Code for Hills, T. T. **Learning, clutter, and age-related cognitive decline: An enrichment-based account of the interdependence between fluid and crystallized intelligence**

2024-04-11

Figure 1.

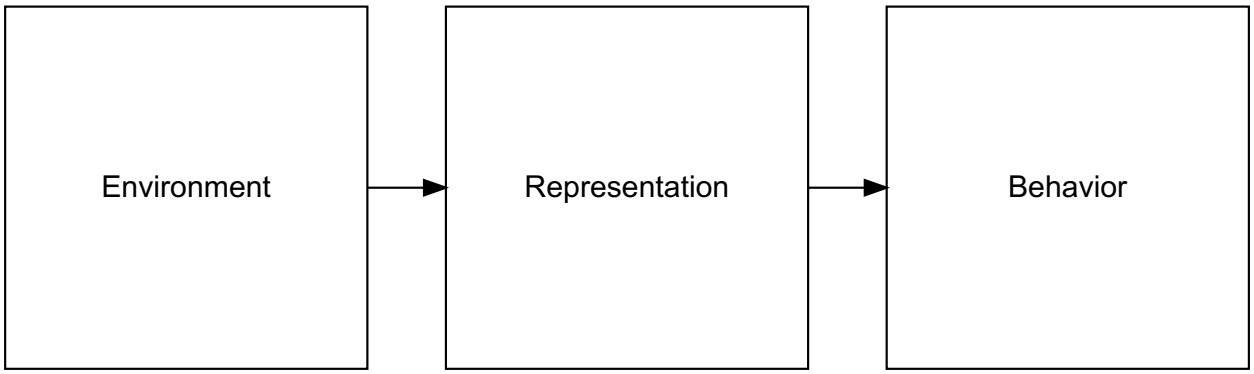

Figure 1: The process of translating experience with the environment into behavior. Arrows represent processes that translate one domain into another. Learning translates experience with the environment into a cognitive representation. Additional cognitive processes then act on the representation to generate behavior.

Figure 2.

