Essentials of a Theory of Language Cognition

NICK C. ELLIS

University of Michigan, Department of Psychology, East Hall, 530 Church Street, Ann Arbor, MI 48109-1043 Email: ncellis@umich.edu

<A>ABSTRACT

Cognition is not just 'in the head;' it extends well beyond the skull and the skin. Non-Cartesian Cognitive Science views cognition as being embodied, environmentally embedded, enacted, enculturated, and socially distributed. The Douglas Fir Group (2016) likewise recognizes languages as emergent, social, integrated phenomena. Language is the quintessence of distributed cognition. Language cognition is shared across naturally-occurring, culturally-constituted, communicative activities. Usage affects learning and it affects languages, too. These are essential components of a theory of language cognition. This article summarizes these developments within cognitive science before considering implications for language research and teaching, especially as these concern usage-based language learning and cognition in second language and multilingual contexts. Here, I prioritize research involving corpus-, computational-, and psycho-linguistics, and cognitive psychological, complex adaptive system, and network science investigations of learner–language interactions. But there are many other implications. Looking at languages through any one single lens does not do the phenomena justice. Taking the social turn does not entail restricting our research focus to the social. Nor does it obviate more traditional approaches to second language acquisition. Instead it calls for greater transdisciplinarity, diversity, and collaborative work.

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/modl.12532.

<END OF ABSTRACT>

Keywords: embodiment; embeddedness; enactivism; extended mind; emergentism; usage-based approaches to language

The Douglas Fir Group (DFG; 2016) recognizes languages as emergent, social, integrated phenomena. Language cognition is shared across naturally-occurring, culturally-constituted communicative activities. Language is the quintessence of distributed cognition. Language and usage are like the shoreline and the sea. Usage affects learning, and it affects languages, too. So, our understanding of language learning requires the detailed investigation of usage, its content, its participants, and its contexts – the micro level of human social action, interaction, and conversation, the meso level of sociocultural and educational institutions and communities, and the macro level of ideological structures.

These emphases parallel theoretical developments in usage-based linguistics and in the cognitive sciences more generally. Mind is not the brain alone. Cognition is not just 'in the head'; it extends well beyond the skull and the skin. Non-Cartesian Cognitive Science views cognition as being embodied, environmentally embedded, autopoietically enacted, and socially encultured and distributed. These are essential components of any theory of language cognition.

This article summarizes these developments within cognitive science before considering implications for language research, especially as these concern usage-based language learning and cognition in second language acquisition (SLA) and multilingual contexts. Here, I prioritize research involving corpus-, computational-, and psycho-linguistics, and cognitive psychological, complex adaptive system, and network science investigations of learner–language interactions. I consider implications for teaching. Looking at languages through any one single lens does not do the phenomena justice. Taking the social turn does not entail restricting our research focus to the social. It does not limit any educational approach to naturalistic exposure. It does not

obviate more traditional approaches to SLA. Instead it calls for greater transdisciplinarity, diversity, and collaboration.

But first, some history of Cognitive Psychology and Cognitive Science, particularly as these domains relate to language, psycholinguistics, applied linguistics, and SLA, and as they have come to recognize embodiment, embeddedness, enactivism, the extended mind and distributed cognition, and emergentism.

<A>COGNITIVE PSYCHOLOGY AND COGNITIVE SCIENCE

Cognitive psychology is the scientific study of mind and of mental functions such as learning, memory, attention, perception, reasoning, motor control, skill, language, and conceptual development. Its founding goals are to determine how the mind represents the world and how it uses these representations in thinking. In the beginnings of the 'Cognitive Revolution,' the brain was viewed as a computational system, and researchers developed models of information processing and successively refined them using the experimental method.

Early classical information processing held that perception, cognition, and action were separable and that they operated in a series of stages: (a) Perception consists in input from world to mind (with the possible contribution of cognition to processing the input in such a way as to render it meaningful or useful for the subject); (b) Cognition uses this perceptual input to form a representation of how things are in the subject's environment and, through reasoning and planning that is informed by the subject's goals and desires, arrives at a specification of what the subject should do; (c) Action is the output, in the form of bodily movements, that results from this cognitive work. Reaction-time measurement (mental chronometry) was used to analyze how long each stage took (assuming serial processing stages) as well as the types of

experimental manipulation that separately affected these stages. The dual-task paradigm was used to investigate whether different abilities share mental resources or not. Cognitive psychological models based on the results of thousands, perhaps tens of thousands of such experiments became increasingly refined to allow for the possibilities of parallel or cascaded processing. The goal was to determine separable modules of processing, their specialisms, and their connectivity. These were often summarized as 'boxes and arrows' models. The evidence base was supplemented with patterns of dissociation and double-dissociation of loss of ability from single clinical cases in Cognitive Neuropsychology (Coltheart, 2001; A. Ellis & Young, 1988). The cognitive neuropsychology of language was particularly fruitful. Cognitive psychology 1950–2000 was a time of breakthroughs, excitement, and brilliance – too much to list here (though see Sternberg, Fiske, & Foss, 2016). We know a tremendous amount about human cognition as a result (e.g., Anderson, 2015; Reisburg, 2013).

One branch of cognitive psychology, psycholinguistics, studies the psychological and neurobiological factors that enable humans to acquire, use, comprehend, and produce language. Again, the primary concern was the mechanisms by which languages are represented and processed in the brain. Psycholinguistics is now a highly developed field (e.g., Gaskell, 2007). It has had considerable influence upon research in SLA (e.g., de Groot & Kroll, 1997; N. Ellis, 1999, 2006a; Hatch, 1983; Kroll & de Groot, 2005; Schwieter, 2015; Segalowitz & Lightbown, 1999; Williams & Gullberg, 2012).

A particularly important innovation in the 1980s and 90s was connectionism: the recognition that many mental phenomena can be seen to emerge from the conspiracy of experiences and that these processes can be computationally modelled in distributed neural nets that simulate the actions of interconnected neurons in the brain (Rumelhart & McClelland, 1986). Emergentist, connectionist, and statistical learning approaches have become a mainstay of cognitive (Elman et al., 1996) and psycholinguistic (Christiansen & Chater, 2001) thinking, as

they have for theories of second language learning (N. Ellis, 1998, 2002, 2003; MacWhinney, 1997; Rebuschat & Williams, 2012).

Nevertheless, despite all the progress, and so much fun, the major focus of mid-twentieth century cognitive psychology was on internal mental processes – cognition 'in the head.' In caricature, 'Good Old-fashioned Psycholinguistics' focused upon a learner characterized as "an associative network, a mechanistic processor of information, relatively unembodied, unconscious, monologic, unsituated, asocial, uncultured, and untutored" (N. Ellis, 2008b, p. 12).

<A>NON-CARTESIAN COGNITIVE SCIENCE AND THE 4ES

In the late twentieth century, cognitive science came to examine a number of additional influences upon the mind. Four in particular, grouped under the label '4E' to stand for anticlassical (or non-Cartesian) cognitive science (*The new science of mind,* Rowlands, 2013), are: Embodiment, Embeddedness, Enactivism, and the Extended Mind (Clancey, 2009; Robbins & Aydede, 2009a; Ward & Stapleton, 2012).

<B>Embodied Cognition

"The body is our general medium for having a world." (Merleau–Ponty, 1962, p. 169)

Embodied cognition is the recognition that much of cognition is shaped by this body we inhabit – by aspects of the entire body including the motor system, the perceptual system, bodily interactions with the environment (situatedness), and by the assumptions about the world that become built into the structure of the organism as a result of repeated experience (Wilson & Foglia, 2017).

Rather than perception and motor systems being merely peripheral input and output devices, embodied cognition posits that the mind and body interact 'on the fly' as a single entity. The pioneering text in psychology was *The embodied mind* (Varela, Thompson, & Rosch, 1991), which explained that "By using the term embodied we mean to highlight two points: First that cognition depends upon the kinds of experience that come from having a body with various sensorimotor capacities, and second, that these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological and cultural context" (pp. 172–173). One readable volume that encouraged this approach within the philosophy of cognitive science was *Being there: Putting brain, body, and world together again* (Clark, 1998). Subsequent research in psycholinguistics led to the development of theories of perceptual symbol systems (Barsalou, 1999) and of grounded cognition (Barsalou, 2008).

The hotbed of embodiment research was Cognitive Linguistics. Lakoff developed his embodied mind thesis that much of human cognition depends upon perceptual and imagery sensorimotor and emotional systems – more concrete and imageable concepts do so directly, more abstract concepts do so by metaphorical extension. The defining texts were *Metaphors we live by* (Lakoff & Johnson, 1980) and then *Women, fire, and dangerous things: What categories reveal about the mind* (Lakoff, 1987). What Lakoff did for semantics, Langacker did for syntax by pioneering cognitive grammar – the analysis of how language communicates embodied meanings in structured ways. His two-volume *Foundations of cognitive grammar* became a major foundation for cognitive linguistic understanding of the relations between conceptualization and grammar (Langacker, 1987, 1999). Cognitive grammar treats human languages as consisting solely of semantic units, phonological units, and symbolic units (conventional pairings of phonological and semantic units). This extension of the notion of symbolic units from lexis to the grammar was in direct opposition to the mainstream linguistic theories of the day, and it paved the way for subsequent construction grammar approaches to

language (e.g., Goldberg, 1995). Tomasello gathered contributions from Langacker, Givón, Croft, Chafe, Wierzbicka, Hopper, Taylor, Goldberg, Van Valin, and Fauconnier together in *The new psychology of language: Cognitive and functional approaches to language structure* (Tomasello, 1998), and a new functional approach to language was established, one that considered how language might be processed using general cognitive mechanisms.

