RICE

Now Do Voters Notice Review Screen Anomalies?

A Look at Voting System Usability

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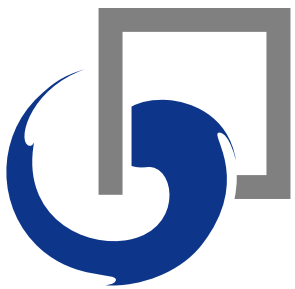

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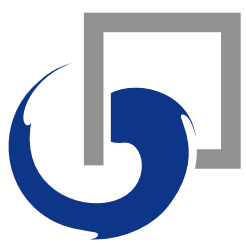
THE COMPUTER-HUMAN INTERACTION LABORATORY AT RICE UNIVERSITY

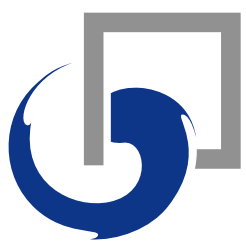
Overview

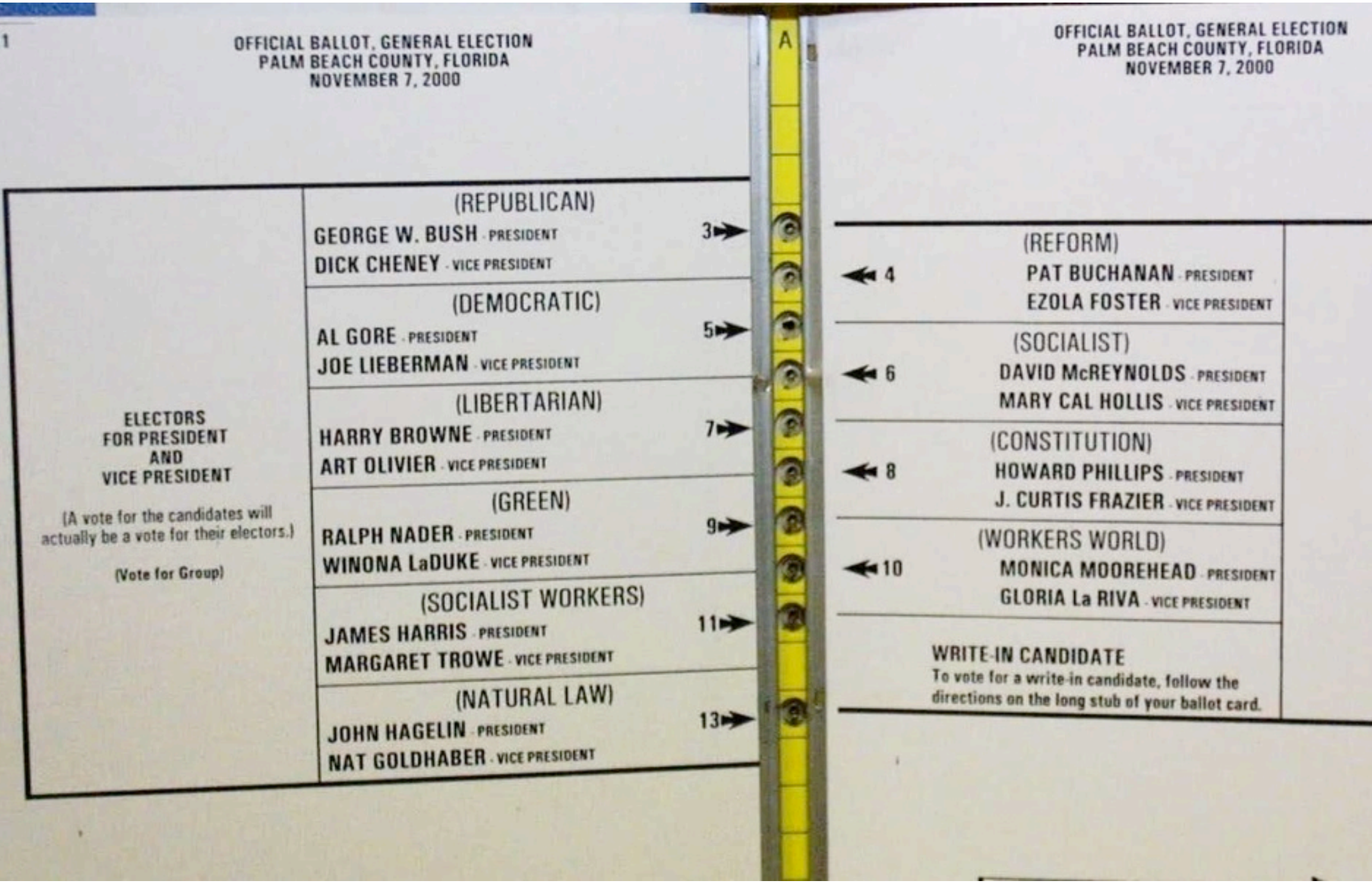
- Background
  - Usability and security
  - Previous research on review screen anomaly detection
- Methods
  - New experiment on anomaly detection
- Results
  - Improved detection
  - Replication of some previous findings
  - New findings
- Discussion