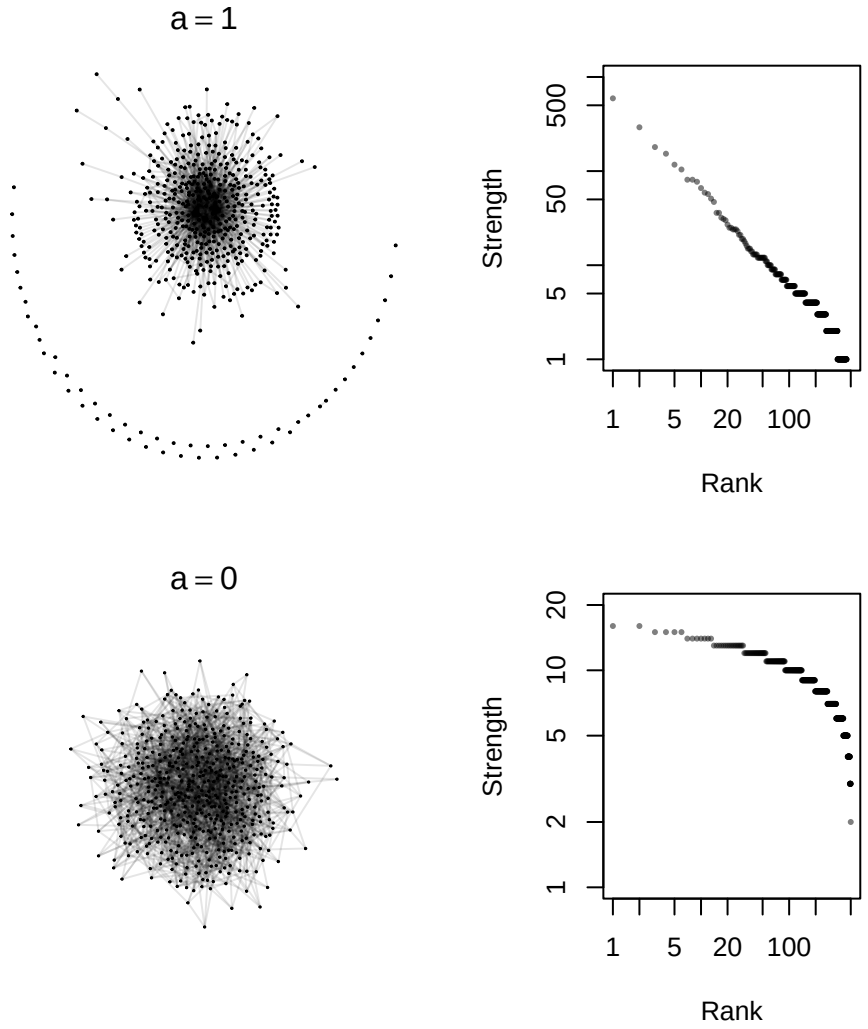

Figure 2: The structure of the environment from which learning takes place. Two network types are shown: A weighted scale-free network ($a = 1$) and a weighted Erdös-Renyi random graph ($a = 0$). Each network has 500 concepts (or nodes) and the weighted edges between them are the result of repeatedly sampling 2000 pairs of nodes and adding 1 to the edge weight between the pairs. The strength distributions (sum of the edge weights) are shown to help communicate the difference in the underlying structure.

Figure 3.

