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Exemplar-Based Visual Discrimination and Categorization in Chickens and Implementation of an Autonomous Agent Model

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Generally, processing of visual stimuli is explained by decomposition of stimuli into characteristic and/or defining elements or features (feature analysis). An animal, when learning relations between stimuli and responses, is assumed to form associations between elements of the stimuli and the responses.

In contrast, an exemplar-based model may propose the representation of stimulus situations as whole configurations, stored in so called exemplars. These exemplars then may serve as units for association with a response.

Empirical Findings

Our experiments on discrimination and categorization in chickens were consistent with an exemplar-based approach to stimulus processing.

In discrimination problems, hens were trained with elemental stimuli followed by tests of transfer performance to stimuli consisting of combinations of these elements, so called compound stimuli, and vice versa. These experiments showed that the chickens' pecking behavior was not controlled by the elements. Instead, the chickens learned the whole stimuli as configurations and based their transfer on overall similarity between these stimuli. Similarity could not be defined by the number of shared elements between stimuli. Additionally, the chickens' mode of processing was not dependent on the integrality or separability of the used compound stimuli.

Also, categorization of four-dimensional geometrical figures was more adequately explained by an exemplar-based approach compared to different ones that assume elements/features or prototypes (Werner & Rehkämper, 1999; 2001).

Theoretical Considerations

Based on these empirical findings, we developed an exemplar-based model of stimulus discrimination and categorization. This model includes the following assumptions (1) stimulus situations are stored in exemplars which represent them as unanalyzed configurations (2) the generalization between stimulus situations is based on the similarity of these exemplars, rather than on the number of features they share. In addition to the explanation of our experimental findings, this model is parsimonious because it

does not need to assume cognitive processes like "feature analysis" and "selective attention".

The autonomous agent model

In addition, we are implementing these theoretical assumptions into an autonomous agent model. The advantage of this modeling approach is that one can directly test the adequacy of theoretical assumptions by measuring the performance of the agent in the same way as was done with the chickens before (same dependent variable, same experimental environment). This is of great significance because the assumption that exemplars store stimuli as unanalyzed whole patterns also implies that this representation and the resulting performance is heavily influenced by the variability in perspective, lighting conditions etc. In order to include these aspects of stimulation, an autonomous agent would be the most representative modeling approach.

First results with this model show a similar acquisition of discrimination of dimensional stimuli in the agent compared with the chickens. Further replication of discrimination and categorization experiments formerly done with chickens are in progress. We expect this work to point to additional hypotheses to test our exemplar-based theory in more detail.

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