Language Emergence for Activities

CS 499 B.Tech Project

Manas Agarwal

Under Dr. Amitabha Mukerjee
Department of Computer Science and Technology
Indian Institute of Technology, Kanpur

Outline

The Problem Area

- Language Emergence and Development
- Action learning and Verbs

The Problem Area

- Language Emergence and Development
- Action learning and Verbs

Language Emergence

- Many theories to explain formation of language structures
- Based on exploiting regularities in interaction with natural world
- Investigated using multi-agent models like **Language Games**

Language Emergence

- Many theories to explain formation of language structures
- Based on exploiting regularities in interaction with natural world
- Investigated using multi-agent models like **Language Games**

Language Emergence

- Many theories to explain formation of language structures
- Based on exploiting regularities in interaction with natural world
- Investigated using multi-agent models like **Language Games**

Language Game

- by Vogt and Steels [1]
- Multi-agent models
- Object identification and Naming

Language Game

- by Vogt and Steels [1]
- Multi-agent models
- Object identification and Naming

Language Game

- by Vogt and Steels [1]
- Multi-agent models
- Object identification and Naming

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- One generation transmits their language to next generation.
- Played by two agents at a time:
  - Speaker
  - Hearer
- Speaker from older generation
- Hearer from newer generation

Language Game

- Agents *make* contact
- Agents *categorize* sensory experience of objects
- Speaker *encodes* feature set into expressions
- Hearer *decodes* the expression from its lexicon
- Hearer compare the decoded features with the expected ones. Positive *feedback* if successful.

Language Game

- Agents *make* contact
- Agents *categorize* sensory experience of objects
- Speaker *encodes* feature set into expressions
- Hearer *decodes* the expression from its lexicon
- Hearer compare the decoded features with the expected ones. Positive *feedback* if successful.

Language Game

- Agents *make* contact
- Agents *categorize* sensory experience of objects
- Speaker *encodes* feature set into expressions
- Hearer *decodes* the expression from its lexicon
- Hearer compare the decoded features with the expected ones. Positive *feedback* if successful.

Language Game

- Agents *make* contact
- Agents *categorize* sensory experience of objects
- Speaker *encodes* feature set into expressions
- Hearer *decodes* the expression from its lexicon
- Hearer compare the decoded features with the expected ones. Positive *feedback* if successful.

Language Game

- Agents *make* contact
- Agents *categorize* sensory experience of objects
- Speaker *encodes* feature set into expressions
- Hearer *decodes* the expression from its lexicon
- Hearer compare the decoded features with the expected ones. Positive *feedback* if successful.

