How using concepts changes them: A graph theory approach

Yoed N. Kenett, Zareh Kaloustian, Sharon L. Thompson-Schill

Center for Cognitive Neuroscience, University of Pennsylvania, Philadelphia PA, USA

Introduction

What is a Robin Hawk?

Attributive

Relational

We examine whether the *consequences* of these combination types on our conceptual system might differ, by comparing semantic memory networks before and after participants perform either attributive or relational conceptual combinations.

We characterized the semantic network of participants using their free association responses to 50 cue words taken from five semantic categories (such as animals or fruits and vegetables).

These association responses were obtained twice, before and after either a baseline condition (no manipulation) or after a conceptual combination task that was biased to elicit either attributive or relational interpretations to half of these cue words.

Conceptual Combination Task

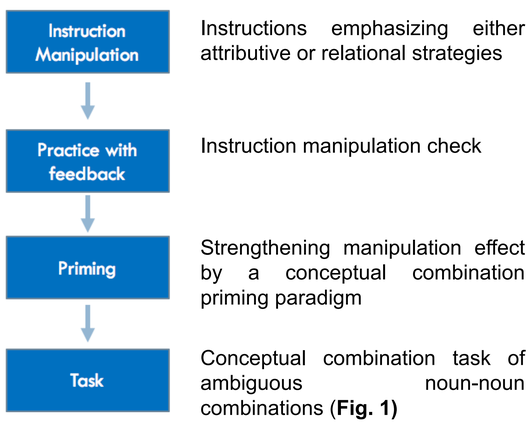

Fig. 1. Ambiguous noun-noun compounds stimuli, divided into five a priori categories.

Semantic Network Analysis

- **Nodes** represent 50 cue words (**Fig. 2**).
- **Edges** represent association correlations (overlap in associative responses generated to any pair of nodes**, Fig. 3**).
- A triangulated maximal filtered graph filter is used to minimize spurious correlations.

Animals		Fruits and vegetables		Nature	
Robin	Octopus	Tomato	Olive	Pine	Mountain
Shrimp	Snake	Carrot	Pineapple	Cactus	Wood
Cheetah	Snail	Melon	Lemon	Tree	Garden
Alligator	Elephant	Strawberry	Peach	Grass	Twig
Whale	Bulldog	Onion	Mushroom	Rose	Flower

Food		Home	
Cracker	Cookie	Oven	Knife
Cake	Popcorn	Refrigerator	Kitchen
Honey	Candy	Sink	Broom
Pretzel	Yogurt	Microwave	Table
Chocolate	Syrup	Trash	Room

Fig. 2. 50 cue words stimuli for semantic networks, divided into a priori categories. Left column in each category are nouns used in Conceptual Combination task (Fig. 1).

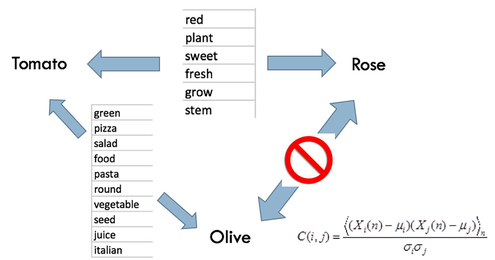

Fig. 3. Association correlation method to compute edges between nodes, according to the overlap of similar associative responses generated to the cue words.

Participants

Table 1. Participant's demographics

Dimension	Baseline	Attributive	Relational
N	45	46	49
M/F	12/33	11/35	15/34
Age	22.0 (3.0)	21.6 (2.9)	21.3 (2.8)
Education	15.7 (2.5)	16.3 (2.5)	15.6 (2.3)

