A GAME-BASED FRAMEWORK FOR STUDYING THE EMERGENCE AND DYNAMICS OF SHARED CONVENTIONS

Christine Cuskley*[1,2] and Simon Kirby[2]

*Corresponding Author: chrstine.cuskley@ncl.ac.uk
[1]Linguistics Centre for Behaviour and Evolution, Newcastle University, Newcastle upon Tyne, UK
[2]Centre for Language Evolution, University of Edinburgh, UK

Gamification in behavioural experiments has become a familiar tool, particularly to study the evolution of language (e.g., Fay, Garrod, Roberts, & Swoboda, 2010; Selten & Warglien, 2007; Irvine & Roberts, 2016). This is mainly approached in two different ways: either by framing the task as a game, introducing game mechanics (e.g., points or rewards), and/or introducing superficial but alluring visual elements which make the task "look" more like a game (Lieberoth, 2015). Recently, Morin et al. (2018) describe the first large-scale attempt to integrate all three of these approaches using *The Colour Game*. Although results are still forthcoming, the game involves a director-matcher style task with colour meanings (represented by swatches) and a pre-specified set of graphical symbols as forms. Much like earlier graphical communication experiments, the explicit goal in the game is to communicate a pre-specified meaning successfully to a partner. However, the scale of this game was much larger, and involved participants being able to choose who they interacted with and how often they played.

Here, we extend efforts in this vein with a multi-player game which revolves around communication with unfamiliar graphical symbols (see Cuskley, 2019 for an example). The game is designed in the style of a browser-based .io game (Castello, 2018) for engaging, voluntary play from the perspective of the participants, and shares broad similarity with agent-based signalling games (Baronchelli, 2016). Players use a pre-specified set of symbols to communicate about colour, but the explicit goal of the game is not communication. Instead, individual players aim to coordinate their own internal colours. Players are embodied 'cells' in a two-dimensional 'petri dish' that can explore freely using simple movements of the mouse. Each cell has a large signal on its body which is visible to other players and can be changed at any time with a simple interface. Players begin as simple cells with only two different coloured 'organelles', and their goal is to become a more complex cell by trading organelles with other players (Figure 1).

This goal is relatively straightforward, but two features have been built into the game which provide a tacit pressure for communication to develop between players. First, the only means by which a player can acquire colours different to

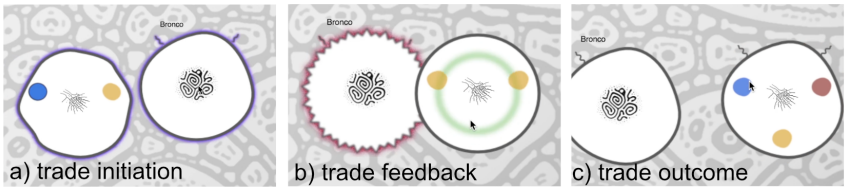

Figure 1. An interaction during game play. All players' central signals are always visible, but players' coloured organelles are only visible to them. Each panel shows a) the initiation of a trade, b) feedback animations for the trade (which resulted in a colour match for the player on the right), and c) the outcome of the trade: the left hand player has levelled up and gained antennae and an additional organelle, while the other player has lost an antenna.

the ones they already have (which is necessary to align their colours and complexify) is to trade organelles with other players. In other words, if they have a red organelle and need a blue one, they must find a player who has a blue one and needs a red one, and propose a trade. Second, a player can only see *their own* organelles, but not the organelles of other players. This means that to make effective colour trades, they need to be able to communicate which colour they are giving away, and seek out other players giving away colours they need. Thus, without the ability to use existing communication channels, players need to develop signalling strategies within the game to coordinate successful trades.

While trade interactions are fundamentally dyadic, the overall game is not: multiple players exist in the same space, and can "overhear" (oversee) interactions between other players. Animations within the game provide information about the outcome of an interaction, and are visible to any players within "eyeshot" of a trade (Fig. 1b). The game records how often players interact, who they interact with, and who else they can see, in addition to the outcomes of interactions for individual players, the signals used, and the meanings (colours) involved. Early pilots of the game with small groups of 4 show two key findings: (i) players report finding game play engaging in and of itself, and their main focus is in-game advancement rather than explicit communciation, and yet, (ii) communication is a pre-requisite for players' success (i.e., players who communicate effectively are more likely to to successfully align their colours, and level up more quickly).

We provide a detailed description of the game concept and mechanics used in these early pilots. We argue that this framework is well-suited not only to studying consensus, but divergence, cooperation and competition, naturalistic social network structure, and issues surrounding form and meaning space constraints. In short, we demonstrate specific potential for studying the emergence of language-like conventions, but also provide an open-ended 'petri dish' for experiments in cultural evolution and collective behaviour generally.

Acknowledgements

This research was supported by British Academy Postdoctoral Fellowship grant no. pf150065.

References

Baronchelli, A. (2016). A gentle introduction to the minimal naming game. *Belgian Journal of Linguistics*, *30*(1), 171–192.

Castello, J. (2018). The rise and rise of io games. In *Rock paper shotgun.* `https://www.rockpapershotgun.com/2018/02/22/the-rise-and-rise-of-io-games/`, accessed 2019-09-13.

Cuskley, C. (2019). Alien forms for alien language: investigating novel form spaces in cultural evolution. *Palgrave Communications*, *5*(1), 1–15.

Fay, N., Garrod, S., Roberts, L., & Swoboda, N. (2010). The interactive evolution of human communication systems. *Cognitive science*, *34*(3), 351–386.

Irvine, E., & Roberts, S. (2016). Deictic tools can limit the emergence of referential symbol systems. In S. Roberts, C. Cuskley, L. McCrohon, L. Barceló-Coblijn, O. Fehér, & T. Verhoef (Eds.), *The evolution of language: Proceedings of the 11th international conference (evolangx11).* Online at `http://evolang.org/neworleans/papers/99.html`.

Lieberoth, A. (2015). Shallow gamification: Testing psychological effects of framing an activity as a game. *Games and Culture*, *10*(3), 229–248.

Morin, O., Winters, J., Müller, T. F., Morisseau, T., Etter, C., & Greenhill, S. J. (2018). What smartphone apps may contribute to language evolution research. *Journal of Language Evolution*, *3*(2), 91–93.

Selten, R., & Warglien, M. (2007). The emergence of simple languages in an experimental coordination game. *Proceedings of the National Academy of Sciences*, *104*(18), 7361–7366.