Implications of Graphics on Usability and Accessibility for the Voter

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Abstract. This paper explores the impact of graphics on the usability and accessibility of voting systems. Graphical elements, as part of voting systems, include both photographs and party logos that indicate specific candidates or political parties, informational icons such as arrows and alert symbols, and animations or other video. After an overview of the history of graphics on ballots, usability and accessibility issues concerning graphics are discussed in detail. The question of whether certain types of graphics would help people with cognitive disabilities vote is then considered in light of research and best practices for usability and accessibility.

Keywords: Accessibility, Animation, Ballots, Graphics, Icons, Logos, Usability, Voter Interface, Voting System.

1 Introduction

The purpose of this paper is to explore the practice of using graphical elements on ballots, the implications for the usability and accessibility of voting systems, and the impact on voters, especially those with cognitive disabilities. It describes the positive and negative impacts of the use of graphics, based on published research literature. The intention is that the findings in this paper will provide a foundation for further research.

There are two major classes of graphical elements: (1) those that that indicate specific candidates or political parties and (2) those used to assist the voter in the process

Disclaimer: This paper describes research performed in support of voting system standards and test methods as part of the National Institute of Standards and Technology (NIST) work on the Voluntary Voting System Guidelines for the US Election Assistance Commission. It does not represent a consensus view or recommendation from NIST, nor does it represent any policy positions of NIST. Certain commercial entities, equipment, or material may be identified in the document to describe an experimental procedure or concept adequately. Such identification is not intended to imply recommendation or endorsement by NIST, nor is it intended to imply that these entities, materials, or equipment are necessarily the best available for the purpose.

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of voting. The pictures, icons, and images in the first category are used to accompany the names of the candidates and parties that appear as written text on paper or electronic ballots. The second class includes informational icons and navigational features such as alert symbols, arrows, or animations and videos. Some discussion of ballot design is included to better understand the context in which graphical elements appear, but note that this paper is not intended as a general discussion of ballot design issues.

2 History and Variety of Graphics on the Ballot

Although voting has existed in various forms since ancient times, graphics have only been a part of voting systems for the past two centuries. This section examines the history of voting systems and graphics used in the United States and describes a variety of voting systems employing graphics from other countries as well.

2.1 Ballots in the United States

The word ballot comes from the Italian ballotta, a small ball that was dropped in a specified container to indicate a voter's choice. The container with the most "ballotte" indicated the winner. Variants of this system using corn and beans were used in colonial America but were replaced by other systems (Evans, 1917). Voice votes and the showing of hands were also popular in early America, but aside from party caucuses in a few states, systems like these have been eliminated in US elections due to a lack of secrecy (Reynolds & Steenburgen, 2006). Paper ballots were eventually adopted by every State after the American Revolution and subsequent voting systems have been attempts to improve on this system. The first paper ballots were scraps of paper on which voters wrote the names of their preferred candidates.

By the 1820s, there were so many elected offices that it became difficult to write the names of each candidate, and by the 1830s, the use of printed ballots became legal in some states. These ballots, or tickets, were mass produced by political parties and distributed to voters to cast into the ballot box on Election Day. Citizens did not need to know how to read or write in order to vote. The parties began to print tickets on colored paper, print in color, and use various pictures on the ballot. In some places, new laws required that ballots be cast unfolded and in plain view. These changes eliminated the secrecy of the ballot by allowing partisan observers to determine the votes by looking at the colors or graphics, which enabled vote-selling and coercion (Evans, 1917). The graphics on these ballots included patriotic images like the bald eagle and the American flag, ornate, abstract decorations, and names of political parties in fancy letters. They also included likenesses of the candidates for President and Vice President, although not for lesser offices. Ballots for Abraham Lincoln included pictures of naval battles and trains. Political slogans or cartoons might be included, some of which would be considered offensive by today's standards (Goodrich, 2004). Some ballots were printed with the name of one party, but the names of the candidates from the other party (Smithsonian, 2004).

These and other controversial voting practices led to a reform movement in the late 1800s. A product of that movement was the Australian ballot system. Beginning in

the 1880s, election officials printed blanket ballots that contained the names of every candidate for every office. Voters received, marked, and cast ballots at the polling place on Election Day. This restored secrecy to the ballot, and simplified, but did not eliminate the use of graphics. In some places, party symbols were placed next to the name of the party, often in a row across the top of the ballot, with the candidates listed below the name and symbol of the corresponding party (See Figure A, Appendix). This allowed illiterate voters to indicate their choice by marking next to the symbol of their party. Some blanket ballots did not contain party symbols, although these were controversial at the time because they were considered by some to be illegal tests of literacy (Smithsonian, 2004; Evans, 1917).

The graphics used as party symbols were not uniform from one place to another. Although these ballots were in use after the famous Thomas Nast cartoons that led to the modern political party symbols of the Democratic donkey and the Republican elephant, these symbols had not been adopted by the parties and were not on these ballots. Democrats most often used a star and Republicans an eagle (Smithsonian, 2004).

In the 1890s, gear and lever voting machines were introduced and became the dominant voting technology in the US. They were similar to the blanket ballot, but the results could be counted immediately and unambiguously. Like the paper ballots, candidates from a single party were grouped together. Party symbols were still sometimes used, but were smaller than on the paper blanket ballots. In places like New York, these continued to be the star and eagle for the two major parties. The eagle was simplified to be recognizable at such a small size, and looks more like a modern icon than the elaborate illustrations of earlier ballots. In some cases, tiny copies of the party symbol were placed next to the name of each candidate. Figure B in the Appendix shows an absentee ballot modeled on the lever machines used in New York. These machines often featured pictures of hands pointing to the levers that represent each party. Versions of the pointing finger still exist on many ballots.

