

FOUNDATIONAL PROPERTIES OF COMMUNICATIVE SYSTEMS

Alexander Porto

Summary of Dissertation Proposal

Spring 2025

Committee:

Dr. Alex Kranjec (Chair)

Dr. Elizabeth Fein

Dr. Christine Cuskley (Newcastle University)

Dr. Marcus Perlman (University of Birmingham)

Abstract

The purpose of this dissertation is to study foundational properties of communicative systems. I provide a framework for experimentally reconstructing of the evolution of language, albeit in reverse-order. I open the dissertation by building a bridge between cognitive linguistics and key movements in the history of philosophy of language. I then experimentally validate this bridge using state-of-the-art, cross-methodological techniques from computational cognitive science, linguistics, and philosophical analysis. In Study 1, I address visual complexity in writing systems. Specifically, I provide a way to metricize angularity across a diverse range of glyphs in current use throughout the world. In Study 2, I explore iconic mappings between non-semantic vocal utterances and glyphs from different writing systems; I show that glyph roundness is a reliable predictor of back vowel mappings and that angularity is a reliable predictor of consonant mappings. In Study 3, I study if and how persons spontaneously produce sound-shape iconic drawings when prompted with non-semantic vocal utterances. Last, in Study 4, I invent a means to test if and how persons produce constrained, rapidly fading, and digitally-synthesized vocal utterances to interlocutors. The purpose is to see if and how persons produce spontaneous semanticity: rapidly-fading micro-languages that contain pattern-governed, transmissible signals in order to inferentially navigate an environment. In so doing, it is my hope to contribute to knowledge about how our inferentially-entrenched situated conceptualizations have linguistically evolved over time.

Keywords: language evolution, cognitive linguistics, philosophy of language, dynamic experiments, semanticity, pragmatics

Outline

1. Philosophical Background: Inference, Language, and Situated Conceptualization

Abstract: The purpose of this section is to exercise a philosophical lesson about the role of linguistic inference in cognitive science accounts of conceptualization. I argue that while it makes good sense to endorse the idea that our conceptual scheme comes about through a complex, multimodal, contextual, and simulative process of what Barsalou calls *entrenched situated conceptualization*, it nonetheless requires a linguistically-articulated inferential framework to get off the ground. I defend the thesis that the cognitive process of entrenched situated conceptualization requires a transposition into inference-first terms. I do this by showing that we can engage in contextual simulated cognition if and only if we have a normative conceptual repertoire, a common ground; and that we can establish common ground if and only if our cognitive processes that afford representational capacities are seen as a way of making second-order maps of an environment.

2. Study 1: Glyph Norming: Measurements of Angularity in Writing Systems

Abstract: Writing systems are an underused source of stimuli for behavioral and computational experiments in cognitive psychology, psycholinguistics, and anthropology, despite being ecologically relevant, and systematically different in shape, structure, and orientation. One possible reason that glyphs of writing systems are not commonly used in behavioral research concerns their profound complexity. Yet, recent developments in computer vision offer tools to automatically assess their visual dimensions. This study describes an open-access database of 3,208 glyphs from diverse writing systems that have been normed by computational analyses in terms of shape angularity using an array of measurements. I further validate these norms by obtaining human judgements of angularity for a subset of 400 glyphs and show that they correlate highly with computational measures, specially with First Order Shannon Entropy. Additionally, I provide methods for standardized glyph generation based on Unicode ranges, a straightforward example of computational shape analysis, and a demonstration of automated transliteration of glyphs from Unicode strings using a pre-existing Python library. These procedures should ease the characterization of angularity of new glyphs and any other kind of visual shape by independent researchers. The present work will be helpful to scientists working across different topics in the various cognitive science subdisciplines.

3. Study 2: Sound Symbolism Across Diverse Writing Systems

Abstract: It is now well-established that the visual features of objects influence the sounds we make to refer to them. This is called *sound symbolism*. I present a two-part study that explores the extent to which the visual features of writing systems correspond to the smallest spoken units of language. Participants ($n = 152$) were prompted to select either a round or angular glyph after hearing one of two kinds of phonemes (vowel or consonant) from the International Phonetic Alphabet. Results from a logistic regression suggest that the type of sound had a significant effect on the choice of glyph, and that vowel sounds increased the marginal likelihood of choosing round glyphs by 30%. The significant correlation between what subjects heard and their choice of glyph suggests that the effect may extend to such sound symbolic relations in real-world writing systems.

4. Study 3: Spontaneous Production of Sound Symbolic Drawings

Abstract: The purpose of Study 3 is to test the extent to which persons spontaneously produce sound symbolic drawings (via shape:sound iconic mappings) in time-limited response to very short speech-like but non-semantic vocal utterances. Study 3 was delivered along with Study 2 to the same participant pool ($n = 152$); participants completed Study 3 prior to Study 2 in order to reduce association and priming with glyphs. I predict that: (1) vowel sounds would result in drawings with greater curvature than consonant sounds and (2) that back vowels would result in drawings with greater curvature than front vowels. So, the overall task of this study is to understand if and to what extent there is a meaningful and spontaneous relationship between speech sounds and the shape of persons' drawings. The hope is to attempt to model the invention of an orthographic system based on short vocal utterances and to test if and how such a system would be iconic in sound-form mappings.

5. Study 4: Spontaneous Semanticity in Dyadic Interactions

Abstract: The purpose of this study is to test if *spontaneous semanticity* emerges in real-time in dyads of artificial language users. I introduce *spontaneous semanticity* as a concept to capture a two-fold idea: that language requires the capacity for spontaneous variation and innovation between users in order to maintain continuous communicative alignment. The basic idea is that, in order for agents to communicate, there needs to be finite, mutually-intelligible patterns (in the broad sense: utterances or gestures that can be used and re-used); however, communication likewise requires spontaneity (the real-time revision of rules in light of novel contextual demands) in order to maintain a continuously aligned conceptual common ground between agents. The point is that semanticity—the capacity of a form to carry meaning across users—follows distinct patterns that are nevertheless flexible across and between different contexts. I am interested in exploring if and how iconic mappings, systematicity, and compositionality emerge in the bottom-up creation of an artificial language in and across real-time dyadic communicative interactions. Additionally, I am interested in seeing if within-dyad patterns hold at an across-dyad level in order to see if iconic categorization occurs at a more general communicative level. I will test this using an *iterated learning* experimental design for the production and reproduction of a highly constrained artificial language. This work is distinct from other iterated learning experiments because participants will be tasked with producing a full-fledged micro-language from scratch, as opposed to learning parts of an artificial language with pre-defined semantic labels. In the end, I hope to provide an account of how persons produce constrained, rapidly fading, and digitally-synthesized vocal utterances to interlocutors. The purpose is to see if and how persons produce spontaneous semanticity: rapidly-fading micro-languages that follow pattern-governed, transmissible signals in order to inferentially navigate an environment.