The Impact of Ballot Type on Voter Errors

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Studies of ballots have traditionally focused on roll-off, candidate order, and partisan advantage. This study is among the first to assess the impact of ballots on individual-level voter errors. We develop new hypotheses by bringing together theoretical insights from usability research and political science about the effects of ballots with and without a straight-party voting option. By comparing voters' intentions to the votes they cast, we are able to create two measures of voter errors: votes unintentionally cast for the wrong candidate and unintentional undervotes. Voters generally make fewer errors of both types when using a standard office-bloc ballot than when using an office-bloc ballot with a straight-party option, with the number of wrong-candidate errors substantially exceeding the number of unintentional undervotes. Voters' background characteristics have a significant impact on their ability to vote without error. Our results offer a new perspective for evaluating the use of the straight-party option.

The 2000 presidential election ushered in a new awareness of and concern for how Americans cast their votes. In reaction, Congress passed the Help America Vote Act of 2002, and many states purchased new voting systems, computerized their voter registration records, and improved their overall election administration. Registration, voting systems, and administration, however, are only part of what voters confront when casting their votes. Whatever the specific mechanisms and procedures in place, voters make use of a ballot. Whether a series of names and images programmed on a touch screen or printed on paper, the way in which the ballot is formatted has the potential to influence voters' abilities to cast their votes as intended and perhaps even influence the outcome of an election. This point was forcefully made by the butterfly ballot that caused such a stir in 2000 (Wand et al. 2001) and the apparent design flaw that affected the congressional election in Sarasota County in 2006 (Frisina et al. 2008).

Ballots constitute a front line of study for a number of reasons. First, the ballot is the means through which voters register their intentions, and it is the dominant feature voters observe once they begin the voting process. Symbolically, it is more meaningful. As Beard pointed out a century ago: "The point of contact between the average voter and his government is the ballot . . . " (1909, 590). Second, varieties of ballot layouts, options, and tasks routinely affect the number of votes cast (undervoting), the expression of voter attitudes (initiatives), and the relative advantage to candidates and parties (candidate order, straight-party options).[1] Third, the impact of ballot design may be conditioned by the mechanism by which

[1]On undervoting, see Kimball and Kropf (2005, 2008) and Lausen (2007); on initiatives, Smith and Tolbert (2004); on candidate order, Krosnick, Miller, and Tichy (2004).

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voting is carried out, an interaction that has long existed (Reynolds and McCormick 1986) but has only recently been studied. Fourth, debates regarding ballot features are driven by political considerations. Allen's statement that "state legislatures are perpetually tinkering their ballot laws in one particular or another" (1906, 38) was recently validated by debates over the straight-party ballot in Illinois and Michigan (Kimball, Owens, and McLaughlin 2002). Finally, voters may be differentially affected by types of ballots or ballot-voting system combinations (Buchler, Jarvis, and McNulty 2004; Herrnson et al. 2008), raising issues of fairness and equality.

Political scientists such as Allen and Beard recognized over a century ago that ballot-related issues influence political behavior and can complicate the lives of election officials, politicians, and voters. As early as 1909, Beard called for additional research on the subject. Over 60 years later, Rusk echoed a similar sentiment in the context of the emergent political behavior literature, including ballots among the "neglected . . . institutional properties [that] provide the framework within which the effects of other independent variables must be judged" (1970, 1220). And very recently, scholars (see, e.g., Fife 2010) have linked ballot-related issues to the further development of American democracy. Only in the past few years, however, have these sentiments spawned systematic research efforts.

Recent election fiascos also have highlighted the fact that ballot design, along with voting technology and election administration, can have a negative impact on public opinion toward the political system. Real and perceived shortcomings can encourage voters to view specific ballots, certain types of voting equipment, an individual election, and even elections generally as failures, civil rights violations, or fraudulent processes (Alvarez and Hall 2008; Fife 2010).

In this study, we contribute to the literature by answering the long-standing call for additional research on ballots and how individuals interact with them, focusing on a specific feature—the straight-party option. We address one of the most important, most difficult, and least studied concerns—the effect of ballot design on individual-level voting errors. This focus requires a different approach to hypothesis development and data collection and some uniquely constructed dependent variables.

We first demonstrate the usefulness of a theoretical perspective that brings together insights from political science and the field of "usability" (Helander, Landauer, and Prabhu 1997; Laskowski et al. 2004; Nielsen 1994).[2]

We then compare two of the most common types of ballots—a standard office-bloc ballot and an office-bloc ballot with a straight-party option—on two of the most dissimilar voting systems currently in widespread use—a touch-screen system and a paper-ballot system with a precinct-based optical scanner (opscan). Because our research assesses the effects of different types of ballots and voting systems on voter errors, we are able to provide generalized support for our theory of voter interactions with ballots. Utilizing a large-scale field study, we examine the extent to which voters cast ballots for unintended candidates (or ballot measures), egregious errors that reduce support for voters' preferred choices, increase support for the opposition, and are impossible to detect with traditional data sources. Our design also allows us to separate intentional from unintentional undervotes, only the latter of which are errors, and to consider the impact of voters' background characteristics on various types of errors.

We find that voters generally make fewer errors of both types when using a standard office-bloc ballot than when using an office-bloc ballot with a straight-party option, with the number of wrong-candidate errors substantially exceeding the number of unintentional undervotes. These results hold both for touch-screen and paper-ballot/optical-scan voting systems. We also find that voters' demographic characteristics have a significant impact on their ability to navigate the straight-party ballot. Overall, our results offer a new perspective for evaluating the use of the straight-party option.

The Impact of Ballots on Voter Accuracy

Voter accuracy has rarely been studied at the individual level. 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. Yet, there are reasons to believe that ballot design can make a considerable difference. Several recent real-life cases indicate the influence of ballot design on voter behavior.[3] The best-known case is that of 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 Patrick Buchanan when they

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[2] Usability studies (also known as human factors psychology and industrial design) typically assess systems in terms of accuracy, errors, user satisfaction, speed, "learnability," efficiency, and "memorabil-

ity." Although we focus solely on accuracy and errors, the other issues should be the subject of future research.

[3] Ballots and ballot handling in the late nineteenth and early twentieth centuries also provided a wide array of opportunities for error and skullduggery (Blodgett 1889; Reynolds and McCormick 1986).

intended to vote for Democrat Al Gore (Sinclair et al. 2000; Wand et al. 2001). In the 2006 congressional election in Florida's 13th district, the ballot was programmed on a touch-screen system in such a way that it was the likely cause of more than 18,000 voters failing to cast a vote (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, Lausen (2007) shows that 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 voting for multiple judicial candidates and 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 2008).