Punch cards and optical-scan ballots were introduced in the 20th century to enable computers to count ballots. In punch card systems, voters punch holes in a card to indicate their choices using an external tool and are guided by an external ballot structure indicating which parts of the card to punch for each candidate. In many cases, the cards themselves contain no such information. Optical-scan systems are marked using a pencil on a paper ballot, by filling in a circle or completing an arrow, and are very similar in principle to the original paper blanket ballot but enable counting by computer. Some optical scan ballots include illustrations showing how to mark the ballot properly. Instructions for the punch card systems typically appear separately from the ballot itself due to space constraints. The Votomatic punch card system contained arrows that pointed from the candidates' names to the proper place to punch the card, although these arrows appeared misleading to some voters in the 2000 Florida election. Party symbols could be used on either of these systems, but were rarely used in punch-card systems due to limited space. Oregon recently switched to an all-postal voting system. The Oregon system uses a standard optical-scan ballot without party symbols or candidate photos, but voters are mailed a voter's pamphlet by the state, featuring information about each candidate, supplied by the candidate, and featuring a black-and-white photo of the candidate.

Touch screen or DRE (Direct Record Electronic) systems replace the paper ballot with an electronic display and recording system. These systems have become the second most popular voting technology in the US (Herrnson, et al. 2008). They generally do not feature party symbols, although this would be possible on some of these systems. Voters generally make their selections by touching a computer screen near or on the name of their preferred candidate, or by using external buttons, or an external input device designed for voters with disabilities. The voter's choice is indicated by a checkmark or "X", often colored differently from other elements on the screen. DRE systems are based on personal computer technology and graphical user interfaces. For example, some of these systems rely on user interface elements such as scroll bars and scroll arrows when there is more information to display than will fit on the screen. They also sometimes feature interface metaphors like a virtual three-dimensional button that reacts when touched by having the border colors invert, to suggest that the button has been pushed back, changing how it reflects ambient light.

2.2 Ballots Outside of the US

There are a variety of ballots and voting systems in use outside of the US. The form of government and the needs of the voters determine many aspects of the ballots. It is informative to consider the use of graphics in different contexts to see the degree to which they support usability and accessibility for their voters.

The Guinea-Bissau ballot paper in Figure C simply shows the candidate names and photos.

In South Africa, full-color photographs of the candidates are printed on paper ballots, along with full-color party logos, and the names of the parties. This practice assisted the large population of people who were voting for the first time in 1994, many of whom cannot read. Late changes to the ballot were made by attaching stickers printed with the new candidates' names, photos, and party logos to spaces at the bottom of the ballots. Figure D shows a South African sample ballot from 1994; the actual ballot was similar.

Zimbabwe, in its recent, controversial election, used ballot papers with the names of the candidates and their parties (Figure E), along with photographs of the candidates and detailed party symbols (Kroeger, A., 2008).

New Zealand uses Mixed Member Proportional representation, a system in which people vote twice, on the same full-color paper ballot, for both a party and a specific local candidate for Parliament (Elections New Zealand, 2008). The parties are arranged in one column, and the candidates in another (Figure F). Although the local candidates are often affiliated with a party, a voter may, by splitting the ticket, support a local candidate in a party other than their preferred party, without reducing the proportion of seats held by their preferred party. On these ballots, party symbols appear next to both the names of candidates and the parties, to make it easier to see the relationship between the candidate and the party. Candidate photos are not used. Two informational icons appear at the top of the ballot, each with a sample check mark, and an arrow pointing to the column of blank spaces where the voter is supposed to make their mark. The two check marks are intended to emphasize that the voter should make one mark in each column.

Brazil uses a portable electronic device with a numerical keypad. Voters indicate their choices by entering a number associated with their candidates. The numbers are publicized before the election, and campaign posters feature pictures of the candidates along with the numbers used to select them. The voting system itself does not use graphics of any kind (BBC News, 2002).

3 Usability Issues for Graphics on Ballots

The use of graphics on ballots has been controversial from the beginning. Although many issues surrounding the use of graphics and the implications for the voter have been resolved, new issues have emerged related to the use of electronic voting technologies as well as modern printing capabilities. This section describes arguments for and against adopting graphics as part of voting systems, particularly in the US.

3.1 General Issues Concerning the Use of Graphics on Ballots

In favor. Graphics may help people with low reading ability to vote. This is the main reason party symbols were used on the blanket ballot (Evans, 1917). Voters who know the party they wish to support, and that party's symbol, or who can recognize the faces of their preferred candidates, do not need to read the words on the ballot to find their choices.

Graphics may speed voting even for people with good reading ability. People have a remarkable ability to find visual objects, and graphics could help them find the party symbol or candidate of their choice quickly. Graphical user interfaces take advantage of this ability and have become the dominant form of computer interface (Ware, C., 2004).

Against. Graphics cannot replace words entirely. Although voting instructions should be kept as simple as possible, some necessary instructions cannot be clearly explained with graphics. Furthermore, ballot questions are often quite complex and cannot be fairly translated into pictures.

Graphics are no longer the only way for people who cannot read to vote secretly. The Help America Vote Act of 2002 requires polling places in the United States to have at least one accessible voting station that includes an audio interface for voters who cannot see the ballot. Voters who have difficulty reading can also use these stations to vote independently.

