

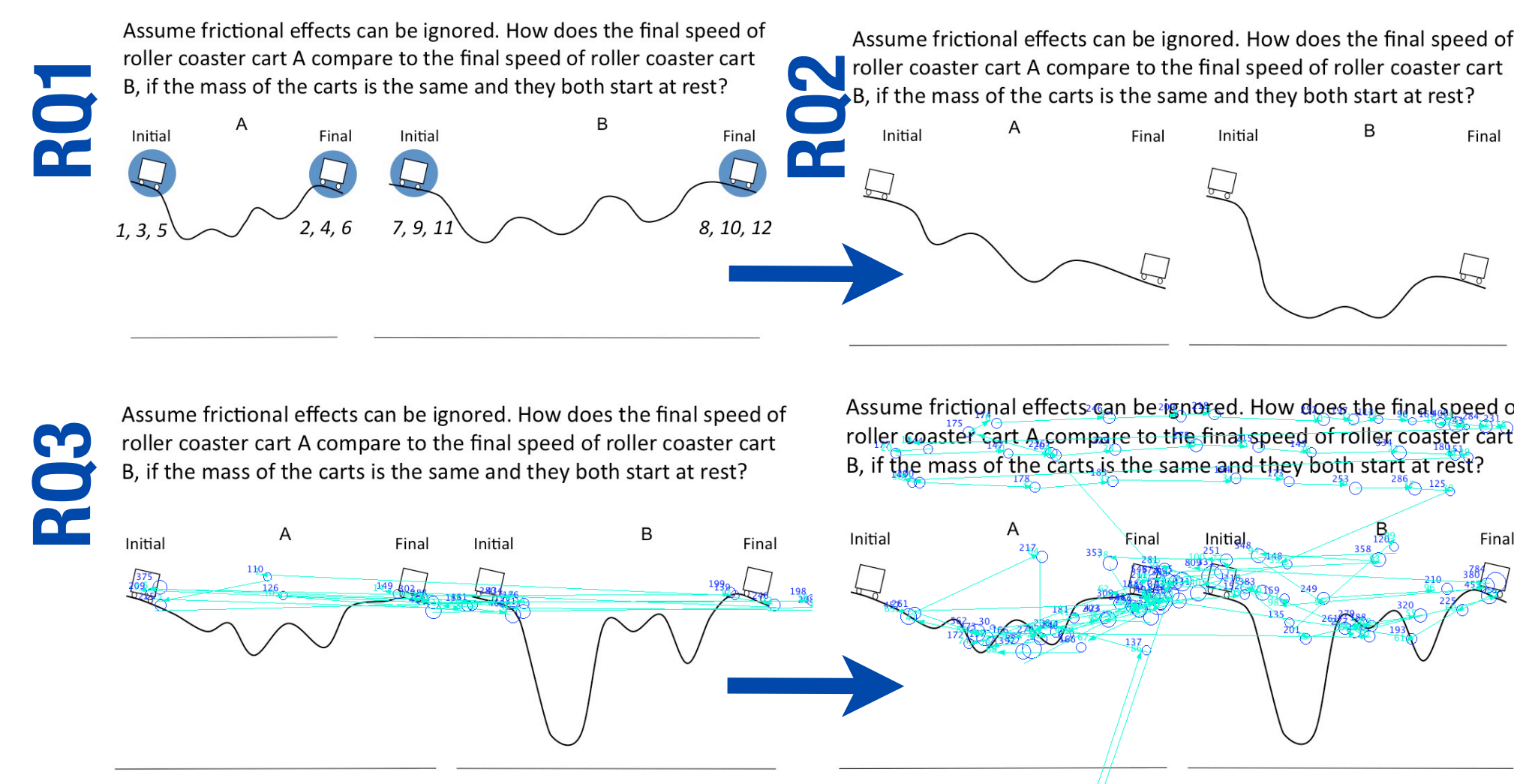
# Influence of Visual Cues on Eye Movements and Reasoning in Physics Problems