An analysis of ballots by Niemi and Herrnson (2003) revealed numerous features of ballots that could lead to confusion and possibly error. One of their primary observations was 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 multicandidate election or voting for an "exception" after using a straight-party option (see also Campbell and Byrne 2009). The order of listing candidates is another potentially confounding factor; rotating ballot order is done in some jurisdictions precisely because it is widely believed that candidates listed first are advantaged. Recent research also has demonstrated that ballot style can influence the number of votes that go unrecorded (see, e.g., Kimball and Kropf 2005).

Ballots with a straight-party option, in effect in 15 states in 2008, also increase straight-ticket voting (Burden and Kimball 1998; Campbell and Miller 1957; Hamilton and Ladd 1996; Rusk 1970), diminish ballot roll-off (Hamilton and Ladd 1996; Walker 1966), and reduce overvoting (Kimball and Kropf 2005).[4] Straight-party options were introduced in the 1890s and early 1900s when U.S. political parties were strong and well organized (Burnham 1965), but were perceived as corrupt and targeted by reformist impulses. The introduction of official, state-administered ballots as replacements for party-distributed ballots that listed only one party's candidates was intended to weaken party machines.[5] Party

column ballots and the straight-party option, in turn, were designed to lessen the harm to parties. They also were considered well-suited to a population with many immigrant and uneducated voters because they facilitated the selection of all of the candidates of one party in one action. In discouraging voters from splitting their tickets or from failing to vote for offices below the top of the ticket, straight-party options have been a success.[6]

Theory and Hypotheses

In contrast to the impact of straight-party options on party voting, we know almost nothing about their effect on individual-level voter errors.[7] We develop hypotheses about such errors by integrating the political science and usability literatures, bringing together insights regarding structure and function. The political science literature on ballot design has focused on the structure ballots imposed on voters. That is, the focus has been on how the ballot mechanically translates the actions of the voter into the votes that are recorded and the partisan advantages it provides. As we discuss below, when a straight-party option is used, it should reduce undervotes for partisan offices by automatically recording votes in all partisan contests, thereby advantaging candidates for lower office who belong to the majority party. To this, we contribute insights regarding how ballot structure influences voter accuracy and the types of errors voters commit. Additionally, from the usability literature we contribute insights regarding functionality. That is, we draw on the main tenets of usability research: systems with simple, straightforward, end-to-end designs, involving fewer steps, requiring little user memory, giving confirmation of one's actions, and providing system-based help are more effective than systems that have added complexity, require individuals to remember previous actions, do not provide assistance with cognitive tasks, and are inefficient (Helander, Landauer, and Prabhu 1997). Some of the qualities that usability research has demonstrated to improve human performance

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[6]In some cases straight-party 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 option from Illinois ballots (Kimball, Owens, and McLaughlin 2002). See also the example of Ohio in the 1940s (Walker 1966, 448).

[7]Day and Becker (1984) came close to assessing error when they showed from poll results that many Illinois voters in 1982 evidently preferred the Republican James Thompson, while election results demonstrated a much larger vote for the Democrat Adlai Stevenson III, apparently because many voters used a (Democratic) straight-party option.

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[4]The 15 states are Alabama, Indiana, Iowa, Kentucky, Michigan, New Mexico, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Texas, Utah, West Virginia, and Wisconsin (National Conference of State Legislators, http://www.ncsl.org).

[5]Reynolds and McCormick (1986) argue that the effect of state-administered ballots was actually to strengthen the two major parties by reducing voting for independent candidates.

on different types of interfaces, such as web sites, apply more to the standard office-bloc ballot, but others apply more to the office-bloc ballot with a straight-party option (Norden et al. 2008; Redish et al. 2010). The presence of these qualities also varies according to the tasks voters are expected to perform and the voting systems on which they are expected to perform them. Thus, from a usability perspective, we should not expect any one ballot, voting system, or ballot-voting system combination to perform better in all areas. Moreover, some combinations of ballots and voting systems are likely to produce more errors of one type than another.

Our first hypothesis relates to wrong-candidate errors (i.e., voting for a candidate other than the one intended). According to the usability literature, complex processes that do not give confirmation of one's actions increase errors. The office-bloc ballot with a straight-party option adds complexity to the voting process with minimal (at best) feedback. Conceptually, this ballot creates challenges for voters who do not understand the idea of a straight-party vote. Because we informed voters in the orientation and via the voter booklet that they would be casting a straight-party vote, and provided a standard set of instructions on the ballot, we reduced the conceptual complexity somewhat; as a result, our error rate might actually be lower than in a real-world setting. Operationally, this ballot creates challenges for those who do not understand how the feature works on a particular voting system.[8] Complexity is added in that voters confront an additional set of instructions and a process that works differently than casting votes office by office. Moreover, there is little, if any, feedback for voters. Even those who read the instructions may not know what, if anything, will happen after they make a selection using the straight-party feature; and after making the selection, whether they were successful. In this instance, the greater complexity of the straight-party option overrides the fact that it requires fewer actions on the part of the voter. Thus:

H1: We expect voters to commit more wrong-candidate errors when using the office-bloc ballot with a straight-party option than the standard office-bloc ballot.

Significantly, from the structural perspective, one error using the straight-party option is multiplied into many when the wrong party is selected.

A second pair of hypotheses relates to unintentional undervotes. Here, political science informs our expec-

tations for partisan contests and usability informs our expectations for nonpartisan contests. The straight-party option reduces the number of steps involved in the voting process by automatically casting votes in all partisan races, thus eliminating voter oversights; this is why some politicians like it and others do not. Due to this design feature:

H2: We expect the number of undervotes for partisan offices to be lower on the office-bloc ballot with a straight-party option than on the standard office-bloc ballot.

This should be especially true in contests in which more than one candidate is to be elected, as in multimember state legislative districts. For the nonpartisan offices, usability insights lead to the opposite prediction. Given the lack of understanding of or attention to the limits of the straight-party option, combined with a lack of feedback:

H3: We expect the number of undervotes for nonpartisan offices to be higher on the office-bloc ballot with a straight-party option than on the standard office-bloc ballot.

Both the social science and usability literatures emphasize that background characteristics have an impact on an individual's knowledge of and ability to master various tasks. A basic tenet of usability is that systems have to be designed so that users of all types have a positive and successful experience (e.g., Helander, Landauer, and Prabhu 1997). Work in political science has for a long time called attention to inequalities in political knowledge and interest (e.g., Delli Carpini and Keeter 1996). The straight-party option was developed with the goal of providing political advantage, not universal accessibility or political equality. Both literatures suggest that voters who are older, have less education, and have lower levels of computer usage or relevant voting experience are likely to commit more wrong-candidate errors and more unintentional undervotes when using the ballot with the straight-party option. Thus, we control for these variables as well as for race and ethnicity even though the evidence on the latter is mixed.[9]

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[8]For evidence on both points, see Campbell and Byrne (2009) and our findings below.

