Believing Is Seeing: Prior Beliefs Affect Problem Solving

Karl G. D. Bailey¹, Lorraine C. Siebold¹, & Rudolph N. Bailey²

¹Behavioral Sciences Department & ²Department of Educational and Counseling Psychology, Andrews University

BACKGROUND
Over the last decade, researchers have increasingly relied on eye tracking technology as a tool for studying mental processing during problem solving (e.g., Ballard, Hayhoe, & Pels, 1995). Researchers have used this paradigm to examine the processing of diagrams (Grant & Spivey, 2003), mechanical systems (Hegarty, 1992), and geometric problems (Epplinio & Suppes, 2001).

USING EYE MOVEMENTS TO STUDY THINKING
Grant and Spivey (2003) conducted an experiment which examined the eye movements of participants who were either successful or unsuccessful at solving the Duncker Radiation Problem while viewing a schematic diagram. They found that:

- Locations fixated by successful problem solvers were related to the internal imagery and processing necessary to identify the solution to the problem.
- Directing visual attention (i.e., eye movements) to locations fixated by successful problem solvers increased the likelihood of identifying a solution.

CURRENT STUDY
However, few studies have considered simple real-world reasoning problems that individuals encounter on a day-to-day basis. We designed the current study to explore the patterns of eye movements produced by subjects involved in processing a real-world task (predicting the next day’s weather).

The following questions guided our analysis:
- To what degree does our knowledge of the world guide visual attention during problem solving?
- When prior beliefs do not lead to problem solving success, how is visual attention re-deployed?
- Do the patterns of visual attention change over time with continuing exposure to the task?

METHODOLOGY, CONTINUED

PROCEDURE
- Participants saw the maps consecutively for seven seconds each while listening to an oral description of the day’s temperature and weather conditions at “Midway” (which served as feedback about their predictions).
- They then heard two questions (“Will the temperature be above 68° tomorrow?”; “Will it rain tomorrow?”) and had five seconds each to press either a ‘yes’ or ‘no’ button.
- Twenty-seven participants completed this experiment.

DISTRIBUTION OF EARLY FIXATIONS
- For the most part, participants’ fixations during the first 2 seconds of viewing a new map were concentrated on the central site (for which the predictions were to be made).
- In addition, in both the normal and rotated maps, participants favored the northwestern region; in the reversed map, the eastern region was also favored.
- In the tables below, individual graphs indicate the probability of fixating the temperature and weather information at one of the sites on the map (e.g., the northern, western, etc.) over the course of the experiment (each point on the line represents fixations on 5 maps).

EXPERIMENT 1, CONTINUED
- Participants were correct on 77% and 79% of temperature predictions and 66% and 67% of weather predictions for the normal and rotated maps respectively.
- However, participants were only correct on 33% and 38% of temperature predictions and 44% and 28% of weather predictions when the upcoming day’s temperature or weather was categorically different from the current day.
- Participants may have been using the current weather at the central location to predict the next day’s weather (reflecting a bias to assume that tomorrow’s weather will be similar to today’s). This strategy was explicitly identified by several participants.

IMPLICATIONS
- Knowledge of typical weather patterns in the midwest led participants to bias their looks towards the northeast; however the strongest tendency was to simply fixate the location that predictions were to be made about - this tendency swamped all other patterns.
- Participants may have been using the current weather at the central location to predict the next day’s weather (reflecting a bias to assume that tomorrow’s weather will be similar to today’s). This strategy was explicitly identified by several participants.
- The tendency to fixate central locations was reduced through the use of hints and over time (through experience with the task).
- Participants who had incorrect beliefs about what rules governed weather patterns perseverated in their eye movements to the irrelevant portions of the map; this may be evidence in the eye movement record of confirmation bias.

REFERENCES

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