the study. In order to assess how the independent variables influence errors across ballot types, we interact each of the independent variables with ballot type.

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This amounted to about 10 percent of the cases. Eliminating these cases probably leads to slight underestimates of the error rates, as errors on write-ins are probably correlated with errors on other parts of the ballot.

## Results

The results are organized as follows. First, we examine the impact of ballot type on votes in two simple elections where the voter is only to cast a vote for one candidate. Second, we focus on the impact of ballot type on more complex situations, such as when voters attempt to change a vote or when they are expected to vote for two candidates in one election. And third, we examine how the number of errors of each type varies by ballot, voting system, and individual characteristics.

The results provide strong support for the hypothesis that in standard elections voters make fewer errors on a standard office-bloc ballot than a ballot with a straight-party feature. At the top of the ballot, the error rates on the ballots with a straight-party feature are more than twice as large as those on the standard office-bloc ballot (see Table 1). For example, on the touch screen voting system, 5% of the voters made errors on the ballot with a straight-party feature when voting for president compared to less than 2% of voters using the standard office-bloc ballot.<sup>11</sup> The results for the Senate election are similar. Moreover, more voters made candidate selection errors, the more severe of the two types of errors, than undervotes. Surprisingly, given the dissimilarities in the interfaces between the two voting systems, the error rates for the paper ballot/opscan system were similar to those for the touch screen system.

[Table 1 about here]

When further complications are added to the voting task the error rates and types of errors can change dramatically. Table 2 presents the results for races where we asked voters to change their vote on the ballot with the straight-party feature (U.S. House of Representatives), change their vote in a non-partisan race, and to vote in races where two candidates were to be elected.

The most remarkable result is the astronomical error rate that results when voters were asked to change a vote after using the straight-party feature—more than 30%, roughly six times the number of errors committed when voting for president. For both the touch screen and opscan systems, the bulk of these errors were votes for the wrong candidate. The requirement on the touch screen to navigate from the review screen back to the race for U.S. House of Representatives and then to first de-select the first candidate chosen and then select the appropriate candidate proved too difficult for many voters. On the paper ballot/opscan system, matters should have been more straightforward, as finding the race required just a glance across the front side of the ballot, but a sizable portion failed to vote for the desired candidate. Given the simplicity of physically performing the task on the paper ballot, the high error rates for both systems suggest that voters were challenged by the concept of a straight-party vote. The error rates for the standard office-bloc ballot, where voters were not asked to change their vote, were similar to those for president and U.S. Senate. Farther down the ballot, on the race for probate judge, changing the vote led to a large number of errors but not nearly as many as on the partisan portion of the ballot. Overall, the results provide support for hypothesis 2.

[Table 2 about here]

The bottom two panels in Table 2 present the results for the second candidate to be elected for State Representative, a partisan race, and State Supreme Court Associate Justice, a non-partisan race, respectively. We find mixed results for hypothesis 3. As anticipated, voters who used the straight-party feature on the touch screen system committed fewer undervotes than those who used the standard office bloc ballot. However, the opposite holds true for the paper ballot/optical scan system, though neither result is statistically significant. Our inspection of the

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<sup>11</sup> The p-values reported in Table 1 are for two-tailed t-tests comparing the error rate across ballot type for each category of error. As can be seen for the table, except for undervotes in the U.S. Senate, all of the differences are

paper ballots suggests that the design of the opscan system makes straight-party voting especially difficult for those who are unfamiliar with the concept. That is, most of the voters who committed undervotes physically filled in the ovals next to the names for each partisan race rather than taking the single action of filling the straight-party oval, thereby failing to take advantage of the straight-party feature's automatic registration of multiple votes for this office. This confusion was not evident on the touch screen system because once voters pushed the virtual button for a straight-party vote and instructed the system to move to the next race, the system moved them directly to the nonpartisan part of the ballot.

The results for the race for Associate Justice help reinforce the findings regarding the impact of the straight-party mechanism on undervotes because the mechanism is not operative in this two-candidate nonpartisan race. Comparing the two contests demonstrates that voters using the straight-party option commit fewer undervotes when the straight-party mechanism is operative than when it is not. In the partisan two-candidate race, the straight-party option automatically chooses two candidates of the same party; in the nonpartisan race, the voter must follow the instructions and deliberately select two candidates from all that are listed.<sup>12</sup>

Our final set of descriptive statistics examines error rates across the ballot (see Table 3). For this analysis we include 18 offices and 20 votes (2 offices were races where 2 were to be elected).<sup>13</sup> Overall, the mean error rate across the ballot was small, but between 27% and 36% of the voters cast ballots with at least one error. The error rates were significantly larger on the office-bloc ballot with a straight-party feature. Once again, the voting for the wrong candidate

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statistically significant at conventional levels.

