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nature human behaviour

Knowledge gaps in the early growth of semantic feature networks

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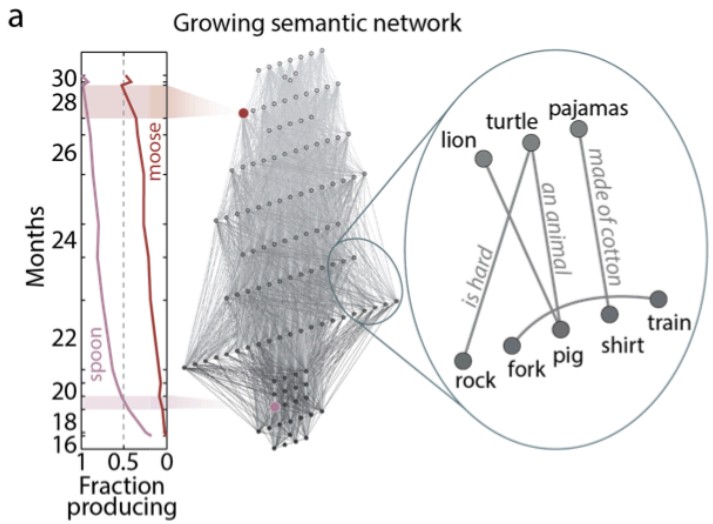
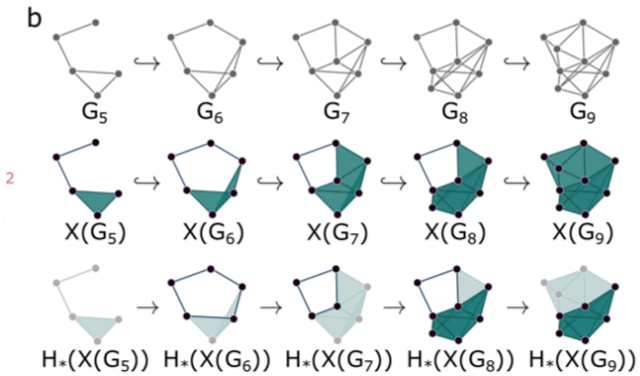
Question and motivation

- How do kids learn new words?
- Is it mediated by relationships between the words that kids already know?
- Hypothesis: A kid more likely to learn a word similar to the words already known
- Contra this hypothesis, they find that there are gaps (missing words) that are created and then filled in
- The paper characterizes the evolution of cavities using applied topology

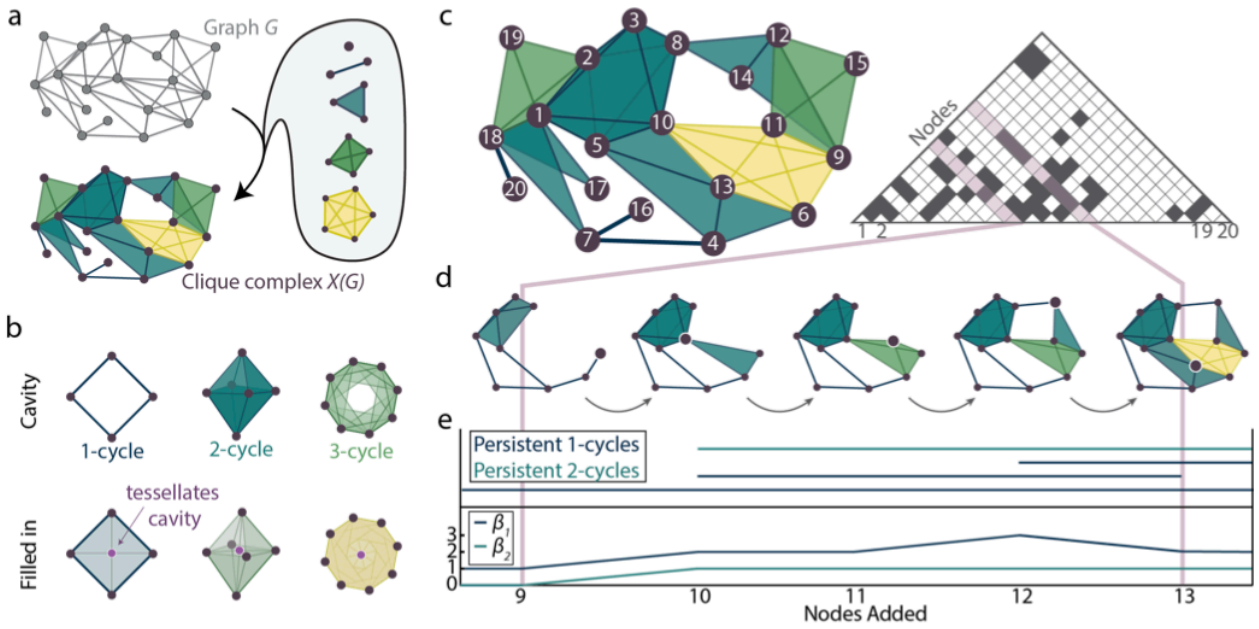
Method


a
Growing semantic network
Months
30
28
26
24
22
20
18
16
1
0.5
0
Fraction producing
moose
spoon
lion
turtle
pajamas
is hard
an animal
made of cotton
rock
fork
pig
shirt
train