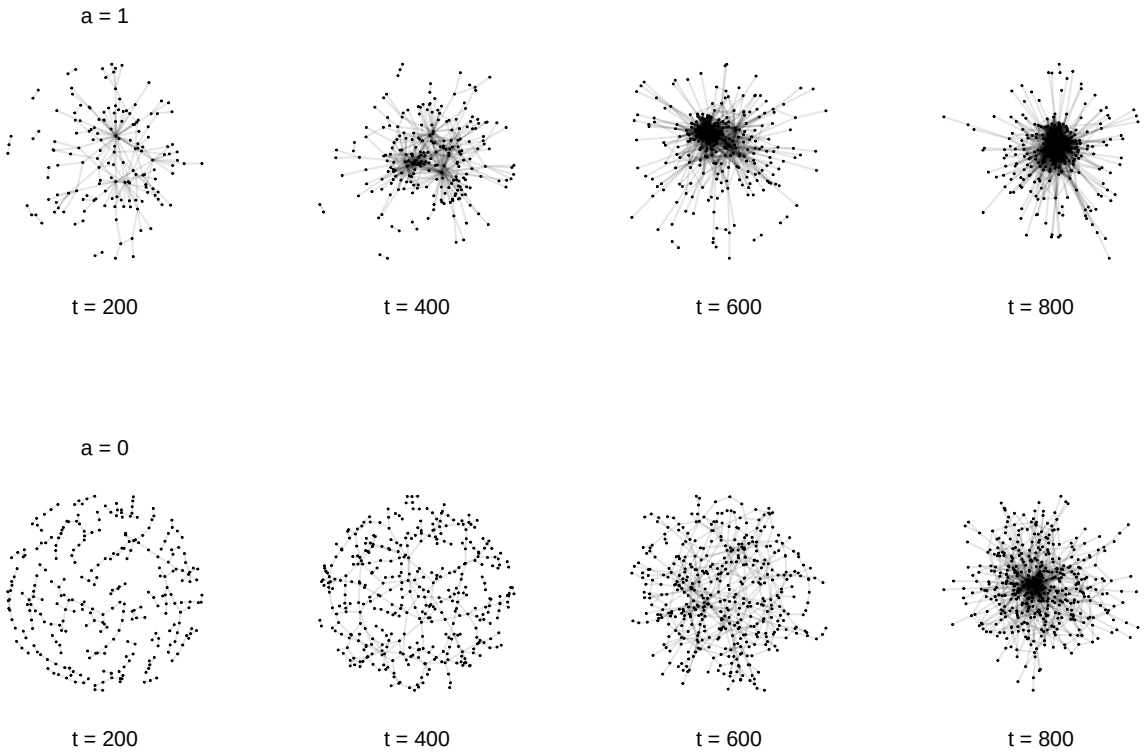

Figure 3: Examples of the growing mental lexicon resulting from training a Rescorla-Wagner model on the network types shown in Figure 2. Training occurs in 200 event epochs, with edges from the environment sampled in proportion to their weight. Nodes represent individual concepts and edges represent learned associations. Unlearned 'isolates' are not shown in the visualization but decline with age: Across the four epochs, the number of isolates is 333, 262, 222, and 191 for $a = 1$ and 239, 123, 63, and 41 for $a = 0$, consistent with a rising vocabulary.

Table 1: Statistics for the environments and growing representations.

			Epoch			
a	Measures	Environment	1	2	3	4
$a = 0$	Nodes	500.00	272.50	391.00	444.00	466.00
	Edges	1985.00	190.5	360.0	580.5	1095.5
	Strength	8.00	0.008	0.015	0.022	0.029
	Degree	7.94	0.76	1.44	2.32	4.38
	ASPL	3.23	0.028	0.122	0.051	0.026
	C	0.01	0.000	0.003	0.010	0.014
$a = 1$	Nodes	444.00	147.5	226	270	298.5
	Edges	1382.50	170.0	408.5	1328.5	2730.5
	Strength	8.00	0.007	0.012	0.016	0.020
	Degree	5.53	0.68	1.63	5.31	10.92
	ASPL	3.11	0.031	0.024	0.014	0.009
	C	0.39	0.158	0.155	0.212	0.249

Note:
Measures are averaged over 1000 environments and cognitive representations learned from those environments over four epochs of 200 learning events each. Nodes indicates the total number of non-isolates in the environment or cognitive representation. Strength is the sum of the edge weights. Degree is the number of associations. ASPL is the average shortest path length. C is the mean local clustering coefficient.

Table 1.

Figure 4.

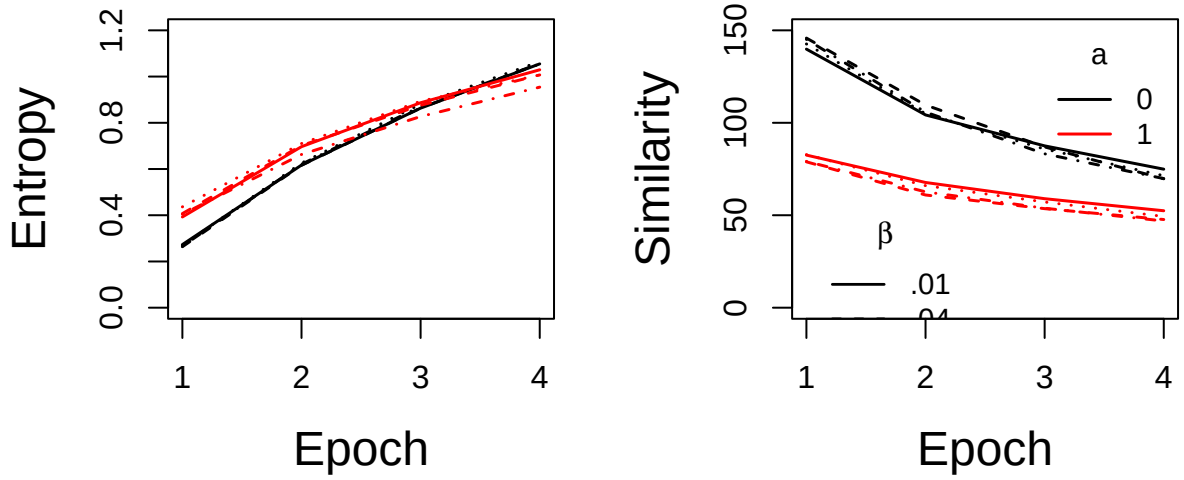

Figure 4: The rising entropy and falling similarity of the aging lexicon as a function of learning.