[9]The literature on the digital divide suggests that blacks are less likely than whites or Asians to be exposed to new technologies (e.g., Mossberger, Tolbert, and Stansbury 2003). Brady et al. (2001), Kimball and Kropf (2005), and others show that blacks are more likely to cast residual votes, but Herron and Sekhon (2005) demonstrate that some of these "errors" are due to the strategic behavior of some black voters.

Methodology

In the field study described below, we tested the abilities of voters to cast their votes as intended when using 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 option, which is similar 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.

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, and each uniquely conditions how a voter perceives the ballot and thus has the potential to influence the impact of ballot style on voter errors. Touch-screen systems, used by 31% of the voting public in 2008, feature an interface similar to those of ATMs used in banking. Paper-ballot/opscan systems, used by roughly 60% of all voters, are similar to multiple-choice forms used in testing and by government and private industry (Election Data Services 2008).

Ballot Styles and Voting Systems

Voting on a standard office-bloc ballot using an opscan system is fairly straightforward. The voter fills in the oval or circle next to the name of each candidate or position on a ballot question he or she intends to support. When the ballot is completed, the voter slides it into a paper feeder in jurisdictions that have optical scanners on-site. This provides feedback about overvoting (voting for more candidates than is allowed for a given office).[10] 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 they can take a second look at the ballot before inserting it into the paper feeder.[11]

Voting on an opscan system using an office-bloc ballot with a straight-party option is similar except that

the first box on the ballot, labeled "STRAIGHT PARTY VOTING," presents the names of all of the parties whose candidates are listed on the ballot with an oval next to it. To vote for every candidate affiliated with one party, the voter fills in the oval next to the name of that party. Thus, the voter's first decision is whether to vote for all of a party's candidates. The next decision is whether to override that initial decision by filling in an oval next to a candidate who is not affiliated with that party, which results in that candidate receiving the vote. Subsequently, the voter can then proceed to the part of the ballot that lists nonpartisan elections and ballot questions. The vote tabulator will count all of the votes for partisan races as votes cast for the party selected in the straight-party voting bloc. The voter slides the ballot into the optical scanner to complete the process.

Consistent with our theory, our observations indicated that some voters were confused by the straight-party option, despite being instructed on how to use it. For example, 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. This did not result in any errors, but it was extremely inefficient and showed the voters' lack of conceptual understanding, operational knowledge, or both.

Voting on a standard office-bloc ballot on a touch-screen system, such as the Diebold AccuVote-TS, is also quite straightforward. Voters touch 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 target area on the screen. After voters navigate their way through all of the offices and ballot questions (if any), one or more review screens show how they voted in each race and indicate whether any races were missed, including when fewer than the allowable number of candidates were selected. If they wish, voters can change their voting decisions 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 option on a touch screen is similar. As is the case with the opscan system, the first decision a voter makes is whether to initially cast every vote in partisan contests for candidates of one party. 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

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[10]Voters who cast overvotes are alerted by a warning tone and a brief text message (e.g., *too many votes—county commissioner*). They have the option of removing their ballot and replacing it with a new one (the prescribed procedure), erasing a filled-in oval where they overvoted, 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 error appearing nearest the top of the ballot.

[11]Pictures of the voting systems are included in the online appendix.

ballot questions that remain on the ballot. Voters who wish to vote straight-party with exception (i.e., override their straight-party vote for one or more candidates) 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 that race when they reach the review screen. Should a voter not wish to use the straight-party option, the screen that offers this option also instructs them to move to the next page, where they begin voting for the first partisan office.

Study Design

Our field study resembles other political science field research and possesses properties common to usability studies. We assembled a demographically diverse group of participants comprising the traits of the population of interest, asked them to perform a set of representative tasks, and observed their performance of those tasks using both obtrusive and unobtrusive measures.[12] The data we analyze in this article focus primarily on voter errors. An expert review by usability specialists and a laboratory study helped us develop hypotheses about voter interactions with ballots and interpret the field study results (Herrnson et al. 2008).

The field study involved a diverse group of about 1,540 participants recruited from university student bodies, faculty, and professional and maintenance staffs; upscale and downscale shopping malls; senior citizens' facilities; community centers; and professional office buildings in three states. The selection of states ensured that some respondents had been exposed to a straight-party option (Michigan) and some had not (Maryland and New York), as well as a variety of voting systems. After receiving a brief orientation to the project, participants were asked to read a voter guide (or information booklet), one for use with a standard office-bloc ballot or one for use with the office-bloc ballot with a straight-party option. The guide resembled the nonpartisan sample ballots mailed to voters by election officials in some localities and published in many local newspapers. Voters frequently circle their choices on voter guides and take them into the voting booth. By recording their voting decisions on a guide and using it at the polling place, voters are able to cast their ballots without relying entirely on memory.

The guides included a paragraph of descriptive information for the candidates for president and for candidates for some state, local, and nonpartisan offices that appeared further down the ballot. The information included their party affiliation, political and professional experience, and positions on prominent issues that typically divide contemporary voters, such as tax cuts and government spending.[13] This information enabled participants to discern key differences among candidates and make substantive choices based on factors that many voters consider when casting their ballots. It helped participants become engaged at the outset, kept them attentive and careful throughout the voting process, and added realism to voter decision making and our simulated election. The seriousness with which the participants took their participation in our voting study was visible in two ways. First, in the course of conducting the study, we observed the participants referring to their voter guides while casting their votes.[14] Second, when analyzing the data, we found that an extraordinary number of participants—more than 50%—took advantage of the opportunity to provide handwritten comments describing their impressions of the voting process. 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 multicandidate races in a number of states, and by providing voters with a summary paragraph for each of the ballot issues and asking them to circle "yes" or "no," depending on their preferences. Of course, providing substantive information about candidates and issues, and employing a voter guide, takes time; in the interest of preventing the simulation from becoming too long, voters were provided with less information, comprising only party affiliation (a standing voting cue) for some lower-level candidates, and instructed to vote for a preselected candidate for some offices. Voters were instructed to circle the names of all of the candidates and issues for whom they intended to vote.[15]

The ballot we used was realistic in content and resembled a ballot that individuals would encounter in the

[12]For a description of the respondents, see online Appendix Table 1a.

[13]The voting guides are reproduced in online Appendix Figure 1.

[14]This personal observation also enabled us to exclude data collected from the few individuals we observed who were not serious about their participation in the study.