Usability and Security

- Consider the amount of time and energy spent on voting system security, for example:
  - California's Top-to-Bottom review
  - Ohio's EVEREST review
  - Many other papers past and present EVT/WOTE
- This despite a lack of conclusive evidence that any major U.S. election has been stolen due to security flaws in DREs
  - Though of course this *could* have happened
- But we know major U.S. elections have turned on voting system usability





http://www2.indystar.com/library/factfiles/gov/politics/election2000/img/prezrace/butterfly_large.jpg

U.S. REPRESENTATIVE IN CONGRESS
13TH CONGRESSIONAL DISTRICT
(Vote for One)

Vern Buchanan	REP	☐
Christine Jennings	DEM	☐

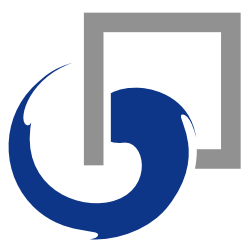
STATE

GOVERNOR AND LIEUTENANT GOVERNOR
(Vote for One)

Charlie Crist Jeff Kottkamp	REP	☐
Jim Davis Daryl L. Jones	DEM	☐
Max Linn Tom Macklin	REF	☐
Richard Paul Denbinsky Dr. Joe Smith	NPA	☐
John Wayne Smith James J. Kearney	NPA	☐
Karl C.C. Behm Carol Castagnero	NPA	☐
Write-In		☐

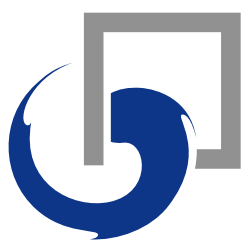
Usability and Security

- There are numerous other examples of this
  - See the 2008 Brennan Center report
- This is not to suggest that usability is more important than security
  - Though we'd argue that it does deserve equal time, which has not been the case
- Furthermore, usability and security are intertwined
  - The voter is the first line of defense against malfunctioning and/or malicious systems
  - Voters may be able to detect when things are not as they should be
    - The oft-given "check the review screen" advice



Usability and Review Screens

- Other usability findings from our previous work regarding DREs vs. older technologies
  - Voters are not more accurate voting with a DRE
  - Voters are not faster voting with a DRE
  - However, DREs are vastly preferred to older voting technologies
- But do voters actually check the review screen?
  - Or rather, how closely do they check?
  - Assumption has certainly been that voters do
- Everett (2007) research
  - Two experiments on review screen anomaly detection using the VoteBox DRE



STEP 1
Read Instructions

STEP 2
Make your choices

STEP 3
Review your choices

STEP 4
Record your vote

Review Choices

Below are the choices you have made. If you would like to make changes, click on the race you would like to change.

If you do not want to make changes, click the 'Next Page' button to go to Step 4.

Your vote will not be recorded unless you finish step 4.

President : **Vice President :**	Vernon Stanley Albur Richard Rigby	**Judge on Court of Criminal Appeals :**	Dan Plouffe
United States Senator :	None	**District Attorney of Harris County :**	None
US House of Representative :	None	**County Treasurer of Harris County :**	None
Govenor of Texas :	None	**Sheriff of Harris County :**	None
Lieutenant Govenor of Texas :	Cassie Principe	**County Tax Assessor of Harris Country :**	None
Attorney General of Texas :	Tim Speight	**Justice of the Peace of Harris County :**	None
Comptroller of Public Accounnts :	Greg Converse	**County Judge of Harris Country :**	None
Commissioner of General Land Office :	Sam Saddler	**Proposition 1 :**	Yes
Commissioner of Agriculture :	Roberto Aron	**Proposition 2 :**	No
Railroad Commisioner of Texas :	Jillian Balas	**Proposition 3 :**	Yes
State Senator of Texas :	None	**Proposition 4 :**	No
State Representative of Texas :	None	**Proposition 5 :**	None
State Board of Education :	Mark Baber	**Proposition 6 :**	None
Presiding Judge on Texas Supreme Court :	Tim Grasty		

Click to go back to previous race

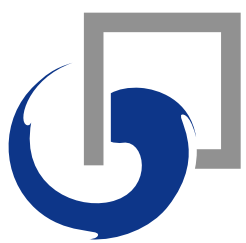
←Previous Page

Click to go to Step 4: Record your vote

Next Page→

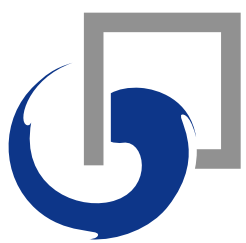
Everett (2007)

- First study
  - Two or eight entire contests were added or subtracted from the review screen
- Second study
  - One, two, or eight changes were made to the review screen
  - Changes were to an opposing candidate or an undervote and appeared on the top or bottom of the ballot
- Results
  - First study: **32%** noticed the anomalies
  - Second study: **37%** noticed the anomalies



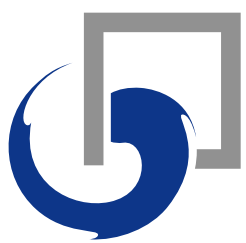
Everett (2007)

- Also examined what other variables did and did not influence detection performance
- Affected detection performance:
  - Time spent on review screen
    - Causal direction not clear here
  - Whether or not voters were given a list of candidates to vote for
    - Those with a list noticed more often
- Did not affect detection performance:
  - Number of anomalies
  - Location on the ballot of anomalies



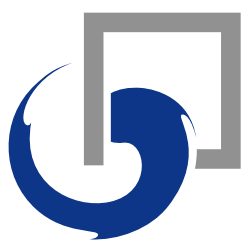
Everett (2007) Limitations

- Participants were never explicitly told to check the review screen.
  - Would simple instructions increase noticing rates?
- The interface did little to aid voters in performing accuracy checks
  - Was there too little information on the screen?



