

Do Perceptually Salient Elements In Physics Problems Influence Students' Eye Movements and Answer Choices?

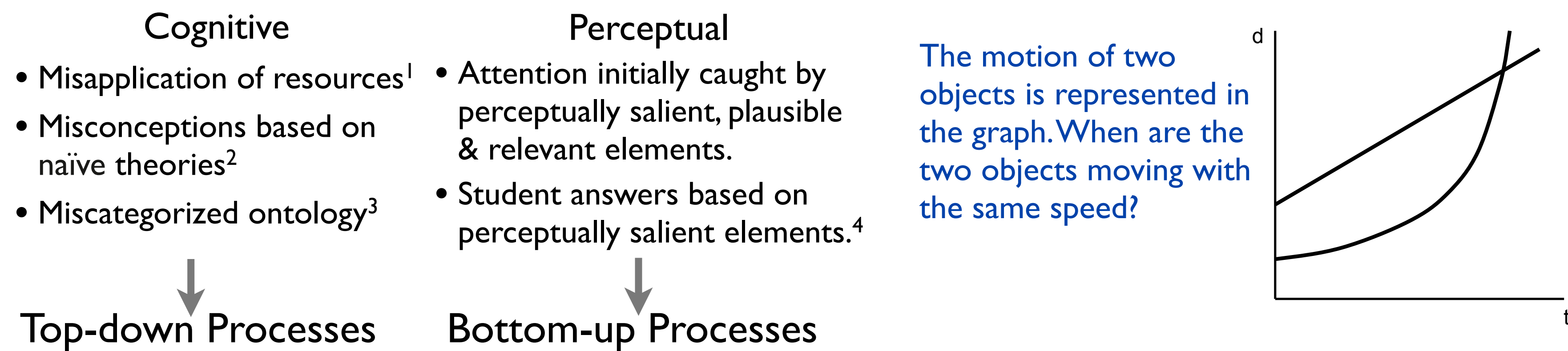
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OBJECTIVE

Understand how manipulation of perceptual salience in physics problem diagrams influences answer choices and eye movements.

PROBLEM: Consistent Wrong Answer Patterns in Physics

Two explanation types for consistent wrong answer patterns in physics: cognitive and perceptual.



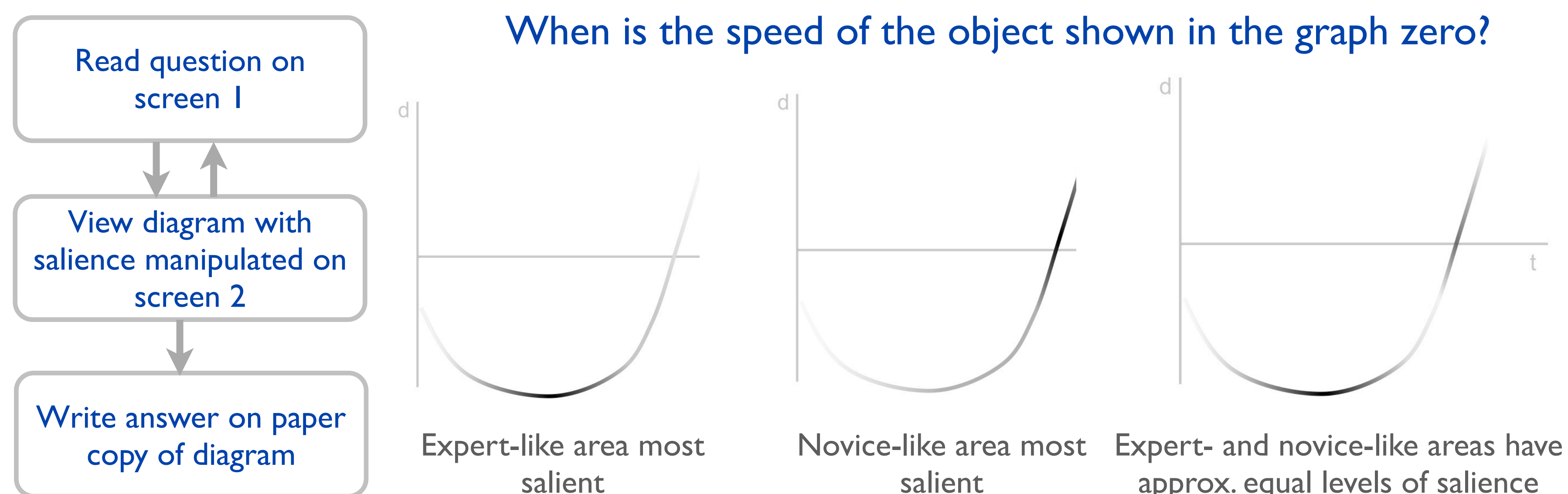
METHOD

Participants. 60 introductory second semester algebra-based or engineering physics students

