A Comparison of Frequency Effects in Two Attitude Retrieval Models*

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* *Details are in original full proceedings article: https://github.com/mark-orr/Orr_ICCM2024

The Problem

- ***Computational models of attitudes, in social psychology, focus on attitudinal structure (e.g., network structure among a set of beliefs); Learning is not well studied.***

- ***We surmise that the study of learning of attitudes would benefit from an architectural (cognitive) approach.***

- ***We compare a prominent computational model of attitudes to an isomorph model based on the ACT-R declarative memory module. The working assumption of this comparison is that the architectural approach provides a useful baseline because it is grounded in human cognition.***

Design

Two Models:

- ACT-R declarative memory attitude model
- Causal Attitude Network (CAN) attractor neural network model (from prior work in social psychology)

Data:

- Synthetic data from universe of all bit vectors 16 elements long (of 2^16)
- Used ζ^1 = 1111111100000000 and ζ^2 = 1111000011110000 as basis patterns for training
- Five sets of training data labeled by the ratio of raw frequency of each of ζ^1 and ζ^2 respectively
- Used the following ratios: 50:50, 60:40, 70:30, 80:20, 90:10
- Any training set also had one example for every possible bit vector of length 16
- In sum: each of five training data sets was comprised of 65,636 examples (2^16 + 100)

Two Simulation Studies:

- Study 1: free recall
- Study 2a: cued recall with cue as ζ^1
- Study 2b: cued recall with cue as ζ^2
- Probability of retrieval of both ζ^1 and ζ^2 was primary dependent variable

Study 1

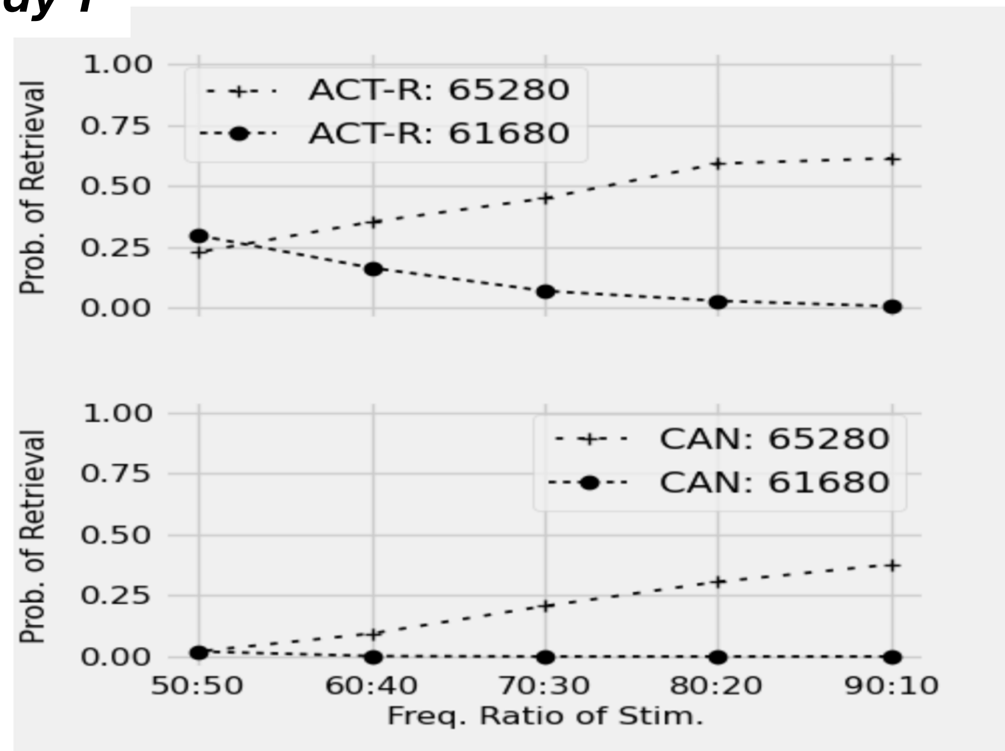

Figure 1: A comparison between the ACT-R (top panel) and CAN (bottom panel) attitude models in the probability of retrieval as a function of each of five conditions of the frequency ratio of the two basis patterns ζ^1 and ζ^2 (the former is 65280; the latter is 61680) in Study 1. No cue was given in this study. Note: ζ^1 is more frequent.

Similar behavior between ACT-R and CAN: As ratio becomes larger, the more frequent basis pattern was more probable on retrieval.