Language Game

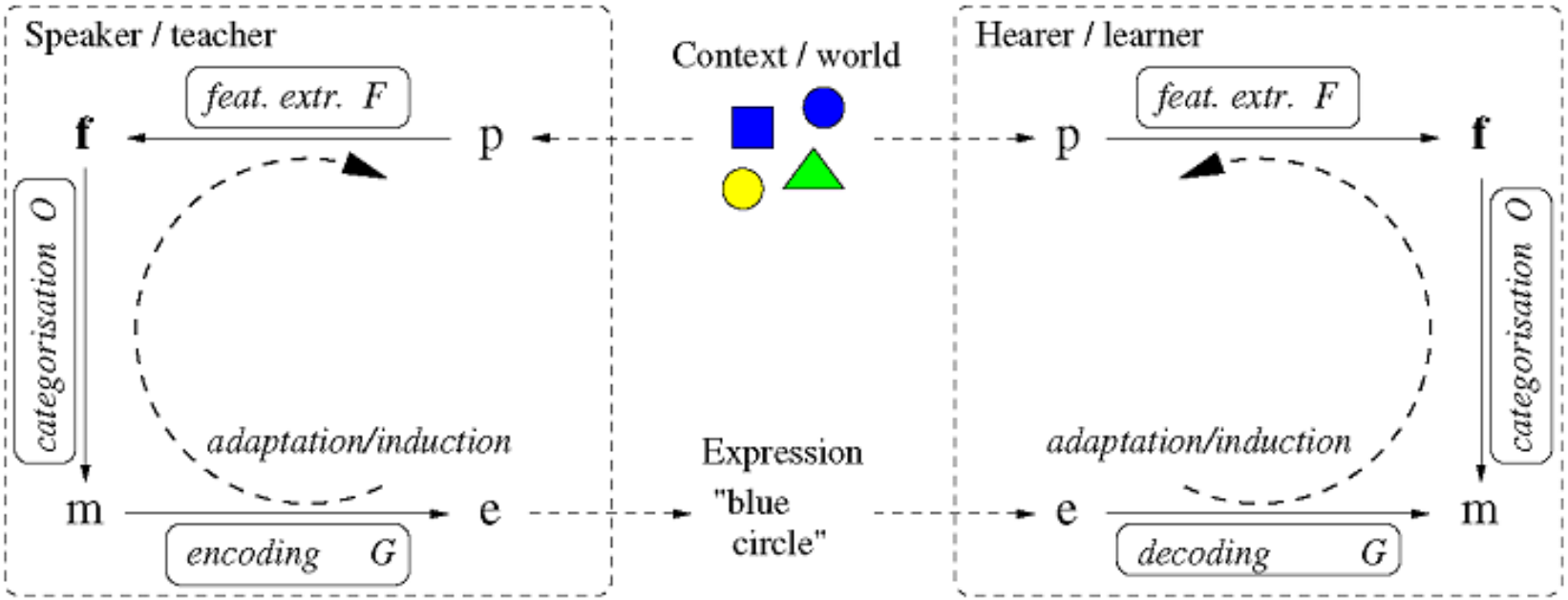

Figure: The Naming game processes used by Vogt. On the left are speaker's processes and on the left are hearer's processes. Between them are the feedback processes.

Language Game

- Framework to model cultural transmission of languages [5].

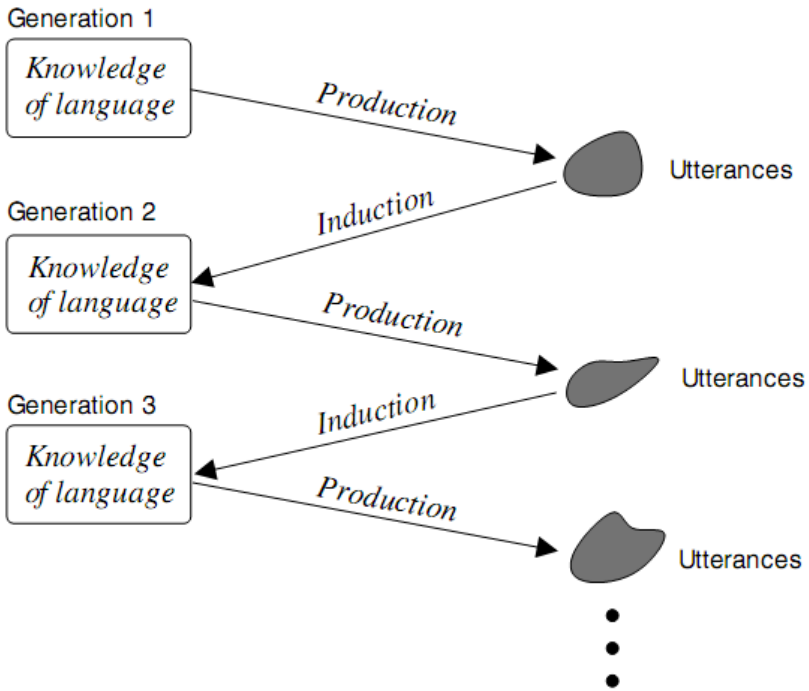

Figure: Iterative Learning Model

Language Game

- Novel users learn from adult users.
- After some number of games, adults leave, replaced by new users.
- This iteration continues.