Eye Tracker. Eye Link 1000 desktop mounted eye tracker

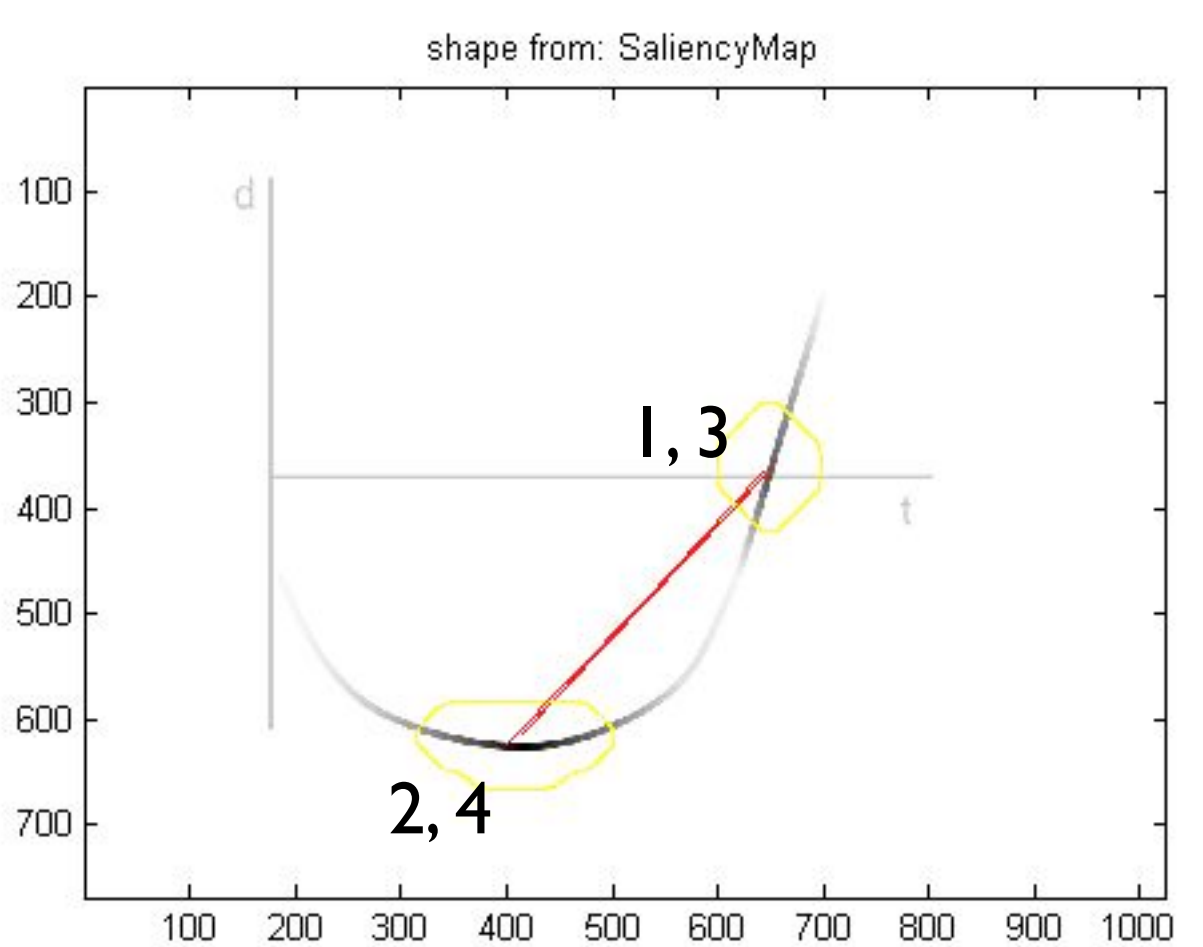
Materials. 15 introductory physics questions where information needed to answer is contained in a diagram. Diagrams also have area consistent with novice-like response.