Graphics will appear different on different media and in different environments. Although both paper-based systems and electronic screens usually feature black text on a white background, paper and electronic systems are not identical. Lighting conditions, visual angle, settings, and wear and tear can alter images on an electronic display. Alignment errors, variations in ink level, quality, and color blends, and storage conditions can alter the appearance of printed images. Thus, it is difficult to ensure that graphics will appear similar on all machines, paper ballots, and absentee ballots. Voters who rely on this information might have difficulty voting if the images do not appear as expected or changed from election to election.

Space is at a premium on ballots. When many candidates appear on the ballot for a single race, it is often difficult to fit all of them on at once and still have the text be legible. Space, and thus font size, was the reason that Florida's infamous 2000 butterfly ballot featured presidential candidates in two columns, which led to the confusion (Smithsonian, 2004). In elections like the California gubernatorial recall, there were so many candidates that they had to be displayed on multiple pages, complicating the voting procedure and potentially placing certain candidates at a disadvantage. Any graphics to appear on a ballot must be small, which can interfere with how recognizable the graphic is (Darcy & Schneider, 1989). Different digital formats resize differently, potentially impacting the quality of graphics printed at different sizes.

Additional elements violate the principle of making ballots as simple as possible. Usability experts agree that it is best to keep interfaces free of extraneous features which can be confusing (Norman, D. A. 1988, Nielsen, 2000). On a ballot, poorly designed graphics can make it difficult for voters to find the candidates they prefer. If the graphics do not help, they should not be included.

Providing graphics places extra burdens on candidates and election officials. Candidates must send the graphics they want to all of the election officials preparing ballots featuring that candidate's contest, and election officials must make sure to design the ballot include these graphics properly. This costs money and takes time. Further, it increases the possibility of errors on the ballot and voter confusion. Voter errors due to poorly designed ballots can be difficult to detect, but can be high enough to affect the outcome of an election.

3.2 Party Logos

Account executive: So, who'd you vote for?
Creative Director: Obama, he's got cool logos.
-- New York Ad Agency, Midtown (overheardinnewyork.com, 2008)

In favor. Party logos can help voters find their preferred party's candidates. Humans process images quickly, and do not necessarily need to fixate on an image in order to see it (Ware, 2004). This could help people find their preferred party without having to read the party label of each candidate. This might also help voters quickly determine whether particular parties are running in a specific race.

Party logos can help little-known parties convey a visual message. This could be interpreted as good or bad, but symbols can quickly get simple ideas across.

Against. Party logos are not standardized. Although we often see the Democratic donkey and Republican elephant in the US, these symbols are not at all standard on ballots. Niemi and Herrnson (2003) detail that, in nine states that use party symbols on the ballot, the symbols are different for each state. Competing parties sometimes use similar symbols. Within the past decade, Democrats have used a star, the flag, the Statue of Liberty, roosters, eagles, and donkeys. In the same time frame, Republicans have used eagles and elephants. The Libertarian Party used the Statue of Liberty in some states, but in Missouri, used a mule as their ballot symbol, to force the Democrats to give up the Statue and switch to the well-known donkey. The Reform and Constitution parties use eagles in some places, and in Oklahoma, the Reform party use a star that looked very similar to a star used by the Democratic Party in some

states. In Michigan, both the Democratic and Republican parties use symbols that combine the printed name of the party, the flag, and tiny portraits of popular Presidents from their party. Many State parties use symbols that are specific to their state, including outlines of the state map by the Libertarian Party in Utah and state symbols by the Green Party in New Mexico.

Party symbols emphasize political parties over individual candidates. In countries like New Zealand where voters choose parties and candidates separately, symbols are used to help voters identify which candidates represent which party. In the US, political parties are almost always included on the ballot alongside the candidate's name, but it is ultimately a candidate that is elected, not a party.

Some candidates would prefer to use their own logos. Candidates for high office hire graphic designers to create campaign logos and signs (Heller, 2008a, 2008b), and might want to use versions of these symbols in place of generic party symbols. They might want to do this to take advantage of a nationwide visual identity campaign that they believe is effective, or because they wish to play down their association with their political party, due to a hostile political involvement, or to portray themselves as an "independent". But other candidates in the same party, or even a different party, might then want to use the same logo as the candidate at the top of the ticket, to indicate an alliance with that candidate. Voters could be confused that different candidates in the same party have different logos, which could lead to "roll-off," the phenomenon in which people vote for the top office and not lower offices, skewing the outcomes of elections (Darcy & Schneider, 1989).

It is hard to control how a political symbol is used. National parties are protective of their symbols and might be upset by a local candidate with views outside the party's mainstream using their symbol. The Republican Party recently sued cafepress.com for selling goods featuring its elephant logo (Smith, 2008). Further intellectual property disputes would be likely if party logos became an even more important aspect of the electoral process.

Party symbols can be controversial, misleading, or misunderstood. For example, in New York, the Right to Life Party uses a picture of a fetus in the womb as its ballot symbol. The Marijuana Reform Party uses a leaf, presumably representing a marijuana leaf. Many parties simply use the initials of the party name as their ballot symbol, which may have alternative interpretations. New York election law regulates party emblems, but the regulations do not ensure that parties choose symbols or symbols that are consistent across States in the US. Nor can regulations ensure that the symbols do not frustrate, upset, or confuse voters. It is difficult to predict the effect a symbol may have on a voter's performance. For example, does the logo help or hinder voters with poor reading ability or with different cultural backgrounds?