[15]Research by Everett, Byrne, and Greene (2006) found no difference in error rates based on whether participants were able to choose freely or were given a set of candidates for whom to vote (undirected and directed voting) or on the use of real or fictional candidates. More recent research by the same team (Byrne, Greene, and Everett 2007) found that fewer errors were produced when voters were directed, suggesting that results "based on directed voting may be underestimating the real error rate" (176). The latter results were not available at the time of our tests, so we used a mix of directed and undirected voting.

voting booth.[16] It consisted of 18 offices and four ballot questions and contained the usual features, including partisan and nonpartisan sections; elections for federal, state, and local offices; an uncontested race; and races with two candidates to be elected. The candidates included men and women whose names represented various ethnic backgrounds and were associated with the Democratic, Republican, and other contemporary parties. The ballot questions were taken from actual ballots.

Once they had completed the voter guide, participants were directed, in random fashion, to vote on one of the voting systems. Written instructions on how to vote were posted at each system, and research assistants, playing the role of election judges, were available to answer voters' questions and help those who appeared to have difficulty completing a ballot. Once voting was completed, voters filled out a questionnaire recording their reactions. Then, they voted on another voting system as determined by the randomization process. The number of participants for each type of ballot was roughly the same; each participant used the same type of ballot throughout the study. Because we were only able to obtain one voting system of each type and the systems 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 the same locations where possible or in similar locations to control for the possibility of systematic bias. Although we had little reason to worry about bias resulting from differences in the types of respondents assigned to each ballot type, to alleviate potential concerns we used a propensity score matching procedure to preprocess the data prior to implementing our statistical tests (see, e.g., Morgan and Winship 2007). Specifically, we used kernel matching to balance the individual characteristics across the two types of ballots, with the matching done separately for each voting system.[17] Individuals were matched across the two ballot types based on measures of education, age, race, computer usage, partisan strength, experience with a similar voting system, and location. The balance across individual characteristics was good before matching and improved after matching (see online Appendix Table 1b).

Finally, participants concluded the study by completing a questionnaire to ascertain background information, such as their prior voting experience, age, race, education level, and other relevant information. Background information, the voter guides (which recorded voter intentions), actual votes cast, and reactions to the voting experience using each system were matched using a unique name cast for a write-in vote and some identification numbers.[18]

Dependent Variables

Our dependent variables measure two different types of voter errors—wrong-candidate errors and unintentional undervotes. Wrong-candidate errors occur when a voter intends to cast a vote for a specific candidate (as indicated by his or her selection on a voter guide) and mistakenly casts a vote for another candidate. Unintentional undervotes occur when a voter intends to cast a vote for a candidate for an office and fails to vote for any candidate for that office. The latter measure contains one component of the "residual vote" used by the CalTech/MIT Voting Technology Project (2001), which combines the number of overvotes, undervotes, and spoiled ballots into a single aggregate-level measure. The residual vote has been an important starting point for comparisons of the performance of different voting systems and ballot designs across different jurisdictions and types of voters (e.g., Brady et al. 2001; Hanmer et al. 2010; Tomz and Van Houweling 2003). One of its major advantages is that it can be used in studies of actual elections. Our measure of undervotes has the benefit of separating unintentional undervotes (committed in error) from intentional undervotes (committed deliberately). Given that undervotes are often intentional (Herron and Sekhon 2005), distinguishing between the two types is important to measuring and understanding errors resulting from voter interactions with ballots. Another improvement associated with our measures of voter errors is that they are based on individual-level data and thus avoid the ecological fallacy.

The metrics in this study enable us to assess the interaction of ballot designs, voting systems, and citizens' traits on their abilities to cast their ballots as intended. Most important, our research design makes it possible

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[16]There were, in fact, two ballots, but they differed only in whether they contained a straight-party feature. We designed our ballot after reviewing ballots used between 1998 and 2000 that were collected from all 50 states. Abbreviated versions of the ballots are reproduced in online Appendix Figures 2 and 3.

[17]Kernel matching is one of the approaches recommended by Morgan and Winship (2007, 109). Matching was implemented using software provided in Leuven and Sianesi (2003). We obtained substantive results that were similar when trying the other approaches.

[18]All write-in names were of the same length and relatively simple. Voters who failed to enter a name that could be matched with a booklet (about 10%) were excluded from the analysis because there was no way to determine whether they voted accurately. Errors on the write-in for those who could be matched are strongly related to errors on other parts of the ballot; thus, eliminating the cases with the worst errors on the write-in almost surely leads to slight underestimates of the error rates.

to determine directly whether an individual casts a vote for the intended candidate or for some other candidate. This is important because voting for the wrong candidate is worse than failing to vote in a race altogether, as one candidate inadvertently loses a vote and an opponent receives it. As a practical matter, this error is especially egregious because the erroneously selected candidate is most likely to be a candidate listed on the ballot immediately before or after the desired candidate and often that candidate's major competitor. Finally, we combine wrong-candidate errors and unintentional undervote errors to create a measure of overall voter errors that is not clouded by the inclusion of intentional undervotes or deficient in its omission of wrong-candidate votes.[19]

Although our research has the advantage of allowing for the study of individual-level differences in interactions with ballots, it is not without shortcomings. Among them is that we were able to introduce only a limited number of treatments. For example, due to reliance on manufacturers to provide and program the voting systems, we could test only one (albeit the most widely used and simple) form of straight-party option and only one ballot-marking system (fill-in-the-oval).[20] These and related issues (such as the use of a convenience sample) result in findings that have strong internal validity, but less external validity than the findings of aggregate-level voting studies. Another limitation is we did not evaluate variations in the time it took to vote across the two ballot types. Since election officials might support straight-party voting due to its potential to reduce the amount of time it takes to vote, future research should examine the relationship between errors and time spent voting.

Statistical Techniques

After providing an overview of the data and testing some basic hypotheses with descriptive statistics, we perform two multivariate analyses: one for wrong-candidate errors

and one for unintentional undervotes. As noted earlier, these analyses were done after preprocessing the data via matching techniques. Because our dependent variables are counts, with an expectation for overdispersion, we use negative binomial regression (Long 1997).[21] 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 strength of partisanship (which functions as a surrogate for voter interest in and knowledge about politics), state (where we capture whether a voter would have been exposed to a straight-party option or a particular voting system), and the order in which the individual voted on the particular voting system (to control for the possibility of learning effects).

Results

We begin with a test of our initial hypotheses in the context of standard races where the task is simply to cast a vote for one candidate. Our first two hypotheses suggest that voters using the ballot with the straight-party option are more likely to cast votes in all partisan races than voters using the standard office-bloc ballot (H2), but more of those votes are likely to be cast for candidates other than the ones voters intend to support (H1).