<sup>12</sup> While the comparison is complicated by the fact that the election for Associate Justice is further down the ballot, the larger number of undervotes relative to wrong candidate errors in the Justice election in comparison to the State Representative election demonstrates that the location of the election on the ballot does not drive the result.

<sup>13</sup> Given the complexities with respect to the instructions for U.S. House of Representatives, Secretary of State, and Attorney General, we exclude these races from the analysis. For the U.S. House we either cannot separate out the

was a larger problem than undervoting.<sup>14</sup> This pattern exists for both the touch screen and opscan systems. An exception emerges with respect to the proportion of ballots that were cast without any errors; on this measure the rate of perfect ballots was smallest on the opscan system with the office-bloc ballot with a straight-party feature.

[Table 3 about here]

Do ballot type and voters' background characteristics interact to produce more or fewer voting errors? Because negative binomial regression provides estimates that are difficult to interpret we focus on the predictions generated by the models. These are of greater substantive interest and enable us to compare errors by ballot type. Moreover, since the negative binomial model is nonlinear, the estimates of the predicted number of errors for a change in a given independent variable will depend on the value of all of the independent variables in the model.<sup>15</sup> This concern is heightened in models, such as ours, that include interaction terms (Ai and Norton 2003). We report the model results in the appendix (Appendix Tables 1 and 2).

What impact does ballot type have on errors made by different groups of voters? First, as expected, voters over the age of 75 make substantially more errors on the straight-party ballot than on the standard office bloc ballot (see Table 4). For example, on the opscan system, the mean number of wrong candidate errors on the standard office bloc ballot for those 75 and up was a mere 0.43, while these same voters are predicted to average over 2 errors on the straight-

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effect of the task and the ballot. For the other two races, based on the nature of the instructions certain types of errors were not possible on both of the ballots.

<sup>14</sup> The difference in the mean number of errors across ballots is statistically different from zero at  $p < 0.001$  for both ES&S and Diebold. Note that the effect holds even after controlling for a variety of individual characteristics, the order of voting, and location. The difference in the mean number of votes for the wrong candidate across ballots is statistically different from zero at  $p < 0.01$  for both ES&S and Diebold.

<sup>15</sup> While one can report factor or percentage changes, which are not sensitive to the value of the other independent variables, these estimates are both less interesting and potentially misleading. With respect to the latter issue, consider an example in which one finds that the percentage change due to a  $\delta$  unit change in one of the independent variables is 100%. In these terms, this seems like a rather large effect; however, to judge properly this effect it is important to know the base from which this change occurs. Obviously, if the change is from an expected count of

party ballot. Voters of all ages make more errors when using the straight party ballot, but the differences are small relative to those for the oldest group of voters. Age has a similar impact on voting when using the touch screen system.

[Table 4 about here]

Also as expected, when the least educated use the straight party option, the average number of candidate errors is high, with a predicted error rate of about 1, regardless of the voting system used. Voters' racial/ethnic backgrounds also interact with ballot type, with a relatively high number of errors predicted for Blacks who use the ballot with the straight-party option. For computer usage and experience using similar voting systems the results are small but generally in the expected direction.

The differences across ballot types for unintentional undervotes are smaller and somewhat less consistent, probably because so few undervotes occurred. Nevertheless, we find some support in the directions of our hypotheses. First, the predictions suggest that voters who are 75 and older committed more undervotes when using the straight-party option than the standard office bloc ballot. Second, the predictions suggest that voters with more education committed fewer undervotes when using the office bloc ballot on the touch screen system, but not the opscan system. However, none of the comparisons across ballots, including these, reach statistical significance.

[Table 5 about here]

### **Conclusion**

Our research demonstrates that ballot design matters. It influences the number of errors of commission—that is selecting an unintended candidate—and omission—so-called undervoting.

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0.1 errors to 0.2 errors we would conclude that the substantive effect is small while if the change were from 1 error to 2 errors we would conclude that the substantive effect is large.