Modern cognitive linguistics (Dabrowska & Divjak, 2015; Ungerer & Schmid, 1996) has established itself across a broad range of inquiries:

> Because cognitive linguistics sees language as embedded in the overall cognitive capacities of man, topics of special interest for cognitive linguistics include: the structural characteristics of natural language categorization (such as prototypicality, systematic polysemy, cognitive models, mental imagery and metaphor); the functional principles of linguistic organization (such as iconicity and naturalness); the conceptual interface between syntax and semantics (as explored by cognitive grammar and construction grammar); the experiential and pragmatic background of language-in-use; and the relationship between language and thought, including questions about relativism and conceptual universals. (Geeraerts, 1995, pp. 111–112)

There are now a number of well-developed theories of construction grammar (Trousdale & Hoffmann, 2013). Together, cognitive linguistics and cognitive grammar have rich implications for SLA and for applied linguistics (N. Ellis & Wulff, 2015a,b; Littlemore, 2009; Robinson & N. Ellis, 2008; Tyler, 2012).

<B>Embeddedness

"Ask not what's inside your head, but what your head's inside of." (Mace, 1977, p. 43)

Embeddedness is the dependence of a phenomenon (an activity, a set of relationships, an organization, or an individual) on its environment (defined alternatively in physical, cognitive, social, institutional, or cultural terms).

The importance of the ecology of mind was made clear by Bateson in his books *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology* (Bateson, 2000 [1972]) and *Mind and nature: A necessary unity (Advances in systems theory, complexity, and the human sciences*) (Bateson, 1979). Bateson (1979) emphasized how our phylogenetic and ontogenetic histories on this planet have shaped our perception: "The rules of the universe that we think we know are buried deep in our processes of perception" (p. 35).

Ecological psychology (Gibson, 1979) emphasizes how aspects of the environment afford various actions to an organism relative to its sensorimotor capacities. For certain animals, trees are climbable: they afford climbing; for certain others, the handles of mugs are graspable: they afford grasping, and so forth. Affordances are ecological rather than merely physical features of the world, being defined in terms of the 'systems' relationship between the organism and its environment. Gibson criticized cognitive, information-processing views that assume indirect perception whereby physical sensations as 'inputs' are matched inside the head against mental representations in order to create meaningful percepts as 'outputs,' and argued instead in favor of direct perception. Affordances are specified in the information array (the 'flow field') of the individual, they present possibilities for action, and they are available for the agent to perceive directly and act upon. For some 21st-century humans living in the mid-Western United States, coffee mugs afford grasping and drinking, chairs afford sitting, the media

afford access to the news, and the coffee shop puts these things together just fine, so they do not need to consider or remember what to do in the morning; rather they simply go with the breakfast flow.

Ecological systems theory (Bronfenbrenner, 1979) is a theory of human development which emphasizes the influences of the environmental systems within which an individual interacts and their relationships with contexts within communities and the wider society. The individual is seen within its immediate microsystem of family, peers, school, and religion, its mesosystem of the interactions between the microsystem components (family and school, family and peers, etc.), the exosystem of societal influences upon the microsystem (such as local politics, mass media, social services, industry, local community), and the macrosystem of the attitudes and ideologies of the cultural setting. Each system contains roles, norms, and rules that may shape psychological development. Bronfenbrenner's ecological systems theory changed the perspective of developmental psychology by identifying the range of environmental and societal influences on child development. His work was integral to the formation in 1965 of the American Headstart pre-kindergarten programs. The Douglas Fir Group (2016) explains the influence of this model upon its framework for 'SLA in a multilingual world' as summarized in the article's Figure 1 (pp. 24–25). Duff (2019, this issue) further analyzes the many dimensions of language socialization and considers how transdisciplinary team-based research is needed to understand cases from multiple, integrated perspectives on different scales of analysis.

Sociocultural Theory (Vygotsky, 1980) argues that human cognition is fundamentally a socially mediated process that is organized by cultural activities, artifacts, and concepts. Vygotsky's main assertion was that human learners are embedded in different sociocultural contexts, and their cognitive development is advanced through social interaction with more skilled individuals. Through social interaction they learn to utilize existing cultural artifacts and to create new ones to regulate their biological and behavioral activity. Mediation happens

primarily through language use, organization, and structure, occurring during participation in cultural, linguistic, and historically-formed settings such as family life, peer group interaction, and institutional contexts like schooling, social leisure activities, and workplaces. Sociocultural Theory (SCT) argues that while the brain is a necessary condition for higher order thinking, the most important mental activities develop through interaction within these social and material environments. Most modern theories of developmental cognitive psychology show strong influences of SCT. SCT has also had significant impact upon SLA, largely through the work of Lantolf and colleagues (Lantolf, 2006; Lantolf & Pavlenko, 1995; Lantolf & Poehner, 2014; Lantolf & Thorne, 2006).

<B>Enactivism

"A path is the wisdom of many feet." (Stepney, 2018, p. 30)

The "Classical Sandwich" view (Hurley, 1998) of the serial operation and the modular separation of the three layers of *perception* $\rightarrow$ *cognition* $\rightarrow$ *action* fails to account for the dynamic relationships between action and perception in situated cognition. Experience of the world is enacted: Mental processes are made up not just of neural processes but also of the routine things that the organism does, hence they are constituted by the ways in which an organism acts on the world and, in return, the ways in which the world acts back. "Cognitive structures *emerge* from the recurrent sensorimotor patterns that enable action to be perceptually guided" (Varela et al., 1991, p. 173). "A cognitive being's world is not a pre-specified, external realm (. . .) but a relational domain enacted or brought forth by that being's autonomous agency and mode of coupling with the environment" (Thompson, 2005, p. 407).

Biologically informed theories of enactivism emphasize *autopoiesis* (*auto* "self", and *poiesis* "creation, production") referring to a system capable of reproducing and maintaining

itself. If cognition is for anything, it is for sustaining an organism's biological viability. Ecological fitness involves adaptivity and skillful interaction. Environmental features depend upon the activity of the cognizing system; in turn, cognition depends upon activity within an environment. Varela et al. (1991) compared cognition to "laying down a path in walking" (p. 237). The existence of a forest trail can be brought about by the activity of agents navigating the forest: "A path is the wisdom of many feet" (Stepney, 2018, p. 30). For agents, being appropriately attuned to the presence of that trail affects their skill in getting efficiently from one point to another in the forest. Actions are motivated. The environmental features to which an agent is cognitively open will be those that are a function of their capacities, activities, and interests, and their cognitive competence needs consist in no more than an appropriate level of attunement to those features and their relevance.

Simon (1962) told the parable of an ant making its homeward journey on a pebbled beach. Its path seems complicated. The ant probes, doubles back, circumnavigates, and zigzags. But these actions are not deep and mysterious manifestations of intellectual power. Closer scrutiny reveals that the control decisions are both simple and few in number. An environment-driven problem solver often produces behavior that is complex only because a complex environment drives it. Apparent complexity may come more from the problem space than from the agent that learns to solve it. N. Ellis (1996) considers some implications for theories of Universal Grammar and of SLA.

From an enactivist perspective, cognition is dynamical sensorimotor processes (rather than prescripted computational syntax) of real time variables, along with a rich self-organizing capacity (rather than a representational machinery): The mind is not in the head, instead it has roots in the body as a whole and in the extended environment where the organism finds itself.

There are some who would go so far as to claim that 4E/anti-classical cognition denies any need at all for mental representations in their theories (Chemero, 2009): If everything is

there in situated cognition, then there is no need for representation in the learner. However, these anti-representationalist views clearly go too far. Clark and Toribio (1994) in their article "Doing without representing?" conclude that there is a continuum of problem spaces: At the nonrepresentational end of that continuum there are cases in which the required responses can be powered by a direct coupling of the system to some straightforwardly physically specifiable parameters available by sampling the ambient environment in some computationally inexpensive way (e.g., a toy car with a 'bump' sensor). At the other end of that continuum there are 'representation-hungry problems' where the problem involves reasoning about absent, nonexistent, or counterfactual states of affairs. It is at this end of the continuum that language comes to the fore.

Clearly, we can take a person out of their usual, richly-perceptual, and situated world and put them in a dark empty room with nothing more than a microphone in front of them, away from their normal environmental affordances, away from their loved ones and normal social circumstances, away from their supportive media and culture, and we can ask them to tell their story. And tell their story they can. They have clear autobiographical memories of events and percepts and motoric routines and scripts and schema. They have language representations enough to enthrall us with their tales. Perhaps the story would be richer back in their contexts, co-constructed with friends; nevertheless, we all have rich autobiographical memories and the language to describe these, even if we do not all have the making of a successful novelist. Experience is important because it impacts upon us, our representations, our minds, our brains, our selves. Some of that experience is worldly, some of it is linguistic, and much of it interrelates.

Enactivism has impacted theories of education in various ways. Interaction is at the heart of SCT and Activity Theory. Situated Cognition (Brown, Collins, & Duguid, 1989; Robbins & Aydede, 2009b) holds that knowing is inseparable from doing, and that all knowledge is

situated in activity bound to social, cultural, and physical contexts. Situated Learning (Lave, 1988; Lave & Wenger, 1990) conceives of learning as increasing participation in *communities of practice* – groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. Learning is a co-constitutive process in which all participants change and are transformed through their actions.

SLA research has likewise been heavily influenced by ideas like these. SCT, identity theory (Norton, 2000), sociolinguistic approaches (Tarone, 2007), cultural approaches (Kramsch, 1993, 2002), conversational analysis (Kasper & Wagner, 2011; Hall, 2019, this issue), interactionist approaches (Gass, 2002; Long, 1980; Mackey, 2012), the sociocognitive approach (Atkinson, 2002), and the various approaches gathered under "alternative approaches to SLA" (Atkinson, 2011) all agree that cognition is socially grounded in interaction. As Wagner (2015) summarizes, in such theories:

> Cognition is not understood as information processing, but as organizing embodied interactions between social actors in meaningful ecologies and reflexively being shaped by those situated encounters. Although the degree to which these approaches buy into issues of embodiment and ecology may differ, they share, as Duff and Talmy argue, a common understanding of learning as happening in context "through praxis . . . in the everyday activities of communities of language users" (Duff & Talmy, 2011, p. 96). The target for many second language learners is not just 'to speak another language,' but to become part of the social and cultural environment in which the language is used. This entails frequent and rich participation in the second-language life worlds into which the learner 'bricolages' his or her way (cf. pp. 95–96).