Procedure. Each participant viewed 5 problems with the expert-like area most perceptually salient, 5 problems with novice-like area most salient and 5 problems with the expert-like and novice-like area having equal levels of salience.



- Perceptual salience manipulated by altering luminance contrast of expert-like and novice-like diagram elements.

- Used *Saliency Toolbox*⁵ to determine numerical values of salience and order in which diagram elements would be fixated.



Saliency feature map output from *Saliency Toolbox*, #'s indicate order of fixations



EyeLink 1000 eye tracker used in study

REFERENCES

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HYPOTHESES

Hypothesis 1: Bottom-up processes based on perceptual salience primarily influence attention.

Correctness

- expert-like salience manipulation = correct answer
- novice-like salience manipulation = incorrect answer
- equal salience manipulation = same # of correct and incorrect answers

Time fixating in expert- & novice-like areas of interest (AOI)

- expert-like salience manipulation = more time in expert-like AOI
- novice-like salience manipulation = more time in novice-like AOI
- equal salience manipulation = same amount of time in expert-like and novice-like AOI

Hypothesis 2: Top-down processes utilizing conceptual resources primarily influence attention.

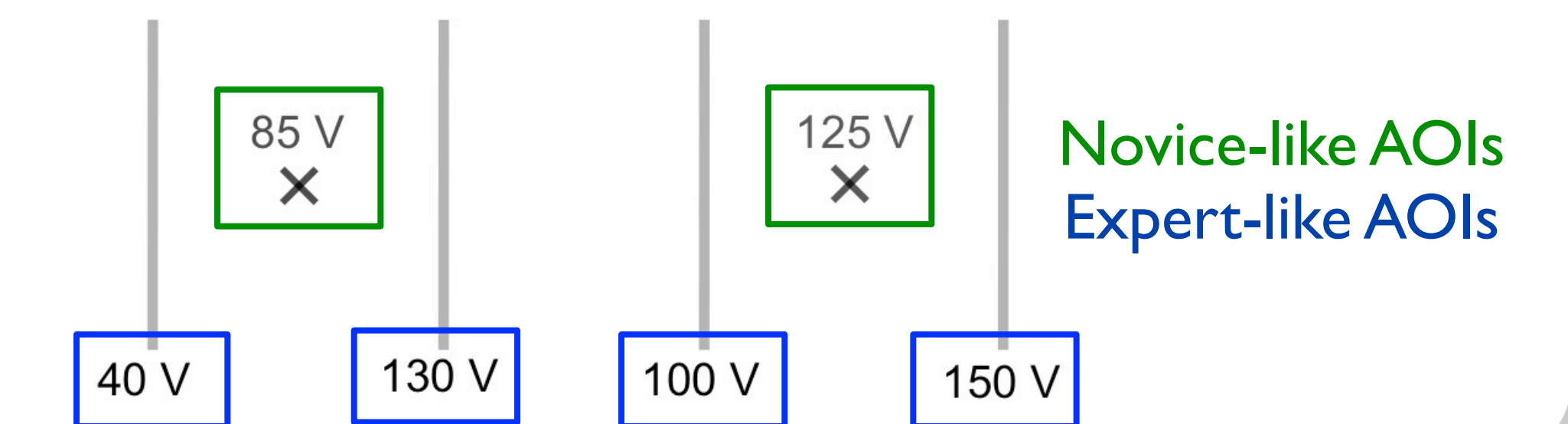
Correctness

- Salience manipulation does not influence answers choices.
- Correctness depends on prior physics knowledge and application.

Time fixating in expert- & novice-like areas of interest (AOI)

- correct answer = more time in expert-like AOI
- incorrect Answer = more time in novice-like AOI

Between which pair of parallel plates is the electric field greater?



ANALYSIS & RESULTS: Correctness

1. Repeated measures ANOVA with the three levels of salience manipulation as IV and the mean correctness of answer as DV.

2. Repeated analysis* including previous semester physics grades for subsets of participants who had taken general (n=24) or engineering physics I (n=16).

Average Correctness All Participants

Salience Manipulation	Average Correctness	Std. Dev.
Expert-like	49.9%	28.0%
Novice-like	53.9%	27.4%
Equal	55.3%	25.6%

- No significant effect of salience manipulation on correctness for students previously enrolled in general or engineering physics I.