3.3 Candidate Photographs

In favor. Candidate photos can help voters find their preferred candidate. Humans are especially good at recognizing faces, in part due to specialized brain structures devoted primarily to face recognition (Kanwisher, et al., 1997).

Against. Graphical variations can have particularly strong effects on photographs. The factors that may contribute to graphics appearing differently are explained above,

but if they made pictures unrecognizable, this could skew the election even more than hard-to-identify party symbols. Viewing an LCD screen from an odd angle can cause colors to invert. Excessive ink in a print run could make a candidate's features impossible to make out. Misaligned color printing is commonplace and could be expensive to correct.

The cost of professional photographs may place a burden on local candidates. Candidates who could not afford a professional photograph would use a lower-quality photograph or no photograph, placing themselves at a disadvantage. Photographs also make late changes to the ballot more difficult.

Photographs invite prejudices and uninformed decisions. In a recent series of experiments (Todorov, et al., 2005, Willis & Todorov, 2006, Ballew & Todorov, 2007), people were shown pictures of actual candidates in US Senate and House elections. Although the participants were not familiar with the candidates, they were able to make judgments about them based on viewing their photographs for a fraction of a second. The surprising finding is that these judgments, particularly the judgment of competence, were significantly correlated with the proportion of votes each candidate received in the actual election, and strongly predicted the winner. Even looking at a photo for a tenth of a second was enough for people to make judgments and predict election winners. The competence judgment was not a substitute for ethnicity or gender, and predicted the winner even when these were the same for both candidates. Placing photographs on the ballot could encourage snap decision making based on superficial information. It could also facilitate voting based on prejudices about ethnicity, gender, age, and anything else that can be gleaned from a photograph.

Candidates might manipulate photos or use visual codes. Candidates might use photographs from when they were younger, or try to make themselves look older to avoid age bias. Changes to appear more competent would probably be useful in light of the findings mentioned above. Politicians routinely have their photographs taken in front of the flag. Candidates can also use backdrops to portray cultural or regional alliances, or use props like a stethoscope or various pins or ribbons to indicate life experience or policy positions, or send coded messages. This could encourage voters to make their decision by looking at the pictures, rather than informing themselves ahead of time about the candidates. In Oregon, where voting is done by mail and voters get a pamphlet from the State featuring photos of the candidates, election officials sometimes have to edit the photos they receive from candidates to make sure they conform to the rules. Notably, an official photograph of George W. Bush was edited to replace a flag in the background with solid gray (Oregon Secretary of State, 2006). Finally, lookalike candidates could run as spoilers, either to intentionally draw votes from a particular candidate, or as a publicity stunt.

3.4 Informational Icons and Illustrations

Although icons are commonly used as interactive parts of a graphical user interface like Mac OS X or Windows, in the context of voting systems, we are using the term icon to mean a small picture meant to convey a concept (Shneiderman & Plaisant, 2005). In this sense, icons are as common on paper ballots as they are on electronic touch-screen systems. This section concerns informational icons, those designed to assist and instruct the voter, not graphics used to represent a particular party or

candidate, which are discussed above. Informational icons include arrows and pointing fingers, as well as alert symbols like an exclamation point in a circle.

In favor. Some concepts are more easily explained graphically than in words. A picture of an oval being filled on an optical scan ballot, or an arrow pointing to a critical part of the ballot can get these concepts across quickly and clearly. Text and pictures can reinforce one another to help avoid confusion caused by ambiguous instructions or illustrations. A checkmark or "X" is one of the simplest and clearest ways of indicating how to select a candidate.

Icons can be used to call attention to important instructions. People tend to ignore instructions unless they get stuck (Galitz, W., 2007). An example ballot by Design for Democracy (2007) uses an alert icon, a circle with an exclamation point inside it, next to the unusual instruction to vote for three candidates in a contest that will have three winners instead of the usual one.

Icons can be used to illustrate quantity without using numbers. The bars indicating mobile phone reception are a common example. In a voting context, the settings on an electronic system can be illustrated with icons. In a prototype voting interface, Bederson (described in Herrnson, et al., 2008) used a combination of colors and numbers to show how many contests had been voted.

Many informational icons are cross-cultural, and do not need to be translated when ballots have to be translated, although there are important exceptions noted below.

Against. Icons can be misinterpreted. Icons based on small illustrations of real objects depend on the viewer being familiar with that object. Fernandes (1995) notes that some objects differ in their appearance regionally and internationally; as do the meanings of common hand gestures. The common pointing finger seen in many ballots could be offensive in places where it is rude to point, or where the left hand is taboo (the left hand is often shown pointing to each row of candidates). While these cultural preferences may not apply to systems used in the US, it is important to be careful in the use of symbols to avoid confusion. Even symbols that are not offensive may be ambiguous. A raised index finger can be pointing up or indicating the number one, depending on the context, and would be a poor choice for an interface that should be as simple as possible.

Illustrations must be made carefully to be as clear as possible. This usually means clean and simple line drawings that accurately reflect the actual system in use, not photographs.

Icons and illustrations, like all graphics, add to the visual complexity of a screen or page. An illustration of every step of a process, or an icon next to every element, will distract the voter and slow the voting process.

Icons have to be designed in accordance with good design principles and verified with usability testing to establish that the meanings are easily understood by voters. Confusion such as, "Can I press this alert icon for more information? Should I fill the circular icons on this paper ballot? Do I need to press this arrow to see more candidates or contests?", distracts voters from accurately completing their ballots.