Current Study: VoteBox Modifications

- Explicit instructions
  - Voting instructions, both prior to and on the review screen, explicitly warned voters to check the accuracy of the review screen
- Review screen interface alterations
  - Undervotes were highlighted in a bright red-orange color
  - Party affiliation markers were added to candidate names on the review screen.



STEP 1
Read Instructions

STEP 2
Make Your Choices

You are now on:

STEP 3
Review Your Choices
Important

STEP 4
Record Your Vote

Review Choices

Below are the choices you have made. If you would like to make changes, click on the race you would like to change. **Please be sure to review your choices and correct any mistakes *before* casting your ballot.**

If you do not want to make changes, click the 'Next Page' button to go to Step 4.

Your vote will not be recorded unless you finish step 4.

President :	Gordon Bearce	R	**Judge on Court of Criminal Appeals :**	None	
Vice President :	Nathan Maclean				
United States Senator :	Fern Brzezinski	D	**District Attorney of Harris County :**	Jennifer A. Lundeed	D
US House of Representative :	Pedro Brouse	R	**County Treasurer of Harris County :**	None	
Govenor of Texas :	None		**Sheriff of Harris County :**	Stanley Saari	R
Lieutenant Govenor of Texas :	None		**County Tax Assessor of Harris Country :**	None	
Attorney General of Texas :	None		**Justice of the Peace of Harris County :**	None	
Comptroller of Public Accounnts :	Therese Gustin	I	**County Judge of Harris Country :**	Dan Atchley	R
Commissioner of General Land Office :	None		**Proposition 1 :**	Yes	
Commissioner of Agriculture :	Roberto Aron	D	**Proposition 2 :**	Yes	
Railroad Commisioner of Texas :	None		**Proposition 3 :**	None	
State Senator of Texas :	None		**Proposition 4 :**	None	
State Representative of Texas :	Petra Bencomo	R	**Proposition 5 :**	Yes	
State Board of Education :	None		**Proposition 6 :**	No	
Presiding Judge on Texas Supreme Court :	None				

Click to go back to previous contest

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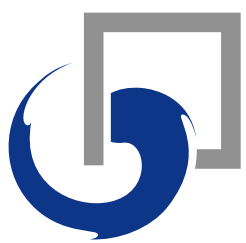
Click to go to Step 4: Record your vote

Next Page→

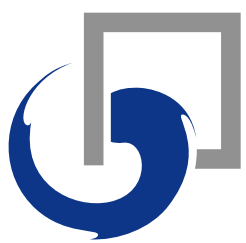
Methods: Participants

- 108 voters participated in our mock election
  - Recruited from the greater Houston area via newspaper ads, paid $25 for participation
  - Native English speakers 18 years of age or older
  - Mean age = 43.1 years (SD = 17.9); 60 female, 48 male
  - Previous voting experience: mean number of national elections was 5.8, mean non-national elections was 6.3
  - Self-rated computer expertise mean of 6.2 on a 10-point Likert scale



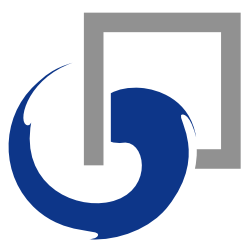
Design: Independent Variables

- Number of anomalies
  - Either 1, 2, or 8 anomalies were present on the review screen
- Anomaly type
  - Contests were changed to an opposing candidate or to an undervote
- Anomaly location
  - Anomalies were present on either the top or bottom half of the ballot



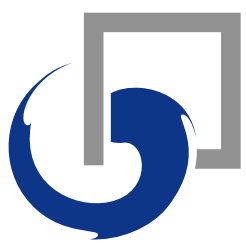
Design: Independent Variables

- Information condition
  - Undirected: Voter guide, voters told to vote as they wished
  - Directed: Given list of candidates to vote for, cast a vote in every race
  - Directed with roll-off: Given a list of candidates to vote for, but instructed to abstain in some races
- Voting system
  - Voters voted on the DRE and one other non-DRE system
- Other system
  - Voters voted on either a bubble-style paper, lever machine, or punch card voting system



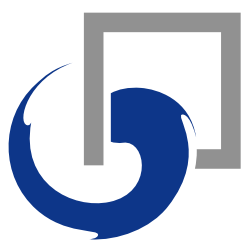
Design: Dependent Variables

- Anomaly detection
  - Voters, by self-report, either noticed the anomalies or they did not
  - Also, self-report on how carefully the review screen was checked
- Efficiency
  - Time taken to complete a ballot
- Effectiveness
  - Error rate
- Satisfaction
  - Subjective SUS scores



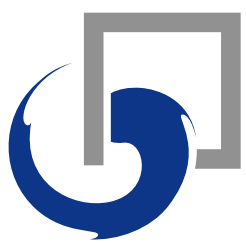
Design: Error Types

- Wrong choice errors
  - Voter selected a different candidate
- Undervote errors
  - Voter failed to make a selection
- Extra vote errors
  - Voter made a selection when s/he should have abstained
- Overvote errors
  - Made multiple selections (DRE and lever prevent this error)
- Also, voters in the undirected condition could intentionally undervote, though this is not an error
  - Raises issue of true error rate vs. residual error rate



