# Gauging Security of Ballot Marking Devices (BMDs): Are Voters Able to Detect Ballot Manipulation?

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## Purpose of this Experiment:

- Some claim (Appel et. al, 2020; Stark 2019) that most voters would be unable to detect the changes made to their ballots
- Expands on the Kortum, Byrne, & Whitmore (2020) study.
  - Requires all participants to check their ballots, rather than determining methods to persuade participants to examine their ballots
- This study is more concerned with whether participants can detect anomalies if they take the time to check their ballot

## Methods

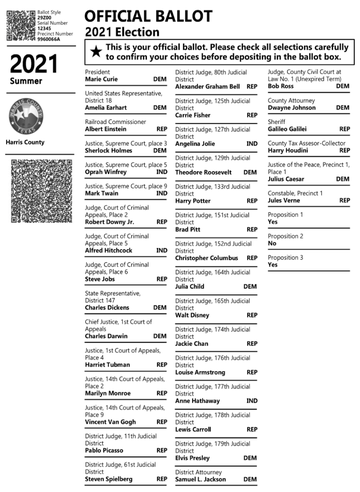
Participants :

- This study utilized a diverse pool of 64 participants eligible to vote in the United States..

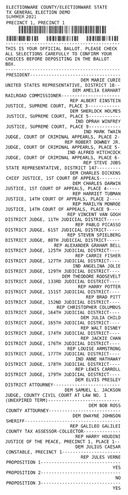
Experimental Task:

- 2 (Ballot design) x 2 (Ballot length) x 2 (Number of Changes) x 2 (Location of Changes) Between-Subjects design.
  - Ballot Design: LA vs. ES&S
  - Ballot Length: 40 contests vs 5 contests
  - Number of Changes: 10 changes vs. 1 change (40 contest ballot); 2 changes vs. 1 changes (5 contest ballot)
  - Location of Changes: Beginning (top 25%) vs. Middle (middle 25%)

LA:




ES&S:




## Procedure

- Participants given a 5 or 40 contest slate (depending on the condition) that they were instructed to use as a guide to vote with.
- Randomly assigned to a condition
- Wizard of oz protocol
- Directed to behave as auditors when inspecting their ballots.
- Completed a survey covering opinion on the overall usability of the voting system, their voting history, and demographics

## Detection Performance

100% of participants were able to detect at least one anomaly.

Out of the total 64 voters, 60 (93.65%) were able to detect all changes made to their ballots.

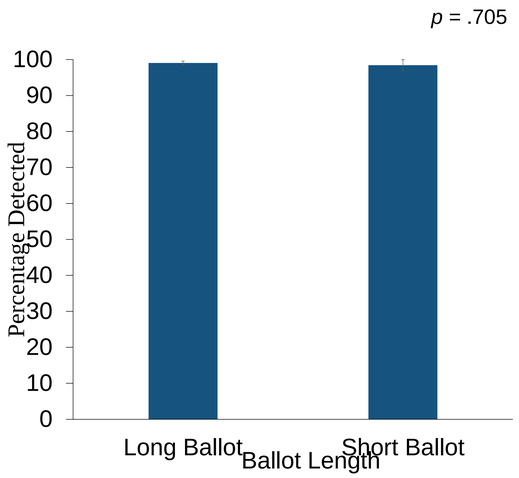



**FIG. 1.** Reflects the percentage of voters who detected anomalies within their ballots in relation to ballot length. "Long" ballots indicating ballots that contained 40 contests and "short" ballots that contained 5 contests. Error bars included in the graph represent one standard error from the mean.

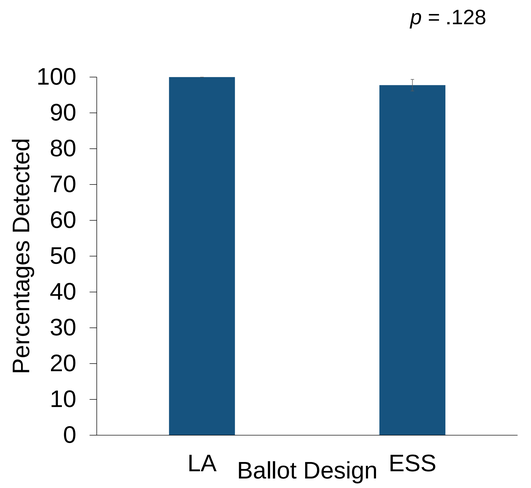



**FIG. 2.** Reflects the percentage of voters who detected anomalies within their ballots in relation to ballot design. "LA" ballots indicating ballots that reflected user-centered guidelines and "ES&S" reflecting the receipt form printed out ballot. Error bars included in the graph represent one standard error from the mean.

