Bilingualism: Language and Cognition

cambridge.org/bil

Bilingual language cognition as a complex adaptive system

Nick C. Ellis

University of Michigan, Michigan, Ann Arbor, USA

Peer Commentary

Cite this article: Ellis NC (2023). Bilingual language cognition as a complex adaptive system. *Bilingualism: Language and Cognition* **26**, 31–32. https://doi.org/10.1017/S1366728922000372

Received: 28 February 2022
Accepted: 5 May 2022
First published online: 28 June 2022

Keywords:
Language as a Complex Adaptive System; 4E Cognition; Cognitive Ecology; Emergentism; Essentials of a Theory of Language Cognition

Address for correspondence:
Nick C. Ellis,
E-mail: ncellis@umich.edu

Titone and Tiv (2022) present a well-crafted, engaging, and persuasive case for a Systems Framework of Bilingualism to guide our understanding of the complex sources of sociolinguistic context that influence people's language use, development, and cognition.

It is only natural that from their beginnings both neuroscience and cognitive psychology prioritized looking inwards for their answers. In so doing, they ignored at their peril the advice of ecological psychologists to 'ask not what's inside your brain – ask what your brain is inside of'. After pursuing some early research showing developmental dyslexia involves far less cut-and-dried dissociations than the acquired disorders surface vs. deep dyslexia, like Titone and Tiv, my epiphany came from reading Rethinking Innateness (Elman, Bates, Johnson, Karmiloff-Smith, Parisi & Plunkett, 1996) – modules are made not born.

I've got to admit, it's getting better. As I explained in Essentials of a Theory of Language Cognition (Ellis, 2019), Post-Cartesian Cognitive Science sees cognition as not just "in the head": it extends well beyond the skull and the skin – it is embodied, environmentally embedded, enacted, encultured (4E Cognition). Cognition is socially distributed (Distributed Cognition and the Extended Mind hypothesis). Hutchins' Cognitive Ecology showed us how the traditional focus upon individual cognition (bounded in social space, in physical space, in time, in brain, and in mind) resulted in an attribution problem: the commitment to the notion that all intelligence is inside an inside/outside boundary forced us to cram everything inside that is required to produce the observed behaviors.

The solution is to go wild, studying language cognition, usage, and emergence in their normal social habitats as "the webs of mutual dependence among the elements of a cognitive ecosystem" (Hutchins, 2010). As Titone and Tiv acknowledge, the Douglas Fir Group (Atkinson, Byrnes, Doran, Duff, Ellis, Hall, Johnson, Lantolf, Larsen–Freeman, Negueruela, Norton, Ortega, Schumann, Swain & Tarone, 2016) encouraged such unbounded perspectives on SLA, as did earlier steps in the socio-cognitive dance following the social turn in SLA (Atkinson, 2011; Ellis, 2015; Hulstijn, Young, Ortega, Bigelow, DeKeyser, Ellis, Lantolf, Mackey & Talmy, 2014). I appreciated the aesthetics whereby Titone and Tiv (2022, Figure 1) emphasize the importance of time by adding moon phases to Douglas Fir Group (2016, Figure 1). I admire the range of sociolinguistic influences they consider and the range of data they present supporting each layer. In understanding language, it is indeed essential to consider the cognitive and the social, as Tomasello has championed: socially-extended cognition, where our mental states are partly constituted by the states of other thinkers, has origins in our enculturation (Tomasello, 1999) and in our uniquely human skills of intentionality: joint intentions, joint attention, collaboration, imitation, prosocial motives, and social norms (Tomasello, 2008). Language is the quintessence of distributed cognition.

Recognizing the multiple agents and their dynamics in a systems framework calls for whole new ways of thinking, new methods, and modelling techniques. The seeds sown in Rethinking Innateness now flourish in Emergentist Approaches (Ellis, 1998; MacWhinney, 1999; MacWhinney & O'Grady, 2015). The Five Graces Group (Beckner, Ellis, Blythe, Holland, Bybee, Ke, Christiansen, Larsen-Freeman, Croft, Schoenemann & Five Graces Group, 2009) outlined the approach as Language as a Complex Adaptive System. Complex systems research (e.g., Newman, 2011) emphasizes such factors as scale-free properties, power-law distributions, robustness, small-world phenomena, agent-based modelling, and networks. Network Science (Barabási & Pósfai, 2016) has revolutionized our understanding of social systems, of brain connectivity (Sporns, 2011) and the human connectome[1], and I believe it has important consequences for the robustness of language acquisition, showing how Plato's problem might be helped to be solved by the latent structures of language usage wherein Zipfian power-law frequency distributions of constructions present to the learner a lion's-share of basic level exemplars that are close to the prototypical meaning and central and well-connected in the semantic network (Ellis, O'Donnell & Römer, 2015; Ellis, Römer & O'Donnell, 2016). For these reasons, I encourage not just systems thinking, but complex adaptive systems thinking.