Results: Anomaly Detection

- **50%** of voters detected the review screen anomalies
  - 95% confidence interval: 40.1% to 59.9%
  - Clear improvement beyond Everett (2007), but still less than ideal
- So, what drove anomaly detection?
  - Time spent on review screen (p = .003)
    - Noticers spent an average of 130 seconds on review screen, mean was 40 seconds for non-noticers
  - Anomaly type (p = .02)
    - Undervotes more likely to be noticed than flipped votes (61% vs. 39%)



Results: Anomaly Detection

- Self-reported care in checking review screen (p = .04)

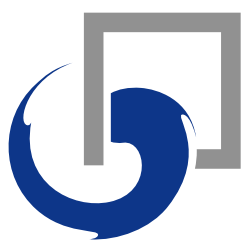
	Not at all	Somewhat Carefully	Very Carefully
Detected	0%	4%	47%
Did Not	6%	24%	19%
Total	6%	28%	66%

- Information condition (marginal, p = .10)

	Undirected	Directed with roll-off	Fully Directed
Detection Rate	44%	42%	64%

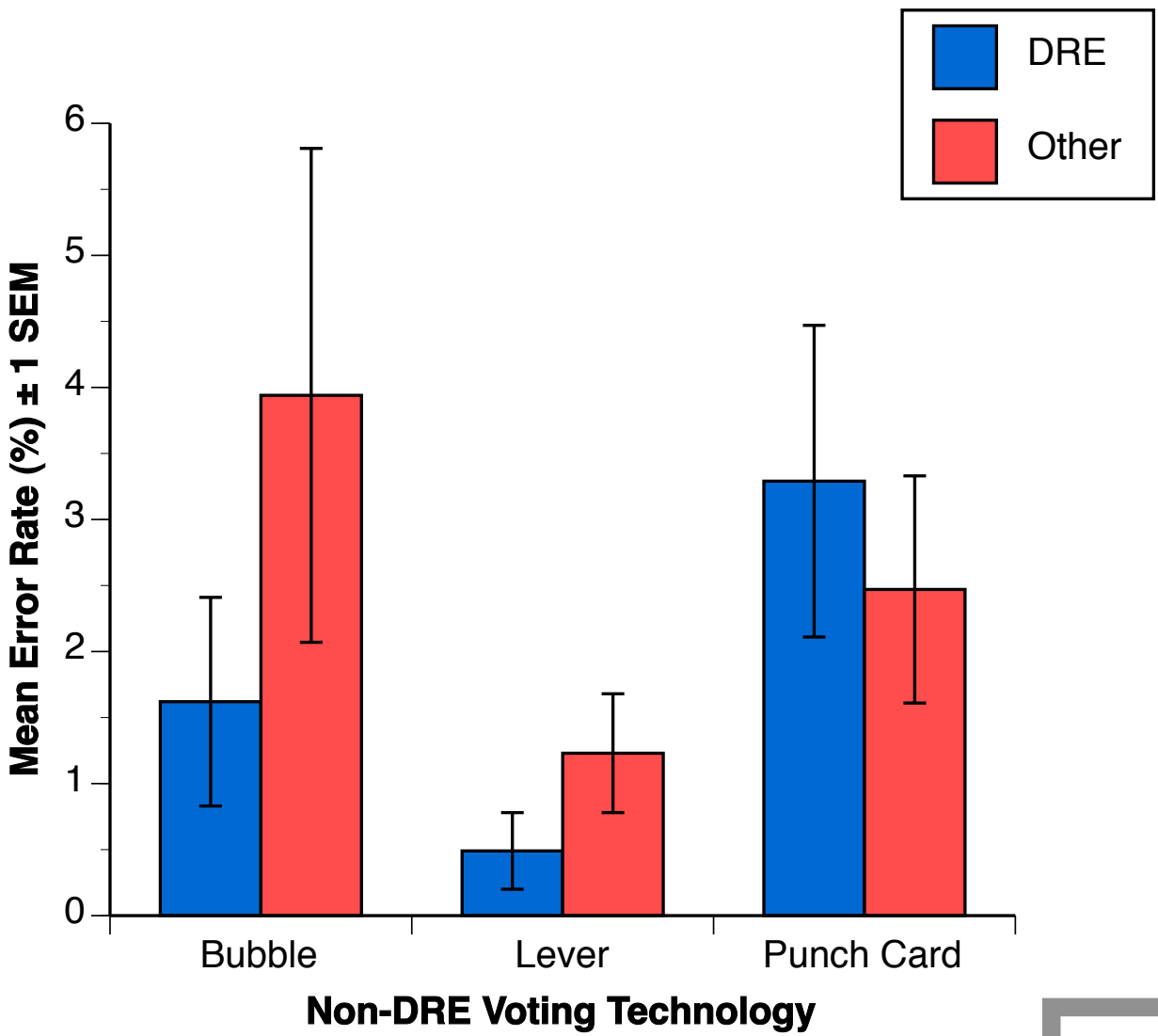
Results: Anomaly Detection

- Suggestive, but not statistically significant
  - The number of anomalies (p = .10)
    - Some evidence that 1 anomaly is harder than 2 or 8
  - The location of anomalies (p = .10)
    - Some tendency for up-ballot anomalies to be noticed more
- Non-significant factors
  - Age, education, computer experience, news following, personality variables

