Does learning occur in the absence of cues?

Error Driven Learning, or EDL, is a theory where the main goal is to minimise uncertainty when learning. One of the most known formalisations of this theory is the Rescorla-Wagner model (1972). If a certain cue is present and an outcome is too, then the connection between the two is strengthened, while if a cue is present but an outcome is not, the connection is weakened. Because the informativeness of a cue is important, Rescorla and Wagner decided that if a cue is not present, it is not informative and therefore there should be no change to the connections.

In contrast, the highly influential paper of Van Hamme and Wasserman from (1994) argues that we can also learn from absent cues. Is it indeed the case that learning occurs in the absence of cues? While Van Hamme and Wasserman agree with Rescorla and Wagner on what happens when cues are present, but suggest an addition when they are not. A non-present cue should be encoded negatively, which leads to a non-present cue and present outcome resulting in a weakened connection and a non-present cue and non-present outcome leading to a stronger connection.

We have created models of both the Rescorla-Wagner and the Van Hamme-Wasserman model and looked how they performed in the experiment from Van Hamme and Wasserman's 1994 paper. In this experiments participants had to indicate how likely it was that an allergic reaction occurs based on foods eaten. There were three types of food, of which two were shown in one trial together with an outcome (an allergic reaction or not). The participants then had to rate on a scale from 0 to 8 for *all three foods* how likely they could cause an allergic reaction (0-very unlikely, 8-very likely). Results of the simulations showed that there we no substantial differences between the Rescorla-Wagner model and the Van Hamme-Wasserman model (Figure 1 and 2). In these Figures we see the activation of all food items asked and their strength to the outcome *Not Allergic* subtracted from the outcome to *Allergic*. The two models make essentially the same predictions. This means that Van Hamme and Wasserman's experiment design was not able to tease apart which of the two models performs better. Therefore, whether or not we learn from absent cues remains an open question.

We propose that EDL is an implicit process, that can be hindered by explicit inference. In the original experiment of Van Hamme and Wasserman ratings were explicitly asked, therefore the results might not reflect EDL, which could explain why the general order of the food groups is the same between the original experiment and the model, but the details are not. Thus the results of Van Hamme and Wasserman might be due to explicit inference, not EDL.

We will adjust the original experiment in three ways. The first experiment will change the stimuli and have a test after each block. In Figure 3 and 4 the only difference between the models is the decrease (or not) of the stimuli when they are not seen again. For the second and third experiment we will alter both the stimuli (which will be the same as in the first change) and the speed at which participants have to react. We expect that by manipulating this speed, we will find a difference in what participants learn in the slower condition (room for explicit inference) and the faster condition (forced implicit learning). We can then compare the performance of the participants to that of the two models and see which one reflects the learning process better.

References

Van Hamme, L. J., & Wasserman, E. A. (1994). Cue competition in causality judgments: The role of nonpresentation of compound stimulus elements. *Learning and motivation*, *25*(2), 127–151.

Wagner, A., & Rescorla, R. (1972). A theory of pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. *Classical conditioning ii*, *64*, 99.

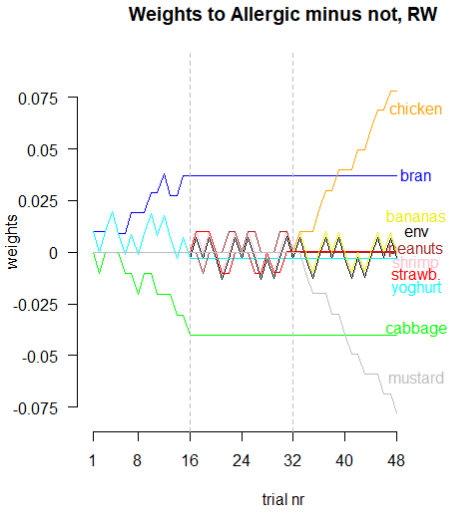

Figure 1: Weights to *Allergic* minus the weights to *Not Allergic* for each of the foods asked. Rescorla-Wagner model prediction.

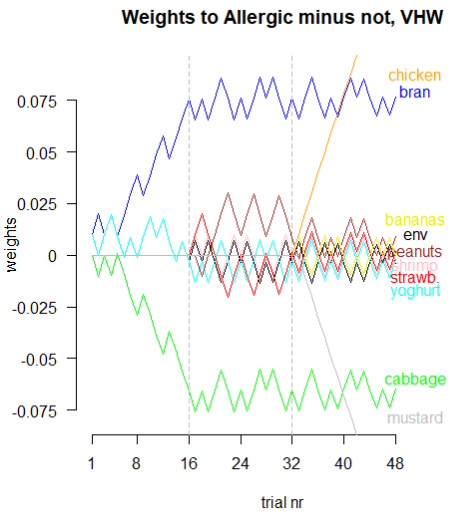

Figure 2: Weights to *Allergic* minus the weights to *Not Allergic* for each of the foods asked. Van Hamme-Wasserman model prediction.

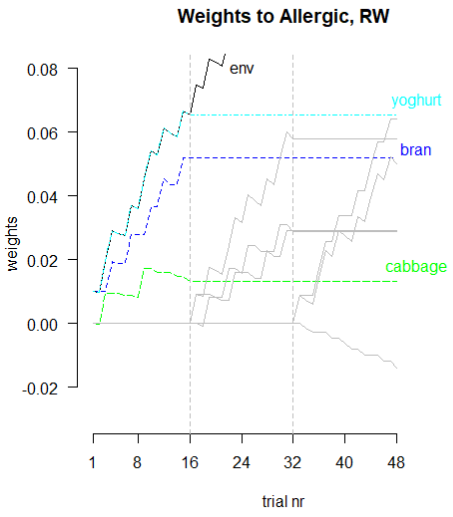

Figure 3: Weights to *Allergic* Rescorla-Wagner model prediction. Foods asked in the first block are in colour, the rest in grey.

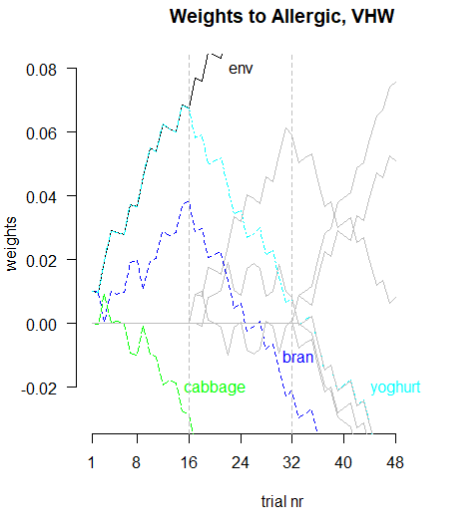

Figure 4: Weights to *Allergic* Van Hamme-Wasserman model prediction. Foods asked in the first block are in colour, the rest in grey.