Study 1

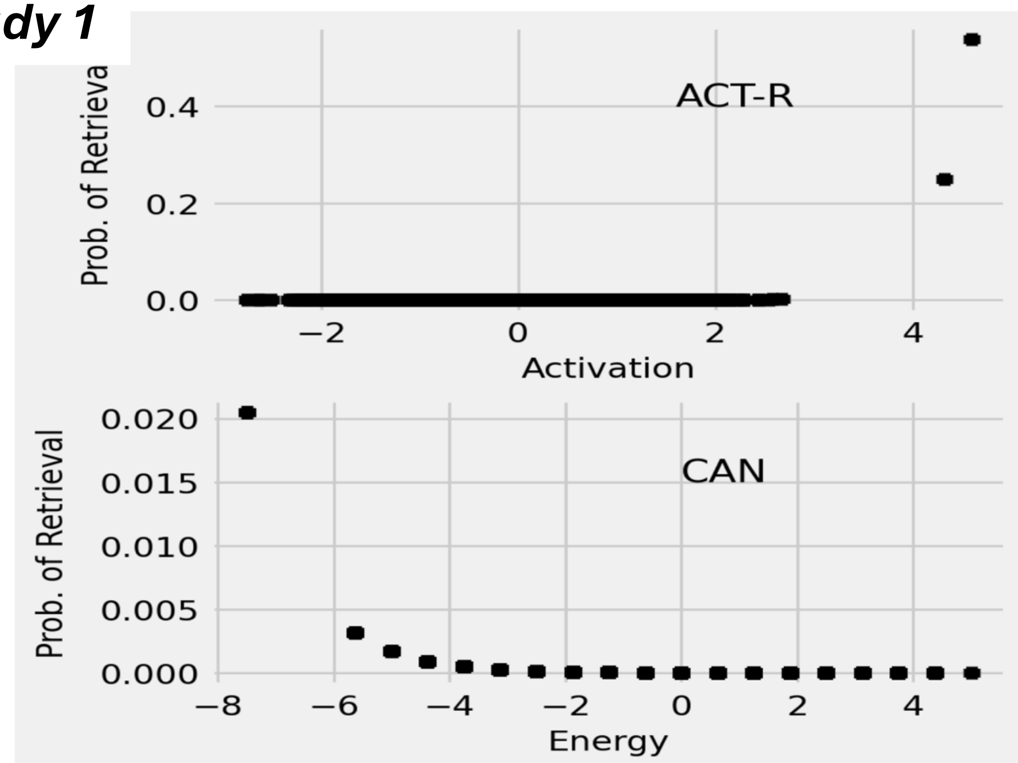

Figure 2: The relation between energy (CAN model) or activation (ACT-R model) (x-axis) and the probability of retrieval (y-axis) for each of the examples in the full configuration space (2^{16} examples). Each panel represents a simulation of the $50 : 50$ condition. Note the different scales of the y-axis in each panel.

Close-up look at how each model operates; both models show clean separation between basis patterns and other patterns in terms of prob. of retrieval (under equal probability for both stimulus patterns).

