# How Does Visual Attention Differ Between Experts and Novices on Physics Problems?

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## OBJECTIVE

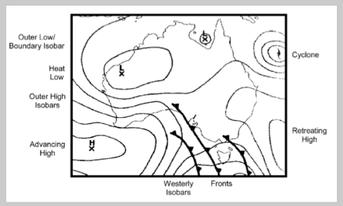
Investigate how the allocation of visual attention differs between experts and novices on physics problems where the critical information needed to answer the problem is contained in a diagram.

## INTRODUCTION

### Previous Research

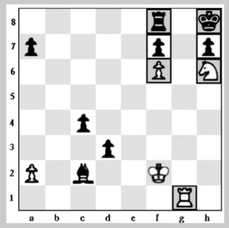
• Experts' visual attention is primarily driven by knowledge and they spend more time than novices looking at relevant information in figures. [1-3]

• Novices' visual attention is driven by noticeable features of environment and they spend more time looking at perceptually salient areas of figures and pictures. [4]




Novices were found to spend more time looking at salient features of a weather map. [3]

Artists spend more time looking at relevant areas of paintings than non-artists. [2]



Expert chess players have higher densities of fixations on relevant chess pieces than intermediate players [1]

**Motivation:** If similar differences in visual attention exist for physics problems, guiding novices' eye movements to match those of experts may be helpful.

### Research Question

How does expertise affect the dwell time in perceptually salient versus thematically relevant areas in a figure?

- *Perceptually salient*: most noticeable portions of a diagram or picture
- *Thematically relevant*: portions of a diagram which contain necessary information
- *Dwell time:* total time spent looking at an area while viewing the diagram

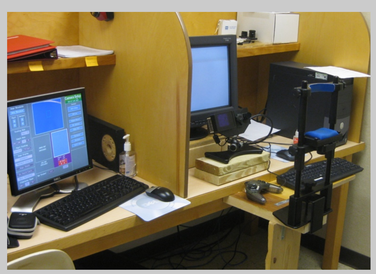
## METHOD

**Participants:** 9 PhD students in physics with teaching experience and 13 introductory psychology students who have taken a physics course.

**Physics Problems:** Participants answered 10 multiple-choice conceptual physics questions where the information needed to answer the question was contained in a diagram.

**Eye Tracking:** Eye movements were recorded with an EyeLink 1000 eye tracker.

1. Instructions and calibration of eye tracker
2. Answer 10 multiple-choice conceptual questions while eye movements recorded
3. Explain reasoning for answers to questions while watching playback of eye movements



EyeLink 1000 (left) and data collection room (right)

## ANALYSIS & RESULTS

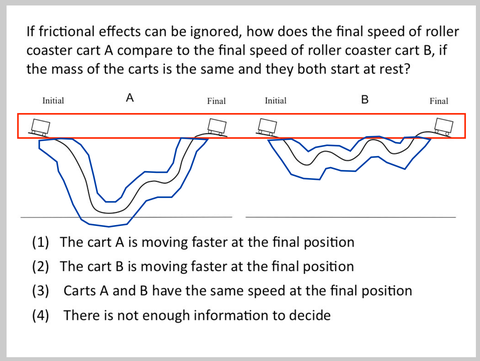
- *Perceptually salient* and *thematically relevant* areas of interest (AOI's) defined by three independent raters.
- One-way ANOVA used to compare percentage of time spent in each type of AOI.
  - -Independent variable: correctness of answer

**Significance determined at alpha=.05 level. Green boxes indicate significant differences.

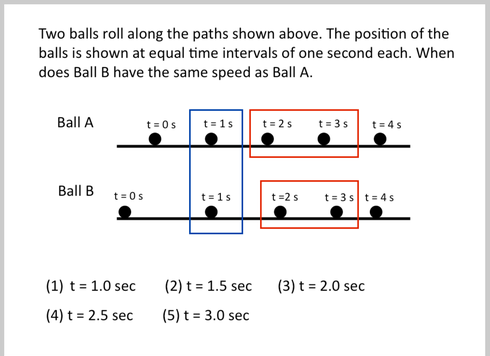
| Thematically Relevant | Perceptually Salient |
|---|---|
| Correct: 26.6%(± 16.1) | Correct: 10.5% (± 8.2) |
| Incorrect: 21.4% (± 12.2) | Incorrect: 31.5% (± 18.3)* |

| Thematically Relevant | Perceptually Salient |
|---|---|
| Correct: 46.6% (± 10.7) | Correct: 19.2% (± 8.2) |
| Incorrect: 25.8% (± 11.5)* | Incorrect: 29.0% (± 6.9* |

Problem 1



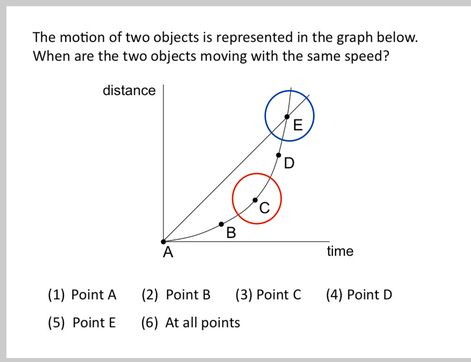

Problem 4



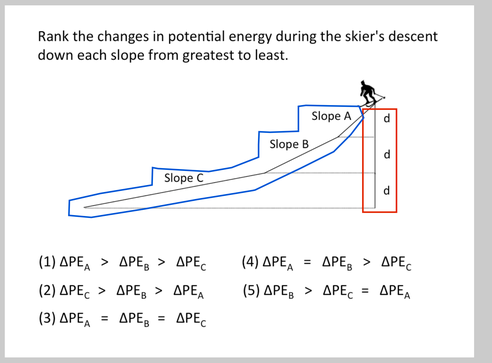

| Thematically Relevant | Perceptually Salient |
|---|---|
| Correct: 29.9% (± 14.2) | Correct: 12.8% (± 9.0) |
| Incorrect: 18.0% (± 10.8)* | Incorrect: 25.3% (±15.8)* |

| Thematically Relevant | Perceptually Salient |
|---|---|
| Correct: 26.0% (± 3.9) | Correct: 46.4% (± 17.1) |
| Incorrect: 14.3% (±11.0)* | Incorrect: 52.9% (± 19.3) |

Problem 7




Problem 10




## CONCLUSION

- Found significant differences in the way those who answered correctly versus incorrectly allocated visual attention on physics problems about energy and speed.
- Provides some evidence to support previous findings:
  - Those who answer **correctly** spend more time looking at **thematically relevant** elements.
  - Those who answer **incorrectly** spend more time looking at **perceptually salient** portions.
- Lays the foundation for future work in guiding novices' attention to mimic that of experts using visual cueing techniques.

## REFERENCES

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4. R.K. Lowe, *Learning and Instruction* **12**, 157-176 (2003).