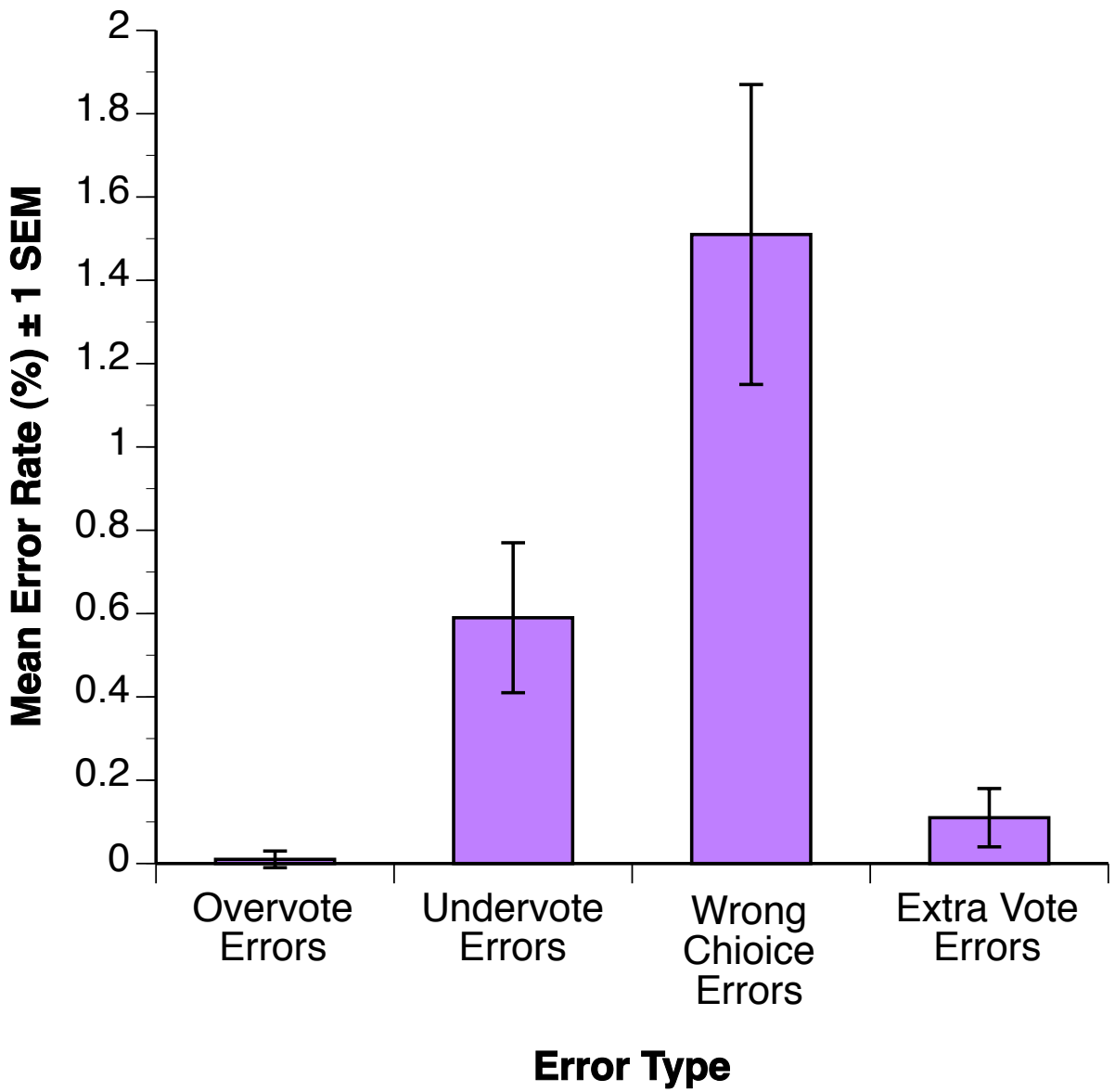


Results: Errors (Effectiveness)

