Evolution of Recursive Operation in Different Cognitive Domains: A Simulation Study

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Goal-directed behavior includes not only sequential processes, but also hierarchical processes. The hierarchical process is a procedure based on recursive operation in which parts of sequence are maintained so that it can be combined with other elements and arranged to have a particular form. Recursive operation is commonly and uniquely observed in human cognitive domains such as language, arithmetic, mind-reading, music, and technology (Greenfield, 1991; Hauser et al., 2002; Arthur 2009; Fitch & Martins, 2014), is hypothesized to rely on shared neural substrates in those domains (Jackendoff, 2011; Asano & Boeckx, 2015; Fujita, 2016). However, why recursive operation emerged in those domains is still unclear. In this presentation, we aim to give insight into the evolution of the recursive operation by using evolutionary simulation. An evolutionary simulation study showed that the adaptive significance of recursive operation in object manipulation is to produce complex and diverse products (Toya & Hashimoto, 2015), in highly competitive environment for resources (Toya & Hashimoto, 2017). On the basis of those previous simulations, we will extend the model to reflect the features of each domain by including environmental parameters so that the repetitive pattern $(AB)^n$ and the embedded pattern A^nB^n, in a produced sequence are evaluated. Language is hypothesized to prefer A^nB^n over $(AB)^n$ and music the other way around. A^nB^n type seems to be more obvious for language than for music (see Rohrmeier et al., 2015 for discussions). On the other hand, the repetitive patterns is more common in music, especially in periodic metrical structure, than in language (Patel, 2008). We predict that agents with recursive operation more frequently evolve in the environment where more A^nB^n patterns have to be produced. The current simulation enables us to investigate the evolution of recursive operation in different domains in terms of different distribution of environmental parameters.

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