3.5 Animations and Video

In favor. Short, simple animated sequences are often used in computer interfaces to illustrate actions. This technique has been adopted by some manufacturers of

electronic voting systems to illustrate unfamiliar techniques. For instance, some systems require the voter to insert a card into a slot on or near the machine as a security measure. This is somewhat akin to inserting a card into an automated teller machine, but the mechanics are different. A short animation is used to show how the card goes into the slot.

Animations can help people learn to use interactive systems quickly, and many people prefer them to explanations without animation (Shneiderman & Plaisant, 2005). Interactive tutorials can be particularly useful for learning complex interfaces. In a voting context, a tutorial would likely take more time than it was worth, and the need for examples might confuse or subtly bias some voters. One simple but effective kind of animation for providing help is the use of virtual sticky notes that appear near important parts of the interface and briefly explain their function (Shneiderman, 2002, Kang, Plaisant, & Shneiderman, 2003).

Instructional videos showing people voting could help familiarize people with unfamiliar procedures. Selker (2007) suggests showing such videos to people as they wait in line to vote. This idea has the potential to make voters more familiar with voting procedures and speed up voting.

Against. Animations, by their nature, take time. If they can convey their message faster than text alone, they may be worthwhile. If they take too long, or are not clear, they will only delay the voting process and confuse voters. It is therefore essential to carefully review and test every animation that is included in a voting interface to ensure that it is clear, concise, and gets its point across faster than text alone.

Animations can be distracting. Animations displayed on a screen while the voter was performing any action not related to the animation, such as a decorative waving flag, should be avoided. Animated characters would probably do more harm than good. Microsoft's Office Assistant, known as "Clippit," was supposed to be cute and provide help by offering suggestions, but it annoyed people and interfered with their work (Shneiderman & Plaisant, 2005).

Instructional videos showing people voting could help familiarize people with unfamiliar procedures, but must be used carefully. First, such videos would take more time than the brief animations showing a single step like inserting a card. They could also be annoying, and would also raise issues of what kind of people to show: their age, gender, and ethnicity, but perhaps even more importantly, the presence or absence of specific disabilities.

Animations or videos can cause seizures in some people with epilepsy. This is especially true when there is a flicker between 2 and 55 Hz. This is why blinking text or graphics, and any choppy, repeated animation are avoided by usability experts. These kinds of graphics can cause visual fatigue and are often annoying even to people without epilepsy (WebAIM, 2008, Shneiderman & Plaisant, 2005).

4 Do Ballot Graphics Help Voters with Cognitive Disabilities?

Historically, graphics have been used on ballots for decoration, to inform or to persuade voters. They have also been used to deceive voters or take away the secrecy of the ballot. But the reason graphics were first included on official ballots was to make

voting easier for people who would have had trouble with a text-only ballot. Are graphics still necessary or useful for this purpose? In this section, we will consider a number of cognitive disabilities that can make text-based voting systems difficult to use and whether the use of graphics on the ballot could affect the voting process for people who have these disabilities.

Cognitive disabilities are the extra difficulties some people have performing certain mental tasks. These difficulties can be very specific, although they may be caused in many ways, which we describe only briefly below to illustrate the scope of this issue. From the perspective of designing for accessibility, it is important to understand the effects, and try to design interfaces to make mental tasks easier for people with each disability (WebAIM, 2008).

4.1 Sources of Cognitive Disabilities

In the US, learning disabilities affect over 7.5% of population, most commonly in the form of reading difficulties called dyslexia (Pastor & Reuben, 2002). Difficulties specific to math and writing also affect some people. People with learning disabilities have normal or above average intelligence, but their specific impairments often persist into adulthood.

Intellectual disabilities are marked by low overall intelligence and are found in about 1% - 3% of the population. It caused by a variety of genetic and environmental factors, although the specific cause is not always known (Lewis, 2007). Intellectual disabilities can inhibit social behavior in addition to cognitive skills.

Dementias are marked by progressive memory loss, confusion, and difficulty with language, but symptoms may vary greatly from one day to another. Alzheimer's disease affects four million Americans, and along with other dementias, will become more common as the population ages (Kantor, 2006).

Brain damage can be caused by injury or disease. About 1.4 million people are treated for Traumatic Brain Injuries, or TBI, annually, including skull fractures and concussions. Many more concussions go untreated. Five million Americans require daily assistance due to TBI (National Institute of Neurological Disorders and Stroke, 2008). Language deficits (called aphasia) caused by brain damage include difficulty reading and writing.

Over 780,000 strokes occur annually in the US, causing cognitive and motor deficits. Strokes can lead to general cognitive deficits, memory and language problems, and neglect disorders, in which a person disregards part of their visual field (National Institute of Neurological Disorders and Stroke, 2008).

4.2 Designing to Accommodate Cognitive Disabilities

Over the past few decades, there has been a major push in the design of devices and interfaces towards the idea that technology should be made to work for the widest possible audience. People differ in age, sex, cultural background, physical size and abilities, cognitive styles and abilities, and the technologies they use. Objects and interfaces designed with only one group in mind may be impossible or difficult to use for a different group. However, there are ways of designing technology such that it is usable for a broad audience, and many of these innovations improve the experience

for all users, or at least do not make it worse. Shneiderman, who coined the term "universal usability" to describe this philosophy, makes the analogy to the curb cuts in sidewalks that were designed to help people in wheelchairs cross the street, but also help people pushing strollers (Shneiderman & Plaisant, 2004). The most important principle of universal usability is to meet the needs of the users. In this section, we will consider the needs of users with cognitive disabilities, and discuss the design choices, for voting systems and ballots, that may meet these needs.