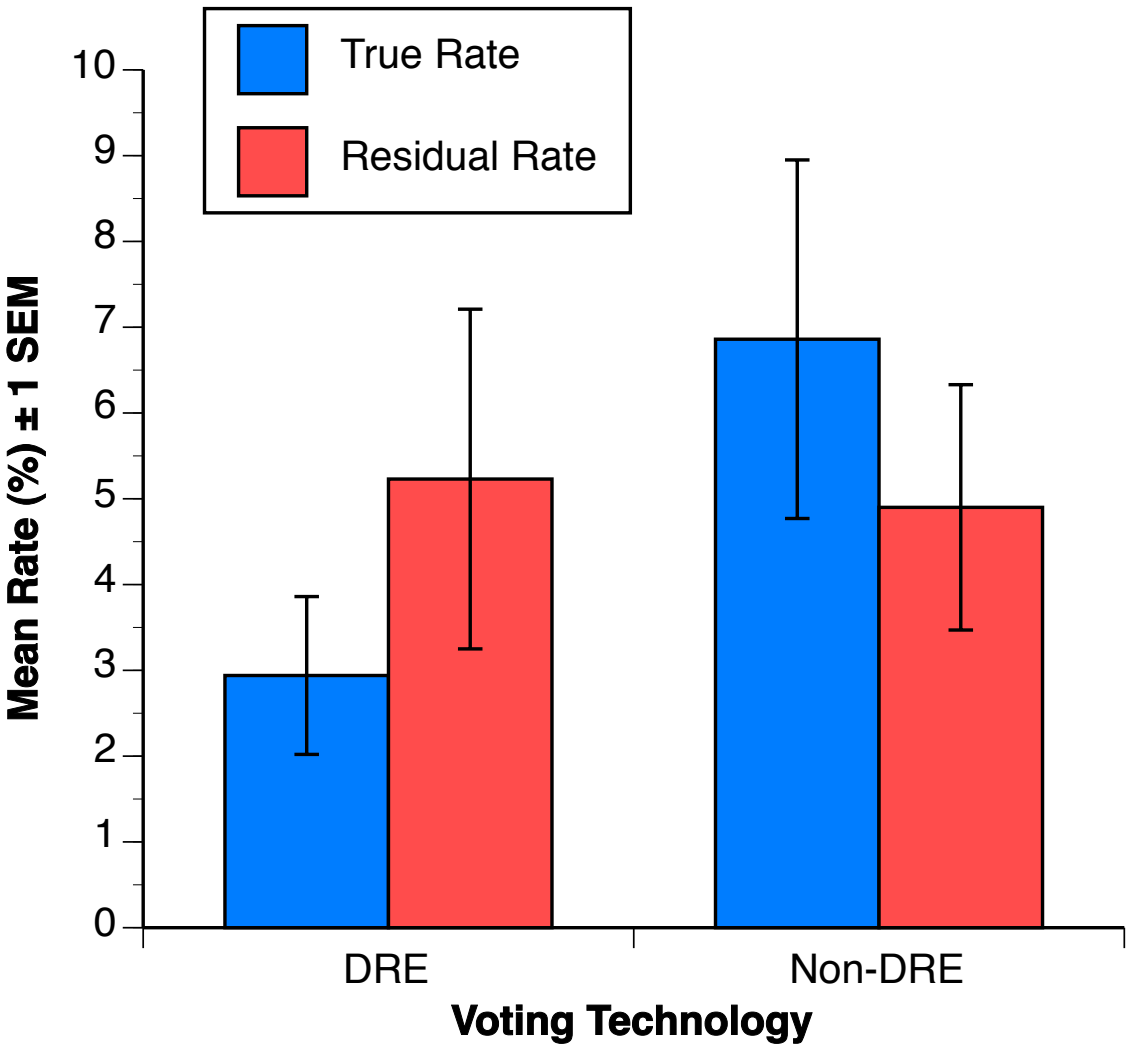
- No system was significantly more effective then the others