Language Game

- Novel users learn from adult users.
- After some number of games, adults leave, replaced by new users.
- This iteration continues.

Language Game

- Novel users learn from adult users.
- After some number of games, adults leave, replaced by new users.
- This iteration continues.

Learning for Activities

- It has been seen that infants build their concepts more on dynamic scenes [4].
- Verbs are essential, provide meaning to sentences.
- *Vogt* work limited to noun learning.
- our model aim to learn verb emergence

Learning for Activities

- It has been seen that infants build their concepts more on dynamic scenes [4].
- Verbs are essential, provide meaning to sentences.
- *Vogt* work limited to noun learning.
- our model aim to learn verb emergence

Learning for Activities

- It has been seen that infants build their concepts more on dynamic scenes [4].
- Verbs are essential, provide meaning to sentences.
- *Vogt* work limited to noun learning.
- our model aim to learn verb emergence

Learning for Activities

- It has been seen that infants build their concepts more on dynamic scenes [4].
- Verbs are essential, provide meaning to sentences.
- *Vogt* work limited to noun learning.
- our model aim to learn verb emergence

Learning Activities

- Our language game consists of a two-body interaction sequence.
- The actions have been modeled on maps for verbs given by *Cohen* [3].

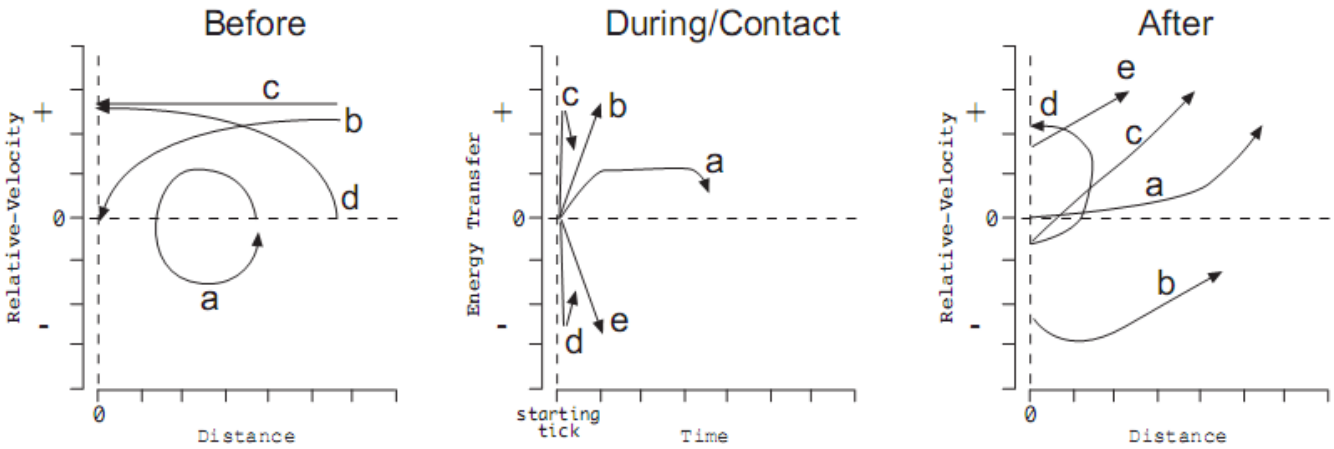

Figure: Push, Shove, Hit, Harass, Bounce, Counter-shove, Chase

Learning Activities

- Our language game consists of a two-body interaction sequence.
- The actions have been modeled on maps for verbs given by *Cohen* [3].