Voters who use standard office bloc ballots make fewer candidate-selection errors than those who use ballots with a straight-party option. These are the most serious type of error because not only do they deprive a candidate of a vote, they also give it to one of the candidate's opponents. Wrong candidate errors also occur with substantial frequency—as the 2000 presidential election showed. Ballot style does not have a uniform effect on all voters. Older, less educated, and Black voters, are more likely to commit wrong candidate errors when using a ballot with a straight-party feature than a standard office bloc ballot. The same is true of voters who are using a specific voting system for the first time.

Our results for undervotes are less clear cut, most likely because these errors do not occur with much frequency. We find that the number of undervotes individuals make generally do not vary across ballot type. However, voters who use a straight-party feature cast fewer undervotes for partisan offices where they are expected to select more than one candidate. Such elections are unusual, but they are the one place where ballots with a straight-party feature offer voters an advantage.

A major implication of our results is that they suggest scholars and election officials should look beyond aggregate measures, such as residual votes, when assessing the voting experience. Another implication is that the challenges voters face when they go to the polls involve more than voting systems; they also involve the ballots that are programmed on them. Given that most state legislatures already have approved the purchase of new voting systems, it seems reasonable that legislators and reformers begin to turn their attention to another fundamental component of the voting process—the ballot itself. Simplifying ballots could go a long way in reducing voter errors and improving elections.

Table 1. Percentage of Errors by Type for Races at the Top of the Ballot by Ballot Type and Voting System

	DRE (Diebold)			Opscan (ES&S)		
	Straight-party	Office-bloc	p-value for diff.	Straight-party	Office-bloc	p-value for diff.
<b>President</b>						
Total Error Rate	5.1	1.9	0.001	6.5	2.4	0.000
Wrong Candidate	4.1	1.7	0.008	6.0	2.4	0.001
Undervote	1.0	0.1	0.033	0.5	0.0	0.056
<b>U.S. Senate</b>						
Total Error Rate	4.9	2.3	0.007	4.8	2.3	0.008
Wrong Candidate	4.0	1.9	0.018	4.4	1.9	0.007
Undervote	1.0	0.4	0.201	0.5	0.4	0.806

Notes:

All undervotes are unintentional undervotes.

The total of wrong candidate and undervote error rates does not always add to the total error rate due to rounding.

All p-values are from 2-tailed t-tests of differences across the office-bloc ballot with straight-party feature (straight-party) and standard office-bloc ballot (office-bloc).

Table 2. Percentage of Errors by Type for Races with Complex Tasks by Ballot Type and Voting System

<i>US House of Representatives, (partisan, change vote on straight-party)</i>	<b>DRE</b>			<b>Opscan</b>		
	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>
Total Error Rate	30.9	1.9	0.000	33.0	1.7	0.000
Wrong Candidate	29.9	1.2	0.000	32.5	1.2	0.000
Undervote	1.0	0.7	0.544	0.5	0.5	0.000
<b><i>Probate Judge (non-partisan, change vote)</i></b>						
	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>
Total Error Rate	12.1	5.6	0.000	15.1	9.7	0.002
Wrong Candidate	9.1	5.1	0.003	9.6	8.3	0.426
Undervote	3.0	0.5	0.000	5.5	1.3	0.000
<b><i>State Representative (second choice, when voting for two)</i></b>						
	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>
Total Error Rate	5.1	4.3	0.508	7.8	4.6	0.0148
Wrong Candidate	3.5	1.6	0.027	4.4	1.6	0.0026
Undervote	1.6	2.7	0.160	3.4	3.0	0.6602
<b><i>State Supreme Court Associate Justice (second choice, when voting for two)</i></b>						
	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>
Total Error Rate	9.1	6.5	0.081	8.2	4.5	0.005
Wrong Candidate	4.1	3.6	0.580	2.3	1.4	0.213
Undervote	5.0	3.0	0.063	5.9	3.1	0.013

Notes:

All undervotes are unintentional undervotes.

The total of wrong candidate and undervote error rates does not always add to the total error rate due to rounding.

All p-values are from 2-tailed t-tests of differences across the office-bloc ballot with straight-party feature (straight-party) and standard office-bloc ballot (office-bloc).