The results provide strong support for our hypothesis regarding wrong-candidate errors. For the two races at the top of the ballot, the wrong-candidate error rates on the ballots with a straight-party option are more than three times as large as those on the standard office-bloc ballot (see Table 1). For example, on the touch-screen voting system, 4.1% of the voters made wrong-candidate errors on the ballot with a straight-party option when voting for president compared to 1.2% of voters using the standard office-bloc ballot. The results for the Senate election are similar. It is noteworthy that in the race for president across both ballot types, and both voting

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[19]We do not test for errors that can be committed on only one system, such as voting for more candidates than allowable, making stray marks on or tearing a paper ballot, screen freezes caused by dragging a finger down the screen, or other equipment failures.

[20]We chose to test an office-bloc ballot over a party-column (or row) ballot because most DREs are only programmed with an office-bloc ballot. Also, an examination of ballots in all 50 states in 1998 or 2000, prior to the adoption of DREs, showed that the office-bloc ballot was much more common, as only 10 states used a party-column/row ballot. The ballot we tested provides one straight-party option that applies to all partisan races; others allow for more (e.g., Oklahoma), and the North Carolina straight-party mark excludes presidential electors. Another ballot-marking system involves connecting arrows to indicate vote choice. We allowed voters to scan paper ballots for errors, an option some jurisdictions do not allow.

[21]Other election studies use a similar approach when ordinary least-squares regression (OLS) is not appropriate (Long 1997), such as when assessing residual votes generated by small numbers of voters (e.g., Kimball, Kropf, and Battles 2006). The same concern holds for wrong-candidate errors and unintentional undervotes. First, the distributions of both types of error have a lower bound of 0 and are strongly skewed, with most of the observations clustered at 0. Second, we expect that errors across the ballot should not be treated as independent events, as those who make one error (e.g., due to problems of understanding the ballot or voting system) are likely to make additional errors. Thus, the nature of our data violates some of the most basic assumptions of OLS. As expected, the alpha estimated from each of the negative binomial regression models is positive and statistically significant, supporting our concern with overdispersion.

TABLE 1 Type and Percentage of Errors for Races at the Top of the Ballot, by Ballot Type and Voting System

	Touch Screen (Diebold)			Paper Ballot/Opscan (ES&S)		
President	**Straight-party**	**Office-bloc**	**Prob.**[a]	**Straight-party**	**Office-bloc**	**Prob.**[a]
Wrong candidate	4.1	1.2	0.013	5.6	1.8	0.005
Undervote	1.0	0.1	0.075	0.2	0.0	0.318
Total Error Rate	5.1	1.3	0.003	5.8	1.8	0.003
U.S. Senate						
Wrong candidate	3.6	1.5	0.072	4.2	1.2	0.010
Undervote	1.0	0.3	0.234	0.2	1.3	0.017
Total Error Rate	4.5	1.8	0.032	4.4	2.5	0.129
(N)	*(507)*	*(634)*		*(503)*	*(635)*	

[a]p-value (two-tailed) is for the difference between straight-party and office-bloc ballots.
Notes: Analysis done after preprocessing the data via kernel matching. 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.

systems, substantially more voters made candidate selection errors—the more severe of the two types of error—than unintentional undervotes.

With respect to our hypotheses regarding undervotes, the results indicate that voters committed few of them but that the straight-party option generally did not reduce their frequency. An exception is found in the Senate race for those using the opscan system; here, the percentage of unintentional undervotes was considerably smaller on the straight-party ballot than on the standard office-bloc ballot. It is worth noting that, despite the dissimilarities in the interfaces of the two voting systems, for the most part the error rates for the paper-ballot/opscan system were similar to those for the touch-screen system. This is somewhat surprising given the public criticisms raised about electronic voting systems (e.g., Alvarez and Hall 2008), but it is consistent with research showing that voters rate various touch-screen systems as favorably, if not more so, than opscan systems (de Jong, van Hoof, and Gosselt 2008; Herrnson et al. 2008, chap. 3).

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 in which two candidates were to be elected: the race for state representative, a partisan contest; and the race for state supreme court associate justice, a nonpartisan race. In both races, voters were asked to "Vote for no more than TWO" candidates. Only voting for the second candidate is shown—i.e., the candidate most likely to be overlooked.

For the partisan race, we again expected that voters would cast fewer undervotes on the ballot with a straight-party option than on the standard office-bloc ballot because the straight-party option enables the voter to complete all of the votes for the partisan office in one action, without having to recognize the new instruction regarding the ability to vote for two (H2). As anticipated, voters using the straight-party option on the opscan system cast fewer undervotes than those who used the standard office-bloc ballot. Though there also were fewer undervotes when voters used the straight-party ballot on the touch-screen system, the difference was neither substantively nor statistically significant.

The results for the nonpartisan election for associate justice, where the straight-party option is not operative, help us to better understand the straight-party option's effect when more than one candidate is to be selected (H3). In the partisan two-to-be-elected 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. Comparing the two contests demonstrates that voters using the straight-party option commit fewer undervotes when the straight-party mechanism is operative (in the race for state representative) than when it is not (in the race for associate justice). While the undervote rates on the standard office-bloc ballot for both races were similar, on the ballot with the straight-party option the percentage of undervotes in the nonpartisan race was much higher, by a factor of almost three, than in the partisan race.[22]

The final set of descriptive statistics examines overall error rates across the ballot. The analysis includes

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[22]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.

TABLE 2 Type and Percentage of Errors for Races with Complex Tasks ("Vote for no more than TWO"), by Ballot Type and Voting System

State Representative (partisan; second choice, when voting for two)

	Touch Screen (Diebold)			Paper Ballot/Opscan (ES&S)		
	Straight-party	Office-bloc	Prob.[a]	Straight-party	Office-bloc	Prob.[a]
Wrong candidate	3.2	2.0	0.299	3.8	1.6	0.050
Undervote	1.6	1.9	0.780	2.2	4.5	0.058
Total error rate	4.7	3.9	0.576	6.0	6.1	0.928

State Supreme Court Associate Justice (nonpartisan; second choice, when voting for two)

	Straight-party	Office-bloc	Prob.[a]	Straight-party	Office-bloc	Prob.[a]
Wrong candidate	4.5	2.6	0.165	2.0	0.9	0.234
Undervote	4.5	2.9	0.201	6.2	3.6	0.074
Total error rate	9.1	5.5	0.054	8.2	4.4	0.029
(N)	*(507)*	*(634)*		*(503)*	*(635)*	

[a]p-value (two-tailed) is for the difference between straight-party and office-bloc ballots.
Notes: Analysis done after preprocessing the data via kernel matching. 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.

