Why is computationalism relevant to language acquisition?

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Computationalism in psychology: treating symbols as relating to the nature of representations, that is, to their encoding in the mind (see Bickhard 1996 for overview)

Computationalism in the rest of CogSci: computational aspects that make a problem easy or difficult.
Computer scientist’s view of computation

Formal language theory (theory of descriptions)

Automata theory (theory of computing with descriptions)

Complexity theory (theory of algorithms and their effective computability)

   Space and time complexity
Objects of computing

strings
  algebra
  formal
  language
  theory
  calculus
  parsing
  and
  automata
  theory

functions
  algebra
  domain
  and
  type theory
  calculus
  lambda
  calculus

algorithms
  complexity
  theory
What makes a problem computationally easy or difficult?

Ambiguity

Non-determinism (not always the same thing as amb.)

Completeness and decidability

Memory kind, and its management

Frequency

Algorithms vs. heuristics
Radical lexicalization

First step towards getting a grip on computational properties.

Rationalists do it by the rules. (Shimon Edelman)

Empiricists do it to the rules.

(1) $S \rightarrow NP \ VP$  
$Det \rightarrow every$
$NP \rightarrow Name$  
$N \rightarrow chemist$
$NP \rightarrow Det \ N$  
$Name \rightarrow Kafka$
$VP \rightarrow V_{iv}$  
$V_{iv} \rightarrow arrived$
$VP \rightarrow V_{tv} \ NP$  
$V_{tv} \rightarrow adored$

$NP=S/VP$ and $VP=S\setminus NP$. Hence $NP=S/(S\setminus NP)$
(2) \[ V_{tv} = VP/\text{NP} \quad V_{iv} = VP \quad NP = VP \setminus V_{tv} \]

\[ \text{NP} = S/VP \quad VP = S\setminus \text{NP} \quad \text{Det} = \text{NP} / \text{N} \]

\[ \text{Name} = \text{NP} \quad \text{N} = \text{NP} \setminus \text{Det} \]

Hence \[ V_{tv} = (S\setminus \text{NP})/\text{NP} \quad V_{iv} = S\setminus \text{NP} \]

\[ \text{NP} = (S\setminus \text{NP}) \setminus ((S\setminus \text{NP})/\text{NP}) \]

\[ \text{NP} = S/(S\setminus \text{NP}) \]
(3) every := Det = NP/N = (S/(S\NP))/N
chemist := N = NP/Det = NP/(NP/N)
Kafka := Name = NP = S/VP=S/(S\NP) and
       (S\NP)/(S\NP)/NP)
arrived := VP = S\NP
adored := VP/NP = (S\NP)/NP
Cognitivism in CogSci: Qualitatively different problems

Computationalism in CogSci: Quantitatively different tasks (i.e., same problem, with some task-specific knowledge)

Empiricist in heart, interactionist at work
Some examples

Nouns-first acquisition

Syntactic acquisition

Innate knowledge of morphemehood

Parameters versus statistics

Emergence of grammatical relations
Some Piagetian stages

Period of Sensorimotor activity

   Stage of reflexes

   Stage of primary circular reactions

   Stage of coordination of secondary circular reactions

Period of Operational thought

Period of Formal operations
**Keren’s first words** (Dromi, 1987)  
Hebrew (Israel)

<table>
<thead>
<tr>
<th>Age</th>
<th>Child’s conven.</th>
<th>Child’s m(d) word</th>
<th>Child’s conven. form</th>
<th>Child’s conven. meaning</th>
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<td>haw</td>
<td>(?)</td>
<td>a dog’s bark</td>
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</tr>
<tr>
<td>11(16)</td>
<td>?aba</td>
<td>(aba)</td>
<td>Father</td>
<td>12(18)</td>
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<td>11(17)</td>
<td>?imaima</td>
<td>(?)</td>
<td></td>
<td>12(19)</td>
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<td>11(18)</td>
<td>ham</td>
<td>(?)</td>
<td>said while eating</td>
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<td>mu</td>
<td>(?)</td>
<td>a cow’s moo</td>
<td>12(23)</td>
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<td>?ia</td>
<td>(?)</td>
<td>a donkey’s bray</td>
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<td>an elephant</td>
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<tr>
<td>12(11)</td>
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<td>(buba)</td>
<td>a doll</td>
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<td>12(13)</td>
<td>pipi</td>
<td>(pipi)</td>
<td>urine</td>
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**Tad’s first words** (Gentner, 1982)  

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<th>15</th>
<th>16</th>
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Eat veggies

Look, veggies! belief update on lexical categories.
Computational considerations

Ambiguity

Frequency

Algorithmic complexity (power set construction)

short strings first; contiguity assumption

Needed for completeness
More examples

Syntactic acquisition

Innate knowledge of morphemehood

Parameters versus statistics

Emergence of grammatical relations

There are computational alternatives to innateness
Conclusion

Computationalism cannot be confined to some naive representationalism.

We care about what representations stand for, not how they are represented.

Weak computationalism is essentially functional, because we are not in the business of constructing minds (yet),

only understanding how it works.

It is not behaviorist. We aim to understand interaction of internal processes and the external world, and task-specificity of knowledge

with as few auxiliary assumptions as possible.
*References

