Visualizing Uncertainty with Icon Arrays:
Communicating the Diagnostic Accuracy of a Cancer Screening Test

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Motivation

There are a handful of existing studies which look at **incorporating uncertainty into icon arrays** in medical communication.

Conflicting evidence related to comprehensibility and how it impacts decision making.

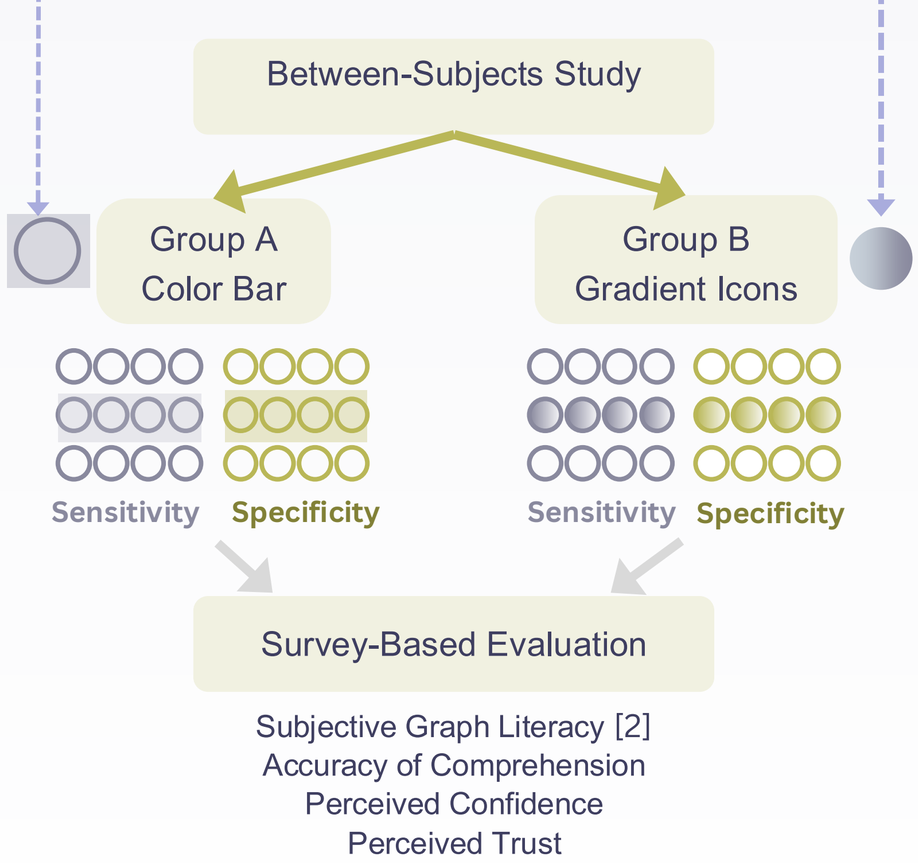
Research Questions

1. Is there a difference in **outcome measures** (accuracy of comprehension, perceived confidence, and perceived trustworthiness) **between visualization techniques** (visualizing uncertainty with color bars and gradients in **icon arrays**)?

2. What is the relationship between **graph literacy** and outcome measures when visualizing uncertainty?

Methods

- **Visualization format**: 10 x 10 static icon arrays
- **Uncertainty**: numerical range, representing diagnostic accuracy (mean and 95% confidence intervals) from a Cochrane Review of collated studies [1].
- **Visual encodings**: 2 visual encodings of uncertainty
  - Color Bar
  - Gradient (within icon)
- **Stimuli**: 2 icon arrays to illustrate the hypothetical screening scenarios:
  - Screened who have cancer (sensitivity*)
  - Screened who do not have cancer (specificity**)