Table 3. Errors across the Ballot by Ballot Type and Voting System

<b>Measure</b>	<b>Touch Screen (Diebold)</b>			<b>Opscan (ES&amp;S)</b>		
	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>	<b>Straight-party</b>	<b>Office-bloc</b>	<b>p- value for diff.</b>
Mean number of errors	0.9	0.5	0.000	1.0	0.5	0.000
Mean Number of Votes for the Wrong Candidate	0.7	0.4	0.000	0.8	0.3	0.000
Mean Number of Undervotes	0.2	0.1	0.148	0.2	0.2	0.347
% of Ballots With 1 or More Errors	30.3	27.7	0.310	36.0	26.7	0.000

Notes:

All undervotes are unintentional undervotes.

The sample sizes are 551 for the Diebold office-bloc ballot with straight-party feature, 554 for ES&S office-bloc ballot with straight-party feature, 683 for Diebold standard office-bloc ballot, and 682 ES&S standard office-bloc ballot.

For both the touch screen and opscan voting systems, the effects of the ballot for the mean number of errors and the mean number of wrong candidate errors hold even after controlling for a variety of individual characteristics, the order of voting, and the location of the field test.

Table 4. Predicted Number of Wrong Candidate Errors Across the Ballot by Ballot Type, Voting System, and Individual Characteristics

	<b>Touch Screen (Diebold)</b>		<b>Opscan (ES&amp;S)</b>	
	<b>Straight- party</b>	<b>Office- bloc</b>	<b>Straight- party</b>	<b>Office- bloc</b>
<b>Ballot</b>	0.74	0.36	0.78	0.34
<b>Age</b>				
Age 75 and Older	2.62	0.52	2.16	0.43
Age 25 - 74	0.53	0.41	0.58	0.34
Age 18 - 24	0.65	0.22	0.63	0.25
<b>Education</b>				
High School Degree or less	1.17	0.51	0.96	0.40
At Least Some Graduate Education	0.50	0.28	0.65	0.31
<b>Race</b>				
Black	0.98	0.52	1.53	0.52
Non-black	0.71	0.33	0.70	0.30
<b>Computer Use</b>				
Never Use a Computer	0.48	0.56	0.88	0.52
Use a Computer 5 - 7 days/week	0.84	0.31	0.74	0.31
<b>Experience with Similar System</b>				
Never Used a Similar System	0.77	0.38	0.93	0.30
Used a Similar System	0.57	0.31	0.55	0.41

Notes:

Results are based on estimates from Appendix Table 1.

Calculations were made by manipulating the values for the ballot and variable of interest while holding all other values at their actual values (see Wolfinger and Rosenstone 1980, Hanmer 2007).

Table 5. Predicted Number of Unintentional Undervotes Across the Ballot by Ballot Type, Voting System, and Individual Characteristics

	<b>Touch Screen (Diebold)</b>		<b>Opscan (ES&amp;S)</b>	
	<b>Straight- party</b>	<b>Office- bloc</b>	<b>Straight- party</b>	<b>Office- bloc</b>
<b>Ballot</b>	0.21	0.11	0.21	0.25
<b>Age</b>				
Age 75 and Older	0.56	0.30	0.41	0.33
Age 25 - 74	0.17	0.12	0.20	0.23
Age 18 - 24	0.10	0.08	0.14	0.15
<b>Education</b>				
High School Degree or less At Least Some Graduate Education	0.55	0.12	0.30	0.32
	0.07	0.10	0.14	0.19
<b>Race</b>				
Black	0.20	0.31	0.42	0.55
Non-black	0.21	0.12	0.18	0.19
<b>Computer Use</b>				
Never Use a Computer	0.31	0.18	0.22	0.57
Use a Computer 5 - 7 days/week	0.16	0.08	0.20	0.17
<b>Experience with Similar System</b>				
Never Used a Similar System	0.19	0.10	0.26	0.21
Used a Similar System	0.30	0.13	0.11	0.34

Notes:

Results are based on estimates from Appendix Table 2.

Calculations were made by manipulating the values for the ballot and variable of interest while holding all other values at their actual values (see Wolfinger and Rosenstone 1980, Hanmer 2007).

