SARAH: Modeling the Results of Spiegel and McLaren (2001).

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This hybrid associative/cognitive model simulates the results of our other paper at this conference, in which we demonstrated that a particular sequence learning task cannot be explained by the entirely associative SRN alone. Our model adds cognitive mechanisms to the SRN, for which we had found evidence in the structured interviews given to subjects (2001a,c). Subjects had verbalized repetitions of circle flashes, symmetries within each sequence and that each sequence had the basic structure ABCBA. The interview also revealed that they made analogies between the sequences they had experienced in training, and we hypothesized that this may have helped them to generalize to the novel sequences on which they were tested. Each cognitive mechanism was implemented as an autonomous agent and was assigned a certain probability of being carried out, e.g. 14.29 percent of the subjects verbalized symmetries, hence p=.1429. The other probabilities can be found in (2001c). More detailed explanations of SARAH (Sequential Adaptive Recurrent Analogy Hacker) and a related hybrid model can be found in Spiegel and McLaren (2001b,c).

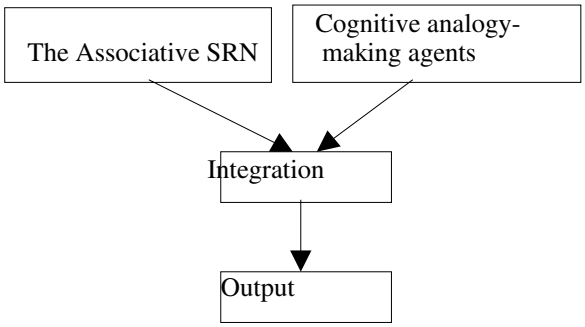

Figure 1: The SARAH model architecture

Training the same number of SARAHs (30) as there were people in the experiment (2001a) on entirely the same task, with six hidden units, a learning rate of .1, 40000 training trials and carrying out the same kind of ANOVA as on the empirical data revealed a significant main effect for the between subjects factor *group*, $F(1,28)=52.78$, $p<.001$, $f=1.37$, $\eta^2=.65$. The Experimental SARAHs ($M_e=.43$, $\pm SE_e=.05$) reveal a significantly higher activity difference when compared with the Control SARAHs ($M_c=.09$, $\pm SE_c=.01$). When considering the novel sequence type (2 Cs), the results resemble the human subjects (2001a) in the way that the SARAHs in the Experimental group show significantly better generalization when compared with the SARAHs

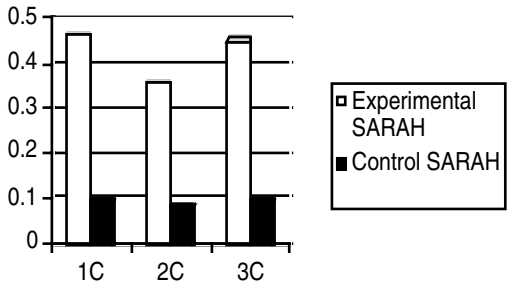

Figure 2: Simulation results for SARAH

in the Control group, $F(1,28)=37.33$, $p<.001$, ($M_e=.36$, $\pm SE_e=.04$ vs. $M_c=.09$, $\pm SE_c=.02$). The results are displayed in Figure 2. Interestingly, when running 30 SRNs with the same parameters on this task, learning of the trained sequences can be obtained, $F(1,28)=12.42$, $p<.01$, $f=.67$, $\eta^2=.31$, $M_e=.11$, $\pm SE_e=.03$ vs. $M_c=-.01$, $\pm SE_c=.01$, but no generalization to novel sequences, $F(1,28)=.44$, $p>.5$. As a result, SARAH may be better able to model the interplay between associative and cognitive processes found in (2001a).

References

Spiegel, R. & McLaren, IPL. (2001a) Human Sequence Learning: Can Associations Explain Everything? In K. Stenning & J. Moore (Eds.): *Proceedings of the Twenty-Third Cognitive Science Conference.* Mahwah, N.J.: Erlbaum.

Spiegel, R. & McLaren, IPL. (2001b) SARAH: A Cognitive Neural Model of Sequence Learning. In *Proceedings of the 5th International Conference on Cognitive and Neural Systems*. Boston University.

Spiegel, R. & McLaren, IPL. (2001c) A Hybrid Model Approach to Generalization in Sequence Learning. In *Proceedings of the International Joint INNS/IEEE Conference on Neural Networks*. Washington, D.C.