

**SIMULATION OF EARLY USAGE-BASED LEXICAL ACQUISITION
IN HUMANS**

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Introduction

Broadly, there are two theories of language acquisition:

- Generativist Approach (by Noam Chomsky)
Language is not learnt but is innate
- Empiricist Approach (by Bates, Powells, MacWhinney, **Tomasello**)
Diffused with the dominant view that language emerges from social contextual use

TOMASELLO'S THEORY OF USAGE-BASED LANGUAGE ACQUISITION

- Language acquisition as context-driven statistical abstractions
- Grammar rules partly syntactic but also semantic
The words are mapped onto intentions- the words 'pick a ball' are associated with the act of picking a ball – later on the intentions are communicated by reverse mapping.
- Innate cognitive abilities for language acquisition are not language specific, but the usual abilities of:
 - Intention inference
 - Pattern finding
 - Predisposition toward social communication

What this simulation does?

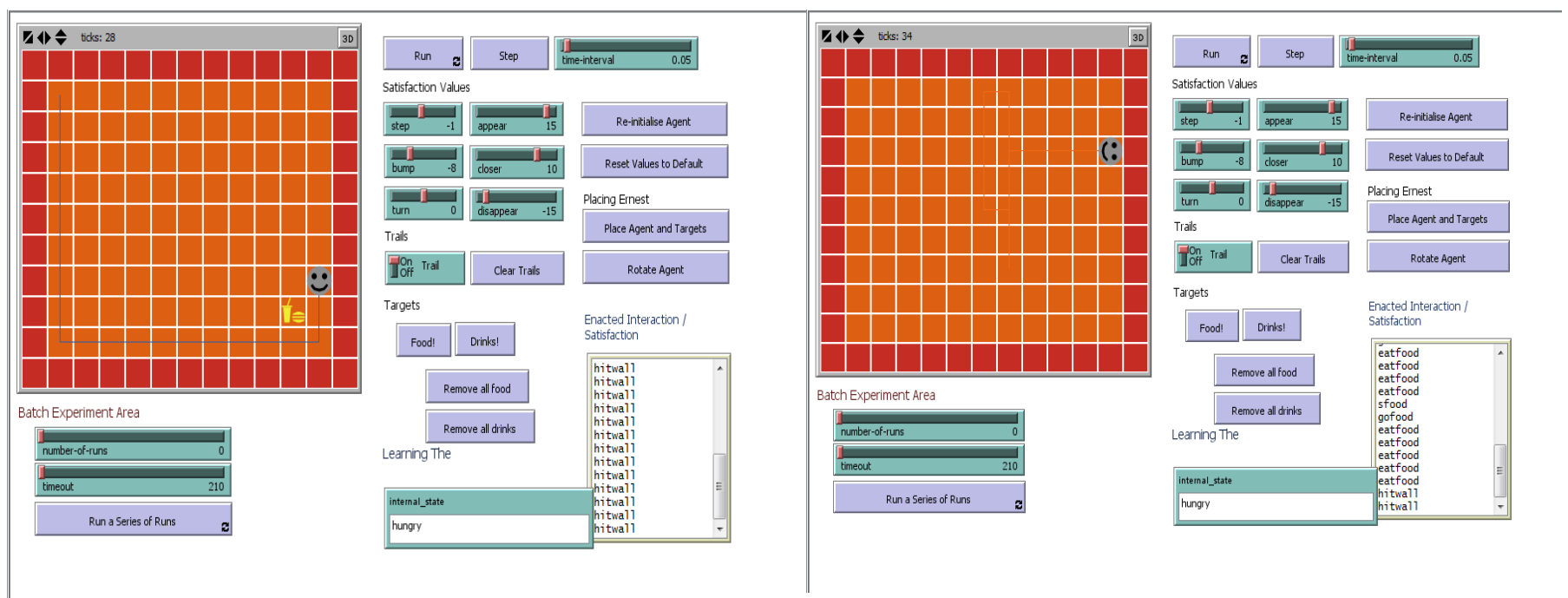
This simulation demonstrates language acquisition in an agent by following Tomasello's theory of usage-based language acquisition. Which is to say, that the agent detects the co-occurrence of linguistic symbols - in the narrative which describes its interactions with the objects in the environment – with its interactions and environments.

This is much like the learning of language in infants who pick up words like “water”, “balls” from their parents speech when they interact with these objects.

Setup and Procedures

Artificial agent: ERNEST (modeled by Georgeon, Ritter)

It has intrinsic motivations and is capable of few primitive actions in a grid-environment:
Step, Turn, See



In my environment for the purpose of language-learning I define four interactions for Ernest which are grounded in its motor-visual space through concurrent satisfaction values:

- Hitting the walls
- Smell the food
- Going towards food
- Eating food

So, whenever any of these interactions are made by Ernest, a sentence is ‘narrated’ to it describing its interaction. For each interaction there are 25 representative sentences in the database

For example, when it is going towards the food, “Are you going to get food?” or “Ernest go get food.” are read by it.