<B>Extended Mind

"Society is our extended mind and body." (Watts, 1989, p. 54)

The recognition that cognition is indivisible from our embodiment, from our environment, and from our situated actions leads naturally on to the idea that cognition is not to be found in the head, nor indeed in the individual, but rather that it is a distributed sociotechnical system. The Extended Mind thesis was championed within cognitive science by Hutchins. His classic *How a cockpit remembers its speeds* (Hutchins, 1995b) is a detailed cognitive ethnography of how pilots of computerized airliners understand what their state-of-the-art automation is doing. The framework is, as he says, "explicitly cognitive, in that it is concerned with how information is represented and how representations are transformed and propagated in the performance of tasks" (p. 265). Yet the analysis of this task of the cockpit of commercial airlines' remembering its aircraft speeds shows how the cognitive properties of such distributed systems can differ radically from the cognitive properties of the individuals who inhabit them. His book *Cognition in the wild* (Hutchins, 1995a) is the founding text of Distributed Cognition (DCog) and Cognitive Ecology: "Culture is (. . .) a human cognitive process that takes place both inside and outside the minds of people (. . .). Culture is an adaptive process that accumulates partial solutions to frequently encountered problems" (p. 354).

Hutchins (1995a, chapter 9) presents an analysis of cognitive psychology from the 1950s–1990s which argues that, for methodological and analytic convenience, it focused upon individual cognition (bounded in social space, in physical space, and in time), and that this strategy resulted in an attribution problem – when one commits to the notion that all intelligence is inside an inside/outside boundary, one is forced to cram everything inside that is required to produce the observed behaviors. The result is to attribute to the inside much more than there should be. Hutchins's book softened boundaries that had been made rigid by

previous approaches by locating cognitive activity in context, where context is not a fixed set of surrounding conditions but rather a wider dynamical process of which the cognition of an individual is only a part. "Just as the construction of these boundaries was driven by a particular theoretical perspective, their dissolution or softening is driven by a different perspective - one that arose of necessity when cognition was confronted in the wild" (Hutchins, 1995a, p. 1). The book is the *locus classicus* for the importance of choosing the right boundaries for the unit of analysis, and for the importance of studying cognition in its normal habitat, in the wild. Hutchins (2010) presents a very readable and succinct *Topics in cognitive science* update of Cognitive Ecology as the study of "the web of mutual dependence among the elements of a cognitive ecosystem" (p. 705). The Douglas Fir Group (2016), and the subsequent AAAL 2018 symposium *SLA without (disciplinary) borders,* likewise encourages unbounded perspectives on SLA.

Hutchins's work set the stage for Clark and Chalmers (1998) to publish philosophical analyses of the active role of the environment in driving cognitive processes. Their "Inga and Otto" thought experiment casts doubt on there being any essential difference between recall from the head (Inga's Internal memory) and that from a readily available auto-authored notebook (Otto's Outside memory). This article was followed by the book *Supersizing the mind: Embodiment, action, and cognitive extension* (Clark, 2010). The extended mind hypothesis claims that the effective circuits of human thought and reason are not entirely 'in the head,' and invites us instead to consider how technologies, social networks, and institutional structures, laws, educational practices, and social policies are proper parts of distributed organs for thought. One particular topical example is the widespread adoption, in diverse fields from surgery to aviation, of checklists as job-aids used to reduce failure by compensating for potential limits of human memory and attention (Gawande, 2009). A more widespread and omnipotent example is the internet and ever-present smartphone access. Better to consider ourselves not as being

firmly bounded biological organisms, but as reconfigurable nodes in a flux of information, communication, and action.

Language is the quintessence of distributed cognition. Language is ever situated, either in the moment and the concrete context or by various means of mental extension to reflect prior or imaginary moments.

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). In their first two years, infants develop their capabilities of attention detection (gaze following), attention manipulation (directive pointing), intention understanding (the realization that others are goal-directed), and social coordination with shared intentionality (engaging in joint activities with shared interest, negotiating meanings), and these processes are central in child language acquisition (Tomasello, 1999, 2008). The nature of language follows from its role in social interaction. Social interactions are typically characterized by what philosophers of action call shared cooperative activity (Bratman, 1992) or joint actions (Clark, 1996). Joint actions are dependent on shared cognition, a human being's recognition that she can share beliefs and intentions with other humans. Thus, both usage-based approaches and SLA research emphasize how language is learned from participatory experience of processing language during embodied interaction in social and cultural contexts where individually desired outcomes are goals to be achieved by communicating intentions, concepts, and meaning with others. Lascotte and Tarone (2019, this issue) provide rich illustrations of the ways in which speakers can agentively shift from one internalized 'voice' or social identity to another in creating narrative, and how this heteroglossia is associated with measurable differences in their language complexity, accuracy, and fluency. Conversation partners scaffold and co-construct meanings. Socially scaffolded 'noticing'

(Schmidt, 1990) solves Quine's (1960) problem of 'referential indeterminacy' and language-expert/language-novice interaction can likewise solve problems of the formal indeterminacy of language. Focus-on-form feedback can scaffold language learning (Doughty & Long, 2003; Doughty & Williams, 1998; Gass, 1997; Gass & Mackey, 2007; Long, 1980; Long & Robinson, 1998). The dynamics of language learning are inextricably linked to the dynamics of consciousness, in neural activity and in the social world as well (Frith & Frith, 2010). Consciousness is co-constructed in social interaction (N. Ellis, 2005a; Frith, 2010). In these ways the input to associative learning is *socially gated* (Kuhl, 2007).

Language itself also plays a huge role in our enculturation (Clark, 2005). Clark and Chalmers (1998) emphasize that "The major burden of the coupling between agents is carried by language (. . .). Indeed, it is not implausible that the explosion of intellectual development in recent evolutionary time is due as much to this linguistically-enabled extension of cognition as to any independent development in our inner cognitive resources" (p. 5). This is a theme developed by Logan (2007) in *The extended mind: The emergence of language, the human mind and culture.* Logan argues that verbal language extends the brain into a mind capable of conceptualization and hence that *mind = brain + language*. According to Logan, before humans acquired verbal language, their brain was a percept processor. Then language made the mind capable of conceptualization and hence able to consider things beyond the here and now. Schumann (Lee & Schumann, 2003; Logan & Schumann, 2005) likewise emphasizes language as a cultural artifact or technology that operates between and among brains. Indeed he separates it from the biosphere, and argues that we live within a symbolosphere, which includes all of the phenomena mediated by symbols, and hence includes all abstract human thought and symbolic communication (Schumann, 2018).

The works cited in this section were all written in the 1990s or later, largely in reaction to cognitivism. However, these ideas have a long history within the philosophy of mind and

language (Joseph, 2017). In particular, Harris (1981, 1987) ploughed a lone, long, straight furrow, arguing against cognitive and linguistic approaches where thinking in all its forms, linguistic and nonlinguistic, was seen to rely on 'programs' analogous to those by which a computer engages in 'information processing.' In its place he developed an Integrational Approach to signs and semiological systems, an integration focus on human communication that is inseparable from environments and from the individual self and human agency. The integrational approach holds that every episode of communication, however trivial, necessarily involves creative activity by the participants, including their own interpretation of the situation in which it occurs. Words are not temporal invariants, instead, every utterance is a new utterance, no matter how many times someone may have 'said it before.' Integrationist approaches presume that linguistic processes are embedded in the social matrix, and, in turn, in a larger complex based on the simple fact that persons have relations to other persons (Duncker, 2017).

Non-Cartesian Cognitive Science, has come to reconsider cognition as being essentially embodied, environmentally embedded, autopoietically enacted, and socially encultured. The human mind extends well beyond the ancient bounds of skull and skin. These are essentials of a theory of cognition. These are essentials of a theory of language cognition. So they are essentials of theories of SLA and of multilingualism (Atkinson, 2010).

This, too, was the spirit of the Douglas Fir Group, which celebrates languages as emergent, social, integrated phenomena. Language cognition is shared across naturally-occurring culturally-constituted communicative activities. Language and usage are like the shoreline and the sea (N. Ellis, Römer, & O'Donnell, 2016). Usage affects learning and it affects languages too. So, our understanding of language learning requires the detailed investigation of usage, its content, its participants, and its contexts – the micro level of human social action, interaction, and conversation, the meso level of sociocultural and educational institutions and

communities, and the macro level of ideological structures. In these ways, language pervades 4E cognition.

<A> EMERGENTISM AND LANGUAGE AS A COMPLEX ADAPTIVE SYSTEM

These ideas are the antithesis of bounded approaches, which assume that the essence of language can be localized, for example, in genes, or brain areas, or language acquisition devices, in separable linguistic structural divisions (such as lexis vs. syntax vs. semantics vs. pragmatics, etc.), or in language learning programs, platforms, or apps, or school curricula, or other human policies. Instead, they fit naturally within emergentist approaches (N. Ellis, 1998; N. Ellis & Larsen–Freeman, 2006a; Elman et al., 1996; Hopper, 1987; MacWhinney & O'Grady, 2015), which view language within a complex adaptive system (Beckner et al., 2009; N. Ellis & Larsen–Freeman, 2006b, 2009; Larsen–Freeman, 1997; Larsen–Freeman & Cameron, 2008) or dynamic systems theory framework (de Bot, Lowie, & Verspoor, 2007):

> Emergentists believe that simple learning mechanisms, operating in and across the human systems for perception, motor action and cognition as they are exposed to language data as part of a communicatively-rich human social environment by an organism eager to exploit the functionality of language, suffice to drive the emergence of complex language representations." (N. Ellis, 1998, p. 657)

Language has a fundamentally social function. Processes of human interaction along with domain-general cognitive processes shape the structure and knowledge of language. Recent research in the cognitive sciences has demonstrated that patterns of use strongly affect how language is acquired, is used, and changes. These processes are not independent from one another but are facets of the same complex adaptive system (CAS).