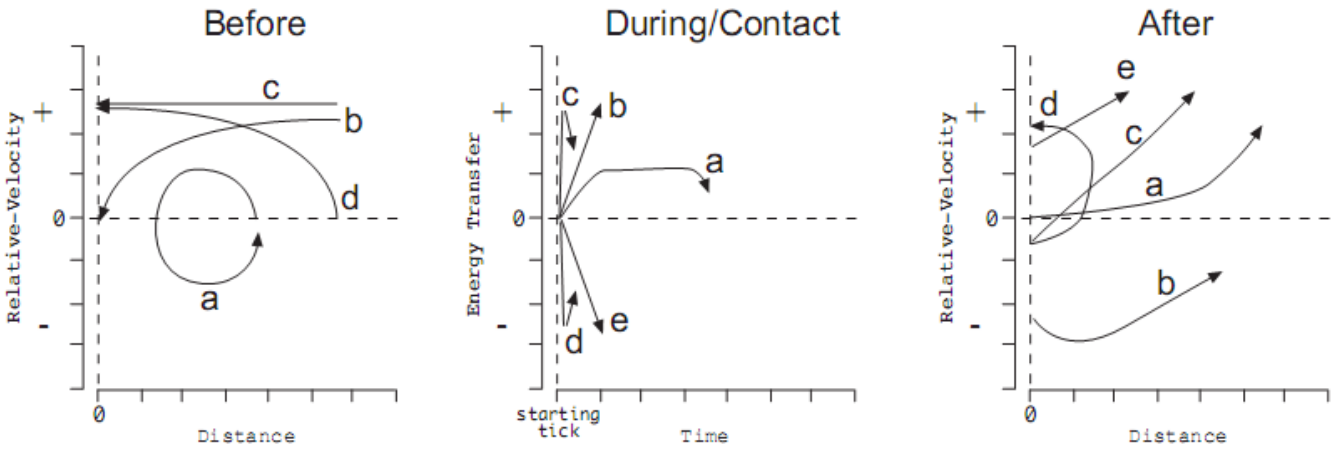

Figure: Push, Shove, Hit, Harass, Bounce, Counter-shove, Chase

Learning for Activities

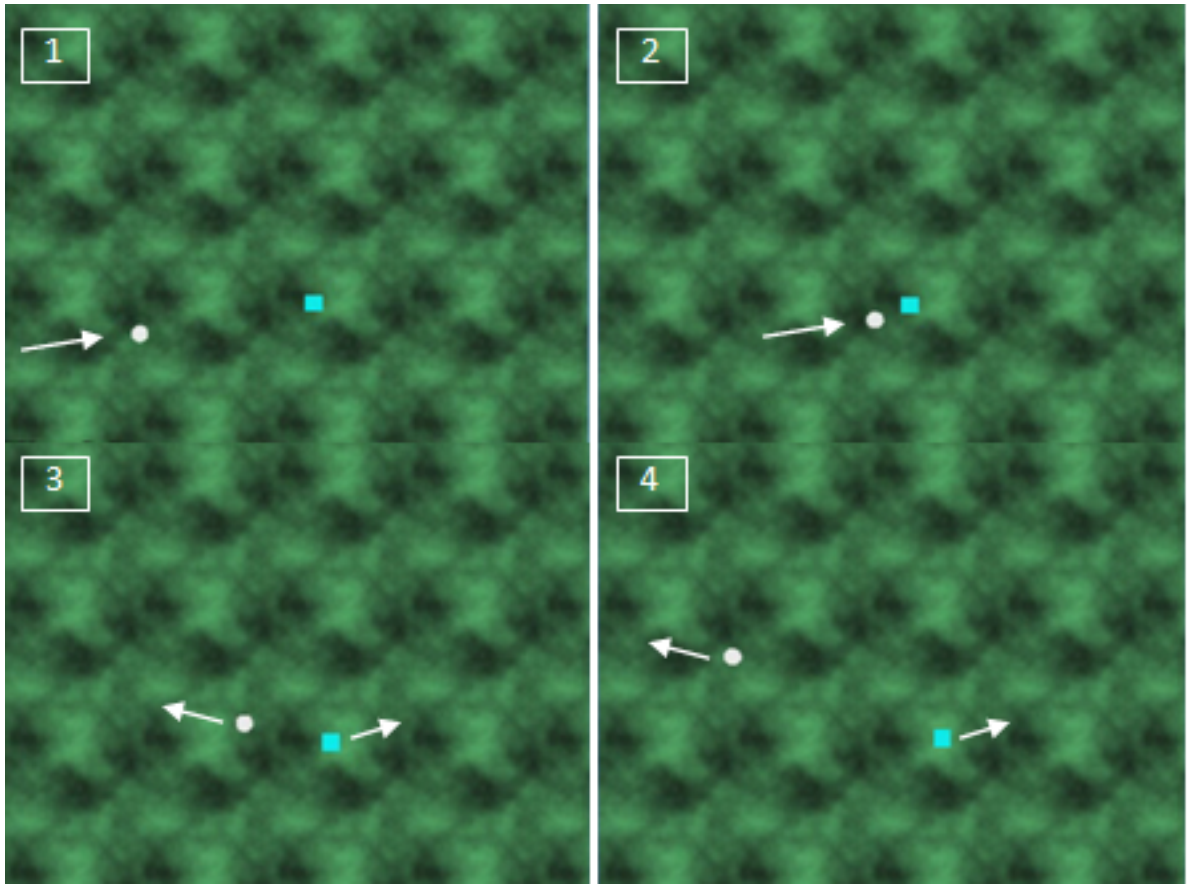

Figure: A Sequence for Bounce

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Learning Activities

- *Satish* Model [2].
- Unsupervised Learning
- Merge Neural Gas Algorithm
- Input signals used are:
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} - \vec{v_A})$
  - $(\vec{x_B} - \vec{x_A}) \cdot (\vec{v_B} + \vec{v_A})$

Results

	C1	*C2*	*C3*	*C4*	Total	% Accuracy
Bounce	1888	42	51	19	2000	94.4%
Push	20	1933	15	32	2000	96.6%
Hit	91	30	1841	32	2000	92.1%
Harass	12	27	34	1927	2000	96.4%

Figure: Clustering Results

Results

Words	Verb	Score of Last Speaker	Score of Last Hearer
"geda"	Bounce	0.98	0.96
"cabe"	Bounce	0.42	0.23
"defe"	Bounce	0.13	0.11
"dega"	Hit	0.96	0.92
"feged"	Hit	0.28	0.16
"dace"	Push	0.96	0.89
"gabe"	Push	0.34	0.26
"daceg"	Harass	0.92	0.92
"cebag"	Harass	0.23	0.17