Bohman and Anderson (2005) identify six categories of functional cognitive disabilities: language comprehension (including reading ability), memory, attention, visual comprehension, math comprehension, and problem-solving. This section addresses ways that interfaces are adapted to be as usable as possible for people with these disabilities.

Reading ability. As discussed in Section 2, graphics are sometimes used to help people with low reading ability to vote, but they are not the only method. Low reading ability refers to several distinct problems, which may overlap in some people. People with the learning disability dyslexia, or with brain damage, may have good language skills in general, but trouble reading words. People with intellectual disabilities usually have low reading ability. Reading can be difficult for people with low vision or who are not fluent in the language on the ballot. Audio interfaces and standards for legible text and plain language can help in many of these cases.

People with dyslexia often use computer-generated speech to help them with text-based web pages (Marshall, 2007). Multiple media formats are recommended by some experts as useful for people with cognitive disabilities (Jiwani, K., 2001). Using audio and text together may help users with some reading ability, as the audio and text will reinforce each other, and the user can still benefit from the visual aspects of the interface. In addition, some dyslexics need clear, simple, consistent graphic navigational icons. Flashing text, font variations, distracting sounds and animations, and textured, patterned backgrounds will cause problems (Marshall, 2007).

Plain language is a movement towards making text easy to read by choosing simple words and familiar grammatical structures. The US Government has been moving towards writing documents intended for the public in plain language. Plain language is not only intended to help people with poor language or reading skills, but also for everyone else by making the information faster to read and more clear (plainlanguage.gov). Short, unambiguous instructions can help avoid the confusion that leads to spoiled ballots (Scott, 2008). Consider the differences between the instructions "vote for one," and "one to be elected," or even "you may vote for one, less than one, but not more than one." The last two are actual instructions found on ballots in Louisiana and South Carolina, respectively (Niemi & Herrnson, 2003). The plain language guidelines described by Redish (2006) include putting instructions in chronological order, and close to the parts of the interface they describe.

Verbal comprehension. Some people have trouble with language in general, which can be worse than simply having trouble reading. For instance people with autism have trouble with non-literal language like irony, idioms, or metaphor (WebAIM, 2008), often regardless of the mode in which the message is conveyed. To accommodate this disability, experts recommend language that is simple and straightforward

with explanations of any unusual terms or phrases. The plain language standards described above can meet many of these needs. Supplemental information sources such as audio, illustrations, or a good help system may help people with verbal comprehension disabilities vote independently. It is difficult to know whether graphics would help people by providing an alternative to language, or simply confuse them by adding extraneous information.

Memory and attention. Some people with TBI, Attention Deficit Disorder (ADD), or intellectual disabilities often have lower attentional control and memory abilities than other people. Minimizing the amount of information that needs to be remembered is a universal goal in interface design (Shneiderman & Plaisant, 2005), and is particularly important for people with memory or attention disabilities. It is poor design, in general, to require people to remember their earlier votes or the meanings of unfamiliar symbols in order to use an interface. The interface should be kept free of distracting elements like unnecessary text or graphics. However, icons can be used to attract attention to important parts of a ballot that might otherwise be missed (Design for Democracy, 2007).

Visual comprehension. On ballots, graphics are often used to supplement text and draw attention to important parts, and this use is recommended by some experts (Design for Democracy, 2007). Cluttered designs or overreliance on icons are bad for most users, but particularly for people with poor object recognition abilities due to brain damage. Icons that rely on wordplay or specific cultural knowledge are generally considered bad for interfaces intended to reach a broad audience (Fernandes, 1995), and could be particularly difficult for users with visual comprehension problems. Graphics should be accompanied by words that convey the same message. Clean line drawings are often more effective than photographs (Fernandes, 1995, Design for Democracy, 2007). Certain kinds of brain damage can limit a person's ability to recognize faces (Kanwisher at al., 1997). For these voters, photographs or drawings of candidates would be of no value.

Mathematics comprehension. Very little math should be necessary to vote. The biggest challenge regarding voters' math comprehension is preventing undervoting and overvoting, which are voting for too few and too many candidates in a race, respectively and this needs to be conveyed as clearly as possible to the voters. Overvoting is prevented in electronic systems. Undervoting cannot be prevented, in part because it may be the voter's intention to vote for fewer than the maximum candidates in a race. However, undervoting can be brought to the attention of the voter in either an electronic voting system or an optical scanner to allow the voter to correct accidental undervotes. Textual or graphical cues (such as an icon in a focal color, for example, yellow or a symbol that will capture users' attention) can help alert a voter (Herrnson, et al, 2008).

Problem-solving ability. Interfaces should be designed to make it clear what actions are available, and hide any irrelevant options. Part of the motivation for plain language is to take the guesswork out of understanding instructions. People who have particular difficulty with problem solving will be greatly helped by well-designed

interfaces, including clear graphical cues (Serra & Muzio, 2002, Shneiderman & Plaisant, 2005, WebAIM, 2008).

Finally, voters, for the most part, prefer to vote independently rather than rely on assistance from either family or poll workers. This need for independence may lead to reluctance to ask for help, even if the voter does not know what to do (Selker, 2007). Some voters with cognitive disabilities may not think of themselves as disabled, may feel some stigma associated with their disability, or may simply not wish to bother poll workers. As a result they do not ask for help or to use assistive technologies. The research suggests that for these voters with cognitive disabilities, and for all voters, voting technologies must be designed to be universally usable and this includes usability and accessibility of the graphical elements.