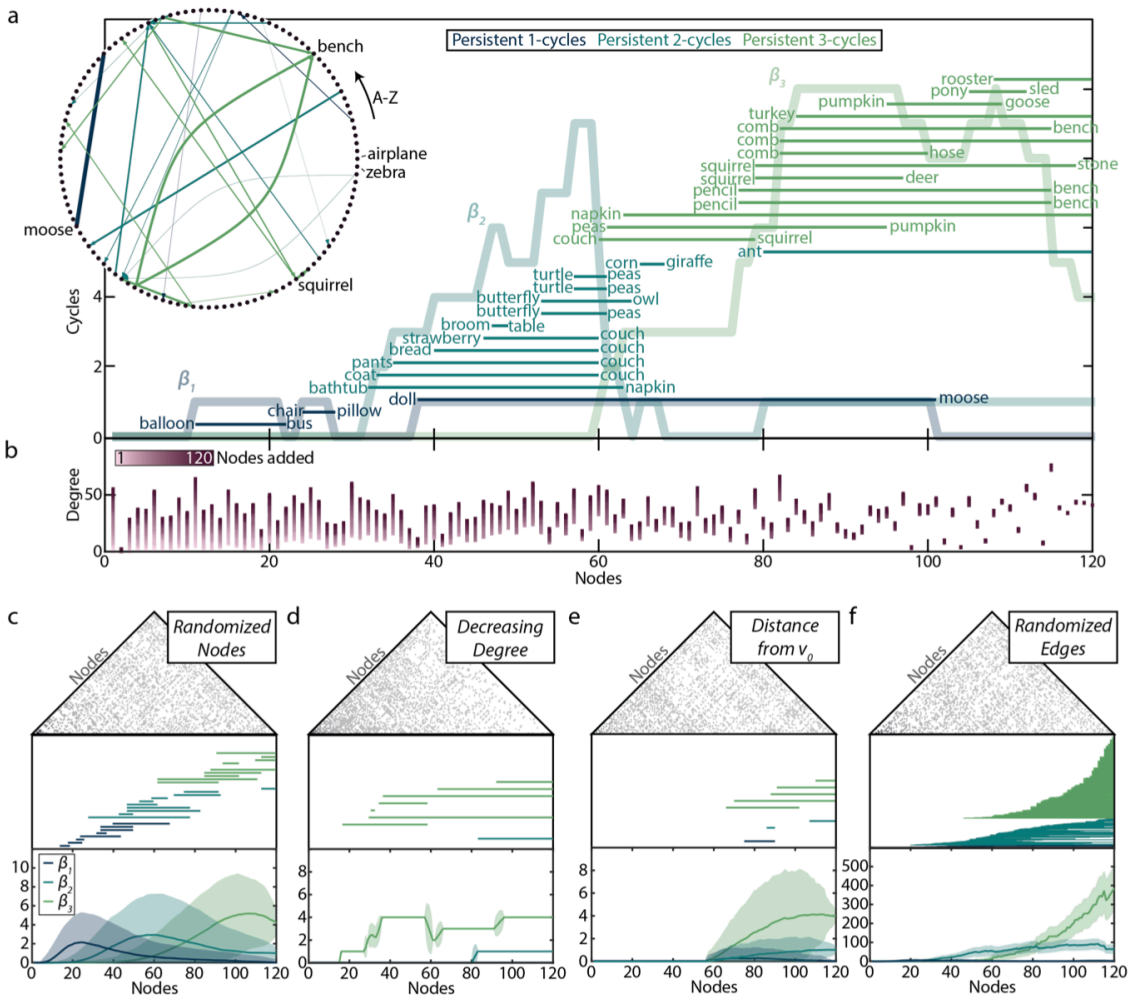

b
balloon
is large
is round
knowledge gap
bear
banana
is white
is yellow
cheese
balloon
filled in
is large
bus
bear
banana
is yellow
cheese


b
G5
G6
G7
G8
G9
X(G5)
X(G6)
X(G7)
X(G8)
X(G9)
H*(X(G5))
H*(X(G6))
H*(X(G7))
H*(X(G8))
H*(X(G9))

Method


a
Graph G
Clique complex X(G)
b
Cavity
1-cycle
2-cycle
3-cycle
Filled in
tessellates
cavity
c
Nodes
1 2
19 20
d
e
Persistent 1-cycles
Persistent 2-cycles
β_1
β_2
0
1
2
3
9
10
11
12
13
Nodes Added

Results


a
b
c
d
e
f
Persistent 1-cycles
Persistent 2-cycles
Persistent 3-cycles
bench
A-Z
airplane
zebra
moose
squirrel
Cycles
Nodes added
Degree
Nodes
Randomized Nodes
Decreasing Degree
Distance from v_0
Randomized Edges
β_1
β_2
β_3

Conclusion

- In contrast to a growing network model, networks are created then filled
- Any ordering of words produces similar topological result
- Topological cavities are conserved feature of the learning process
- Edge properties (in this case, *features)* are more important than node order

Thoughts

- Massive variability in the number of words that kids know….suggests not that they know the wrong words, but that they don't understand the appropriate relations between them?
- Suggests semantic similarity is not the only driver of semantic growth?