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

Adrian Carmichael, Adam Larson, Elizabeth Gire, Lester Loschky & N. Sanjay Rebello, *Kansas State University*

OBJECTIVE

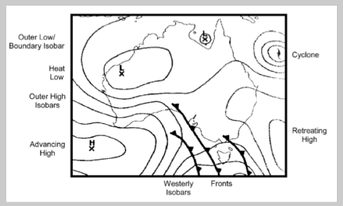
Investigate how the allocation of visual attention differs between experts and novices on physics problems where the critical information needed to answer the problem is contained in a diagram.

INTRODUCTION

Previous Research

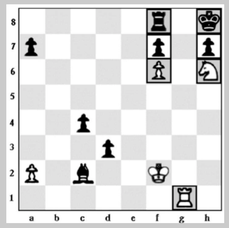
• Experts' visual attention is primarily driven by knowledge and they spend more time than novices looking at relevant information in figures. [1-3]

• 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

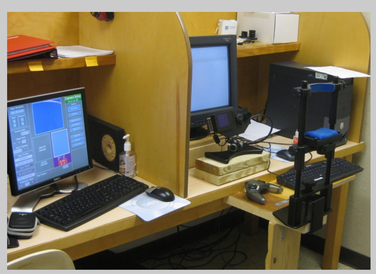
METHOD

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

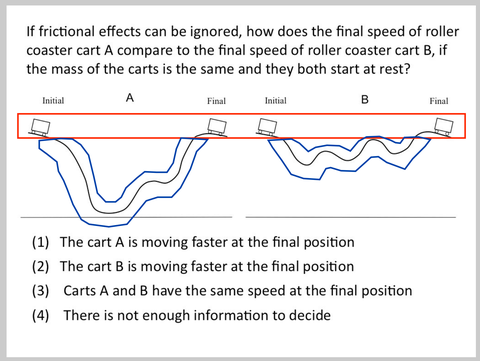
- *Perceptually salient* and *thematically relevant* areas of interest (AOI's) defined by three independent raters.
- One-way ANOVA used to compare percentage of time spent in each type of AOI.
  - -Independent variable: correctness of answer

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

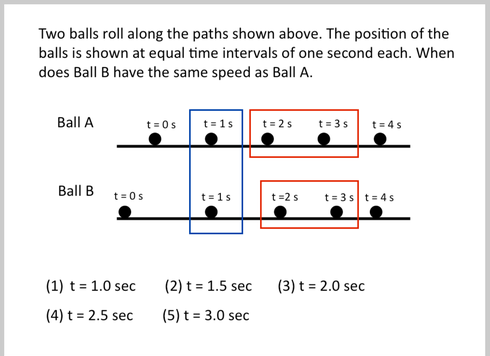
Thematically Relevant	Perceptually Salient
Correct: 26.6%(± 16.1)	Correct: 10.5% (± 8.2)
Incorrect: 21.4% (± 12.2)	Incorrect: 31.5% (± 18.3)*

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



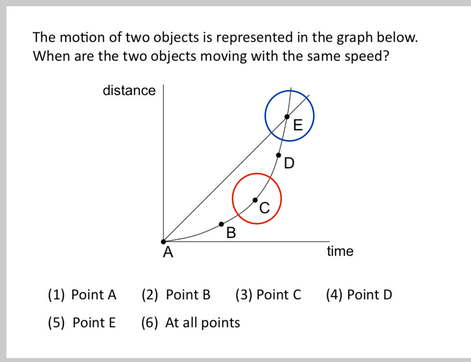
Problem 4



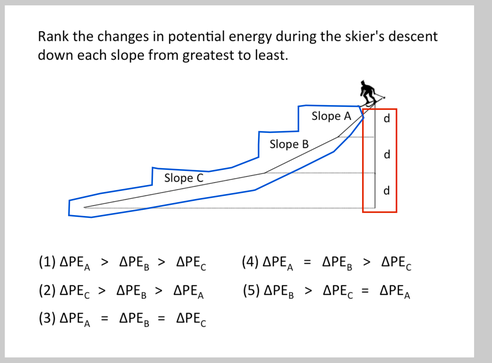
Thematically Relevant	Perceptually Salient
Correct: 29.9% (± 14.2)	Correct: 12.8% (± 9.0)
Incorrect: 18.0% (± 10.8)*	Incorrect: 25.3% (±15.8)*

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.

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