Language as a CAS involves the following key features: The system consists of multiple agents (the speakers in the speech community) interacting with one another. The system is adaptive; that is, speakers' behavior is based on their past interactions, and current and past interactions together feed forward into future behavior. A speaker's behavior is the consequence of competing factors ranging from perceptual constraints to social motivations. The structures of language emerge from interrelated patterns of experience, social interaction, and cognitive mechanisms. The CAS approach reveals commonalities in many areas of language research, including first and second language acquisition, historical linguistics, psycholinguistics, language evolution and computational modeling. (Beckner et al., 2009, pp. 1–2)

The Associative–Cognitive CREED holds that SLA is governed by the same principles of associative and cognitive learning that underpin the rest of human knowledge. The major principles of the framework are that SLA is Construction-based, Rational, Exemplar-driven, Emergent, and Dialectic. Language learning involves the acquisition of constructions that map linguistic form and function. Competence and performance both emerge from the dynamic system that is the frequency-tuned conspiracy of memorized exemplars of use of these constructions, with competence being the integrated sum of prior usage and performance being its dynamic contextualized activation. The system is rational in that it optimally reflects prior first language (L1) usage. The L1 tunes the ways in which learners attend to language. Learned-attention transfers to L2 and it is this L1 entrenchment that limits the end-state of usage-based SLA. But these limitations can be overcome by recruiting learner consciousness, putting them into a dialectic tension between the conflicting forces of their current stable states of interlanguage and the evidence of explicit form-focused feedback, either linguistic, pragmatic, or metalinguistic, that allows socially-scaffolded development. (N. Ellis, 2006b)

De Bot, Lowie, and Verspoor (DBL&V)) present a persuasive case for language as a complex dynamic system where cognitive, social, and environmental factors continuously interact, where creative communicative behaviors emerge from socially co-regulated interactions, where there is little by way of linguistic universals as a starting point in the mind of *ab initio* language learners or discernable end state, where flux and individual variation abound, where cause-effect relationships are nonlinear, multivariate and interactive, and where language is not a collection of rules and target forms to be acquired, but rather a by-product of communicative processes. Usage-based approaches (Ellis, 2003; P. Robinson & Ellis, 2008) view the regularities of language as emergent phenomena: the rule-like regularities captured by linguists are mere descriptions, explananda not explanans." (N. Ellis, 2007, p. 23)

<A>LEARNING AND REPRESENTATION

<B>Connectionist Learning

Late twentieth-century cognitive science recognized that many mental phenomena (concepts, categories, schemata, prototypes, constructions, paradigms, representations . . .) can be seen to emerge from the conspiracy of experiences, with more frequent exemplar types having greater influence.

> We see the traces laid down by the processing of each input as contributing to the composite, superimposed memory representation. Each time a stimulus is processed, it gives rise to a slightly different memory trace - either because the item itself is different or because it occurs in a different context that conditions its representation - the traces are not kept separate. Each trace contributes to the composite, but the

> characteristics of particular experiences tend nevertheless to be preserved, at least until they are overridden by canceling characteristics of other traces. Also, the traces of one stimulus pattern can coexist with the traces of other stimuli, within the same composite memory trace. (Rumelhart & McClelland, 1986, p. 193)

Connectionism explored how these learning processes can be computationally modelled in distributed neural nets that simulate the actions of interconnected neurons in the brain (Elman et al., 1996; Rumelhart & McClelland, 1986). Exemplar theory explored how humans make category judgments by comparing new stimuli with an 'exemplar cloud' of instances already stored in memory. Statistical learning, machine learning, and deep networks are now widespread across computational learning theory in artificial intelligence, computer science, and cognitive science. Cognitive psychology recognized that these processes of human cognition take place automatically and unconsciously. There was much research demonstrating implicit learning (Reber, 1993) and implicit memory (Schacter, 1987). Following Nisbett and Wilson (1977), there has been widespread recognition of the overwhelming influences of implicit cognition.

Frequency effects on learning are well recognized in psycholinguistics (Bod, Hay, & Jannedy, 2003; Bybee & Hopper, 2001), and there is much research evidencing connectionist (Christiansen & Chater, 2001), statistical (Saffran & Kirkham, 2018), and exemplar-based (Pierrehumbert, 2016) language learning.

Likewise in SLA and applied linguistics, there is widespread recognition of the influence of frequency of experience upon learning and representation (N. Ellis, 2002), of connectionist and statistical learning mechanisms (N. Ellis, 1998, 2003a; MacWhinney, 1997; Rebuschat & Williams, 2012), and of the importance of implicit language cognition (N. Ellis, 1994; Rebuschat, 2015).

<B>Connectionist Memory

In connectionist models, remembering is an inferential process, constructive as much as reproductive. "Connectionist models trade localized, symbolic processing for distributed operations that extend over an entire network of components and so result in the emergence of global properties resilient to local malfunction. For connectionists a representation consists in the correspondence between such an emergent global state and properties of the world; it is not a function of particular symbols" (Varela et al., 1991, p. 8). Memory traces are not stored separately but are integrated or "superposed" in the same set of weights. Remembering is the temporary reactivation of a particular pattern or vector across the units of a network. This is successful, or not, dependent on the conspiring influences of the current input and the history of the network, as consolidated in the connection weights between units. If the current input is strongly associated with the memorized pattern of weights for a particular construction, so it is successfully reactivated or "redintegrated." Redintegration refers to the restoration of the whole of something from a part of it. The everyday phenomenon is that a small part of a memory can remind a person of the entire memory.

<B>Representation Quality

The quality and richness of a representation is a function of the type and token frequencies of the exemplars experienced and of their richness of features and associations.

<C>Richness of features and associations. In 1890, in the defining text of the Principles of psychology, James considered language representations as follows:

> Every nameable thing, act, or relation has numerous properties, qualities, or aspects. In our minds the properties of each thing, together with its name, form

> an associated group. If different parts of the brain are severally concerned with the several properties and a farther part with the hearing, and still another with the uttering, of the name, there must inevitably be brought about (through the law of association which we shall later study) such a dynamic connection among all these brain-parts that the activity of any one of them will be likely to awaken the activity of all the rest. (p. 55)

This is a remarkable description of the essence of connectionist learning given that it was written 80 years before the advent of computational connectionist models. It likewise envisioned patterns of brain representations of word meanings over a century before the possibility of their confirmation in fMRI imaging of localizable dynamic activity across voxels in the cortex (see *Predicting human brain activity associated with the meanings of nouns* [Mitchell et al., 2008] and *Natural speech reveals the semantic maps that tile human cerebral cortex* [Huth et al.,2016]). It has proven to be essentially correct. On the whole, the memory representations that result from an experience are representative of that experience:

1. If the properties of the experience are rich, imageable, and multimodal, so too is the memory (*embodied cognition* – e.g., perceptual symbol systems [Barsalou, 2008] ; imageable words are better remembered than abstract words [Paivio, 1990]; words in the brain [Pulvermüller, Cappelle, & Shtyrov, 2013])
2. If the properties of experience are richly contextualized, so too is the memory (*embedded cognition* – e.g., context-dependent memory [Smith & Vela, 2001]; the cognitive interview [Fisher & Geiselman, 1992])
3. If the properties of experience are goal-directed and rich in dynamical sensorimotor processes, so too is the memory (*enactivism* – e.g., enactment effects in memory [Cohen, 1989])

4. If the experience is part of a cultural script, if it plays out in interaction with others, so these are part of the memory too (*extended mind* – e.g., scripts, plans, goals, and understanding [Schank & Abelson, 1977]; collaborative recall and collective memory [Sutton, 2009], scaffolding [Donato, 1994]).

The richness can come from depth of processing (Craik & Lockhart, 1972; Lockhart, 2002) along the 4E dimensions listed here, and it can be enhanced through emotional content too (McGaugh, 2003). Psychologically rich experience leads to richer representation and better explicit recall.

<C>Flow. The major force of learning is usage experience – engaged, motivated, purposeful, authentic, rich, enacted usage. Csikszentmihalyi (2014) refers to optimal experience as "flow":

> It is useful to remember occasionally that life unfolds as a chain of subjective experiences. Whatever else life might be, the only evidence we have of it, the only direct data to which we have access, is the succession of events in consciousness. The quality of these experiences determines whether and to what extent life was worth living." (p. 209)

Broadly, we expect that the quality of the flow likewise determines the quality of language representations.

<C>Frequency. More experience leads to stronger representation. Language is like other expertise in that it requires considerable practice – the rule of thumb is that accomplishing expertise demands 10,000 hours on task. Frequency of experience is central in usage-based approaches to language acquisition (N. Ellis, 2011; N. Ellis & Wulff, 2015b) as it is in skill-theoretic approaches (DeKeyser, 2007; Segalowitz, 2010). Cognitive linguistic and construction grammar approaches emphasize that language learning is the learning of many tens of thousands of constructions (words, morphemes, lexico-grammatical-functional patterns . . .) and of the probabilistic relations between them and between them and their functions, their speakers, their contexts, and their genres (Bod et al., 2003; Bybee & Hopper, 2001; Gries, 2012, 2013; Gries & N. Ellis, 2015). This information can only come from usage (Cadierno & Eskildsen, 2015; N. Ellis, O'Donnell, & Römer, 2013; N. Ellis & Wulff, 2015a; Robinson & N. Ellis, 2008).

<B>Representation Access

Memories may be available but not accessible (Tulving & Pearlstone, 1966). Recognition is easier than recall. It is a common classroom experience that learners may have 'got it' one day, only apparently to have lost it the next. These are problems of retrieval. What is needed for successful access is to be reminded by an appropriate retrieval cue. There is considerable research on context-dependent memory (Smith & Vela, 2001). The encoding specificity principle of memory provides a general theoretical framework for understanding how contextual information affects memory (Tulving & Thomson, 1973). Specifically, the principle states that memory is improved when information available at encoding is also available at retrieval, that is, when the mental context at recall matches that at encoding. The relevant factors include the environmental context and the mental context including perceptual factors, emotional factors, scripts, plans, goals and understandings. The more these can be reinstated, the more recall is optimized, as demonstrated in fields as diverse as the cognitive interview in

eyewitness testimony (Fisher & Geiselman, 1992), the role of scaffolding in education (Vygotsky, 1980), and in second language education (Donato, 2000; Lantolf, 2006; Lantolf & Poehner, 2014). Lightbown (2008) applies transfer appropriate processing as a model for classroom second language acquisition.

