



Universiteit
Leiden

The Netherlands

Collaborative meaning-making: the emergence of novel languages in humans, machines, and human-machine interactions

Kouwenhoven, T.

Citation

Kouwenhoven, T. (2025, October 30). *Collaborative meaning-making: the emergence of novel languages in humans, machines, and human-machine interactions*. SIKS Dissertation Series. Retrieved from <https://hdl.handle.net/1887/4281976>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/4281976>

Note: To cite this publication please use the final published version (if applicable).

Collaborative Meaning-Making

The Emergence of Novel Languages in Humans, Machines,
and Human-Machine Interactions

Tom Kouwenhoven

Collaborative Meaning-Making

The Emergence of Novel Languages in Humans, Machines,
and Human-Machine Interactions

Proefschrift

ter verkrijging van
de graad van doctor aan de Universiteit Leiden,
op gezag van rector magnificus prof.dr.ir. H. Bijl,
volgens besluit van het college voor promoties
te verdedigen op donderdag 30 oktober 2025
klokke 13:00 uur

door Tom Kouwenhoven

geboren te Nijmegen

in 1995

Promotor:

Prof.dr. S.A. Raaijmakers

Co-promotores

Dr. T. Verhoef

Dr.ir. R.E. de Kleijn

Promotiecommissie:

Prof.dr. M.M. Bonsangue

Prof.dr. K.J. Batenburg

Prof.dr. G. Lupyan

(University of Wisconsin–Madison)

Prof.dr. R. Verbrugge

(Rijksuniversiteit Groningen)

Dr. L.P.A. Galke

(University of Southern Denmark)

Dr. F.H. Poletiek

Keywords: Language Evolution, Human-Machine collaboration, Grounding, Large Language Models

Cover by: OpenAI and Alice Mulder.

SIKS Dissertation Series No. 2025-47

The research reported in this thesis has been carried out under the auspices of SIKS, the Dutch Research School for Information and Knowledge Systems.



Copyright © 2025 Tom Kouwenhoven. All rights reserved.

Preface

“Without Practice, No Emergence

‘To know’ and ‘to understand’ are different.

*Even though we know, without putting that knowledge to practice,
we cannot understand.”*

—Daihonzan Eiheiiji temple, Japan 2022

One of the benefits of being a scholar is that you get to travel to all kinds of places around the world. It was during my first-ever conference on language evolution that I had the pleasure of visiting the Daihonzan Eiheiiji monastery in Japan. A truly unique and memorable experience which is difficult to put into words really. You must have been there to understand the feeling. It was here that this one excerpt out of the 14 teachings exposed in the corridor caught my eye. These teachings were related to the beliefs important in that monastery, but for me, these words encompass almost perfectly what language evolution is, and so I take the liberty of sharing my interpretation before diving into the scientific part.

What it means for me, in light of this thesis, is that interactions (i.e., practice) cannot be underestimated when it comes to the making of new words (i.e., emergence) and understanding language. Languages obtain meaning when we put them into practice; when we interact and use our knowledge of our language to understand the meanings of each other.

Contents

1	Introduction	1
1.1	Background	2
1.2	Dissertation design	15
2	Grounding and the Need for Structure	27
2.1	Introduction	28
2.2	Background	29
2.3	Current study	31
2.4	Methods	31
2.5	Results	32
2.6	Discussion	36
2.7	Conclusion	38
3	Computationally Modelling Human Emergent Communication	39
3.1	Introduction	40
3.2	Background	41
3.3	Methods	43
3.4	Modelling human sequential behaviour	46
3.5	Discussion	49
3.6	Conclusion	50
4	Kiki or Bouba?	51
4.1	Introduction	52
4.2	Background	54
4.3	Methods	57
4.4	Results	59
4.5	Discussion	64

4.6	Conclusion	65
4.7	Limitations	65
5	The Curious Case of Representational Alignment	67
5.1	Introduction	68
5.2	Background	70
5.3	Representational alignment	71
5.4	Methods	72
5.5	Results	76
5.6	Discussion	79
5.7	Conclusion	82
5.8	Limitations	82
6	Searching for Structure	85
6.1	Introduction	86
6.2	Background & Related work	87
6.3	Methodology	89
6.4	Evaluation	93
6.5	Results	93
6.6	Iterated learning	97
6.7	Discussion	99
6.8	Conclusion	101
7	Shaping Shared Languages	103
7.1	Introduction	104
7.2	Background	105
7.3	Methodology	108
7.4	Evaluation	111
7.5	Results	112
7.6	Discussion	115
7.7	Conclusion	117
8	Conclusions	119
8.1	Answers to Research Questions	120
8.2	Reflection	127

A Kiki or Bouba?	133
A.1 Full set of images	133
A.2 GPT-4o prompting	134
A.3 GPT-4o pseudoword probabilities	135
B The Curious Case of Representational Alignment	137
B.1 Channel capacity	137
B.2 Interaction between the alignment term and cross-entropy	139
B.3 Pre-trained vision modules	140
C Searching for Structure	143
C.1 Additional results iterated learning	143
C.2 Prompts	143
D Shaping Shared Languages	149
D.1 Prompts	149
D.2 Generalisation to novel stimuli	153
D.3 Testing additional LLMs	153
Bibliography	157
Summary	182
Samenvatting	184
Acknowledgements	186
List of publications	189
Curriculum Vitae	191
SIKS dissertation series	193