Results: Error Types

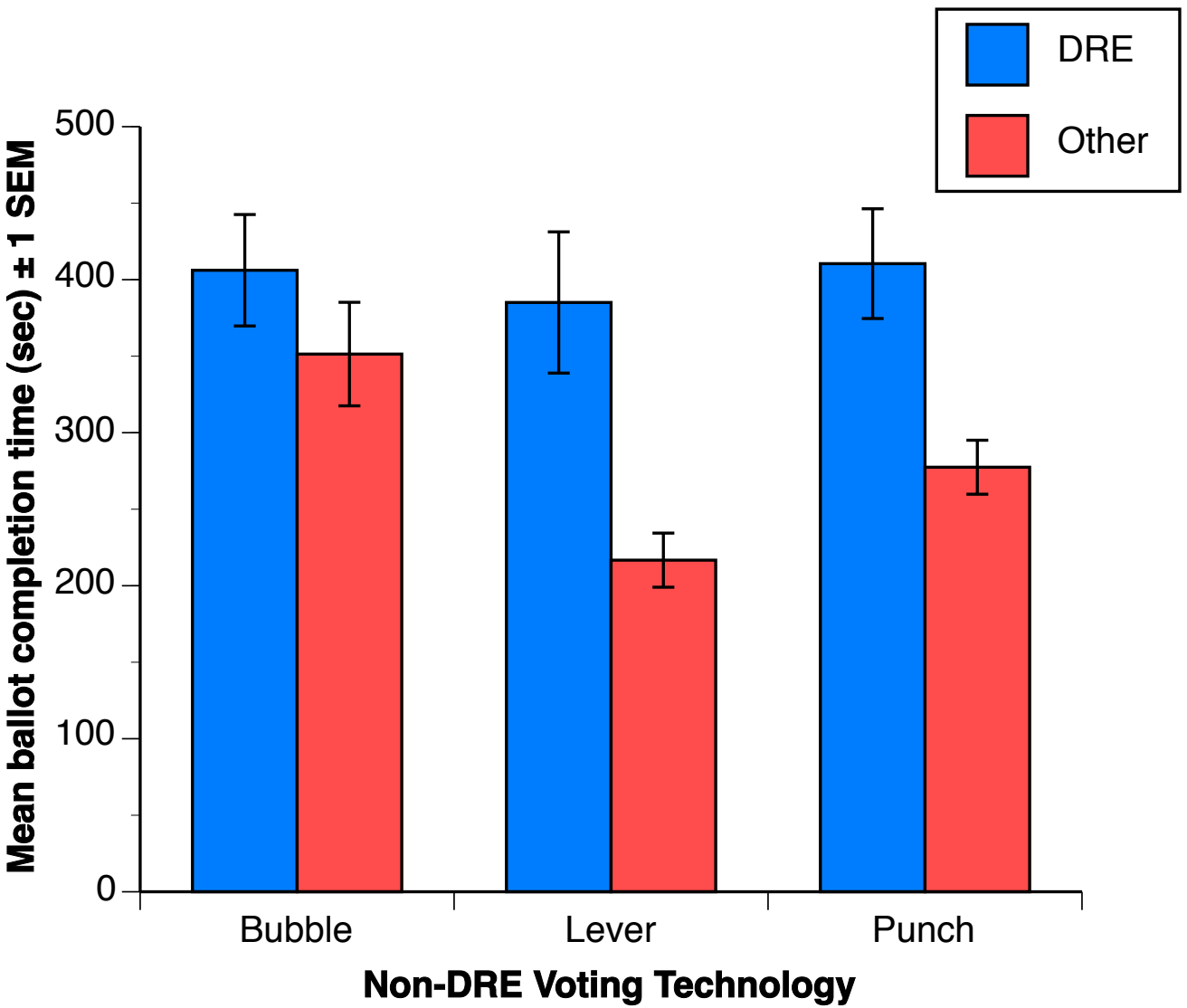


Results: True Errors vs. Residual Vote



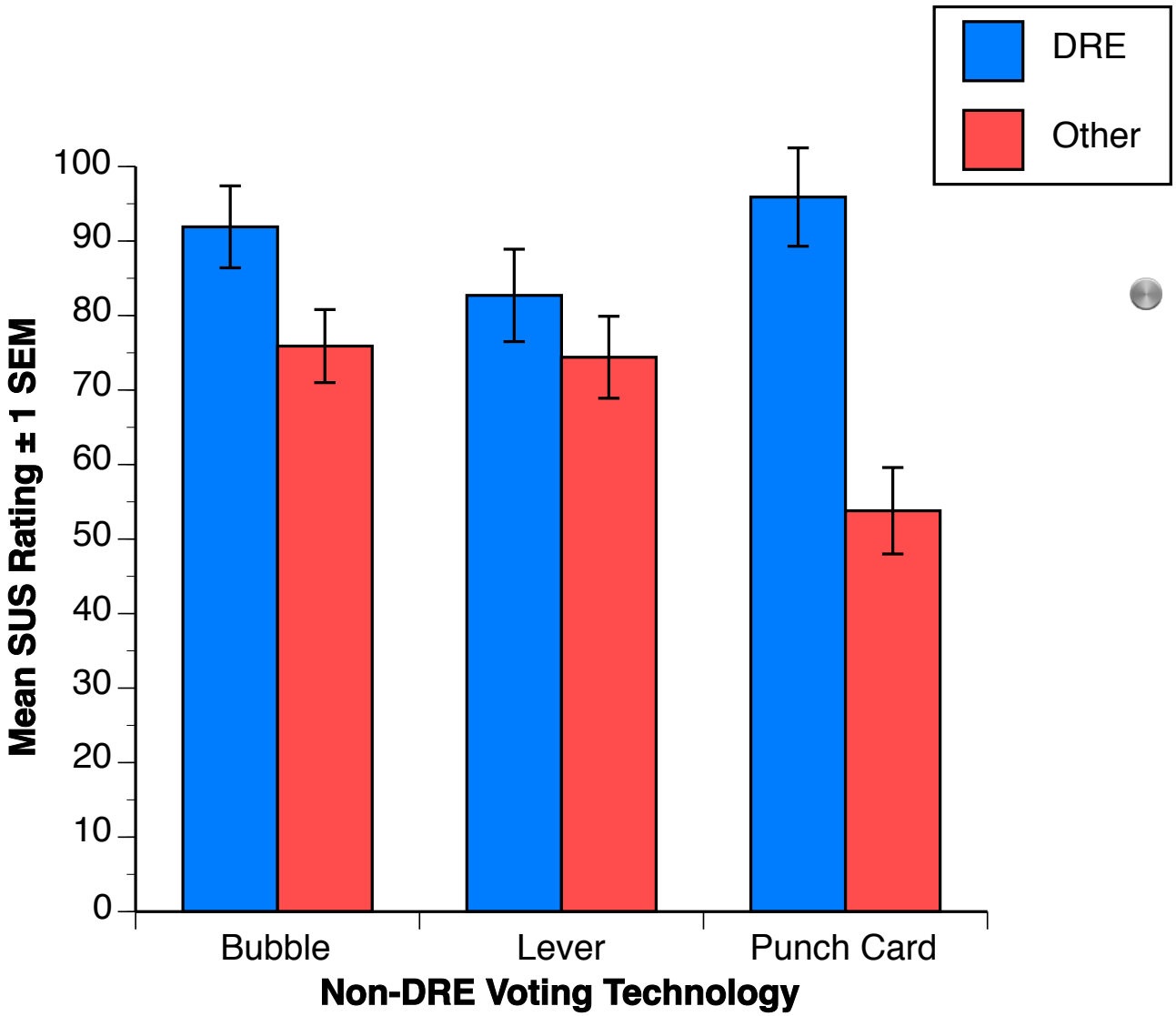
- At the aggregate level agreement was moderate
- However, agreement was poor at the level of individuals
- For DREs: $r(32) = .30$, $p = .10$
- For others: $r(32) = .02$, $p = .89$