Learning and remembering are always situated. Their contexts extend beyond the here and now, streaming backwards in time through our personal and cultural histories:

> But our assessment of the role of situations in driving and shaping memory need not be restricted to the role of contextual features which happen to be outside the skin: that might be a relatively superficial characteristic. In even the most abstruse and detached activities of autobiographical remembering, our memory processes still lean and operate on the internal wing of the vast extended system of cultural and personal habits, hints, and patterns through which the inner representational regime has been sculpted and disciplined (Clark, 2005, p. 264). Again, adding a genuinely diachronic dimension to our picture of the neuroscience and psychology of memory means that we don't have to see the temporarily isolated brain as fundamentally or intrinsically alone, having to revert to some purely biological starting-state whenever the trappings of culture aren't around. For, again, in our unusual case the biological brain is itself incomplete and always already permeated by structures and history which take it out of itself." (Sutton, 2009, pp. 229–230)

<A>USAGE-BASED APPROACHES AND RESEARCH PRIORITIES

Embodiment, environmental embeddedness, enaction, social enculturation, situatedness, and distributed cognition pervade usage-based approaches to language acquisition which investigate how we learn language while engaging in communication, the

"interpersonal communicative and cognitive processes that everywhere and always shape language" (Slobin, 1997, p. 267).

Usage-based theories hold that an individual's creative linguistic competence emerges from the collaboration of the memories of all the meaningful interactions in their entire history of language usage (Behrens, 2009; Bybee, 2010; Dabrowska & Divjak, 2015; N. Ellis, 2015; N. Ellis et al., 2013; Robinson & N. Ellis, 2008; Tomasello, 2003; Trousdale & Hoffmann, 2013). Hopper (1998) describes grammar as the "sediment of usage":

> We say things that have been said before. Our speech is a vast collection of hand-me-downs that reach back in time to the beginnings of language. The aggregation of changes and adjustments that are made to this inheritance on each individual occasion of use results in a constant erosion and replacement of the sediment of usage that is called grammar." (p. 146)

The same applies across all of the systems of language. Learning a language involves the learning of constructions. These are the form–function mappings that are conventionalized as ways to express meanings in a speech community. Constructions range from morphemes – the smallest pairing of form and meaning in language – to words, phrases, and syntactic frames (Goldberg, 2006; Trousdale & Hoffmann, 2013). That is, simple morphemes such as *–able* (meaning 'capable of, susceptible of') are constructions in the same way as simple words like *nut* (meaning 'a fruit consisting of a hard or tough shell around an edible kernel'), formulaic phrases like *thanks a lot* (meaning 'Thank you' to a very high degree, orders of magnitude, really), idioms like *It is driving me nuts* (meaning 'It is greatly frustrating me'), and abstract syntactic frames like Subject–Verb–Object–Object (meaning that something is being transferred, as realized in sentences as diverse as *Max gave the squirrel a nut*, *Nick gave Max a hug*, or *Steffi baked Max a cake*, where nuts, hugs, and cakes are being transferred, respectively). As the latter examples illustrate, not all constructions carry meaning in the traditional sense; many

constructions rather serve a more functional purpose. The passive construction, for instance, serves the function of shifting the focus of attention in an utterance from the agent of the action to the patient undergoing the action (compare the passive *A cake was baked for Max* with its active counterpart *Steffi baked Max a cake*) (Wulff & N. Ellis, 2018).

Language learning involves learning the associations within and between constructions. Constructionist accounts of language acquisition involve the distributional analysis of the language stream and the parallel analysis of contingent perceptual activity, with abstract constructions being learned from the conspiracy of concrete exemplars of usage following statistical learning mechanisms (Rebuschat & Williams, 2012) relating input and learner cognition. Psychological analyses of this learning of constructions as form-pairs is informed by the literature on the associative learning of cue–outcome contingencies where the usual determinants include for the construction: its frequency of experience, salience of form, significance of meaning, prototypicality, redundancy vs. surprise value, and the contingency of form and function; for the learner: factors relating to learned attention, automaticity, transfer, overshadowing, and blocking (N. Ellis, 2008c, 2017). These various psycholinguistic factors conspire in the acquisition and use of any linguistic construction.

Taking the social turn does not do away with linguistic structure. Instead it poses a set of questions relating to how language structure is learned from situated experience. Thus, cognitive linguistics, usage-based approaches, and 4E cognitive science complement our understanding of language cognition. One current collaboration is the "Thinking, Doing, Learning" conference series. The call for TDL4 states: "The conference brings together researchers interested in a wide variety of questions to be answered about language usage, language learning, and cognition – from societal issues of what it means to interact in an L2 to how speakers carry out and accomplish social actions in moment-to-moment sense-making activities, and from the environments of language use to the nature of the sediments of these

usage events that are left as 'acquired linguistic constructions' in the individual language learner." (Hannele Dufva, e-mail March 3, 2018).

Like CA and interactional approaches (Hall, 2019, this issue), usage-based approaches emphasize the social and the semiotic in the creation of language, but additionally they recognize that repeated episodes of usage result in entrenchment and the emergence of linguistic structure. Contra Hall (2019, this issue), I see nothing conceptually confusing in the notion of construction grammar, and the enterprise of cognitive linguistics is fully in the transdisciplinary spirit of DFG. The scientific study of language has long recognized that language has observable, reliable, and productive structure at various levels (phonology, morphology, syntax, phraseology, pragmatic, stylistic, etc.) across multiple modalities of expression. We must embrace the richness and sophistication of linguistic description, while at the same time recognizing the paucity of linguistic theories of learning.

These are exciting times to work in usage-based approaches to language learning because the enterprise brings together people working from different but complementary empirical and theoretical approaches: cognitive linguistics, construction grammar, functional linguistics, cognitive psychology, learning theory, psycholinguistics, statistical learning theory, child language acquisition, neuroscience, corpus linguistics, computational science, natural language processing, emergentism and complex systems theory, conversational analysis, dynamic systems theory, sociolinguistics, and social learning theory.

All of these approaches can be brought to bear in researching how our history of usage affects language acquisition, knowledge, and processing. For example, N. Ellis et al. (2016) recently summarized a 10-year research program into the latent structure verb–argument constructions (VACs) as associations of form and function by means of a corpus analysis of verb selection preferences in 100 million words of usage and analysis of the semantic network structure of the verbs in these VACs. Our research emphasizes the importance of item-based

patterns and their perceptual groundings in acquisition, with abstract schematic patterns emerging from the conspiracy of particular usage patterns and their interpretations. Our analyses show that these constructions are (a) Zipfian in their verb type–token constituency in usage, (b) selective in their verb form occupancy, and (c) coherent in their semantics, with a network structure involving prototypical nodes of high betweenness centrality. Psychological theory relating to the statistical learning of categories suggests that these are factors which promote learning. We show how first and second language acquisition is driven by these usage patterns, and we also report a range of psycholinguistic experiments showing that frequency, contingency, and semantic prototypicality drive language processing in both conscious free-association tasks and in automatic ballistic processing in recognition threshold, naming, lexical decision and semantic psycholinguistic processing tasks. Finally, we use connectionist modelling to simulate acquisition from these input patterns, and agent-based modeling to investigate processes of language change.

A central concern is how latent patterns of usage promote robust acquisition. If language is not to be isolated in any particular top-down controlling system or language acquisition device, if it is emergent, then how come it is robustly emergent? How come you learned language from your people, I learned language from my people, our people never met, yet we can share meanings? There is so much exciting work to be done investigating the relations between language experience and language acquisition, knowledge, structure, and processing.

Understanding how usage affects an individual learner's languages demands the recording of longitudinal corpora of learner language and subsequent transcription and analysis using a variety of corpus, conversation analysis, and computational techniques, many specially devised for learner language. It requires psycholinguistic investigation of the learner's language processing. It demands linguistic theory. It necessitates an appreciation of the psychology of learning to understand how processes of implicit, explicit and statistical learning, categorization

and analogy, proceduralization, and schematization affect the development of individual learners' linguistic systems from the conspiracy of experiences of usage that vary in frequency, salience, contingency, prototypicality, emotionality, embodiment, groundedness, and so forth. Attention is key in learning, cognition, and instruction; attention can be personally, environmentally, socially, and culturally motivated. How do explicit and implicit learning together support language acquisition, what is the nature of their interface?

Understanding how usage affects languages calls for 'big-data' corpus investigations of representative language usage in different sociocultural institutions and communities of practices and how these change over time. The analysis of the distributional characteristics of linguistic constructions and their meanings as representative of the language that learners experience requires considerable computational corpus analysis and Natural Language Processing; then these findings need to inform experimental studies of processing (Gries & Divjak, 2012; Gries & Wulff, 2009; McEnery & Hardie, 2012; Rebuschat, Meurers, & McEnery, 2017). How the participant agents and processes interact dynamically while maintaining robust latent structures demands collaborations with Complex Adaptive Systems, Dynamic Systems Theory, and Networks Science.

There is much else still to research. There is considerable research in first language acquisition; second language acquisition has had less attention; the multilingual focus of the present volume prioritizes expanding these inquiries to "all types, all shades and grades, of multilingualism" (Ortega, 2019, this issue, p. xxx). Ortega explains these research priorities very clearly in her contribution to this special volume.

Christiansen and Chater (2017) conclude their article "Towards an integrated science of language" like this:

Reintegrating the language sciences also presents huge opportunities for linking together different aspects of the study of language: viewing language acquisition as the process of acquiring the ability to process specific constructions; seeing language evolution as shaped by the processing and learning biases of the brain; providing a historical explanation for language change and variation based on the diffusion and modification of constructions; and reconnecting linguistics with the construction of workable computer language processing systems. Although such reintegration has been hampered in the past by the fragmentation of the study of language across university departments, conferences and funding bodies, the tide is now shifting and an integrated science of language is gradually emerging. We envisage a future where broad, interdisciplinary departments of language science will become increasingly common." (p. 3).