Study 1

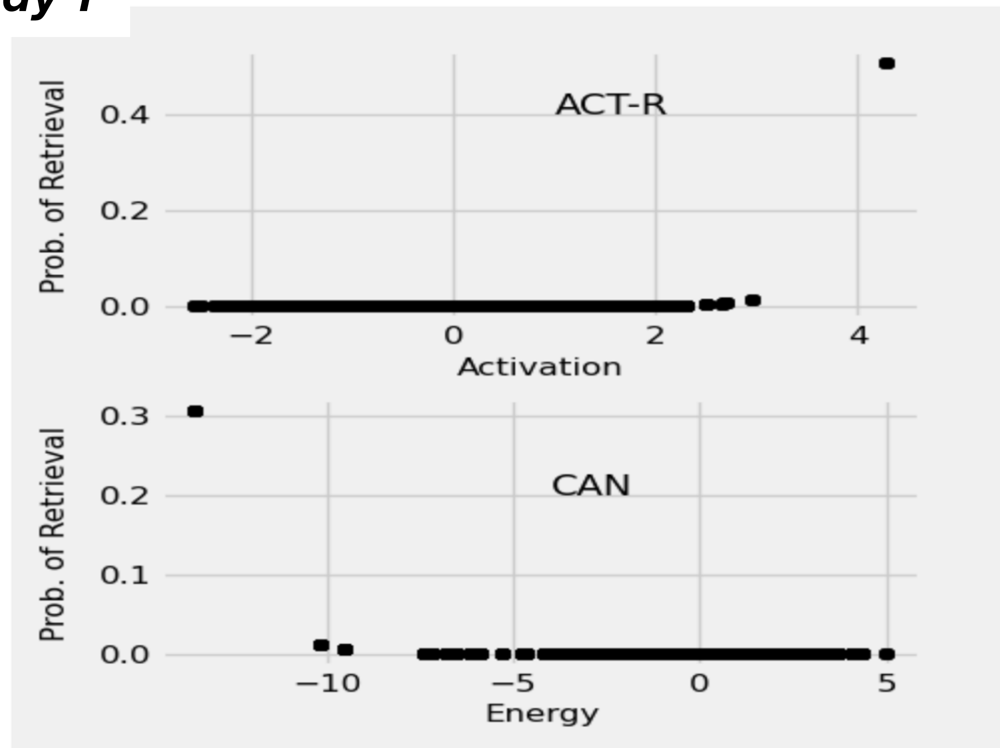

Figure 3: The relation between energy (CAN model) or activation (ACT-R model) (x-axis) and the probability of retrieval (y-axis) for each of the examples in the full configuration space (2^{16} examples). Each panel represents a simulation of the 80 : 20 condition. Note the different scales of the y-axis in each panel.

Close-up look at how each model operates; both models have clean separation between more frequent and less frequent basis in terms of prob. of retrieval (under unequal probability for basis patterns).

Study 2a

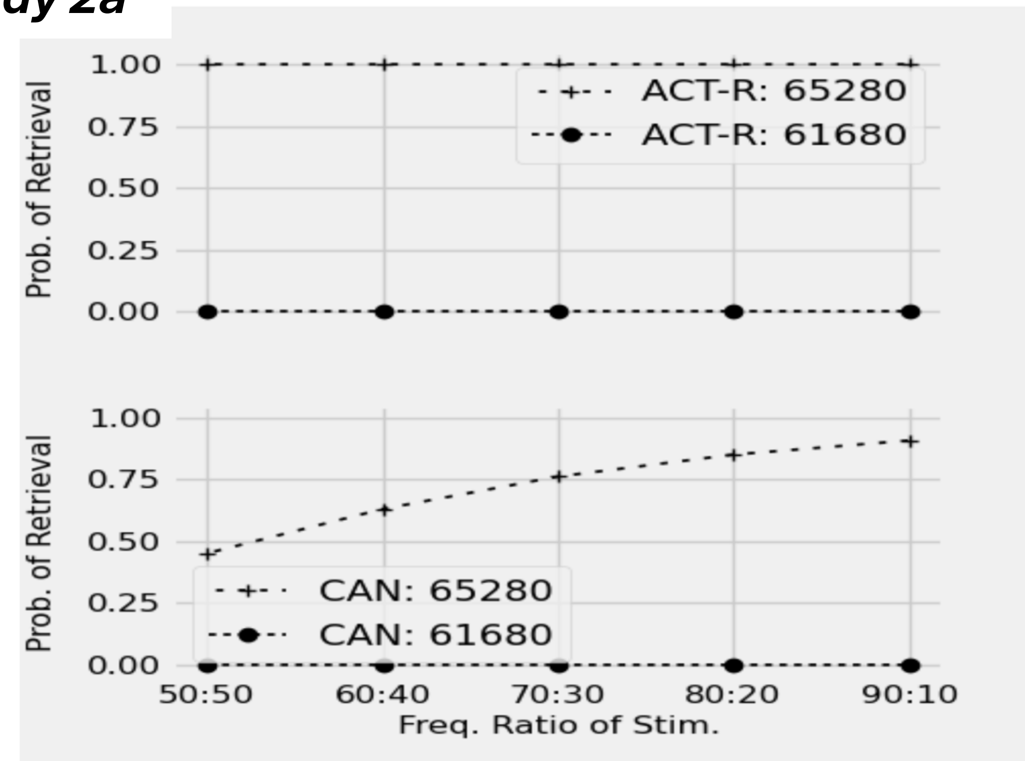

Figure 4: A comparison between the ACT-R (top panel) and CAN (bottom panel) attitude models in the probability of retrieval as a function of each of five conditions of the frequency ratio of the two basis patterns ζ^1 and ζ^2 (the former is 65280; the latter is 61680) in Study 2a. The cue was the more frequent pattern ζ^1.