A good analogy can often help in our thinking (Hofstadter & Sander, 2013). When considering bilingualism, language and cognition, one of my favorite analogical domains is

[1]http://www.humanconnectomeproject.org/

© The Author(s), 2022. Published by Cambridge University Press

CAMBRIDGE UNIVERSITY PRESS

transportation, cars and society. When buying a used car, it's always useful to look under the hood / bonnet (AmE / BrE), to consider how old it is, how many miles are on the clock, number of prior owners, history of accidents or trauma, whether it has been regularly serviced, garaged, cherished etc. A dead battery can ruin your day, as can a traffic jam at rush hour, but in different ways. With regard to the relationship that Titone and Tiv demonstrate between their measures of language entropy and aspects of language control and/or resting state functional connectivity in bilinguals, I am reminded of EPA fuel economy statistics which give, for each make of car, separate miles-per-gallon estimates for city and highway driving. High entropy, stop-and-go urban driving uses more gas, energy, and oxygen[2]; it requires more control (consider how tired and attentionally / emotionally drained you would be after an hour of driving in a new city like Paris or London vs. an hour on the interstate); and it involves many more connections (consider the number or detail of directions a maps app requires for a ten-mile city vs interstate trip). The number and nature of edges / links / connections and their strength / carrying-capacity / bandwidth is key in social, neural, transport (…, language, and semantic) networks, as are the connectedness and centrality of the nodes they connect.

Of course, analogical thinking is only a start in generating hypotheses. The real work is in the language science that follows – in vivo, in vitro, in silico; in the lab, in the scanner, in corpora and computer models, and in the wild. I'm excited to see where these complex adaptive systems approaches will take our research.

References

Atkinson D (2011) *Alternative approaches to second language acquisition*. London: Routledge.

Atkinson D, Byrnes H, Doran M, Duff P, Ellis N, Hall JK, Johnson K, Lantolf J, Larsen–Freeman D, Negueruela E, Norton B, Ortega L, Schumann J, Swain M and Tarone E (2016) A transdisciplinary framework for SLA in a multilingual world. *Modern Language Journal*, **100**, 19–47. doi: 10.1111/modl.12301

Barabási A-L and Pósfai M (2016) *Network science*: Cambridge University Press.

Ellis NC (1998) Emergentism, connectionism and language learning. *Language Learning*, **48**, 631–664.

Ellis NC (2015) Cognitive and social aspects of learning from usage. In Cadierno T and Eskildsen SW (eds), *Usage-based perspectives on second language learning*. Berlin: DeGruyter Mouton, pp. 49–73.

Ellis NC (2019) Essentials of a theory of language cognition. *Modern Language Journal*, **103** (Supplement 2019), 39–60. doi: 10.1111/modl.12532

Ellis NC, O'Donnell MB and Römer U (2015) Usage-based language learning. In MacWhinney B and O'Grady W (eds), *The Handbook of Language Emergence*. Chichester, West Sussex: John Wiley and Sons, pp. 163–180.

Ellis NC, Römer U and O'Donnell MB (2016) *Language usage, acquisition, and processing: Cognitive and corpus investigations of construction grammar*. Malden, MA: Wiley-Blackwell.

Elman JL, Bates EA, Johnson MH, Karmiloff-Smith A, Parisi D and Plunkett K (1996) *Rethinking innateness: A connectionist perspective on development*. Cambridge, MA: MIT Press.

Hofstadter D and Sander E (2013) *Surfaces and essences: Analogy as the fuel and fire of thinking*. New York: Basic Books.

Hulstijn JH, Young RF, Ortega L, Bigelow MH, DeKeyser R, Ellis NC, Lantolf JP, Mackey A and Talmy S (2014) Bridging the gap: Cognitive and social approaches to research in second language learning and teaching. *Studies in Second Language Acquisition*, **33**.

Hutchins E (2010) Cognitive Ecology. *Topics in Cognitive Science*, **2**, 705–715. doi: 10.1111/j.1756-8765.2010.01089.x

MacWhinney B (ed.). (1999) *The emergence of language*. Hillsdale, NJ: Erlbaum.

MacWhinney B and O'Grady W (Eds.). (2015) *The handbook of language emergence*. Oxford: Wiley-Blackwell.

Newman ME (2011) Complex systems: A survey. *arXiv preprint arXiv:1112.1440*.

Sporns O (2011) *Networks of the Brain*. Boston, MA.: MIT press.

"The Five Graces Group" (Beckner C, Blythe R, Bybee J, Christiansen MH, Croft W, Ellis NC, Holland J, Ke J, Larsen-Freeman D and Schoenemann T.) (2009) Language is a complex adaptive system: Position paper. *Language Learning*, **59**(Suppl 1), 1–26. https://doi.org/10.1111/j.1467-9922.2009.00533.x

Titone DA and Tiv M (2022) Rethinking Multilingual Experience through a Systems Framework of Bilingualism. *Bilingualism: Language and Cognition*.

Tomasello M (1999) *The cultural origins of human cognition*. Boston, MA: Harvard University Press.

Tomasello M (2008) *The origins of human communication*. Cambridge, MA: MIT Press.

[2]Cf. BOLD signal

https://doi.org/10.1017/S1366728922000372 Published online by Cambridge University Press