<A>IMPLICATIONS FOR TEACHING

A longstanding concern of applied linguistics is the investigation of the different patterns of language competence that result from different patterns of language experience (classroom instruction vs. naturalistic exposure; foreign/second/heritage/first language acquisition; early vs. late exposure; simultaneous vs. successive bilingualism; implicit vs. explicit language learning; spoken vs. written exposure; implicit and explicit language learning; focus on meaning/focus on formS/focus on form; types of correction; etc. (N. Ellis, 1994; R. Ellis, 2010; Kelly, 1969; Long & Robinson, 1998; Long & Doughty, 2009; Spada, 2011). The interest is both theoretical and applied in that answers to these questions allow the catering of language experience to different language learner needs. The relevant enquiries are ongoing. However, we know broadly that a focus on grammar results in grammatical competence, sometimes accompanied by low

fluency, whereas a focus on meaning can results in communicative competence and fluency, sometimes accompanied by low accuracy.

Forty years ago, Krashen (1982) described students of grammar-instruction who had "learned" and could explain rules like the third person singular "*-s*", but who were not able to use them in casual conversations because they had not yet 'acquired' them. Krashen's response was to advocate a *Natural Approach*, which held that (a) language acquisition does not require extensive use of conscious grammatical rules, and does not require tedious drill; (b) acquisition requires meaningful interaction in the target language—natural communication—in which speakers are concerned not with the form of their utterances but with the messages they are conveying and understanding; (c) comprehensible input is the crucial and necessary ingredient for the acquisition of language; and (d) that real world conversations with sympathetic native speakers who are willing to help the acquirer understand are very helpful.

Lightbown (2008, pp. 28–29) summarized the subsequent 30 years as follows:

> For more than thirty years, pedagogical practice and second language research have emphasized the value of language learning that takes place in situations where learners are actually engaged in using language rather than in learning word lists and grammar rules in anticipation of using the language at some future time. This includes instructional models such as content-based instruction or a version of communicative language teaching in which there is essentially no form-focused language teaching and students are expected to learn language "incidentally", while their attention is focused on meaning (Howatt, 1984; Snow, Met, & Genesee, 1992). Form-focused instruction that is isolated from communicative language use has become rare in many classrooms (Lightbown & Spada, 2006). The preference is to integrate form focus into a rich communicative context (Long & Robinson, 1998). One approach to language

> teaching that has been strongly criticized is the kind of mechanical drill in which students repeat sentences that are related only by the fact that they share some grammatical pattern (Lightbown, 1983; Long, 1991; Wong & VanPatten, 2003). DeKeyser (1998) makes this point particularly well when he says, 'Drills make sense only if they are defined in terms of behaviors to be drilled (. . .) but [audiolingual methodologists] forgot to define the behaviors they wanted to establish (. . .) *conveying personal meanings*' (pp. 53–54).

These emphases are sustained now in socially and culturally motivated approaches to language exposure, as already quoted from Wagner (2015, p. 75): "The target for many second language learners is not just 'to speak another language,' but to become part of the social and cultural environment in which the language is used. This entails frequent and rich participation in the second-language life worlds into which the learner 'bricolages' his or her way." Digital technologies give increasing opportunities for rich 'rewilding' of education (Dubreil & Thorne, 2017; Thorne, 2018) and we should be optimistic that such embodied, environmentally embedded, enacted, socially encultured, and situated environments (Eskildsen & Wagner, 2015) can provide flow and concomitantly rich language learning.

Nevertheless, there are certain aspects of language to which uninstructed second language learners operating in the real-world wilds commonly prove impervious, where input fails to become intake (Corder,1967). Schmidt's paradigm case of a naturalistic learner, Wes, was very fluent, with high levels of strategic competence, but low levels of grammatical accuracy. He was described as being interested in the message, not the form, and as being impatient with correction. In discussing Wes's unconscious naturalistic acquisition of English as a second language (ESL) in the 5 years since coming to America, Schmidt (1984) reported:

> If language is seen as a medium of communication, as a tool for initiating, maintaining and regulating relationships and carrying on the business of life, then W

> has been a successful language learner (. . .). If language acquisition is taken to mean (as it usually is) the acquisition of grammatical structures, then the acquisition approach may be working, but very slowly (. . .). Using 90% correct in obligatory contexts as the criterion for acquisition, none of the grammatical morphemes counted has changed from unacquired to acquired status over a five year period. (p. 5)

Likewise, in the large European Science Foundation (ESF) crosslinguistic and longitudinal research project, Klein and Perdue (1992) examined how 40 adult learners picked up the language of their social environment by everyday communication. They described the interlanguage of these learners as the 'Basic Variety.' All learners, independent of source language and target language, developed and used it, with about one-third of them fossilizing at this level in that although they learned more words, they did not further complexify their utterances in respects of morphology or syntax. In this Basic Variety, most lexical items stem from the target language, but they are uninflected. "

> There is no functional morphology. By far most lexical items correspond to nouns, verbs and adverbs; closed-class items, in particular determiners, subordinating elements, and prepositions, are rare, if present at all (. . .). Note that there is no functional inflection whatsoever: no tense, no aspect, no mood, no agreement, no casemarking, no gender assignment; nor are there, for example, any expletive elements" (Klein, 1998, pp. 554–555).

At the population level too, the proportion of second language speakers affects the morphological complexity of the language (N. Ellis, 2008a; McWhorter, 2002, 2004; Mufwene, 2001, 2008; Trudgill, 2002a, 2002b).

There are good cognitive psychological reasons why functional morphology is less learnable than lexis in SLA because of factors including low salience, low contingency, blocking, and learned attention (N. Ellis, 2006c, 2008c, 2017) and thus why form-focussed instruction might be relevant if that is what particular language learners want to be able to do in their language (Doughty & Williams, 1998; N. Ellis, 2005). The problem then is how best to integrate focus on meaning and form-focused instruction, and a lot of careful thought and educational research has been dedicated to this problem (Doughty & Long, 2003; R. Ellis, 2005, 2012; Long & Doughty, 2009; Ortega, 2013). Task-based language teaching (TBLT; R. Ellis, 2003; Long, 2014) tries to encourage interaction and engagement in meaningful authentic language while focussing students to do meaningful tasks using the target language. Robinson and Ellis (2008), Littlemore (2009), Tyler (2012), and Ortega et al. (2016) describe usage-inspired L2 teaching and other applications of cognitive-linguistics. However, the full implications of this theory of language cognition for teacher training, teaching methods, and educational policy require extensive further consideration.

The various learner competences outlined in this section are different. They are simply different, not objectively worse or better than one another. Semantics and syntax play their different roles in our essential communications. It is a worthy linguistic exercise to describe different profiles of complexity, accuracy, and fluency, and a worthy goal of cognitive psychology and usage-based linguistics to understand their origins. Different language experiences result in different types of language knowledge. If the goal is sharing communication in the here-and-now, that is quite a different goal from writing an essay for academic purposes. Some learners strive for fluency, some for grammatical correctness, some for sharing meanings, some for cultural integration. We should acknowledge and support learners' linguistic goals toward self-determination (Norton, 2000) and agency (Larsen–Freeman, 2019, this issue).

Linguistic prescriptivism is a different matter entirely (Curzan, 2014; Joseph, 1987). As Ortega (2019, this issue) cautions, the field of SLA should ever strive to avoid unconscious prescriptivism through judgmental comparisons against native speaker norms. We are all subject to implicit bias relating to self-justification, ethnocentrism, homophily, ingroup bias, and outgroup antipathy (Nosek, Hawkins, & Frazier, 2011; Staats et al., 2015), and there is arguably no greater source of self and identity than language. Heeding Ortega's call for a broadening of our focus toward the wider world of multilingualism will not only act against this trend, but will also increase the validity, relevance, and interest of our research base.

<A>INDIVIDUALS AND THEIR ECOLOGY

Languages, usage, culture, social experience, are all ecological phenomena. They are emergent from complex adaptive systems. So much so, that one can imagine that they are basically indivisible from their environments. Yeats's poem "Among school children" (1989, originally published 1928) questions both his own lifelong search for a unity of being and modern regimented curricula that deny creative individuality. He later revised this work, lightening the pessimism by means of the addition of a final stanza that sees a possibility of understanding the whole in terms of the unity of dynamics and complexity: He asks "How can we know the dancer from the dance?" and "O chestnut tree, great rooted blossomer, Are you the leaf, the blossom, or the bole?" In recognizing variation, individuality, and contextualization in time and space, we must not lose sight of the wood for the trees.

As researchers, we might identify one individual in the community, focus in on them, and identify their idiosyncratic characteristics. They carry their language with them to tell their life stories in their characteristic ways. Individuals have constancies – individual differences are reliable. As linguists we might stop the speech stream and identify individual unit patterns,

which we might label as a phoneme, lexeme, morpheme, or other construction. We can identify and label these and other speech acts in their registers and genres as they strike us as being interesting categories in the ecology. And often, when we look for others of the same type, we find they share reliable associations and interpretations. Any of these types also have characteristic patterns of interaction in collocation, or lexicosyntax, or sociolinguistic choice. Usage is patterned both syntagmatically and paradigmatically. Ecologies are patterned both synchronically and diachronically. Theories are likewise situated in their time, their place, and their thinkers. Patterns are emergent.

The Three Goals

The first goal is to see the thing clearly itself

in and for itself, to see it simply and clearly

for what it is.

No symbolism, please.

The second goal is to see each individual thing

as unified, as one, with all the other

ten thousand things.

In this regard, a little wine helps a lot.

The third goal is to grasp the first and second goals,

to see the universal and the particular,

simultaneously.

Regarding this one, call me when you get it.

(Budbill, 1999)

REFERENCES

Anderson, J. R. (2015). *Cognitive psychology and its implications* (8th ed.). New York: Worth Publishers.

Atkinson, D. (2002). Towards a sociocognitive approach to second language acquisition. *Modern Language Journal, 86*, 525–545.

Atkinson, D. (2010). Extended, embodied cognition and second language acquisition. *Applied Linguistics, 31*, 599–622.

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

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22*, 577–660.

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology, 59*, 617–645.

Bateson, G. (1979). *Mind and nature: A necessary unity*: New York: Hampton Press.

Bateson, G. (2000 [1972]). *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. Chicago, IL: University of Chicago Press.

Beckner, C., Blythe, R. A., Bybee, J., Christiansen, M. H., Croft, W., Ellis, N. C., . . . Schoenemann, T. (2009). Language is a complex adaptive system. Position paper. *Language Learning, 59, Supplement 1*, 1–26.