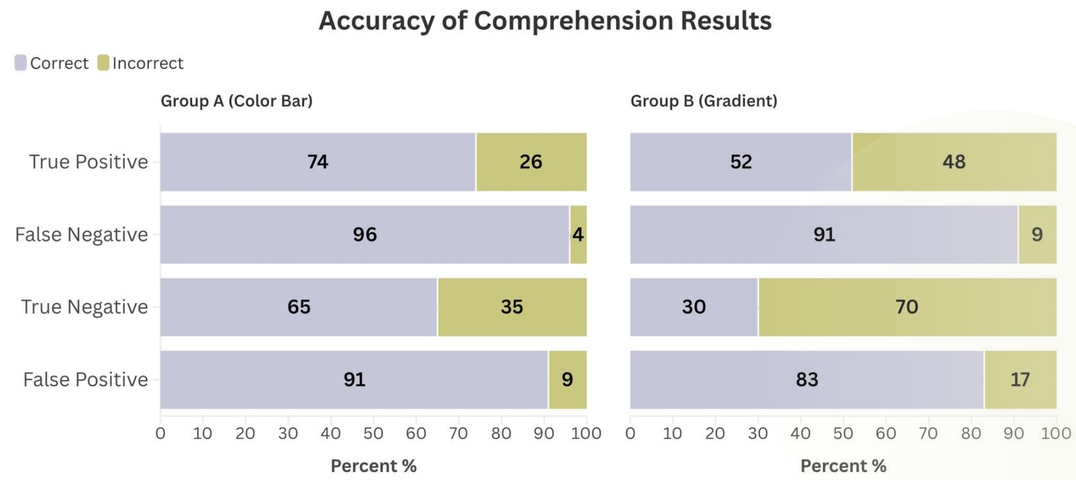


Sensitivity is the ability of a test to yield a positive result for a subject who has that disease. Sensitivity=(True Positives)/(True Positives +False Negatives).
**Specificity* is the ability of the test or instrument to obtain normal range or negative results for a person who does not have a disease. Specificity=(True Negatives)/(True Negatives +False Positives) [3]

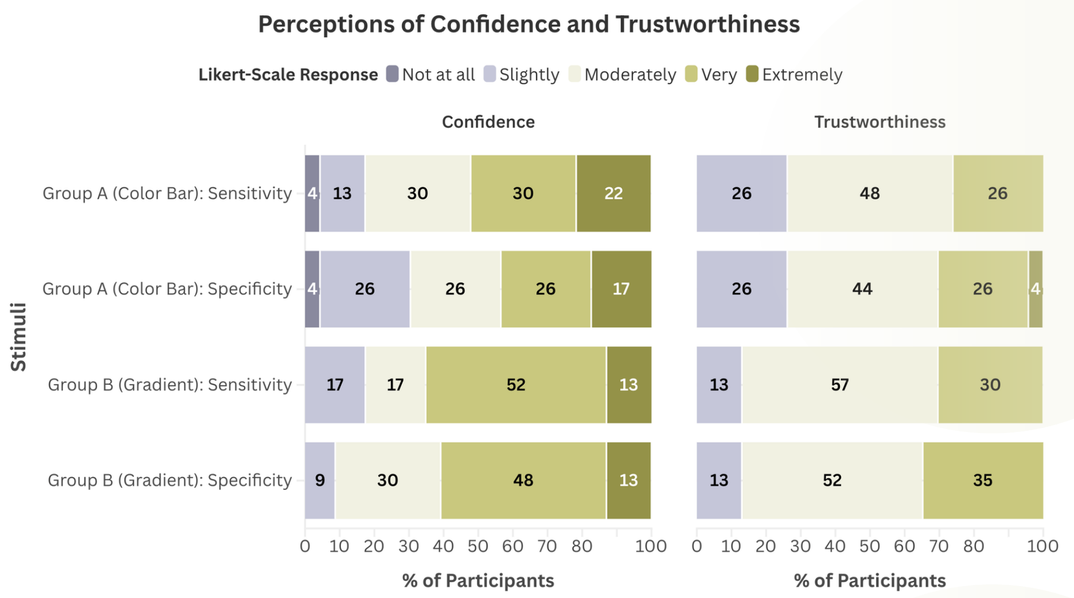
Results

Accuracy of Comprehension*	Subjective Graph Literacy	Perceived Confidence	Perceived Trust
Color Bar > Gradient	Weak correlation with outcome measures	No significant difference between groups	No significant difference between groups
Mean Accuracy: 81.5% vs 64.1%	Mean Score: 49.9 out of 60 across groups	Median composite score: 7 out of 10	Median composite score: 6 out of 10

*Statistically significant result



Color bar encoding resulted in greater accuracy of comprehension than gradient shaded icon (81.5% vs 64.1%).



When presented with uncertainty, participants refrained from extreme perceptions of trustworthiness.

Future Work

- **Qualitative analysis** via semi-structured interviews aiming to look deeper into participant comprehension and perceptions of uncertainty visualization.
- **Data-driven storytelling techniques** [4] may help communicate the multiple outcomes and are also worth exploring.

References

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