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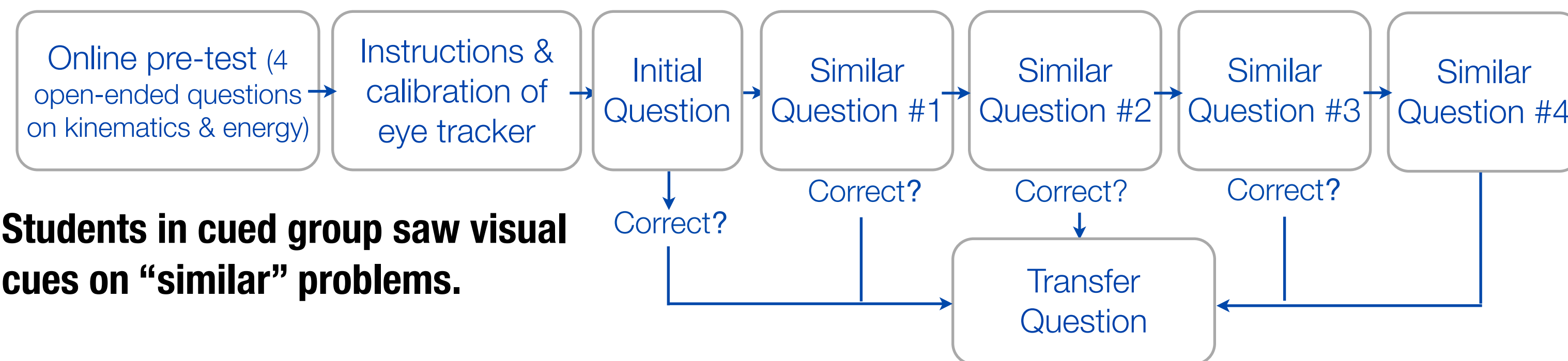
Can a 6-second visual cue modeled after experts' eye movements overlaid on a physics question really help students come to the right answer?

## RESEARCH QUESTIONS

1. Do visual cues modeled after experts' eye movements help students answer physics questions?
2. Does students' ability to answer transfer problems improve after seeing visual cues?
3. Do cues influence students' eye movements on current and subsequent problems?



## METHOD



Students in cued group saw visual cues on "similar" problems.

Assume frictional effects can be ignored. How does the final speed of roller coaster cart A compare to the final speed of roller coaster cart B, if the mass of the carts is the same and they both start at rest?

**Problem 1: "Roller coaster" problem**

Rank the changes in potential energy during the skier's descent down each slope from greatest to least.

