Linguistic Meanings as Cognitive Instructions

Knowlton et al (2021). *Ann N.Y. Acad. Sci.* (1500): 134-144.

Theoretical Framework

Computationalism

The mind creates *representations* and performs algorithmic *computations* on those representations.

When applied to language processing, the computational picture might look like the following:

> When processing a sentence, the mind creates representations corresponding to the basic lexical items in a sentence (e.g. ‘dot’, ‘blue’), and then executes a *compositional* algorithm to determine the meaning of the sentence as a whole.

Which compositional algorithm the mind employs will depend (at least partly) on the logical vocabulary in the sentence.

> E.g. ‘all of the dots are blue’ must be associated with a different computation than ‘some of the dots are blue’.

Intensional Semantics

The meaning of a sentence is contains more information than just its *truth-conditions*.

In the computational setting, this means that there can be distinct algorithms that are extensionally equivalent, i.e. they map all the same inputs to all the same outputs.

Extensionally Equivalent, But Intensionally Distinct?

Suppose we divide objects up into just two exclusive types, A’s and B’s. Then the following expressions are all truth-conditionally equivalent:

1. Most of the objects are A’s
2. There are more A’s than B’s
3. $|\{x \mid x \text{ is an } A\}| > |\{x \mid x \text{ is an } A \text{ or a } B\}| - |\{x \mid x \text{ is an } A\}|$
4. $|\{x \mid x \text{ is an } A\}| > |\{x \mid x \text{ is a } B\}|$

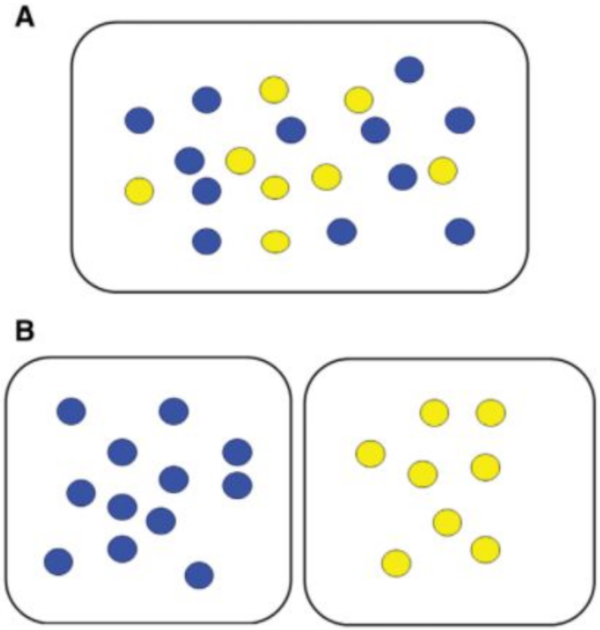
But 3 and 4, at least, are intensionally distinct.

‘More’ vs ‘Most’

Are ‘more’ sentences like ‘there are more A’s than B’s’ intensionally distinct from ‘most’ sentences like ‘most of the objects are A’s’? That is, does the mind use a different process when understanding them?

Knowlton et al designed some clever experiments that provide evidence that the answer is ‘yes’, and that ‘more’ sentences are computed similarly to 4 (in that they involve comparing independent subsets), whereas ‘most’ sentences are computed similarly to 3 (in that they involve comparing a subset to a superset).

Experiments 1&2



Cognitive Requirements

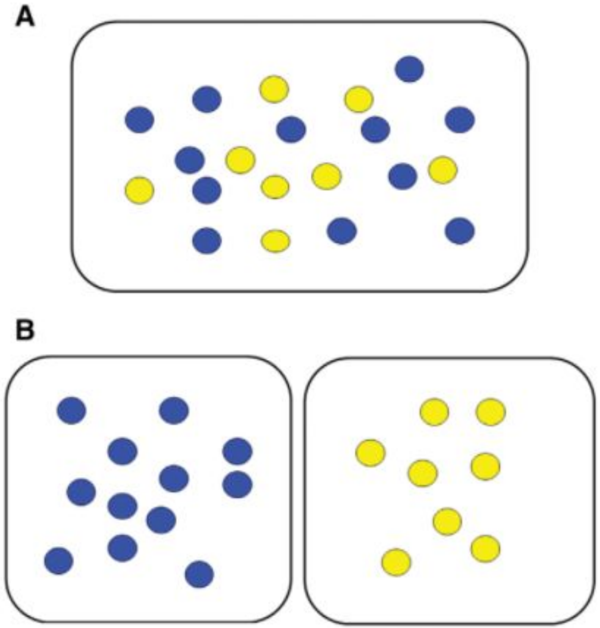
Let ‘A’ stand for ‘blue dots’ and ‘B’ stand for ‘yellow dots’

Computing the truth of 3 requires estimating the size of the set of dots that are either blue or yellow, i.e. the superset of all dots.