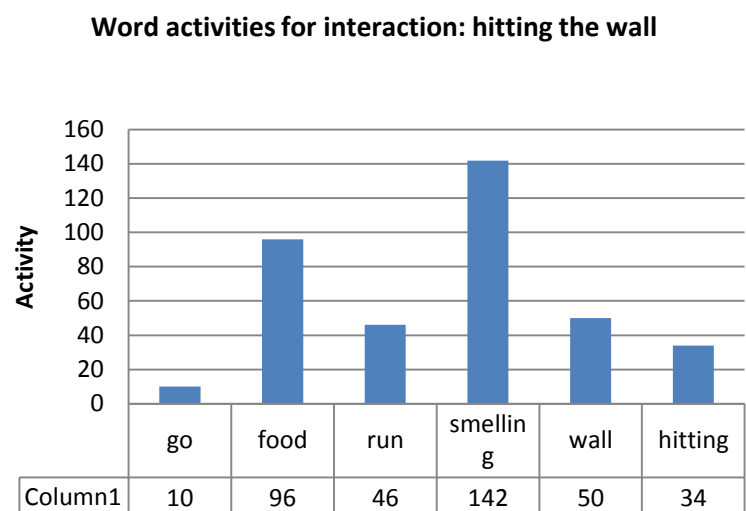
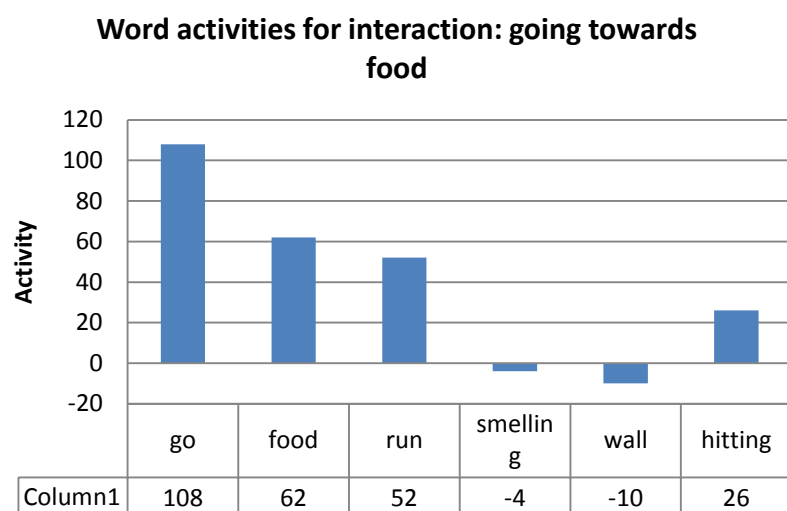
For any trial 220 such interactions are made and then the words in these sentences are associated to the grounded interactions through a Hopfield Network.

Results

- Most likely words associated with an interaction

Hit the wall	Smell food	Go to food	Eat food
Wall	Smell	Get	Eat
Hit	Smelling	Go	Eating
Slow	Nice	Food	Finishes
Careful	Sweet	Going	Quickly
Stop	Smells	Towards	Eats

- The activities of different words in different interactions



- **CONTEXT-BASED LEARNING**

- The words are activated only in the context in which they are grounded.
- For example:
 - “What will momma buy?” when given with no context the answer is “null”.
 - However when the same question is asked in context that Ernest is “eating” the answer is “cotton candy”
 - “Where are you going?” when given with no context, doesn’t give any salient word responses
 - The same question when asked while Ernest is going towards food, gets the response “almost towards food”
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Conclusion

So, this simulation implements Tomasello's usage-based language acquisition successfully.

- Words are grounded in perceptions/actions, as well as associated with each other in a context dependent manner
- The semantics of words are inferred much before syntax is learnt.
- No cognitive ability specific to language is employed, instead the usual cognitive abilities of pattern recognition and intention inference assist in language learning

References

Georgeon, O. L., & Ritter, F. E. An intrinsically-motivated schema mechanism to model and simulate emergent cognition. *Cognitive Systems Research* (2011), doi:10.1016/j.cogsys.2011.07.003

<http://e-ernest.blogspot.in/>

Cowie, Fiona, "Innateness and Language", *The Stanford Encyclopedia of Philosophy* (Summer 2010 Edition), Edward N. Zalta (ed.)

Tomasello, Michael. "First steps toward a usage-based theory of language acquisition." *Cognitive Linguistics* 11.1/2 (2000): 61-82.

Cangelosi, Angelo, et al. "Integration of action and language knowledge: A roadmap for developmental robotics." *Autonomous Mental Development, IEEE Transactions on* 2.3 (2010): 167-195.

Salvi, Giampiero, et al. "Language Bootstrapping: Learning Word Meanings From Perception–Action Association." *Systems, Man, and Cybernetics, Part B: Cybernetics, IEEE Transactions on* 42.3 (2012): 660-671.