**Problem 3: "Skier" problem**

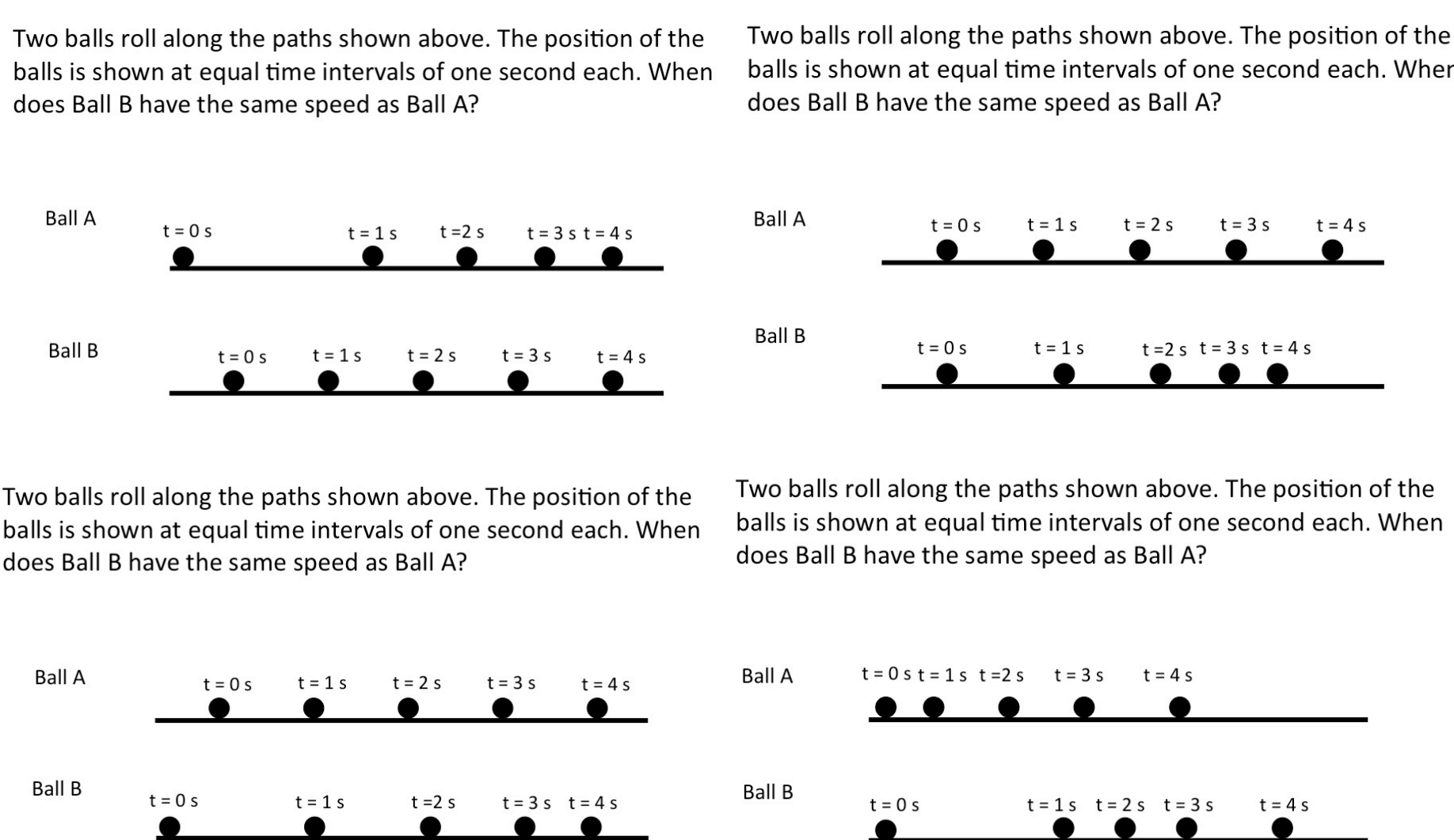
Two balls roll along the paths shown above. The position of the balls is shown at equal time intervals of one second each. When does Ball B have the same speed as Ball A?

**Problem 2: "Ball" problem**

The motion of two objects is represented in the graph below. When are the two objects moving with the same speed?

**Problem 4: "Graph" problem**

Colored shapes appeared for 500 ms each, for a total cueing time of 6 seconds. Numbers in italics represent order in which cues appeared.



Four "similar" problems for ball problem set. Similar problems have the same problem statement, but different diagrams.