Behrens, H. (2009). Usage-based and emergentist approaches to language acquisition. *Linguistics, 47*, 383–411.

Bod, R., Hay, J., & Jannedy, S. (Eds.). (2003). *Probabilistic linguistics*. Cambridge, MA: The MIT Press.

Bratman, M. (1992). Shared cooperative activity. *The Philosophical Review, 101*, 327–341.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.

Brown, J. S., Collins, A., & Duguid, S. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*, 32–42.

Budbill, D. (1999). The three goals. *From moment to moment: Poems of a mountain recluse*. Port Townsend, WA: Copper Canyon Press.

Bybee, J. (2010). *Language, usage, and cognition*. Cambridge: Cambridge University Press.

Bybee, J., & Hopper, P. (Eds.). (2001). *Frequency and the emergence of linguistic structure*. Amsterdam: John Benjamins.

Cadierno, T., & Eskildsen, S. W. (Eds.). (2015). *Usage-based perspectives on second language learning*. Berlin: de Gruyter Mouton.

Chemero, A. (2009). *Radical embodied cognitive science.* Cambridge MA: The MIT Press.

Christiansen, M. H., & Chater, N. (2017). Towards an integrated science of language. *Nature Human Behaviour, 1*, 0163. doi: 10.1038/s41562-017-0163

Christiansen, M. H., & Chater, N. (Eds.). (2001). *Connectionist psycholinguistics*. Westport, CO: Ablex.

Clancey, W. J. (2009). Scientific antecedents of situated cognition. In P. Robbins & M. Aydede (Eds.), *The Cambridge handbook of situated cognition* (pp. 11–34). Cambridge: Cambridge University Press.

Clark, A. (1998). *Being there: Putting brain, body, and world together again*. Cambridge, MA: The MIT Press.

Clark, A. (2005). Word, niche and super-niche: How language makes minds matter more. *THEORIA. An International Journal for Theory, History and Foundations of Science, 20*, 255–268.

Clark, A. (2010). *Supersizing the mind: Embodiment, action, and cognitive extension*. Oxford: Oxford University Press.

Clark, A., & Chalmers, D. J. (1998). The extended mind. *Analysis, 58*, 7–19.

Clark, A., & Toribio, J. (1994). Doing without representing? *Synthese. Special Issue: On connectionism and the frontiers of artificial intelligence, 101*, 401–431.

Clark, H. H. (1996). *Using language*. Cambridge: Cambridge University Press.

Cohen, R. L. (1989). Memory for action events: The power of enactment. *Educational Psychology Review, 1*, 57–80.

Coltheart, M. (2001). Assumptions and methods in cognitive neuropsychology. In B. Rapp (Ed.), *Handbook of cognitive neuropsychology: What deficits reveal about the human mind*. New York: Psychology Press.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*, 671–684.

Csikszentmihalyi, M. (2014). Toward a psychology of optimal experience. In M. Csikszentmihalyi (Ed.), *Flow and the foundations of Positive Psychology: The collected works of Mihaly Csikszentmihalyi* (pp. 209–226). Dordrecht: Springer.

Curzan, A. (2014). *Fixing English: Prescriptivism and language history*. Cambridge: Cambridge University Press.

Dabrowska, E., & Divjak, D. (Eds.). (2015). *Handbook of cognitive linguistics*. Berlin: de Gruyter Mouton.

de Bot, K., Lowie, W., & Verspoor, M. (2007). A dynamic systems theory to second language acquisition. *Bilingualism: Language and Cognition, 10*, 7–21.

de Groot, A. M. B., & Kroll, J. F. (Eds.). (1997). *Tutorials in bilingualism: Psycholinguistic perspectives*. Hillsdale, NJ: Lawrence Erlbaum.

DeKeyser, R. (Ed.). (2007). *Practice in a second language: Perspectives from applied linguistics and cognitive psychology*. Cambridge: Cambridge University Press.

DeKeyser, R. M. (1998). Beyond focus on form: Cognitive perspectives on learning and practicing second language grammar. In C. Doughty & J. Williams (Eds.), *Focus on form in classroom second language acquisition* (pp. 42–63). Cambridge: Cambridge University Press.

Donato, R. (1994). Collective scaffolding in second language learning. In J. Lantolf & G. Appel (Eds.), *Vygotskian approaches to second language research* (pp. 33–56). Norwood, NJ: Ablex.

Donato, R. (2000). Sociocultural contributions to understanding the foreign and second language classrooms. In J. Lantolf (Ed.), *Sociocultural theory and second language learning*. Oxford: Oxford University Press.

Doughty, C., & Long, M. (2003). Optimal psycholinguistic environments for distance foreign language learning. *Language Learning and Technology, 7*, 50–80.

Doughty, C., & Williams, J. (Eds.). (1998). *Focus on form in classroom second language acquisition*. New York: Cambridge University Press.

Douglas Fir Group. (2016). A transdisciplinary framework for SLA in a multilingual world. *Modern Language Journal, 100* (Supplement 2016), 19–47.

Dubreil, S., & Thorne, S. L. (Eds.). (2017). *Engaging the world: Social pedagogies and language learning*. Boston, MA: Cengage.

Duff, P. A. (2019). Social dimensions, differences, and processes in second language acquisition: Critical perspectives. *Modern Language Journal, 103* (Supplement 2019), xxxx.

Duff, P. A. , & Talmy, S. (2011). Language socialization approaches to second language acquisition. In D. Atkinson (Ed.), *Alternative approaches to second language acquisition* (pp. 95–116). New York: Routledge.

Duncker, D. (2017). The notion of an integrated system. In A. Pablé (Ed.), *Critical humanist perspectives: The integrational turn in philosophy of language and communication* (pp. 135–153). London/New York: Routledge.

Ellis, A. W., & Young, A. W. (1988). *Human cognitive neuropsychology*. Hove, Sussex: Erlbaum.

Ellis, N. C. (Ed.). (1994). *Implicit and explicit learning of languages*. San Diego, CA: Academic Press.

Ellis, N. C. (1996). Analyzing language sequence in the sequence of language acquisition: Some comments on Major and Ioup. *Studies in Second Language Acquisition, 18*, 361–368.

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

Ellis, N. C. (1999). Cognitive approaches to SLA. *Annual Review of Applied Linguistics, 19*, 22–42.

Ellis, N. C. (2002). Frequency effects in language processing: A review with implications for theories of implicit and explicit language acquisition. *Studies in Second Language Acquisition, 24*, 143–188.

Ellis, N. C. (2003). Constructions, chunking, and connectionism: The emergence of second language structure. In C. Doughty & M. H. Long (Eds.), *Handbook of second language acquisition* (pp. 33–68). Oxford: Blackwell.

Ellis, N. C. (2005). At the interface: Dynamic interactions of explicit and implicit language knowledge. *Studies in Second Language Acquisition, 27*, 305–352.

Ellis, N. C. (2006a). The Associative–Cognitive CREED. In B. VanPatten & J. Williams (Eds.), *Theories in second language acquisition: An introduction* (pp. 77–96). Mahwah, NJ: Lawrence Erlbaum.

Ellis, N. C. (2006b). Cognitive perspectives on SLA: The Associative Cognitive CREED. *AILA Review, 19*, 100–121.

Ellis, N. C. (2006c). Selective attention and transfer phenomena in SLA: Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics, 27*, 1–31.

Ellis, N. C. (2007). Dynamic systems and SLA: The wood and the trees. *Bilingualism: Language & Cognition, 10*, 23–25.

Ellis, N. C. (2008a). The dynamics of second language emergence: Cycles of language use, language change, and language acquisition. *Modern Language Journal, 41*, 232–249.

Ellis, N. C. (2008b). The psycholinguistics of the interaction hypothesis. In A. Mackey & C. Polio (Eds.), *Multiple perspectives on interaction in SLA: Second language research in honor of Susan M. Gass* (pp. 11–40). New York: Routledge.

Ellis, N. C. (2008c). Usage-based and form-focused language acquisition: The associative learning of constructions, learned-attention, and the limited L2 endstate. In P. Robinson & N. C. Ellis (Eds.), *Handbook of cognitive linguistics and second language acquisition* (pp. 372–405). London: Routledge.

Ellis, N. C. (2011). Frequency-based accounts of SLA. In S. Gass & A. Mackey (Eds.), *Handbook of second language acquisition* (pp. 193–210). London: Routledge/Taylor Francis.

Ellis, N. C. (2015). Cognitive and social aspects of learning from usage. In T. Cadierno & S. W. Eskildsen (Eds.), *Usage-based perspectives on second language learning* (pp. 49–73). Berlin: de Gruyter Mouton.

Ellis, N. C. (2017). Salience in usage-based SLA. In S. Gass, P. Spinner, & J. Behney (Eds.), *Saliency in second language acquisition* (pp. 21–40). New York: Routledge/Taylor & Francis.

Ellis, N. C., & Larsen–Freeman, D. (Eds.) (2006a). Language emergence: Implications for applied linguistics. *Applied Linguistics, 27*, 558–740.

Ellis, N. C., & Larsen–Freeman, D. (2006b). Language emergence: Implications for applied linguistics (Introduction to the Special Issue). *Applied Linguistics, 27*, 558–589.

Ellis, N. C., & Larsen–Freeman, D. (Eds.). (2009). *Language as a complex adaptive system*. Mahwah, NJ: Wiley.

Ellis, N. C., O'Donnell, M. B., & Römer, U. (2013). Usage-based language: Investigating the latent structures that underpin acquisition. *Currents in Language Learning, 1*, 25–51.

Ellis, N. C., Römer, U., & O'Donnell, M. B. (2016). *Language usage, acquisition, and processing: Cognitive and corpus investigations of construction grammar*. Malden, MA: Wiley–Blackwell.

Ellis, N. C., & Wulff, S. (2015a). Second language acquisition. In E. Dabrowska & D. Divjak (Eds.), *Handbook of cognitive linguistics* (pp. 409–431). Berlin: de Gruyter Mouton.