TABLE 3 Errors across the Ballot, by Ballot Type and Voting System

	Touch Screen (Diebold)			Paper Ballot/Opscan (ES&S)		
	Straight-party	Office-bloc	Prob.[a]	Straight-party	Office-bloc	Prob.[a]
Mean number of errors	0.9	0.6	0.009	1.0	0.7	0.008
Mean number of votes for the wrong candidate	0.7	0.4	0.004	0.8	0.4	0.000
Mean number of undervotes	0.2	0.2	0.803	0.2	0.3	0.497
Partisan offices	0.07	0.08	0.826	0.04	0.10	0.017
Nonpartisan offices	0.10	0.08	0.478	0.19	0.16	0.589
Percentage of voters who made at least one error	30	30	0.968	35	30	0.153
(N)	*(507)*	*(634)*		*(503)*	*(635)*	

[a]p-value (two-tailed) is for the difference between straight-party and office-bloc ballots.
Notes: Analysis done after preprocessing the data via kernel matching. All undervotes are unintentional undervotes.

18 offices and 20 votes (two offices were races where two were to be elected).[23] The number of errors per ballot is seemingly small, averaging just over one-half to one per ballot (see Table 3), but they are consequential. As suggested by H1, the error rates were significantly larger on the office-bloc ballot with the straight-party option. As with the specific races shown above, voting for the wrong candidate was a larger problem than unintentional undervoting, a result that holds for both the touch-screen and opscan systems. We find modest support for H2, that undervotes on partisan contests are lower on the ballot with a straight-party option.[24] However, contrary to H3, undervotes on the nonpartisan portion of the ballot do not differ by ballot type.

When viewed another way, the magnitude of the error rate is considerably more striking. Depending on the ballot type and voting system, between 30% and 35% of the voters cast a ballot with at least one error (see the bottom row of Table 3). The error rate was the same across the

[23]Given complexities in the instructions for voting for the U.S. House of Representatives, Secretary of State, and Attorney General, we exclude these races from the analysis. For the latter two, the instructions precluded the possibility of certain types of errors on both ballots. For the U.S. House race, we asked only those voters using the straight-party ballot to go back and change their vote, so we cannot separate the effect of the task from that of the ballot. The layout of the ballots makes it highly unlikely that votes for other races were influenced by this additional task. Our observations from the field test corroborate this.
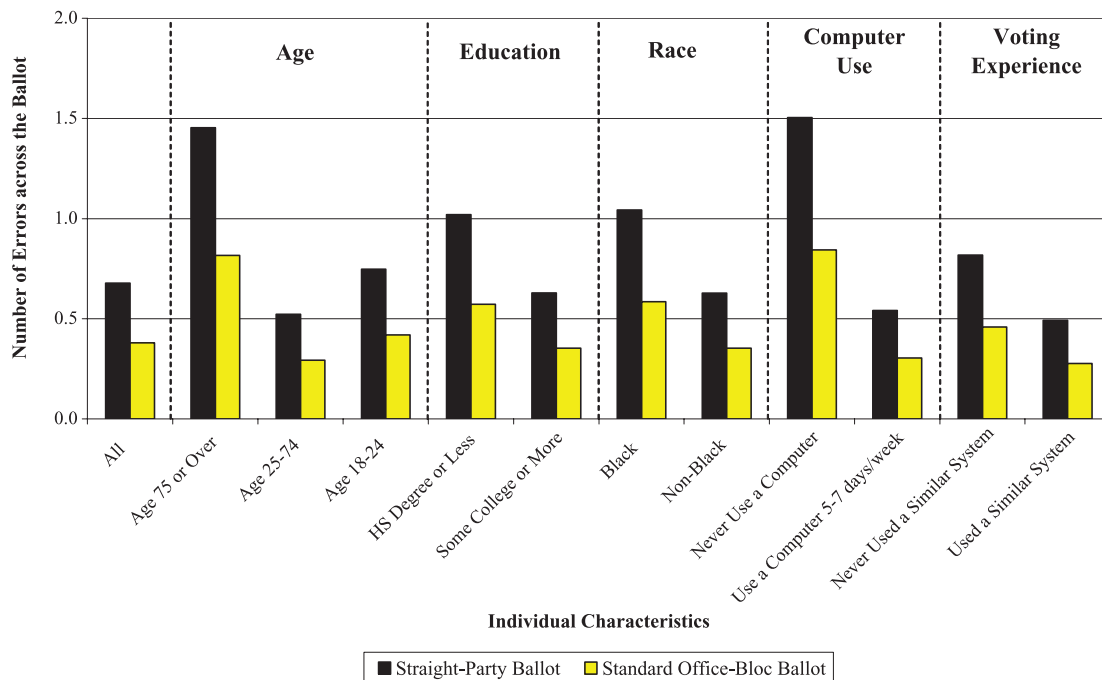
[24]Voters were expected to have (or were assigned) preferences in all but one partisan office. Where they lacked such preferences, the straight-party option would likely have a greater effect.

FIGURE 1   Predicted Number of Wrong-Candidate Errors across the Ballot by Ballot Type, Voting System, and Individual Characteristics

