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**Permalink**
https://escholarship.org/uc/item/3p16d9m1

**Journal**
Proceedings of the Annual Meeting of the Cognitive Science Society, 26(26)

**ISSN**
1069-7977

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**Publication Date**
2004

Peer reviewed

# A Critique of the Small Sample Account of Covariation Detection

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The starting point for this project was the finding that people with a low working memory capacity perform better in a covariation detection task (Kareev, Lieberman, & Lev, 1997). In the task people successively encountered envelopes with two different colors and each time had to decide which out of two objects they think they will contain. The explanation for the low capacity advantage is that people with a lower working memory capacity have to rely on smaller samples when they make decisions. This helps them to detect a correlation earlier, because statistically small samples are more likely to indicate a correlation that exceeds the correlation in the population (Kareev, 1995b).

## Experiments

We conducted two experiments with an extended version of the original task to test and model the original finding that low capacity people perform better in a covariation task. An implication of the small sample account is that they are also better in detecting a change in the correlational structure of the environment. As in the original experiment, working memory capacity was assessed with a digit span test. The original finding was replicated in the first but not in the second experiment, thus it seems to be a weak and unstable effect. It is worth noting that the probability of replicating a result at the same or a higher level of significance (and in the same direction) is only 50% (Goodman, 1992). Contrary to the predictions by the small sample account there was a high capacity advantage after a change in the first experiment. In the second experiment we did not find any differences between low and high capacity people, neither before nor after a change. Therefore, we focus on the first experiment with regard to modeling.

## Modeling

Two different models have been tested, a naïve window model and a reinforcement learning model. Every model was fitted to each individual separately since we wanted to relate capacity to model parameters. The naïve window model that tries to translate the small sample idea directly could not capture the low capacity advantage. But we were able to model it with the reinforcement learning model (Camerer & Ho, 1999) with a decay, a sensitivity and an initial attraction parameter, where we forced the variance in each of the parameters separately by fixing the other two to their means. All three versions were able to capture the low capacity advantage on covariation detection, but only the initial attraction version was related to capacity *and* could predict behavior after a change.

## Conclusions

The small sample account is not clearly supported by our data. First, the deduced hypothesis of a low capacity advantage after a change does not hold, we find either no effect or the opposite. Second, the naïve window model and the reinforcement learning model version with the decay parameter which has the strongest connection to memory have to be rejected. Instead, an initial attraction parameter model is successful, indicating a faster learning process of low capacity people in the beginning, but not later on. Still, faster learning can be interpreted as relying on smaller samples. But it is also congruent with the finding of Weir (1964) that children use the simple but most successful payoff maximization strategy (i.e. always choose the more frequent option given a color) earlier in a similar task because they are simply reinforcement driven. Adults, in contrast, develop complex hypothesis and apply complex strategies because they believe that there exists a perfect solution, but they end up worse. As capacity differs between children and adults (Kail, 1984) and plays an important role in hypothesis generation (Dougherty and Hunter, 2003) this could be an explanation for the low capacity advantage.

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