Does learning occur in the absence of cues?

Error Driven Learning (EDL) is a framework that models implicit, bottom-up learning by minimising the uncertainty in the learner's expectations about upcoming events. Well-known formalisations of EDL include the Rescorla-Wagner model (1972) and the almost identical Delta Rule (Wasserman et al., 1993). Generally, we model learning using a fully connected, two-layer network (i.e. input layer representing cues, output layer representing outcomes and no hidden layers). The informativeness of cues is a key notion in EDL, only if cues are present the connection weights between cues and outcomes are updated. With each learning event the connections between present cues and outcomes are strengthened, while the connections between present cues and absent outcomes are weakened.

However in their frequently cited paper, Van Hamme and Wasserman (1994) have argued based on experimental data, that we can also learn from absent cues. They proposed an extension to the Rescorla-Wagner model: An absent cue should be encoded negatively, which leads to an absent cue and present outcome resulting in a weakened connection and an absent cue and an absent outcome leading to a stronger connection.

We want to know if learning really does occur in the absence of cues and if we can disentangle these two models of EDL. We have implemented two computational simulations that model the experimental study reported by Van Hamme and Wasserman (1994). One of the simulations implements the Rescorla-Wagner model and the second simulation includes the extended model proposed by van Hamme and Wasserman, which allows for learning in the absence of cues. 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). Both of our computational simulations predict no substantial differences between the Rescorla-Wagner model and the Van Hamme-Wasserman model, when the test include the same two outcomes as the training (Figure 1 and 2). Although the strength of activations (i.e. model expectation) is different, qualitatively the two models make 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.

In addition, it is not clear whether the experiment of Van Hamme and Wasserman reflect implicit learning, because they measured explicitly participants' ratings of informativeness of the cues. However, we view EDL as an implicit process, which may be hindered by explicit inference.

To investigate learning in the absence of cues we will run three experiments, all modifications of the experiment of Van Hamme and Wasserman. The first experiment uses new stimuli and implements a test at the end in which we will test the learned outcome against a new one. By including a test at the end, we can trace the change of weights over the course of the experiment to investigate the quantitative differences between the two simulations (see Figure 3 and 4). 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. In the second experiment participants will get a long time to answer, while in the third we will cut the answer time short. 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

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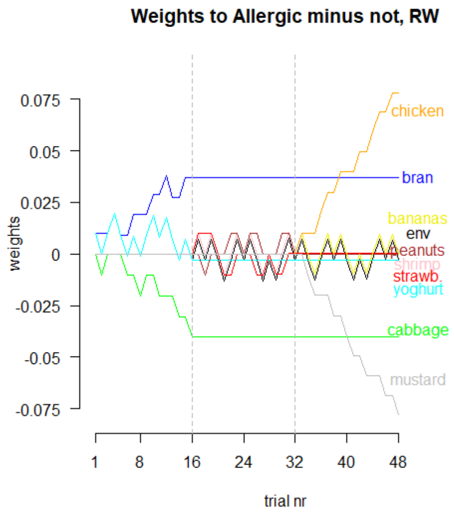

Figure 1: Weights to *Allergic* minus the weights to *Not Allergic* for each of the foods asked. Rescorla-Wagner model prediction.

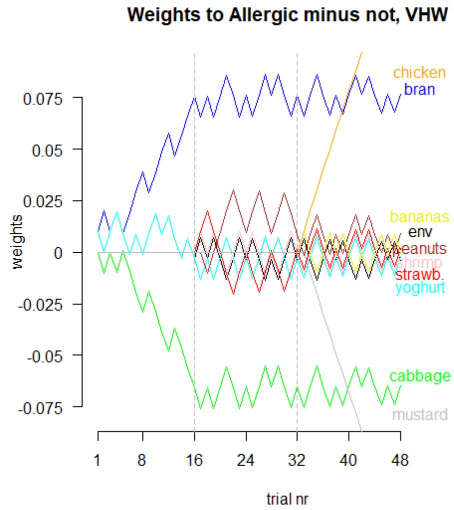

Figure 2: Weights to *Allergic* minus the weights to *Not Allergic* for each of the foods asked. Van Hamme-Wasserman model prediction.

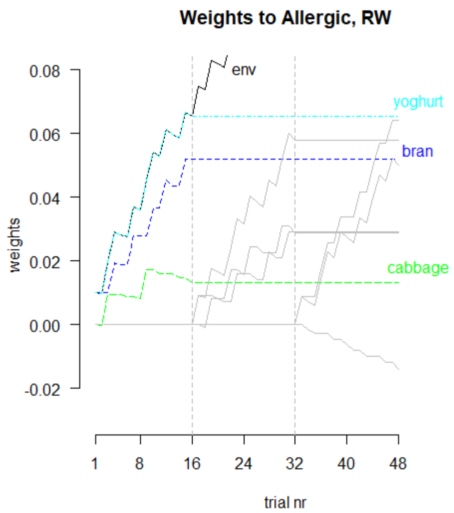

Figure 3: Weights to *Allergic* Rescorla-Wagner model prediction. Foods asked in the first block are in colour, the rest in grey.

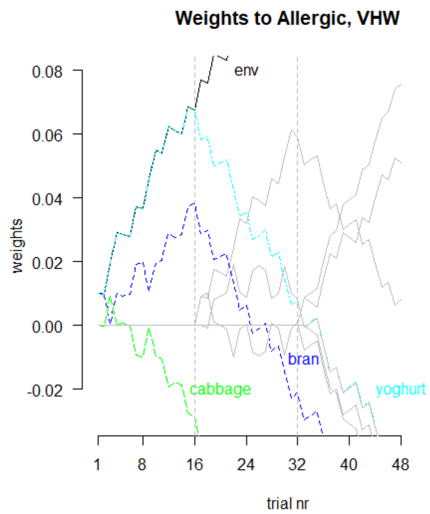

Figure 4: Weights to *Allergic* Van Hamme-Wasserman model prediction. Foods asked in the first block are in colour, the rest in grey.