Results

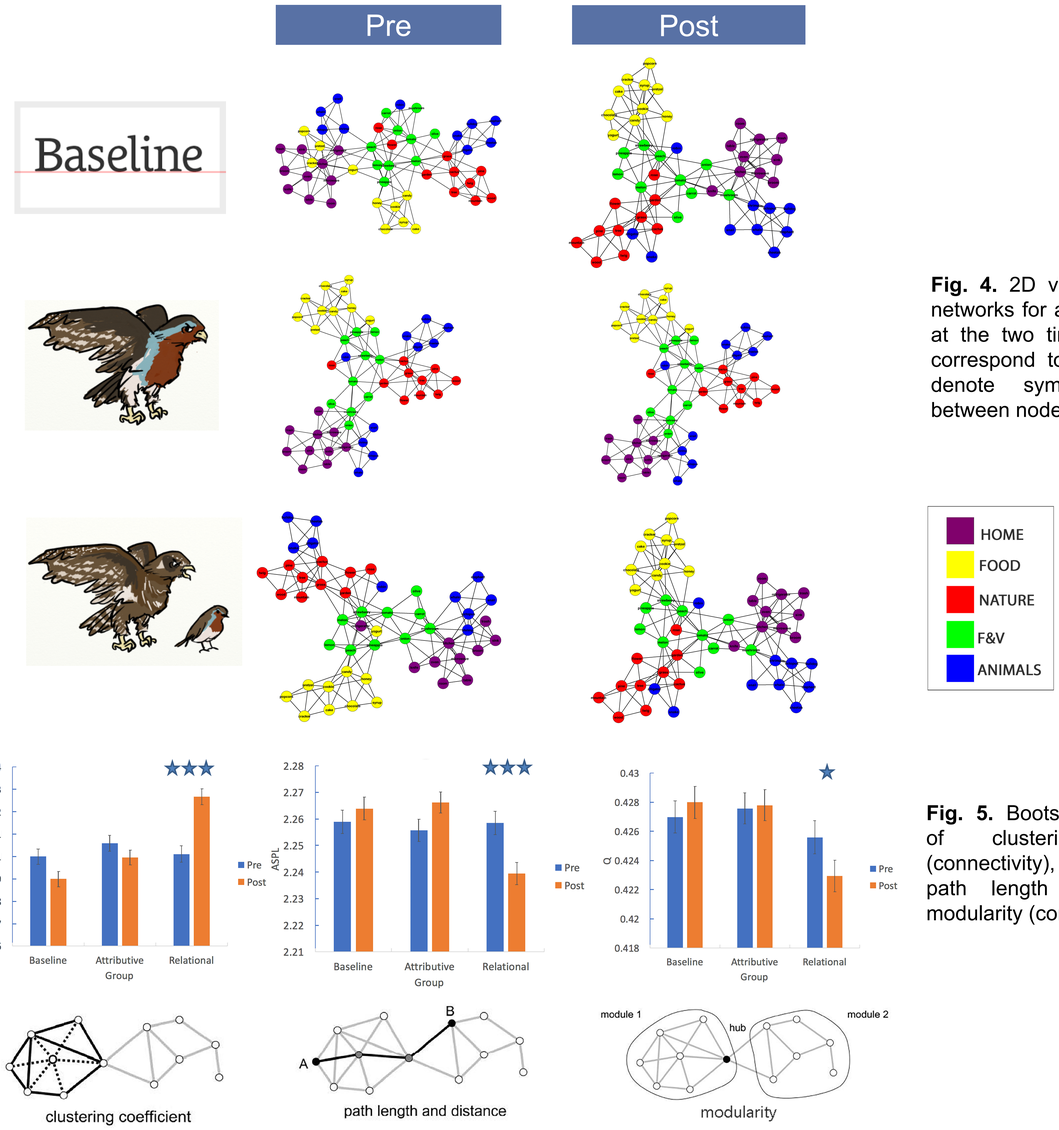

Fig. 4. 2D visualization of the networks for all three conditions at the two time points. Colors correspond to category. Edges denote symmetrical relation between nodes.

Fig. 5. Bootstrapping analysis of clustering coefficient (connectivity), average shortest path length (distance) and modularity (communities).

Conclusions

- Relational combinations, compared to attributive combinations, affects the structure of semantic network (connectivity, distances, community structure).
- This effect may be related to increased "flexibility" of the semantic network
- Thus, we quantitatively investigate the dynamic nature of semantic memory, in line with current theories on its dynamic nature

Further information can be found in a conference proceeding describing preliminary results of this study: https://web.sas.upenn.edu/schill-lab/files/2017/07/Kenett-and-Thompson-Schill2c-2017-1hijnq4.pdf

This research was funded by an NIH award to Sharon Thompson-Schill (R01 DC015359-02).