## Appendix

Appendix Table 1. Number of Wrong Candidate Errors Across the Ballot by Ballot Type, Voting System, and Individual Characteristics (estimates are from negative binomial regression)

<b>Variable</b>	<b>Touch Screen (Diebold)</b>		<b>Opscan (ES&amp;S)</b>	
	<b>Coefficient</b>	<b>Standard Error</b>	<b>Coefficient</b>	<b>Standard Error</b>
Ballot	1.125	0.841	-0.192	0.941
Black non-Hispanic	0.323	0.309	0.776	0.313
Computer Use	0.137	0.110	-0.043	0.104
Education	-0.287	0.124	-0.131	0.123
Age 18-24	0.212	0.274	0.086	0.321
Age 75 and up	1.604	0.461	1.311	0.431
System Experience	-0.297	0.309	-0.529	0.265
Republican	-0.459	0.261	-0.276	0.268
Michigan	0.389	0.270	0.101	0.301
New York	0.301	0.291	0.544	0.281
Order	0.003	0.064	0.054	0.070
Black*Ballot	0.110	0.476	-0.214	0.482
Computer Use*Ballot	-0.281	0.146	-0.087	0.156
Education*Ballot	0.085	0.174	0.040	0.179
Age 18-24*Ballot	-0.833	0.412	-0.394	0.444
Age 75 and up*Ballot	-1.371	0.582	-1.090	0.582
System Experience*Ballot	0.114	0.451	0.867	0.370
Republican*Ballot	0.497	0.362	-0.035	0.383
Michigan*Ballot	-0.871	0.389	-0.208	0.398
New York*Ballot	-0.954	0.532	-0.707	0.516
Order*Ballot	-0.007	0.090	-0.034	0.097
Constant	-0.638	0.595	-0.247	0.636
alpha	3.801	0.412	4.416	0.465
Log likelihood	-953.0		-952.4	
N	1141		1138	

Appendix Table 2. Number of Unintentional Undervotes Across the Ballot by Ballot Type, Voting System, and Individual Characteristics (estimates are from negative binomial regression)

Variable	Touch Screen (Diebold)		Opscan (ES&S)	
	Coefficient	Standard Error	Coefficient	Standard Error
Ballot	-1.740	1.155	1.176	1.029
Black non-Hispanic	-0.061	0.493	0.810	0.383
Computer Use	-0.160	0.142	-0.018	0.120
Education	-0.693	0.175	-0.247	0.153
Age 18-24	-0.511	0.429	-0.320	0.376
Age 75 and up	1.203	0.552	0.735	0.552
System Experience	0.456	0.441	-0.837	0.385
Republican	0.475	0.374	0.406	0.307
Michigan	0.353	0.433	0.154	0.406
New York	0.309	0.429	0.682	0.334
Order	-0.299	0.100	-0.170	0.083
Black*Ballot	1.007	0.701	0.257	0.577
Computer Use*Ballot	-0.036	0.186	-0.285	0.165
Education*Ballot	0.614	0.256	0.070	0.226
Age 18-24*Ballot	0.077	0.654	-0.124	0.558
Age 75 and up*Ballot	-0.290	0.711	-0.379	0.686
System Experience*Ballot	-0.232	0.630	1.344	0.497
Republican*Ballot	-1.612	0.593	-0.281	0.435
Michigan*Ballot	-1.380	0.616	-0.858	0.524
New York*Ballot	0.214	0.682	-0.266	0.540
Order*Ballot	0.219	0.140	-0.067	0.117
Constant	0.990	0.836	-0.587	0.727
alpha	3.938	0.833	3.785	0.655
Log likelihood	-407.3		-544.8	
N	1141		1138	

## Variable Coding

Ballot: 1 = standard office bloc ballot, 0 = straight party ballot.

Black non-Hispanic: 1 = Black non-Hispanic, 0 = other

Computer use: 1 = never use a computer, 2 = use once a month or once every two weeks, 3 = use one or two days per week, 4 = use three to four days per week, 5 = use five to seven times a week

Education: 1 = high school degree or less, 2 = some college but no degree, 3 = college degree, 4 = some graduate training to Ph.D.

Age 18-24: 1 = Age 18-24, 0 = other

Age 75 and up: 1 = Age 75 or older, 0 = other

System Experience: 1 = previously used a similar voting system (touch screen or paper, respectively), 0 = did not previously use a similar voting system

Republican: 1 = Strong or Weak Republican, 0 = other

Michigan (New York): 1 = Michigan (New York), 0 = other

Order: 1-6 denoting order in which the given voting system was used

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