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Combining the Adaptive Toolbox and Connectionist Frameworks: An Approach to Decision Making and Aging

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The adaptive toolbox approach (Gigerenzer, Todd, & the ABC Research Group, 1999) analyzes environments and proposes detailed cognitive mechanisms that exploit the structures identified. This poster argues that the posited mechanisms are suitable for implementation in a connectionist framework. Furthermore, it is proposed that implementing decision mechanisms as neural networks allows addressing developmental issues in decision making. These claims are supported by reporting implementations of decision strategies using simple recurrent networks (SRN; Elman, 1990) and modeling age differences.

SRNs were used to implement two decision strategies: TTB (Gigerenzer et al. 1999), and an evidence accumulation strategy (EAS). SRNs are well suited to deal with the pair-comparison task, which is the focus of the reported modeling efforts, because internal states are fed back at every step, supplying such networks with a memory, and allowing them to process information sequentially over time. To obtain a probability that a network chooses a particular option a Luce choice rule was employed.

Aging Decision Strategies

Li (2002) has proposed that deficits in neuromodulatory efficiency due to aging can be modeled by adjusting the gain (*G*) parameter of the sigmoidal activation function of neural networks. According to this approach, the activation function of neural units takes the form:

$$Activation_{it} = \frac{1}{1+e^{-(G_{it} \times Input_{it} + bias)}} \quad (1)$$

where *i* refers to a unit, *t* indicates the processing step, *Input* refers to the input supplied to the unit, and *bias* refers to a negative bias unrelated to aging. Finally, *G* is a random number sampled from a uniform distribution ($G_i, \in [G_{min}, G_{max}]$, $G_{min} > 0$).

Age-related decline in neuromodulation and its effect on strategy efficiency was modeled by using Equation (1) as the activation function of the output layer of successfully trained SRNs on the pair comparison task. The mean of the distribution from which *G* was sampled was reduced for older networks, while keeping the range of *G* constant. Sampling *G* from a distribution with a lower mean produces less pronounced and more variable activations, thus making differences between object's activations harder to distinguish by a choice rule. As a consequence, the probability of someone choosing an alternative not recommended by a particular strategy increases with age. Some predictions made by this model include (see Figure 1) (1) young TTB and WADD users perform better and vary less than old decision-makers; (2) the difference in performance between young and old TTB decision-makers is smaller than the difference between equivalent WADD networks; (3) options with similar profiles are harder to distinguish for older compared to young decision makers. These predictions are currently being tested by training young and older adults to use TTB and EAS, and analyzing their error patterns as a function of the strategy used and trial difficulty.

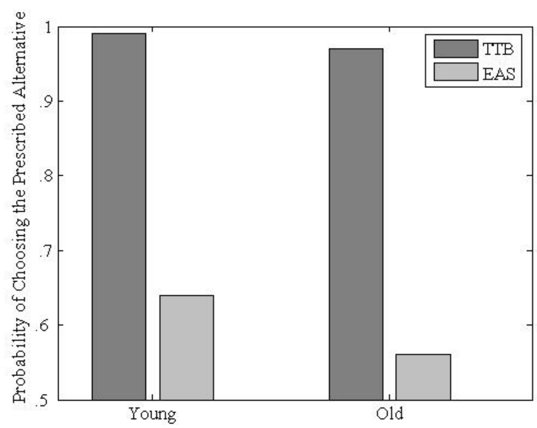

Figure 1: Probability of choosing the option prescribed by TTB and EAS given different age (*G*) levels.

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