5 Conclusions

Much of the discussion in this paper reflects best practice of interface design based on human factors, usability, and accessibility research. The analysis in this paper reveals the underlying complexity of the effect of graphical elements on ballots and electronic voting systems. However, there is only a small amount of research that focuses on voting systems, such as (Design for Democracy 2007) and (Selker 2007). In particular, the use of graphics on ballots has been suggested as a way to address the needs of voters with cognitive disabilities. However, specific research is needed to establish that graphics indeed will support these voters. Research does show that basic universal usability concepts and plain language address many of the cognitive issues and is helpful to all voters.

6 Future Research

There are two basic questions about the usability and accessibility of graphics on ballots. First, do graphics on the ballot affect the usability of voting systems or influence voting patterns? Second, do graphics on the ballot provide better accessibility for voters with cognitive disabilities?

6.1 Usability Research

Usability is most often studied with careful observation by the researcher one-on-one with the user interacting system. To understand how the design of graphical elements affects voting systems for the majority of users, however, requires a different approach (Hernnson, et al. 2008). This typically involves simulated elections and large numbers of participants. The participants go through the election process as if voting.

The goal here is not to compare systems, but features of systems with careful experimental design. We would like to know whether a graphical feature affects the accuracy or speed of voting and whether it affects voters' decisions. This approach could be used to investigate potential problems with graphics on the ballot such as poorly reproduced photos or candidates' appearances.

6.2 Accessibility Research

Do graphics make ballots more or less accessible for people with cognitive disabilities? The link between the disability and the technology to alleviate it is not as obvious as audio systems for the blind or input devices for those with dexterity problems. A further complication is that many people with what we are here calling cognitive disabilities do not consider themselves disabled, and vote using standard voting technology as opposed to special accessible systems. People with more severe cognitive disabilities may not vote often or are used to having people help them vote, including marking their ballots for them.

Research and best practices have shown that, in general, the best way to make interfaces accessible to people with cognitive disabilities is to make them as clear and simple as possible. Many of the technologies that help people with other kinds of disabilities to vote, such as audio, external control devices, and adjustable text, will help people with cognitive disabilities as well. But, is it possible that graphically-based systems will help those who cannot use text? This would be a case in which graphics could be the difference between being able to vote and not. Experiments could be designed to explore the effectiveness of party logos, candidate photos, and informational graphics. Participants with a wide variety of cognitive disabilities could be used to test various implementations of graphics on voting systems.

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Appendix: Figures A through E of the Ballots

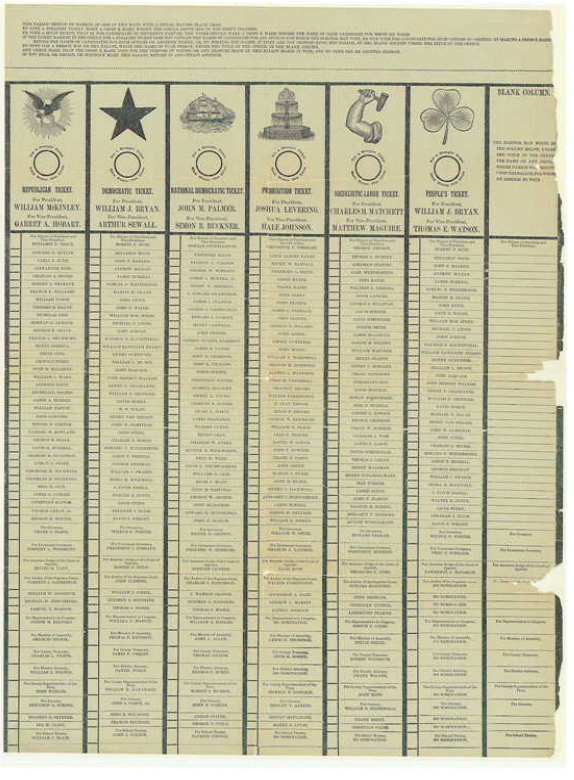

Fig. A. Blanket ballot, featuring detailed party symbols. http://americanhistory.si.edu/vote/reform.html

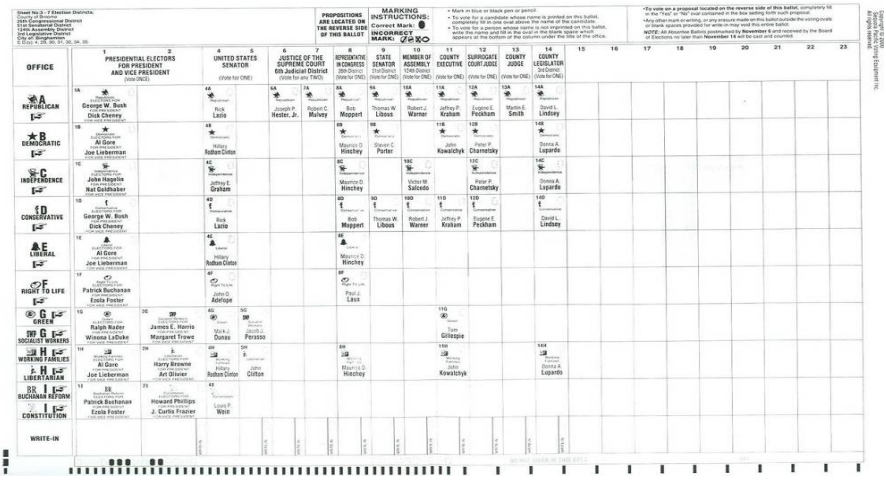

Fig. B. A Broome County, New York absentee ballot from 2000. The eagle and star represent the Republican and Democratic Parties.
http://vote.nist.gov/ballots_n/NY_broome20001107absent.pdf