Results: Efficiency



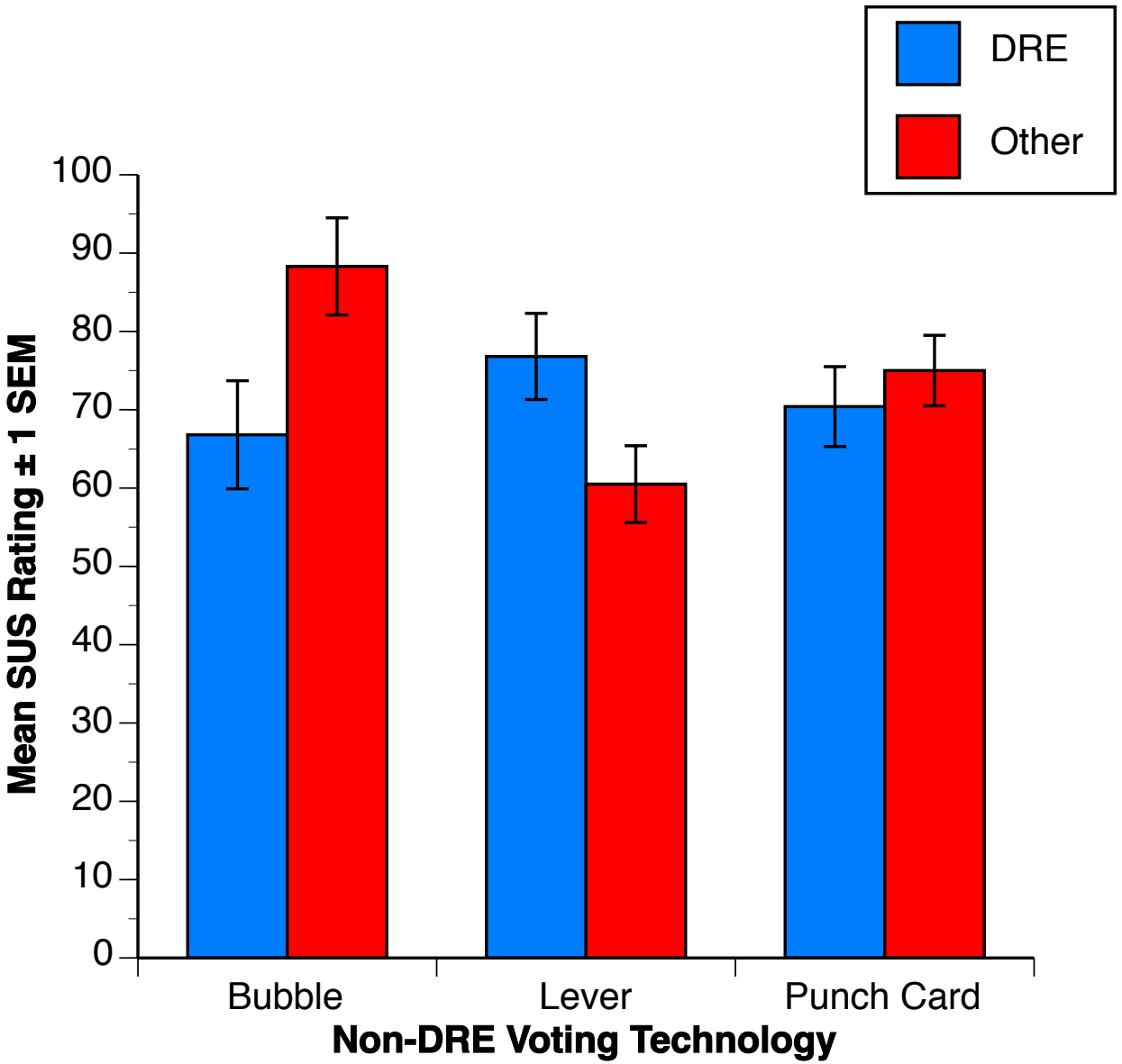
- The DRE was consistently slower then the non-DRE voting technologies
- Noticing of the anomalies was **not** a significant factor in overall DRE completion times

Results: Satisfaction, Non-noticers



- Those who did not notice an anomaly preferred the DRE
  - Despite no clear performance advantages
  - Replicates previous findings

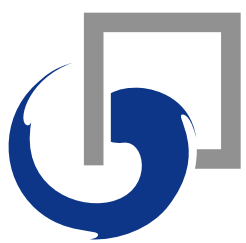
Results: Satisfaction, Noticers



- However, if an anomaly was noticed, voter preference was mixed

Discussion

- Despite our GUI improvements, only 50% of voters noticed up to 8 anomalies on their DRE review screen
  - While this is an improvement over Everett (2007), half of the voters are still not noticing anomalies
  - Data suggest that the improvement is mostly in detecting anomalous undervotes (orange highlighting helps!)
    - But vote flipping is still largely invisible
  - This suggests that simple GUI improvement may not be enough to drastically improve anomaly detection



Discussion

- VVPATs
  - If voters are not checking review screens, how likely are they to check an external paper record?
- Residual vote rate
  - The relationship between the residual vote rate and the true error rate may not be straightforward
  - May be dangerous to simply assume correspondence
- Subjective vs. objective performance
  - In general, no strong association between preference and performance
  - However, voters who noticed the anomalies were less satisfied with the DRE