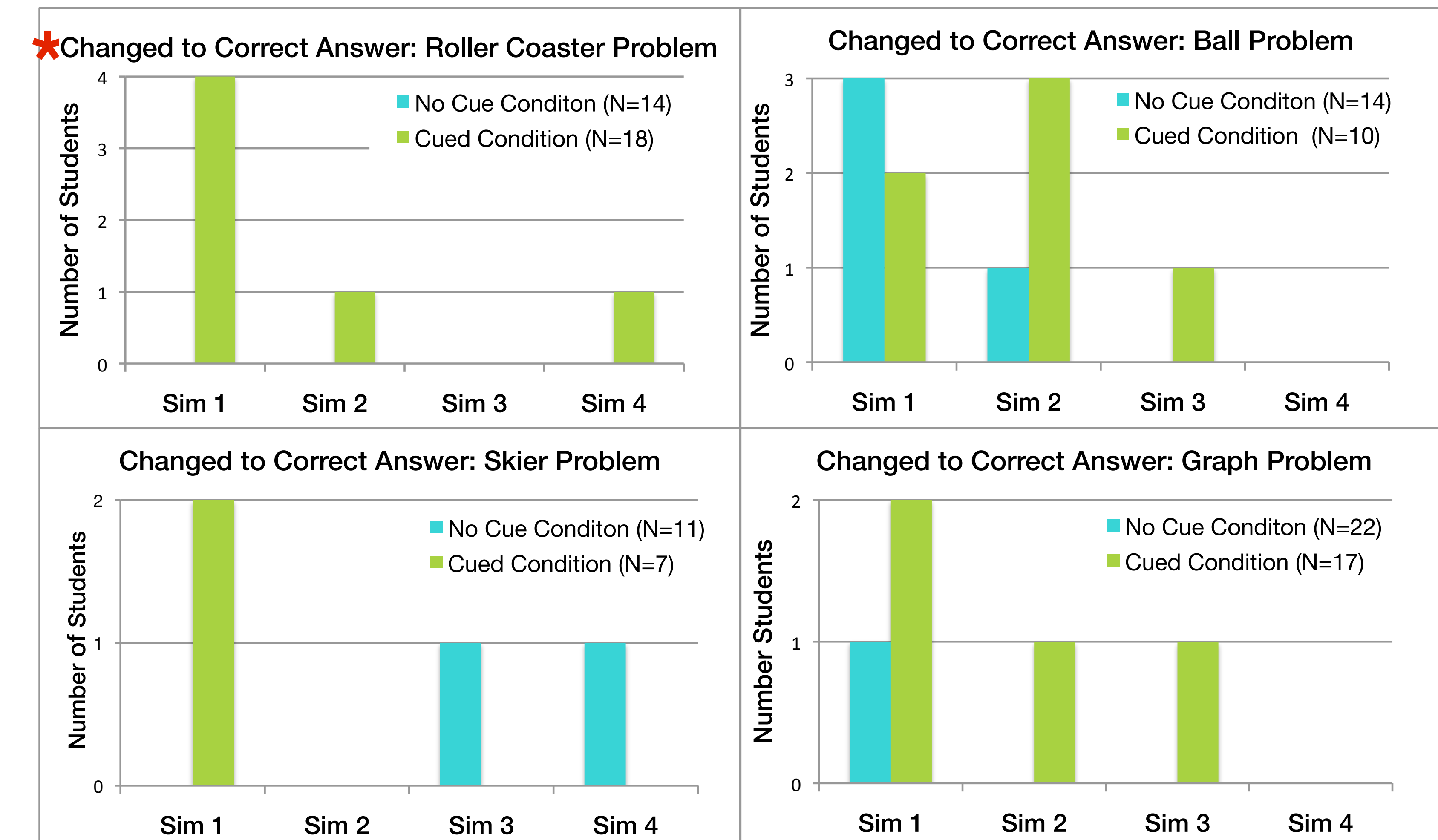


Eye tracker used for study.