Fig. C. Guinea-Bissau ballot paper
http://aceproject.org/regions-en/gi/GW ACE Electoral Knowledge Network

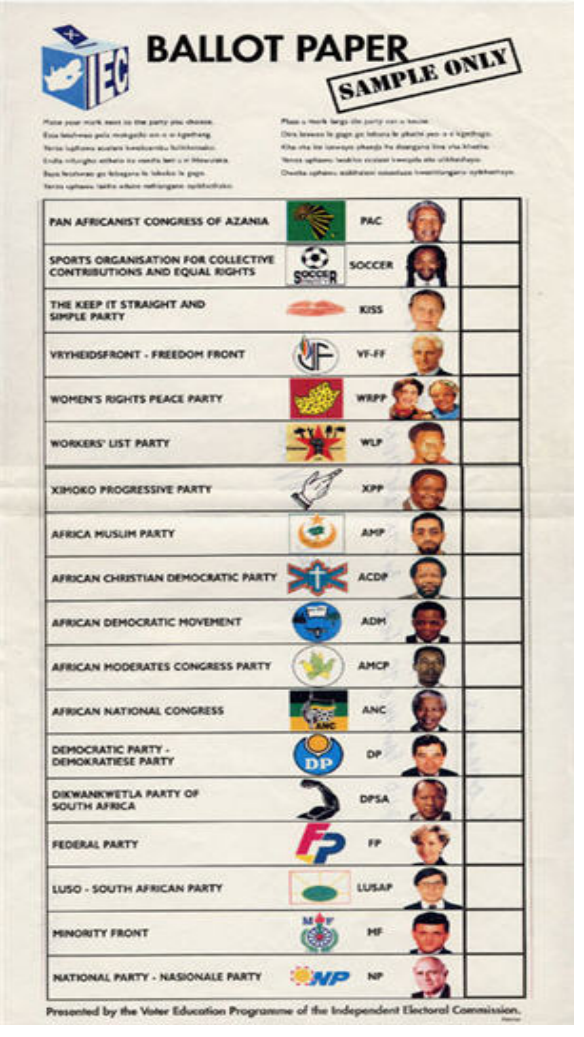

Fig. D. A sample ballot from the Republic of South Africa's 1994 elections. The name of the party, a party symbol, the initials of the party, and a picture of the presidential candidate are included. All pictures are in full color. Note that the names of the candidates, including the winner, Nelson Mandela, are not included.
The actual ballot was very similar but included stickers featuring late additions to the ballot.
http://aceproject.org/south_africa_3_lg.jpg/image_view_fullscreen
ACE Electoral Knowledge Network1998-2006 © ACE Electoral Knowledge Network

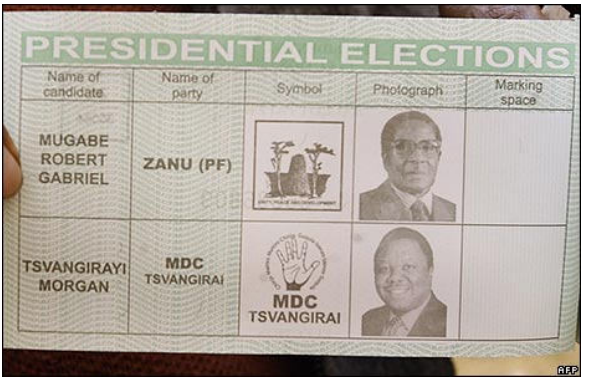

Fig. E. A paper ballot from the controversial 2008 run-off election in Zimbabwe. The ballot features the names of the candidates and their parties, as well as black-and-white party symbols and photographs. Tsvangirai withdrew from the run-off due to voter intimidation, but remained on the ballot. The photo is from AFP, and was the third picture in this BBC web gallery: http://news.bbc.co.uk/2/hi/in_pictures/7476935.stm

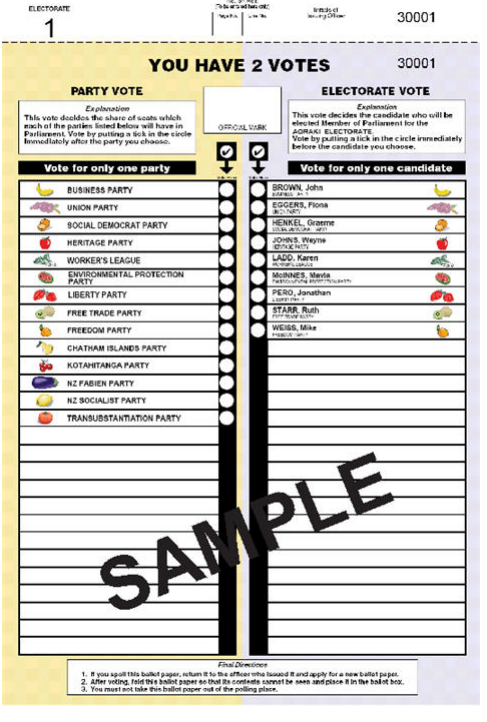

Fig. F. A sample ballot from New Zealand