Figure: Lexicons and their Scores

Results

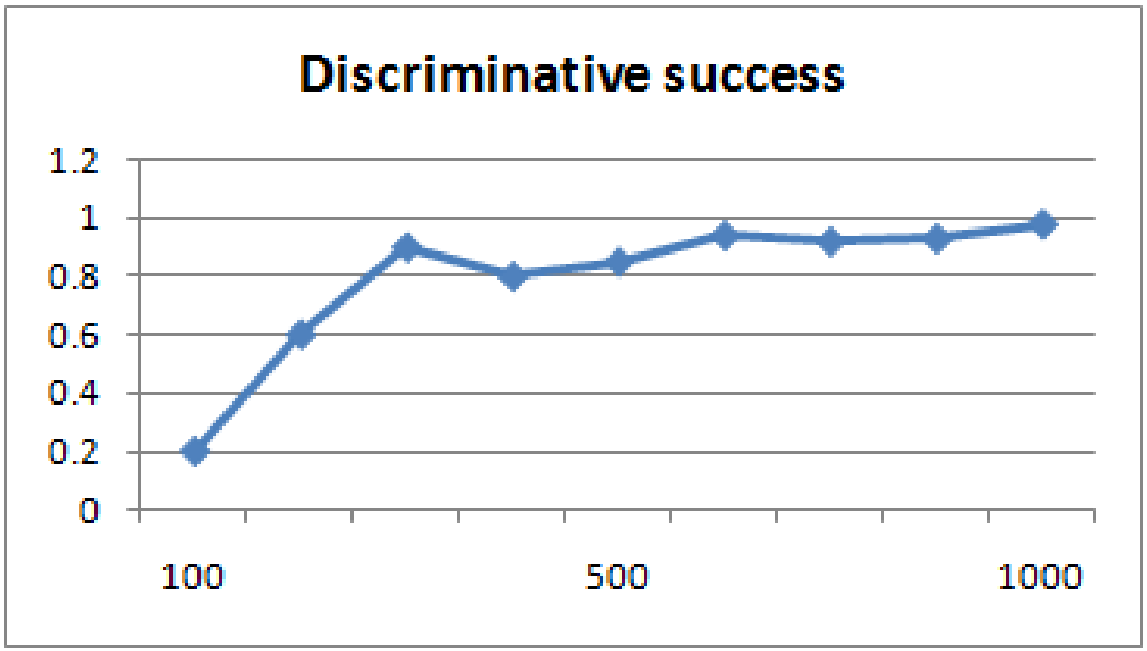

Figure: Discriminative success plot

Reference

1. Steels, L. and Vogt, P. , *Grounding adaptive language games in robotic agents.*
2. Brighton,H., Kirby,S. and Smith,K. , *Situated cognition and the role of multi-agent models in explaining language structure.*
3. Cohen,P.R.,Morrison,C.T. and Cannon,E., *Maps for verbs: The relation between interaction dynamics and verb use.*
4. Satish,G. and Mukerjee,A. , *Acquiring linguistic argument structure from multimodal input using attentive focus.*
5. Mandler, J. *Actions organize the infant's world. In Action Meets Word: How Children Learn Verbs.*

Reference

1. Steels, L. and Vogt, P. , *Grounding adaptive language games in robotic agents.*
2. Brighton,H., Kirby,S. and Smith,K. , *Situated cognition and the role of multi-agent models in explaining language structure.*
3. Cohen,P.R.,Morrison,C.T. and Cannon,E., *Maps for verbs: The relation between interaction dynamics and verb use.*
4. Satish,G. and Mukerjee,A. , *Acquiring linguistic argument structure from multimodal input using attentive focus.*
5. Mandler, J. *Actions organize the infant's world. In Action Meets Word: How Children Learn Verbs.*

Reference

1. Steels, L. and Vogt, P. , *Grounding adaptive language games in robotic agents.*
2. Brighton,H., Kirby,S. and Smith,K. , *Situated cognition and the role of multi-agent models in explaining language structure.*
3. Cohen,P.R.,Morrison,C.T. and Cannon,E., *Maps for verbs: The relation between interaction dynamics and verb use.*
4. Satish,G. and Mukerjee,A. , *Acquiring linguistic argument structure from multimodal input using attentive focus.*
5. Mandler, J. *Actions organize the infant's world. In Action Meets Word: How Children Learn Verbs.*

Reference

1. Steels, L. and Vogt, P. , *Grounding adaptive language games in robotic agents.*
2. Brighton,H., Kirby,S. and Smith,K. , *Situated cognition and the role of multi-agent models in explaining language structure.*
3. Cohen,P.R.,Morrison,C.T. and Cannon,E., *Maps for verbs: The relation between interaction dynamics and verb use.*
4. Satish,G. and Mukerjee,A. , *Acquiring linguistic argument structure from multimodal input using attentive focus.*
5. Mandler, J. *Actions organize the infant's world. In Action Meets Word: How Children Learn Verbs.*

Reference

1. Steels, L. and Vogt, P. , *Grounding adaptive language games in robotic agents.*
2. Brighton,H., Kirby,S. and Smith,K. , *Situated cognition and the role of multi-agent models in explaining language structure.*
3. Cohen,P.R.,Morrison,C.T. and Cannon,E., *Maps for verbs: The relation between interaction dynamics and verb use.*
4. Satish,G. and Mukerjee,A. , *Acquiring linguistic argument structure from multimodal input using attentive focus.*
5. Mandler, J. *Actions organize the infant's world. In Action Meets Word: How Children Learn Verbs.*