When cueing the more frequent base pattern; see same high-order phenomena where cueing works in both models. But, the CAN model behavior still depends on frequency ratio; the ACT-R model ignores the frequency ratio; i.e., ACT-R is more dependent on the cue in this study compared to CAN (or CAN is more dependent on training).

Study 2b

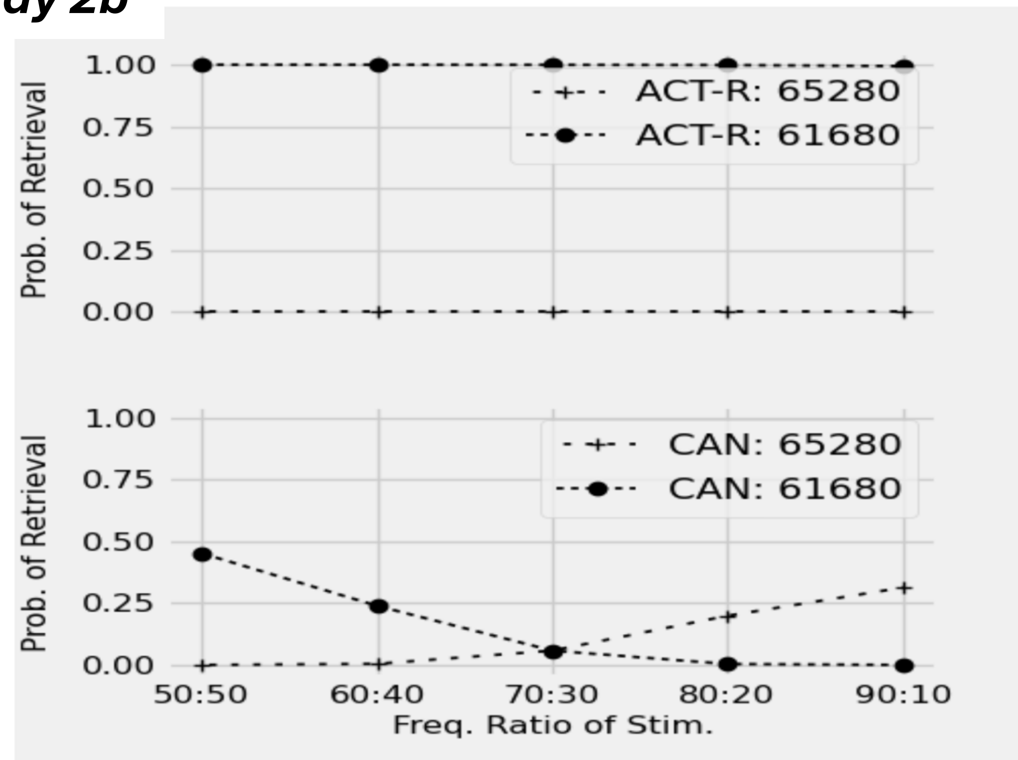

Figure 5: A comparison between the ACT-R (top panel) and CAN (bottom panel) attitude models in the probability of retrieval as a function of each of five conditions of the frequency ratio of the two basis patterns ζ^1 and ζ^2 (the former is 65280; the latter is 61680) in Study 2b. The cue was the less frequent pattern ζ^2.

When cuing the less frequent base pattern wee see similar results as in Study 2a. Cueing works in both models. But, the CAN model behavior still depends on frequency ratio; the ACT-R ignores the frequency ratio. I.e., ACT-R is more dependent on the cue in this study compared to CAN (or CAN is more dependent on training).

Conclusions

1. ***With varying frequency ratios of two learned patterns, ACT-R and CAN models showed similar behavior during free recall.***

2. ***ACT-R and CAN behave differently under cue. ACT-R is very sensitive to cue; the cue drives retrieval. CAN is different—cue matters only when prior knowledge is aligned with it; otherwise prior knowledge wins out.***

3. ***Theoretical import: The attitude construct, at first blush, is not clear on what should be the respective roles for prior knowledge (training freq.) vs. immediate context (cue). Our work points out that this issue is important to consider when moving forward with computational or mathematical theory.***

4. ***Future Work: This work is provisional, highly so. Some areas for future work (i) rational analysis of the attitude context, (ii) explore more the degree of learning in the CAN model, (iii) explore more realistic representations in ACT-R DM for the attitude task.***