Figure 5.

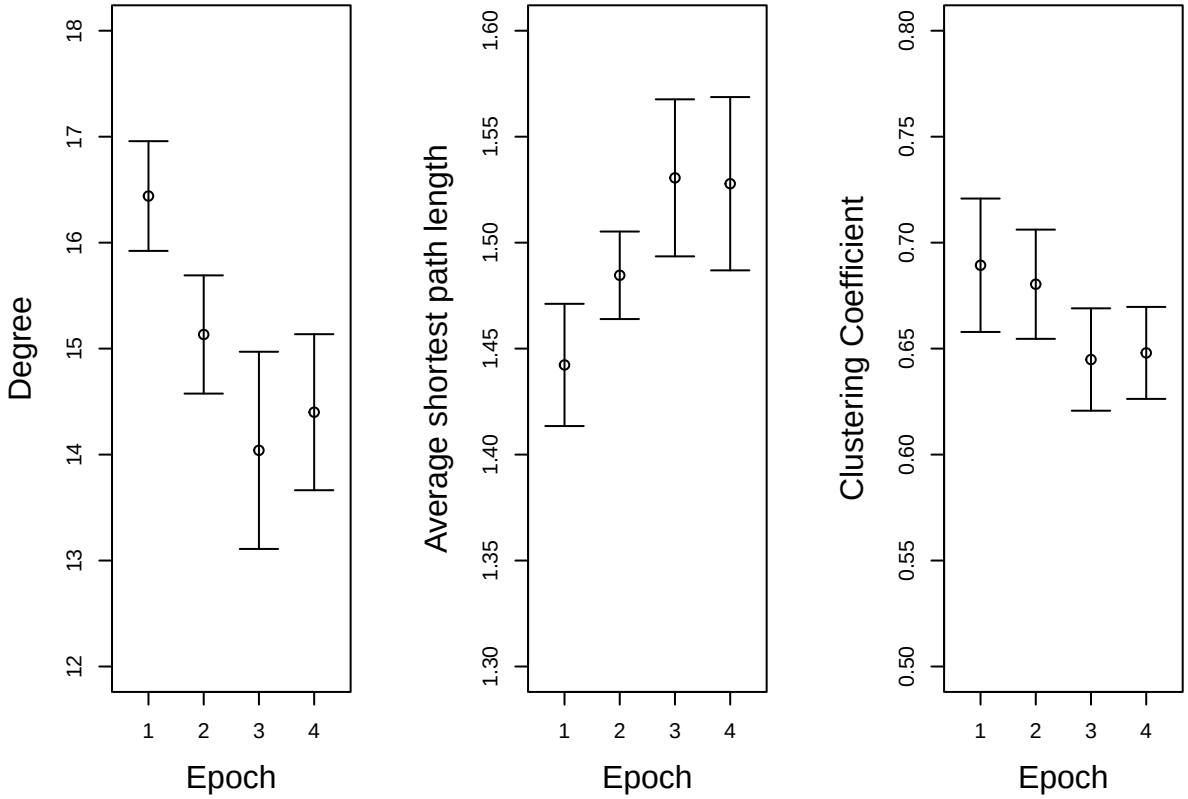

Figure 5: The degree, average shortest path length, and clustering coefficient for networks of associations across the lifespan. Simulations were repeated for learning cognitive representations in 1000 different environments ($a = 1$) with four training epochs each of 200 learning events each($\beta = .1$). Representations were then each sampled from by 10 simulated participants who each retrieved 3 associates for each of 30 cues with probability proportional to the associative strengths output from the Rescorla-Wagner training epochs. The cosine similarity of cues was then computed from the cue by association matrix to produce associative networks for each epoch. These networks were then thresholded separately for each learning environment by the median similarity value across all ages. Error bars indicate one standard deviation. Results are consistent with Dubossarsky et al., 2017.