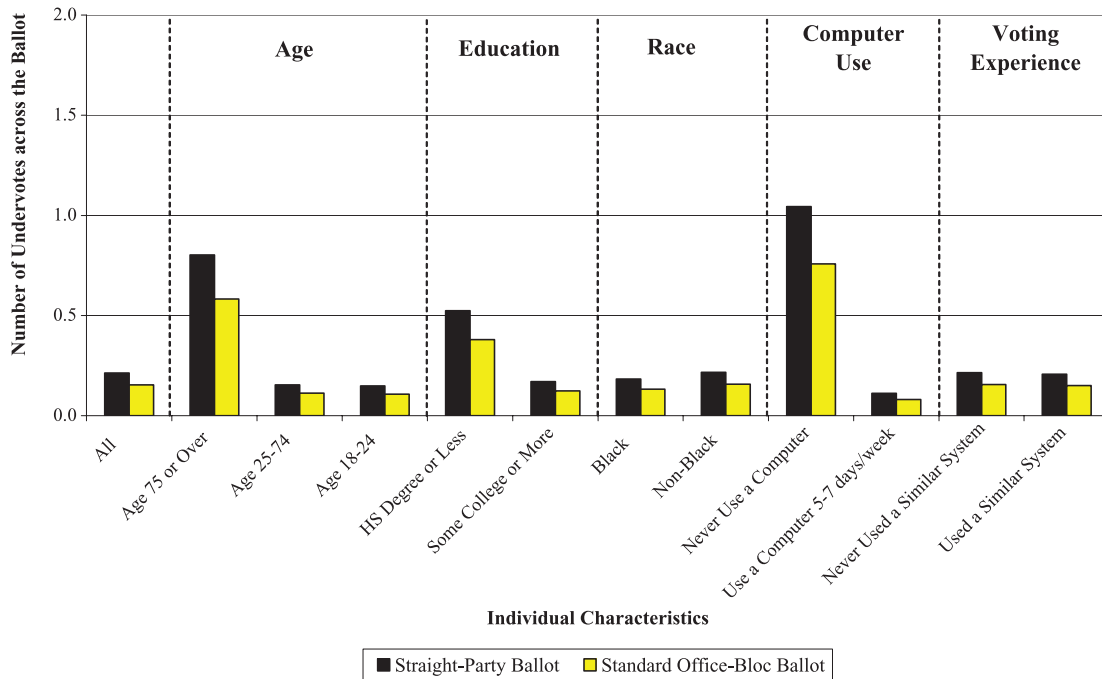**Panel a: Touch-Screen Voting System (Diebold)**
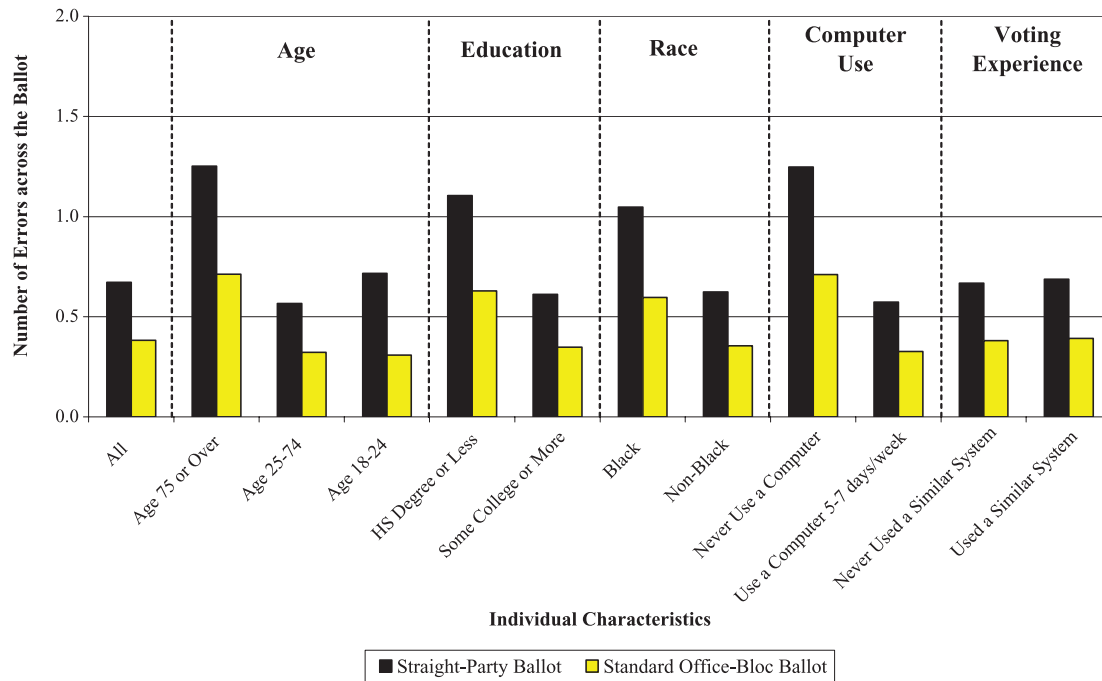
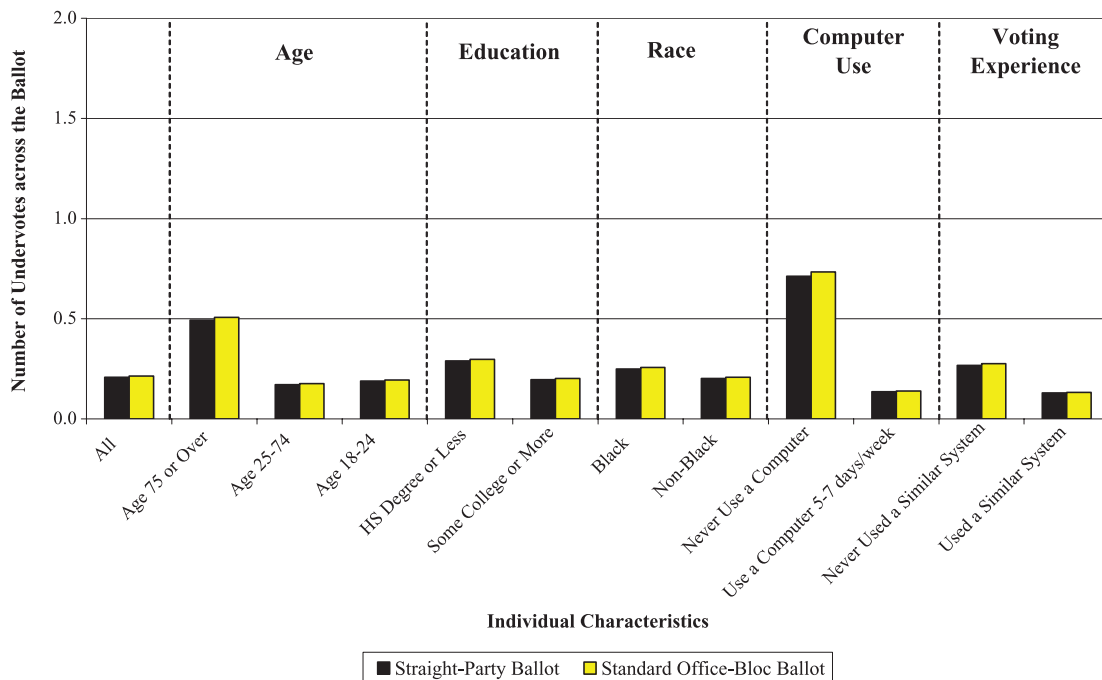**Panel b: Paper-Ballot/Optical-Scan Voting System (ES&S)**

Notes: Results are based on estimates from online Appendix Tables 3 and 4. Calculations were made by manipulating the values for the ballot while holding all other values at their observed values (see Hanmer and Kalkan 2011). All differences between the straight-party ballot and the office-bloc ballot are statistically different at $p < 0.05$ (two-tailed). The basic pattern of higher errors on the straight-party ballot holds for the control variables (not shown).

