Psychological foundations of number: numerical competence in human infants

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Spelke and Number Systems

- Numerical approximation- infants can distinguish between 2 sets of numbers (sets)
- Exact numerical values- infants have difficulty learning exact numbers greater than one because they are sets of individuals
- Language and core knowledge systems- combining 2 systems allows infants to understand a “set of individuals”

What abilities do we have without language? Do we possess numerical competence without language?

Wynn argues that we can compute and manipulate numbers without language. We do possess numerical competence without language.

Why is this important?
Wynn discusses certain processes, i.e. numerical computation, as being not only innate, but universal to all species (since language is not needed).

Experiments

- Non-linguistic humans tested: infants
- Goal: to see the effects of not having language on numerical competence
- Linguistic determinism- Does language determine how we perceive the world?
- Significance of longer looking
  - Infants look longer at a novel or unexpected stimulus.
Experiments

- Infants can distinguish different small numbers of items.
  - Infants were presented with displays of objects of small quantities.
  - When presented with new set of objects of a different quantity, looking time increases.
  - These results were constant, even when spacing and motion changed.
  - Longer looking- the different number is a novel stimulus.

- Infants can enumerate units other than objects.
  - Puppet jumping
  - Number of jumps changed
  - Duration and tempo changed: same results
  - Longer looking- infants can tell difference between different number of jumps; when a new number is presented, they look longer.
  - Jumps embedded in sequence of continuous motion: same results.
  - Infants were not simply separating motion from non-motion.

Experiments: Numerical Computation with 5 month old infants

- 1 + 1 test
  - Puppet seen placed in display stage
  - Screen hid it from view
  - Hand entered with identical object and exited stage empty
  - Screen dropped to reveal 1 object or 2 objects
  - Infants looked longer at the single puppet because of unexpected result.

Computation 1 + 1 tests

The table shows sequence of events for 1+1 tests: one possible outcome and one impossible outcome.
Experiments: Numerical Computation in 5 month old infants

- **2 – 1 tests**
  - Same procedure as 1 + 1, except two puppets are placed in stage, and hand removes one
  - Infants look longer at the 2 puppets compared to the expected 1 puppet
  - Conclusion: infants can add and subtract small quantities of numbers.

Numerical Computation vs. Display Changes

- Does the infant actually add/subtract, or is their reaction a response to a change in the visual environment of the stage?
  - 1 + 1 = 2 or 3
  - Expectations: infants will look at 2 and 3 puppets for the same amount of time (both show alteration of display stage).
  - Results: infants look longer at 3 puppets because of unexpected result
  - Conclusion: infants can compute numbers.

Zero

- 2 models for explaining how infants deal with the concept of zero
  - Accumulator model: counts and measures duration using pulses and switches
    - 2 – 1: accumulator increased by 2 increments; when 1 item is removed, accumulator is decremented by 1; resulting expectation is 1 puppet
    - 1 – 1: infants has no expectations about the number of puppets
Zero

- Models
  - Object Tracking model: visual system constructs temporary representations of objects in a given scene
    - Mismatches between mental representation and altered scene prompt infant to look longer
    - 2 – 1: infant makes temporary rep. of 2 puppets in mind; when 1 is removed, mismatch between mental rep. and actual scene occurs
    - 1 – 1: infant expects to see no puppets

Conclusions

- We do not need language in order to be numerically competent.
- How this relates to what we’ve discussed in class?
  - Opposes Whorf: we do not need language for thought about numbers

1 – 1 = 1

- Infants are not surprised when 1 puppet – 1 puppet = 1 puppet
- Not surprising when objects "magically" appear
- Accumulator model: no signal, model goes offline- infant has no numerical expectations

Are the conclusions fair?

- Infants do seem to possess ability to compute numbers without language.
- Models
  - Accumulator model
  - Object-tracking model