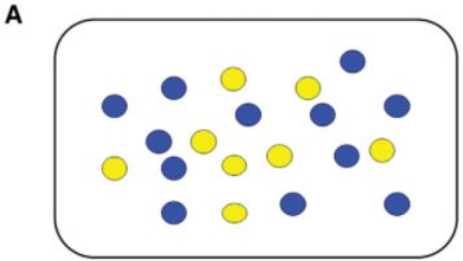
> 3. |{x | x is an A}| > |{x |x is an A or a B}| - |{x | x is an A}|

Computing the truth of 4 requires estimating the size of the set of yellow dots.

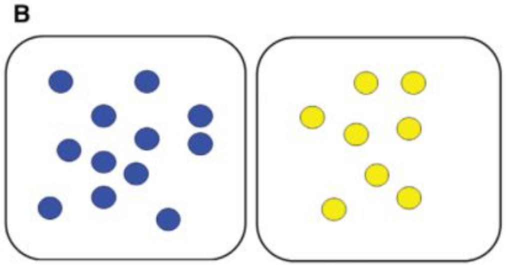
> 4. |{x | x is an A}| > |{x | x is a B}|



When it’s easier to satisfy the cognitive requirements

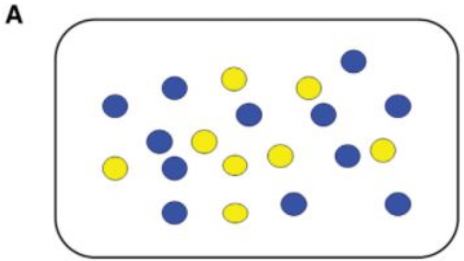


It is easier to estimate the size of the set of *yellow or blue dots* than the size of the set of *yellow dots*



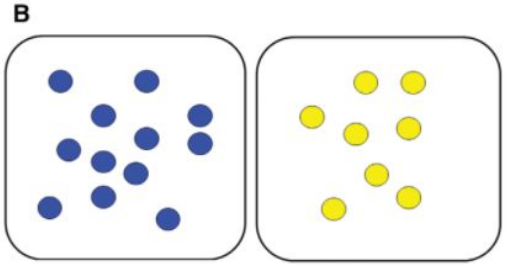
It is easier to estimate the size of the set of *yellow dots* than the size of the set of *yellow or blue dots*

Preference for easier computation



It is easier to estimate the size of the set of *yellow or blue dots* than the size of the set of *yellow dots*

Preference for association with 3



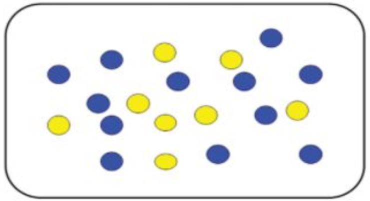
It is easier to estimate the size of the set of *yellow dots* than the size of the set of *yellow or blue dots*

Preference for association with 4

Predictions

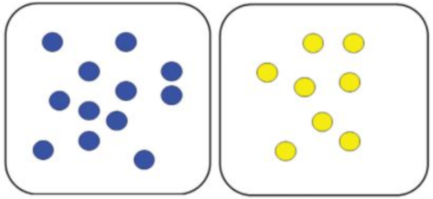
If the above assumptions are true, then we can test hypotheses about the intensional information associated with ‘most’ and ‘more’ sentences. In particular, if one of these kinds of sentences are computed along the lines of 3 or 4, and the other kind is computed along the lines of the other formula, then there should be a preference for associating one of the kinds of sentences with one of the images rather than the other, and vice versa.

A



→ Preference for association with 3 → ‘More’ / ‘most’ sentences computed by 3 → Preference for association with ‘more’ / ‘most’ sentences

B



→ Preference for association with 4 → ‘More’ / ‘most’ sentences computed by 4 → Preference for association with ‘more’ / ‘most’ sentences

The Test (pt 1)

Experiment 1 tested these predictions giving participants **both image A and B** and either a ‘most’ sentence or a ‘more’ sentence, and asked to select which image best exemplifies the given sentence.

The result was that participants selected the intermixed image A more often when given the ‘most’ sentence, and selected the separated image B more often when given the ‘more’ sentence.

What hypothesis does this support about the computational process associated with ‘most’ sentences? What about the process associated with ‘more’ sentences?

The Test (pt 2)

Experiment 2 tested these predictions giving participants **one of either image A or B** and both a ‘most’ sentence and a ‘more’ sentence, and asked to select which sentence best exemplifies the given image.

The result was that participants selected the ‘most’ sentence more often when given the intermixed image A, and selected the ‘more’ sentence more often when given the separated image B.

What hypothesis does this support about the computational process associated with ‘most’ sentences? What about the process associated with ‘more’ sentences?

Your Task

Replication

We will be attempting to replicate experiments 1&2 while playing around with a few parameters of the experiment design. You will be divided into groups of 2 (or occasionally three).

For this week, you'll be creating the materials needed to run your experiment. This means you'll be creating two images and two sentences in accordance with the parameters on a design document we have created.

All the materials should be submitted on a single PDF file, but each group member should submit their own copy of this file.