Memory-Related Differences in a Correlation Detection Task in ACT-R

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Kareev, Lieberman and Lev (1997) reported the counterintuitive finding that people with a lower short-term memory capacity performed better on a correlation detection task. 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. They assumed that low spans perceived the correlations as more extreme because they relied on smaller samples which overestimate correlations. However, this *small sample account* has bees criticized recently, because small samples also bear a higher risk of false alarms (Juslin & Olson, 2005; R. B. Anderson et al., 2005). Therefore, we alternatively assumed that people with a lower short term memory capacity show more simple, but at the same time more successful predictive behavior, maximizing, which consists of always deciding for the more frequent object (here: given the color of the envelope). There is convergent evidence from the probability learning literature that lower or reduced memory capacities go along with a higher prevalence of maximizing (e.g., Wolford et al., 2004).

ACT-R model

We designed an instance based model of the correlation detection task in ACT-R (J. R. Anderson et al., 2004). The model tries to retrieve chunks from declarative memory that represent the different objects to determine the decision it makes. The competing hypotheses, differences in perception based on samples of different sizes versus differences in predictive behavior, can be related to two different parameters. The decay parameter d in base-level learning affects how much weight is put on more recent information compared to older information. The higher the impact of recency, the fewer items are important for a decision, which leads to paying attention to a small sample. The noise parameter s affects how likely it is that the more activated chunk will win the retrieval competition. Without noise, the more activated chunk would always be retrieved, resulting in perfect maximizing. Higher noise allows that a less activated chunk is retrieved from time to time resulting in a lower frequency of maximizing. We believe that this parameter thus nicely reflects differences in predictive behavior. We modeled the difference between low and high spans from one condition of Kareev et al. (1997) separately by varying either decay d or noise s. Both faster decay d and lower noise s predicted a higher frequency of maximizing. Both variants of the model made opposite predictions on additional trials in which the correlation was reversed. After this *shift* faster decay also predicted a higher frequency of maximizing, but lower noise predicted a lower frequency of maximizing. That is, a shift allows us to distinguish between the small sample hypothesis and the predictive behavior hypothesis. According to the small sample hypothesis, low spans should perform better before and after a shift, while according to the predictive behavior hypothesis, low spans should perform worse after a shift.

Experiments

Two correlation detection experiments were conducted. Midway in the experiments there was a shift, that is, the correlation was reversed. We found that low spans showed maximizing more frequently than high spans before a shift, replicating the result by Kareev et al. (1997). After a shift, however, high spans maximized more frequently than low spans. Surprisingly, short-term memory capacity only explained variance for men, but not for women, a result we also found in reanalyzing Kareev et al.'s data.

Conclusion

The results are congruent with the noise variant of the model and thereby with the predictive behavior hypothesis. In contrast, the small sample account is not supported. That is, a lower short-term memory capacity does not seem to impact on the perception of correlation based on samples of different sizes, but seems to foster maximizing, which leads to a disadvantage when the correlation is reversed.

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