- Students with average grades in the top third of the EPI grade distribution had significantly higher correctness scores.

No significant effect of salience manipulation on correctness for all participants

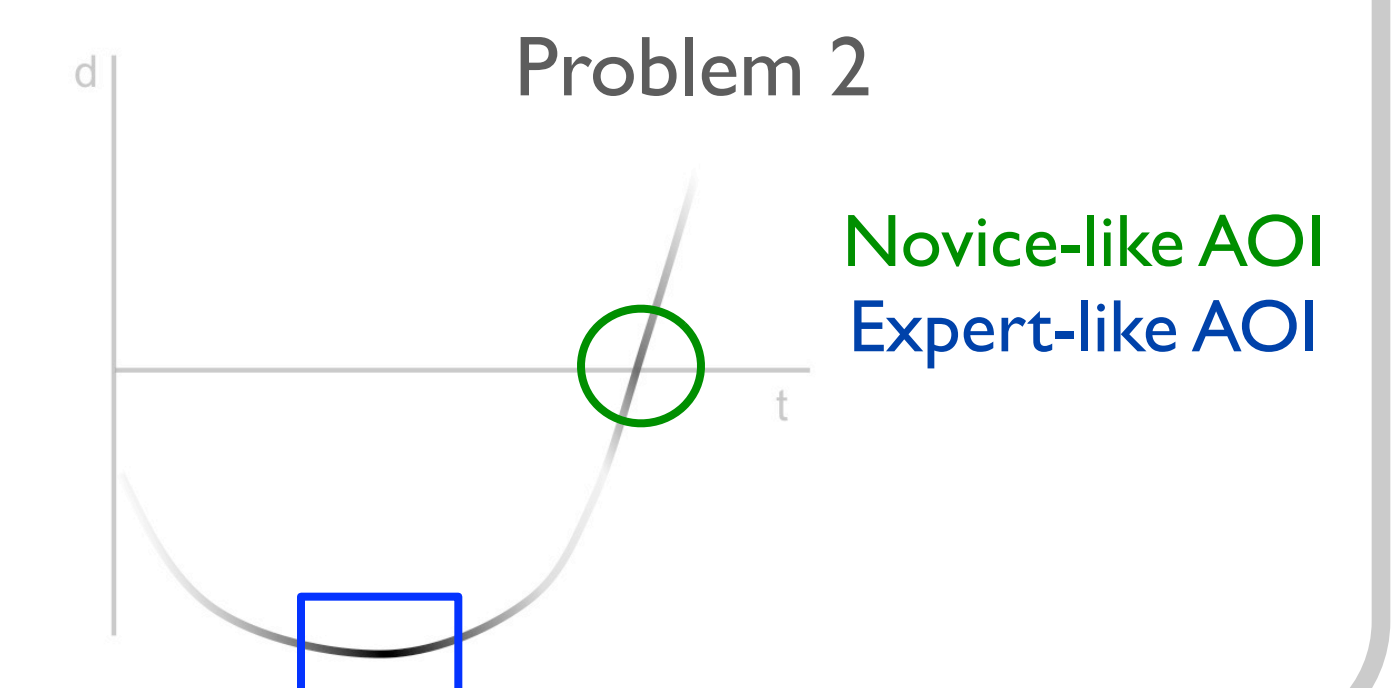
*Completed repeated measures ANOVA with salience manipulation and "top" and "bottom" third of previous semester physics course as the IV and the mean correctness of the answer as DV.

ANALYSIS & RESULTS: Time Spent Fixating in Areas of Interest

- Expert-like AOIs:* elements in diagram which contain information needed to answer correctly.
- Novice-like AOIs:* area consistent with most common incorrect answer, as documented in PER literature.
- Calculated % time in diagram / % of diagram area (PTPA) for expert- and novice-like AOIs & compared across salience manipulations.

- No significant difference in time spent (PTPA) in expert and novice-like AOIs across manipulations for 14 of 15 problems.

- Higher PTPA for novice-like salience manipulation in novice-like AOI on problem 2.



CONCLUSION

Did not find evidence for perceptual salience influencing answer choices or eye movements in physics problems.

- No significant differences in correctness of answers across salience manipulations for all students and subsets who had taken general and engineering physics I.

- No significant differences in time spent in expert- and novice-like AOIs across salience manipulations on 14 of 15 problems.