Compositionality as one of the enabling factors to communicate conceptualized meaning

Ibuki Iwamura[*1], Hayate Funakura[2], and Takashi Hashimoto[1]

[*]Corresponding Author: ibuki_iwamura@jaist.ac.jp
[1]Graduate School of Advanced Science and Technology, Japan Advanced Institute of Science and Technology, Nomi, Japan
[2]Graduate School of Human and Environmental Studies, Kyoto University, Kyoto, Japan

1. Introduction

Humans linguistically communicate their conceptualized meanings that do not simply refer to the external world (Langacker, 2001, 2002, 2014). People may differently conceptualize the same objective event and reflect the different conceptualizations in linguistic forms. Thus, the meaning of a form is not uniquely determined only from the objective external event. Those who have not acquired how to reflect conceptualization in forms have difficulty in inferring the speaker's subjective conceptualized meanings.

The iterated learning model (ILM), a model for cultural evolution of compositional language simulating intergenerational transmission (Kirby, 2002, among others), does not treat conceptualized meanings since it posits that forms refer to external events. Further, listener agents in ILM receive complete information about both meanings and forms. It is not obvious whether compositionality evolves when conceptualized meanings are communicated as actual linguistic communication. While learners in a holistic language world cannot understand mappings between speaker's conceptualized meanings and holistic forms, compositionality may facilitate learners to infer the mapping.

In this study, we investigate under what condition compositional language is transmitted via a process of cultural evolution when agents can reflect their own conceptualized meaning in forms.

2. Model and Experiment

We simplified the ILM, which is based on definite clause grammar proposed by Kirby (2002), with limited number of letters, 3, and added the conceptualized

meaning as agent's internal variable and the ability to reflect it in forms. The conceptualized meaning is represented by a variable added to the semantic representation of predicate-argument structure, $p(\alpha_1, \alpha_2)/CV$ where p is a predicate, α_1 and α_2 are arguments, and CV signifies the conceptualized meaning, which takes only binary values, 0 or 1, for simplicity. Note that this simplification holds the essence of conceptualization since binary options such as active/passive voices and special relationships like "A on B/B below A" are not determined objectively by external events but are decided subjectively through language users' conceptualization. Supposing shared intentionality, learner agents perceive invisible speaker's CV at a certain probability, set as 0.8 in our experiment. The finite semantic space comprised 200 predicate-argument structures (excluding reflexivity), composed of 5 predicates (transitive verbs) and 5 individuals expressing external events, the binary CVs (200 = 5*5*4*2). The learner was exposed to half of the input data (100/200) as bottleneck. We performed experiments with varying degrees of compositionality of the initial language and observed the transition of topological similarity (TopSim), as a measure of compositionality (Brighton, Smith, & Kirby, 2005). We found that the high TopSim did not necessarily ensure the stable transmission of compositional conceptualized language. We also observed a sudden accidental decline of TopSim at certain generation, where agent had linguistic knowledge with weak expressivity and multiple distinct rules for a single meaning-form pair. This means that even if similar meanings, that is, one different element in predicate-argument structures, are mapped to similar forms, the production processes may largely differ. TopSim cannot represent this difference, indicating an issue in it.

3. Discussion

Humans conceptualize objective events from their own perspectives and reflect their conceptualized meanings in forms. Compositionality may facilitate learner or listener to infer the mapping between speaker's subjective conceptualized meaning and linguistic form. Thus, compositionality may work as a scaffold for evolving language that allows for communicating conceptualized meaning. However, as our result shows, a high degree of compositionality is not sufficient for transmission of a linguistic system with conceptualized meanings. Additionally, we point out the problem of TopSim in terms of conceptualized meaning. TopSim represents the correlation between the similarity among the objective meanings and that among the linear forms. Using TopSim as a compositionality measure presents at least two problems. One is that the calculation of TopSim does not consider the conceptualized meaning, so we here had to calculate it for each CVs separately. The second is that it assumes that in compositional languages similar forms correspond to similar meanings. However, when conceptualized meanings are reflected to forms in a language, as the change of linear order are often observed in natural languages, two different forms correspond to a single objective meaning, which causes decline in TopSim even if the language is compositional.

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