## Time on Task

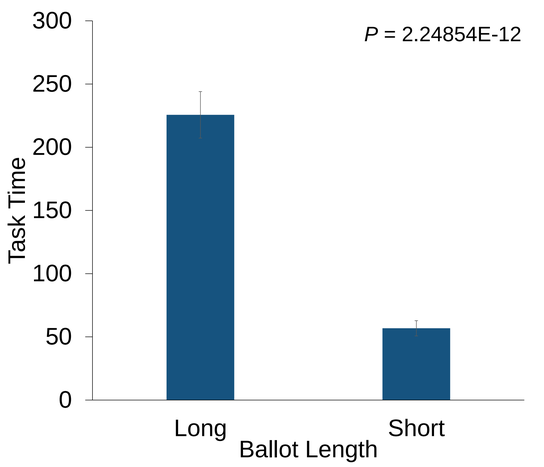



**FIG. 3.** Reflects the time it took voters to check their ballots in relation to ballot length. "Long" ballots indicating ballots that contained 40 contests and "short" ballots that contained 5 contests. Error bars included in the graph represent one standard error from the mean.

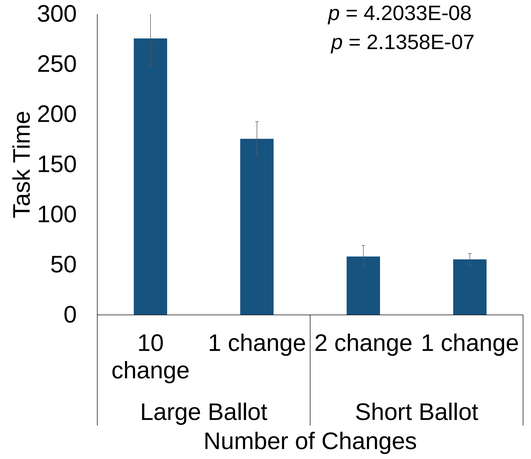



**FIG. 4.** Reflects the time it took voters to check their ballots in relation to number of changes made to the ballot contests. The p-value at the top reflects the comparison of the 10 change and 2 change conditions, the second p-value reflects the comparison of the 1 change conditions. Error bars included in the graph represent one standard error from the mean.

## Results

Detection Performance across conditions:

- Overall, there were no significant differences across conditions.

Time on Task:

- Overall, there were mostly no significant differences across conditions,
- Except in the condition of ballot length. And There were also significant differences time on task for number of changes with 10 changes vs. 2 changes in the long vs. short ballots respectively (M = 275.69, SD = 111.26; M = 58.25, SD = 43.64; t(30)= 2.04, p = 4.20E-08). These significant results were also found in the 1 change vs. 1 change conditions in long vs. short ballots respectively (M =175.63, SD = 68.38; M = 55.38, SD = 22.64; t(30)=2.04, p = 2.14E-07).

## Discussion

- Voters *can* detect changes in their ballots
  - Non-significant findings indicate that this is the case across all conditions
- Similar to the previous Kortum, Byrne, & Whitmore (2020) findings
- Appel (et. al, 2019) mentions the tendency of voters to not look at their ballots or only glance for an average of 4 seconds.
- Bernhard (et. al 2020) also mentions that there is an increase in checking ballots when voters are alerted to check .
- What can be done?
  - Motivation of voters – Methods of motivating voters to check their ballots.
  - Education – educating voters on the importance of checking their ballots
  - Considerations for including a station for checking ballots
    - Time
  - Verbal or Written Instructions
  - Encouraging the use of pre-prepared slates for real-world voting

## Conclusion

- Voters *can* detect changes made in their Ballots
- Two ways that voters can fail to detect changes:
  - Not checking their ballots at all
  - Failing to detect a change after checking voter ballot
- As voter's can't be forced to check their ballots like in this study, follow-up studies would need to be conducted on encouragement methods.

## References

Appel, A., R. A. DeMillo, and P. B. Stark. (2020). "Ballot-Marking Devices (BMDs) Cannot Assure the Will of the Voters." Election Law Journal 19(3): 432–450.

Bernhard, M., A. McDonald, H. Meng, J. Hwa, N. Bajaj, K. Chang, and J. A. Halderman. (2020). "Can Voters Detect Malicious Manipulation of Ballot Marking Devices?" IEEE Symposium on Security and Privacy, 679–694. doi: 10.1109/SP40000.2020.00118.

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## Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. (SMA-1853936 and SMA-1559393).