FIGURE 2 Predicted Number of Unintentional Undervotes across the Ballot by Ballot Type, Voting System, and Individual Characteristics

Panel a: Touch-Screen Voting System (Diebold)

Individual Characteristics

■ Straight-Party Ballot   □ Standard Office-Bloc Ballot

Panel b: Paper-Ballot/Optical-Scan Voting System (ES&S)

Individual Characteristics

■ Straight-Party Ballot   □ Standard Office-Bloc Ballot

Notes: Results are based on estimates from online Appendix Tables 5 and 6. Calculations were made by manipulating the values for the ballot while holding all other values at their observed values (see Hanmer and Kalkan 2011). None of the differences between the straight-party ballot and the office-bloc ballot are statistically different at $p < 0.05$ (two-tailed). Similar conclusions are drawn for the control variables (not shown).

two ballot types when the touch screen was used, but on the opscan system the percentage of ballots with at least one error was greater on the ballot with the straight-party option.[25]

The results in Figure 1 (generated from negative binomial regressions) predict the number of wrong-candidate errors across the ballot by voter characteristics.[26] 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.[27] For example, on the opscan system the mean number of wrong-candidate errors on the standard office-bloc ballot for those aged 75 and up was 0.82, while voters of that age group are predicted to average almost 1.5 errors on the straight-party ballot. The results are similar for the touch-screen system.[28]

Also as expected, when the least educated use the straight-party option the average number of candidate errors is high, regardless of the voting system used. Error rates across ballot type also differ by voters' racial or ethnic backgrounds. Voters of all races make more errors on the ballot with the straight-party option than the standard office-bloc ballot, but non-Hispanic blacks make considerably more errors when using the ballot with the straight-party option. Voters who never used a computer tend to have high error rates in general, and as expected, these voters committed more errors when they used the straight-party option.

The differences across ballot types for unintentional undervotes are generally smaller and less consistent across individual characteristics and voting systems, probably because so few undervotes occurred (see Figure 2). Nevertheless, the results show that with a touch-screen

[25]The error rates are surprisingly high. But in an experiment using college students, who are used to taking standardized tests, and paper ballots, the error rate was 1% and 14 of 126 ballots (11%) had at least one error. See Everett, Byrne, and Greene (2006).

[26]Because negative binomial regression provides coefficient estimates that are difficult to interpret directly, we focus on the more substantively interesting predicted counts generated by the models. Moreover, since the negative binomial model is nonlinear, the estimates of the predicted number of errors for a change in a given independent variable depend on the value of all of the independent variables in the model. We report the model results for Figures 1 and 2 in online Appendix Tables 3–6. While one can report factor or percentage changes, which are not sensitive to the value of the other independent variables, they are less interesting and potentially misleading.

[27]Calculations were made by manipulating the values for the ballot while holding all other values at their actual values (see Hanmer and Kalkan 2011). To assess the statistical significance of the effect of the ballot on the number of errors committed, confidence intervals were constructed using stochastic simulation (see Herron 1999).

[28]For each voting system, the differences between the ballot with the straight-party option and the standard office-bloc ballot are statistically significant at p < 0.05 (two-tailed).

system, voters who are 75 and older cast more undervotes with the straight-party option than the standard office-bloc ballot. Perhaps the most interesting result is that regardless of voter characteristics, the number of unintentional undervotes was almost identical across the two ballot types on the opscan voting system. However, not too much should be made of this apparent equality across groups because, as our earlier results show, unintentional overvotes occur less frequently than wrong-candidate errors, especially among blacks and the least educated.

Conclusion

Elections in the first decade of the twenty-first century have focused attention, to an extent unprecedented since the adoption of the secret ballot a century earlier, on the methods citizens use to vote. Although recent media coverage has focused heavily on voting systems, it has become clear over the course of a decade that the entire electoral process, from registration through vote counting, is in need of thorough examination. Our research has focused on one of the least studied parts of the process—how individuals interact with the ballot.

Using a field study that allows us to match voter intent with votes cast, we demonstrate that voters who use standard office-bloc ballots make fewer candidate-selection errors and fewer total errors than those who use ballots with a straight-party option. Voters who use a straight-party option have fewer unintentional undervotes for partisan offices, especially when multiple candidates are to be selected, but they commit as many or more errors of omission in nonpartisan races. Our results do not permit estimation of the number of errors in any given election because errors will vary from time to time and from one jurisdiction to another depending on factors unique to each contest. However, the surprisingly large number of errors and the greater number of and patterns of errors among those who use a ballot with a straight-party option suggest that this ballot feature is frequently misunderstood and misused, especially by older and less educated voters.

Our results highlight the importance of individual-level research that records voting intentions in order to learn whether new ballot designs or voting systems improve voters' abilities to cast their votes accurately. The findings also have implications for public policy beyond their ballot-specific results. The relatively high incidence of wrong-candidate errors among older, less educated, and, evidently, among black voters who use a ballot with a straight-party option has repercussions for civil rights and

voter education. They demonstrate that although perhaps not intended, ballot design—like voter identification and registration laws, the allocation of voting equipment, and the financing of campaigns—can increase the political disadvantages of traditionally underrepresented groups. More generally, the findings suggest that making more voter education and assistance available at precincts where numerous senior citizens and less educated persons vote could help equalize the voting experience. We hope additional light is shed on this issue through future studies that investigate other aspects of usability, such as efficiency and satisfaction.

Challenges that voters face when they go to the polls involve more than voting systems; they also involve ballots. Given that most state legislatures already have purchased new voting systems, it seems reasonable that legislators and reformers turn their attention in the future to another fundamental component of the voting process—the ballot itself. Ballot features designed for the hand-marked, hand-counted paper ballots introduced at the end of the nineteenth century lead to complexities and errors when used on modern touch-screen and paper-ballot/optical-scan voting systems. Simplifying ballots and configuring them to suit the operations of specific voting systems could go a long way toward reducing voter errors and improving elections. Voter education programs and informed on-site assistance could have similar effects. Given the centrality of elections to representative democracy, such efforts are warranted.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Online Appendix Figure 1 shows the voter information guides for the standard office-bloc ballot and for the office-bloc ballot with straight-party option.

Online Appendix Figures 2 and 3 show portions of the standard office-bloc ballot and the office-bloc ballot with straight-party option (in their paper ballot versions).

Online Appendix Pictures 1a and 1b show the ES&S Model 100 optical scanner without a ballot and with a ballot being scanned, respectively.

Online Appendix Pictures 2a and 2b show the Diebold AccuVote-TS opening screen and ballot with votes cast, respectively.

Online Appendix Table 1a presents the background characteristics of the study participants across the three locations.

Online Appendix Table 1b presents the background characteristics of the study participants as well as their characteristics, for each voting system, before and after the matching process.

Online Appendix Table 2 presents the coding of the variables.

Online Appendix Tables 36 present the statistical estimates used to generate Figures 1 and 2 in the text.

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