## RESULTS

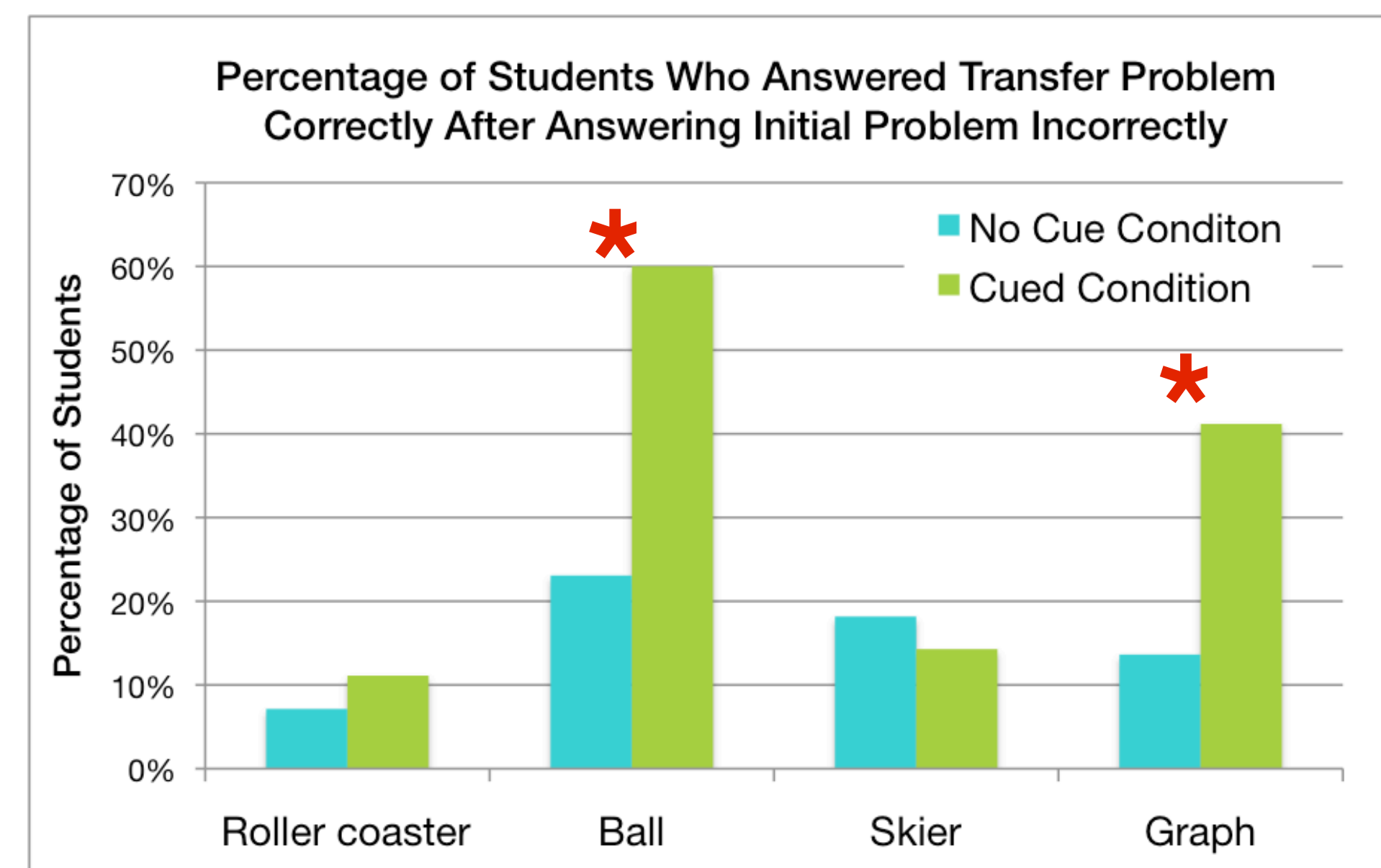
### Correctness of Similar Problems

- Students who answered initial problem incorrectly saw up to four similar problems.
- Graphs to the right show number of students who answered one of similar problems correctly.
- Significant difference between number of students in each group who answered roller coaster "similar" problems correctly. (Mann-Whitney U test  $p=.002$ )



