# How Novices Reason About Anomalies

**Susan B. Trickett (stricket@gmu.edu)**
**Thomas Watkins (twatkin1@gmu.edu)**
Department of Psychology, George Mason University
4400 University Dr., Fairfax, VA 22030 USA

**J. Gregory Trafton (trafton@itd.nrl.navy.mil)**
Naval Research Laboratory, NRL Code 5513
Washington, DC 20375 USA

## Introduction

Theories that address how people respond to anomalous data either explicitly state or imply that anomalies are processed differently from non-anomalous data. (Chinn & Brewer, 1992; Alberdi, Sleeman, & Korpi, 2000; Trickett, Trafton, Schunn, & Harrison, 2001). However, studies of reasoning about anomalies do not provide an experimental basis for comparison between responses to anomalous versus non-anomalous data.

We investigated differential reasoning processing by manipulating whether data met (non-anomaly) or violated (anomaly) expectations.

## Method

9 GMU undergraduates participated. There were 3 conditions, Expectation Confirmation (EC), Expectation Violation—small (EVs), and Expectation Violation—big (EVb) in a within-subjects design.

The materials consisted of a report about an evaluative study. It described a problem, a manipulation expected to improve the situation, details of the study and its results. There were 6 sets of materials, each pertaining to a different topic. Participants performed 2 tasks in each condition, with materials and conditions randomized using a Latin square.

Participants were trained to give talk-aloud protocols. They read the report and predicted the results of the study, using a multiple choice form (manipulation would yield an improvement over the control; manipulation would be worse than the control; or no difference between conditions.) Participants rated their confidence in their prediction, on a 1 to 7 point Likert scale.

Participants were then shown the study's results, according to condition: graph matched prediction (EC), graph did not match prediction but the conditions differed by a small spread (EVs), or graph did not match prediction and the conditions differed by a large spread (EVb). Participants were asked whether their prediction was correct, and how they could account for the results.

## Results and Discussion

We coded participants' reasoning strategies: Conceptual Simulation/CS (*because at night they probably didn't know what was going on so they wanted to go around it…*); Personal Experience/PE (*I go hill-hopping all the time*); Refer to Story/RS (*Was this just freshmen? Just freshmen, the orientation*); No Reasoning/NR.

Despite a slight, non-significant increase in the use of CS in the EVb condition (EVb:78%; EVs: 50%; EC: 53%), there was no significant difference in strategy use for each condition. This suggests that although participants noticed the anomalies and frequently expressed surprise, they failed to differentially process large and small anomalies, or indeed, between anomalous and non-anomalous results.

We collapsed the results across condition for the remaining analyses (see Table 1). Participants made little use of the information in the story, either at prediction or at explanation, relying on PE (especially at prediction) and CS (especially at explanation). Table 1 shows interesting shifts in strategy use in different phases of reasoning. Initial heavy reliance on PE at prediction decreased significantly at explanation, $\chi^2(1) = 3.8$, $p = .05$. Use of CS increased significantly, $\chi^2(1) = 19.7$, $p<.01$, suggesting that this strategy serves a particular explanatory function.

Overall, these results are something of an anomaly themselves. At the least, they suggest that the participants lacked effective strategies for predicting outcomes and for dealing with experimental data in general. Although CS can be an effective strategy, it is most likely to yield useful information when grounded in actual data or theory. However, these participants tended to rely on PE instead.

Table 1: Strategy use at prediction and explanation (%)

| Phase | CS | PE | RS | NR |
|---|---|---|---|---|
| Prediction | 9.3 | 46.3 | 24.1 | 20.4 |
| Explanation | 60.4 | 24.5 | 26.4 | 11.3 |

**Acknowledgements**

This research was supported in part by grant 55-7850-00 to the third author from ONR.

## References

Alberdi, E., Sleeman, D. H., & Korpi, M. (2000). Accommodating surprise in taxonomic tasks: The role of expertise. *Cognitive Science*, *24*(1), 93-122.

Chinn, C. A. & Brewer, W. F. (1992). Psychological responses to anomalous data. In *Proceedings of the 14th Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Erlbaum.

Trickett, S. B., Trafton, J. G., Schunn, C. D., & Harrison, A. (2001). "That's odd!" How scientists respond to anomalous data. In *Proceedings of the 23rd Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Erlbaum.

Trickett, S. B., & Trafton, J. G. (2002). The instantiation of and use of conceptual simulations in evaluating hypotheses: Movies-in-the-mind in scientific reasoning. In *Proceedings of the 24th Annual Conference of the Cognitive Science Society*. Hillsdale, NJ: Erlbaum.