**Title**: A Model-based Approach towards Cognitive Games for Discovery Learning: A Web-based Paradigm and Neural Network Analysis

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**Abstract**. The development of cognitive games is gaining more and more educational and scientific importance as they have been demonstrated to tap and improve executive functions and components of working memory capacity (WMC). The design of already developed products is mainly based on the logics of conventional memory tasks, such as complex span variants. Their extension by self-guided learning activities (e.g., the selection of to-be-learned items), however, would be necessary to measure and train executive functions, which are involved in- and outside formal learning contexts, such as discovery learning in high schools or critical search on the Web. A further gap concerns the data analysis, which typically draws on general performance scores and does not quantify the contributions of underlying cognitive mechanisms. To go beyond this technique of analysis and derive estimates of process-pure parameters, appropriate cognitive-computational models need to be identified and adapted to the context of cognitive games.

The present work aims to address both gaps by testing a model-based paradigm in a sample of N=110 high school students: iteratively and in a self-guided manner, a student needs to search for pictures of dinosaur exemplars (by choosing from three binary dimensions, e.g. whether the dinosaur can fly or not) and to subsequently select and memorize the correct category label. For the cognitive-computational analysis, we extend an existing neural network model of working memory to analyze students' memory performance (e.g., their learning curves in choosing correct labels) and search patterns (e.g., spacing of practice trials).

On a behavioral level of observation, we find WMC-dependent differences both with respect to search and the correct retrieval of already practiced category labels (e.g., more effective spacing and steeper learning curves for high than low WMC students). The model-based simulation yields a satisfying goodness of fit and results in parameter estimates, by which WMC-dependent differences can be partially attributed to variations in a response inhibition parameter that controls for the extent of inhibition of retroactive interference.

These results provide the basis for the development of a cognitive game, which embeds the presented paradigm into an appealing game environment. Future work will explore the game's effects on executive functions, such as updating working memory content or response inhibition, and the validity of the model extension by examining its parameters' relationships to standardized tests on executive functions.