

Visual Cueing in Physics Problem Solving

Advisory Board Meeting

March 16, 2012

QUESTIONS FOR FUTURE STUDIES

Below are some of the research questions that we hope to address in forthcoming studies. We hope to gain insights and advice from the Advisory Committee on these and other questions

- Should we increase cue duration? For example, in our previous studies using cues, we presented cues for 4-6 seconds. But should we present the cues for longer than that?
 - Could this depend on what experts do?
 - Our experts took from 10-30 seconds to correctly answer a problem, and our novices took even longer, to correctly solve a problem.
 - Although saliency effects on eye movements and attention are very rapid, physics problem solving is very slow. Thus, the cueing may need to extend much longer in time to take account of this fact.
 - However, the duration should be appropriate for the particular problem. (Or, perhaps, simply continue until the problem has been solved.)
 - If so, would the duration of the cues be arbitrary or non-generalizable to different contexts and problems?
 - Is there some way to come up with a set of general principles that could be applied widely to different sorts of problems?
- Should we increase cue strength? If so how do we do this? Some possibilities are:
 - Increasing cueing strength based on bottom-up cueing (e.g. multiple cues presented on the same figure)
 - Increasing the strength of the cue by perceptually grouping the conceptual information needed to answer the problem.
 - We may want to look at the literature on effective presentation of visual information in graphs to get ideas here.
- Should we use both exogenous and endogenous cues?
 - We assume the impact of the perceptual salience in the first two seconds is affecting cognition after those first two seconds. However, this is just the first step in the processes regarding thinking about the problem. So we:
 - First use an exogenous cue to attract attention. This may get people thinking about the appropriate construct.
 - Next, provide a stronger cue that could be either perceptually salient or it could represent the conceptual information needed to solve the problem.
 - In this way, the concept (top-down) is primed by salient information (bottom-up)
- Should we use both organizational and integrative cues?
 - We may want to look at the literature on effective presentation of visual information in graphs to get ideas here (e.g., Christopher Wickens' work on this topic).
- Do we need to tell people that the cue will help them?
 - In normal instruction, teachers give students explicit instruction. But the use of cues seems an inherently implicit instructional strategy.
 - How does this relate to the distinction between explicit declarative knowledge (e.g., of a principle or concept from a lecture or textbook) versus implicit procedural knowledge (e.g., used when solving a problem)?

- A key question is whether the cueing is more beneficial than simple explicit instruction.
 - We could compare the following conditions:
 - Explicit instruction only e.g. Typical practice in teaching or tell students that the cues are to help them on the problems
 - Implicit cueing only e.g. What we have done so far
 - Explicit instruction & explicit cueing
- How many times should we repeat the cueing in similar problems without making the students aggravated?
 - This is related to the more important issue of generalization of the cued problems to uncued problems.