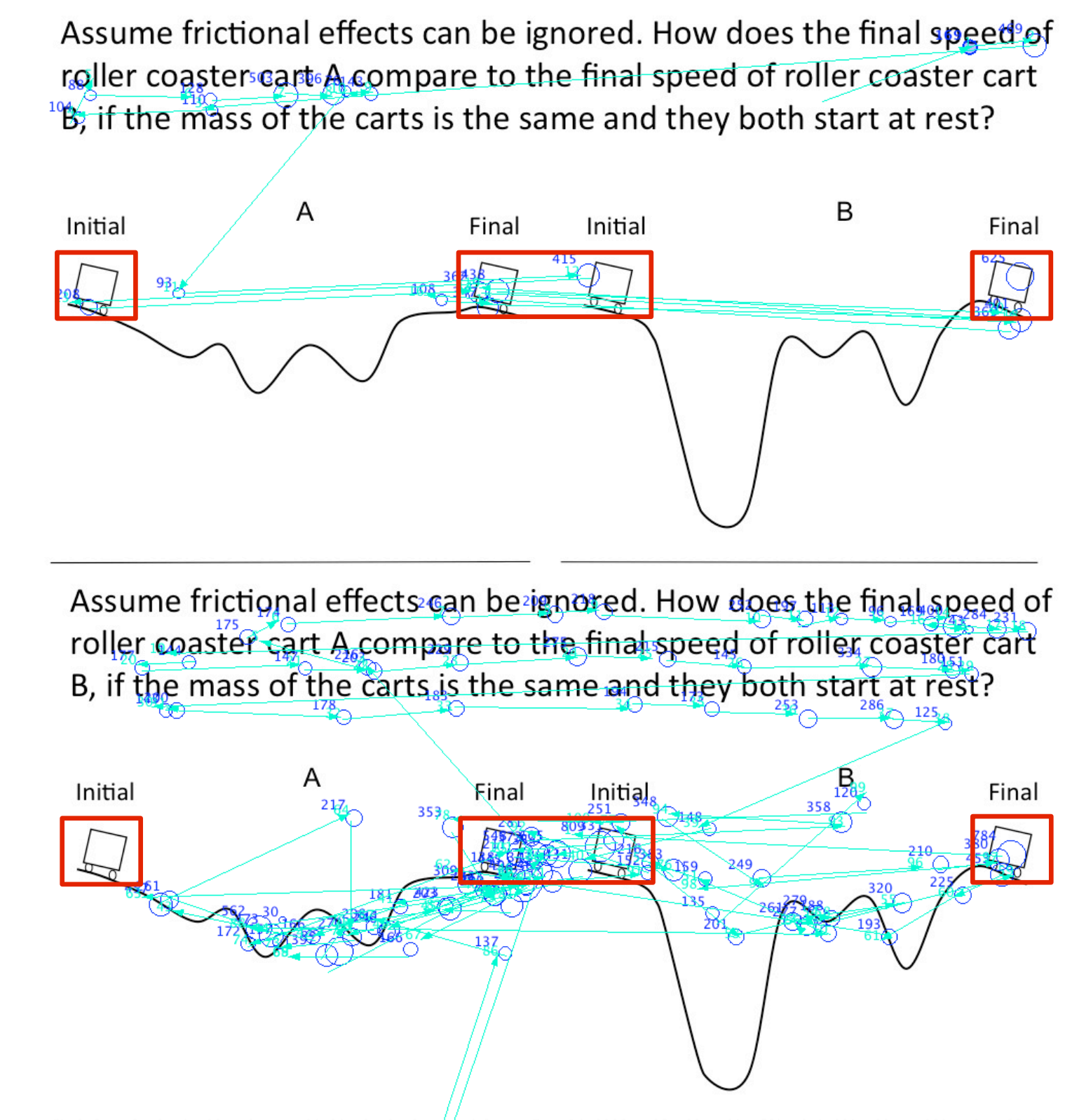
### Correctness of Transfer Problems

- After giving correct answer on similar problem, students saw transfer problem without cues.
- Graph below shows % of students who answered transfer correctly after answering initial incorrectly.
- Nearly significant difference on ball transfer problem ( $p=.06$ ) and graph transfer problem ( $p=.054$ ).



### Eye Movements: Roller Coaster Problem

- Determined number of horizontal saccades between roller coaster carts while viewing cues and after cues ended.
- Significant difference in % of saccades following cues for those in cued group who answered correctly versus incorrectly ( $F(1,14)=10.8, p=.005$ ).
- No difference in horizontal saccades between carts after cues ended between groups.



	Cued	No Cue
Percentage of Saccades in Pattern Similar to Cues: <i>During Cues</i>	52.6%	0.96%* (Did not see cues)
	Cued: Correct	Cued: Incorrect
	85.5%	46.4%*

	Cued	No Cue
Percentage of Saccades in Pattern Similar to Cues: <i>After Viewing Cues</i>	2.1%	1.0%

## CONCLUSIONS

- In some cases, short duration visual cues can help students answer conceptual physics questions that they were previously unable to answer (roller coaster problems).
- Visual cues can influence transfer problem performance. Those who saw visual cues answered ball and graph transfer problems more correctly.
- Following cues closely with eyes is related to getting correct answer on roller coaster problems.
- Seeing visual cues doesn't seem to influence eye movements after cues cease on roller coaster problems.

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