Ellis, N. C., & Wulff, S. (2015b). Usage-based approaches to SLA. In B. VanPatten & J. Williams (Eds.), *Theories in second language acquisition: An introduction* (2nd ed., 75– 93). New York: Routledge/Taylor & Francis.

Ellis, R. (2003). *Task-based language learning and teaching*. Oxford: Oxford University Press.

Ellis, R. (2005). Principles of instructed language learning. *System, 33*, 209–224.

Ellis, R. (2010). Explicit form-focussed instruction and second language acquisition. In B. Spolsky & F. M. Hult (Eds.), *The Handbook of educational linguistics* (pp. 437–455). Chichester, UK: John Wiley.

Ellis, R. (2012). Form-focused instruction and second language learning. In R. Ellis, *Language teaching research and language pedagogy* (pp. 271–306). Malden, MA: Wiley–Blackwell.

Elman, J. L., Bates, E. A., Johnson, M. H., Karmiloff–Smith, A., Parisi, D., & Plunkett, K. (1996). *Rethinking innateness: A connectionist perspective on development.* Cambridge, MA: The MIT Press.

Eskildsen, S. W., & Wagner, J. (2015). Embodied L2 construction learning. *Language Learning, 65*, 268–297.

Fisher, R. P., & Geiselman, R. E. (1992). *Memory enhancing techniques for investigative interviewing: The cognitive interview*. Springfield IL: Charles C. Thomas.

Frith, C. (2010). What is consciousness for? *Pragmatics and Cognition, 18*, 497–551.

Frith, U., & Frith, C. (2010). The social brain: Allowing humans to boldly go where no other species has been. *Philosophical Transactions of the Royal Society, B, 365*, 165–176.

Gaskell, G. (Ed.). (2007). *Oxford handbook of psycholinguistics*. Oxford: Oxford University Press.

Gass, S. (1997). *Input, interaction, and the development of second languages.* Mahwah, NJ: Lawrence Erlbaum.

Gass, S. (2002). Interactionist perspectives in SLA. In R. Kaplan (Ed.), *Handbook of applied linguistics* (pp. 170–181). Oxford: Oxford University Press.

Gass, S., & Mackey, A. (2007). Input, interaction and output: An overview. *AILA Review, 19*, 3–17.

Gawande, A. (2009). *The checklist manifesto: How to get things right*. New York: Henry Holt and Company.

Geeraerts, D. (1995). Cognitive linguistics. In J. Verschueren, J.–O. Östman, & J. Blommaert (Eds.), *Handbook of pragmatics* (pp. 111–116). Amsterdam: John Benjamins.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston, MA: Houghton Mifflin.

Goldberg, A. E. (1995). *Constructions: A construction grammar approach to argument structure.* Chicago: University of Chicago Press.

Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford: Oxford University Press.

Gries, S. T. (2012). Frequencies, probabilities, association measures in usage-/exemplar-based linguistics: Some necessary clarifications. *Studies in Language, 11*, 477–510.

Gries, S. T. (2013). 50-something years of work on collocations. *International Journal of Corpus Linguistics, 18*, 137–165.

Gries, S. T., & Divjak, D. S. (Eds.). (2012). *Frequency effects in language learning and processing*. Berlin/New York: de Gruyter Mouton.

Gries, S. T., & Ellis, N. C. (2015). Statistical measures for usage-based linguistics. *Currents in Language Learning, 2*, 228–255.

Gries, S. T., & Wulff, S. (2009). Psycholinguistic and corpus linguistic evidence for L2 constructions. *Annual Review of Cognitive Linguistics, 7*, 164–187.

Hall, J. K. (2019). The contributions of conversation analysis and interactional linguistics to a usage-based understanding of language: Expanding the transdisciplinary framework. *Modern Language Journal, 103* (Supplement 2019), xxxx.

Harris, R. (1981). *The language myth*. London: Duckworth.

Harris, R. (1987). Language as social interaction: Integrationism versus segregationism. *Language Sciences, 9*, 271–286.

Hatch, E. (1983). *Psycholinguistics: A second language perspective*. Rowley, MA: Newbury House.

Hopper, P. J. (1987). Emergent grammar. *Berkeley Linguistics Society, 13*, 139–157.

Hopper, P. J. (1998). Emergent grammar. In M. Tomasello (Ed.), *The new psychology of language: Cognitive and functional approaches to language structure* (pp. 155–176). Mahwah, NJ: Lawrence Erlbaum.

Howatt, A. P. R. (1984). *A history of English language teaching*. Oxford: Oxford University Press.

Hurley, S. (1998). *Consciousness in action*. Cambridge MA: Harvard University Press.

Hutchins, E. (1995a). *Cognition in the wild*. Cambridge, MA: The MIT Press.

Hutchins, E. (1995b). How a cockpit remembers its speeds. *Cognitive Science, 19*, 265–288. doi:

Hutchins, E. (2010). Cognitive ecology. *Topics in Cognitive Science, 2*, 705–715.

Huth, A. G., de Heer, W. A., Griffiths, T. L., Theunissen, F. E., & Gallant, J. L. (2016). Natural speech reveals the semantic maps that tile human cerebral cortex. *Nature, 532*(7600), 453–458.

James, W. (1890). *The principles of psychology* (Vol. 1). New York: Dover.

Joseph, J. E. (1987). *Eloquence and power: The rise of language standards and standard languages*. Oxford: Blackwell.

Joseph, J. J. (2017). *Language, mind and body: A conceptual history*. Cambridge: Cambridge University Press.

Kasper, G., & Wagner, J. (2011). A conversation-analytic approach to second language acquisition. Alternative approaches to second language acquisition. In D. Atkinson (Ed.), *Alternative approaches to second language acquisition* (pp. 117–142.). Abingdon, UK: Routledge.

Kelly, L. G. (1969). *25 centuries of language teaching*: *An inquiry into the science, art, and development of language teaching methodology.* Rowley, MA: Newbury House.

Klein, W. (1998). The contribution of second language acquisition research. *Language Learning, 48*, 527–550.

Klein, W., & Perdue, C. (1992). *Utterance structure: Developing grammars again*. Amsterdam: John Benjamins.

Kramsch, C. (1993). *Context and culture in language teaching*. Oxford: Oxford University Press.

Kramsch, C. (Ed.). (2002). *Language acquisition and language socialization: Ecological perspectives*. London: Continuum.

Krashen, S. D. (1982). *Principles and practice in second language acquisition*. Oxford: Pergamon.

Kroll, J. F., & de Groot, A. M. B. (Eds.). (2005). *Handbook of bilingualism: Psycholinguistic approaches*. Oxford: Oxford University Press.

Kuhl, P. K. (2007). Is speech-learning gated by the 'social brain'? *Developmental Science, 10*, 110–120.

Lakoff, G. (1987). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago: University of Chicago Press.

Lakoff, G., & Johnson, M. H. (1980). *Metaphors we live by*. Chicago: University of Chicago Press.

Langacker, R. W. (1987). *Foundations of cognitive grammar: Theoretical prerequisites* (Vol. 1). Stanford, CA: Stanford University Press.

Langacker, R. W. (1999). *Grammar and conceptualization*. Amsterdam: Walter de Gruyter.

Lantolf, J. (2006). Sociocultural theory and L2: State of the art. *Studies in Second Language Acquisition, 28*, 67–109.

Lantolf, J., & Pavlenko, A. (1995). Sociocultural theory and second language acquisition. *Annual Review of Applied Linguistics, 15*, 38–53.

Lantolf, J., & Poehner, M. (2014). *Sociocultural theory and the pedagogical imperative in L2 education: Vygotskian praxis and the research/practice divide*. London: Routledge.

Lantolf, J., & Thorne, S. (2006). *Sociocultural theory and the genesis of second language development*. Oxford: Oxford University Press.

Larsen–Freeman, D. (1997). Chaos/complexity science and second language acquisition. *Applied Linguistics, 18*, 141–165.

Larsen–Freeman, D. (2019). On language learner agency: A complex dynamic systems theory perspective. *Modern Language Journal, 103* (Supplement 2019), xxxx.

Larsen–Freeman, D., & Cameron, L. (2008). *Complex systems and applied linguistics*. Oxford: Oxford University Press.

Lascotte, D., & Tarone, E.. (2019). Heteroglossia and constructed dialogue in SLA. *Modern Language Journal, 103* (Supplement 2019), xxxx.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge: Cambridge University Press.

Lave, J., & Wenger, E. (1990). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lee, N., & Schumann, J. (2003, March 22–25). *The evolution of language and of the symbolosphere as complex, adaptive systems.* Paper presented at the American Association for Applied Linguistics, Arlington, VA.

Lightbown, P. M. (1983). Exploring relationships between developmental and instructional sequences in L2 acquisition. In H. Seliger & M. H. Long (Eds.), *Classroom oriented research in second language acquisition* (pp. 217–243). Rowley, MA: Newbury House.

Lightbown, P. M. (2008). Transfer appropriate processing in classroom second language acquisition. In Z.–H. Han (Ed.), *Understanding second language process* (pp. 27–44). Clevedon, UK: Multilingual Matters.

Lightbown, P. M., & Spada, N. (2006). *How languages are learned*. Oxford: Oxford University Press.

Littlemore, J. (2009). *Applying cognitive linguistics to second language learning and teaching*. Basingstoke/New York: Palgrave Macmillan.

Lockhart, R. S. (2002). Levels of processing, transfer-appropriate processing, and the concept of robust encoding. *Memory, 10*, 397–403.

Logan, R., & Schumann, J. (2005). The symbolosphere, conceptualization, language, and neo-dualism. *Semiotica, 155*, 201–214.

Logan, R. K. (2007). *The extended mind: The emergence of language, the human mind and culture*. Toronto: University of Toronto Press.

Long, M. H. (1980). *Input, interaction, and second language acquisition.* (Unpublished doctoral dissertation). University of California, Los Angeles, CA.

Long, M. H. (1991). Focus on form: A design feature in language teaching methodology. In K. de Bot, R. Ginsberg, & C. Kramsch (Eds.), *Foreign language research in cross-cultural perspective* (pp. 39–52). Amsterdam: John Benjamins.

Long, M. H. (2014). *Second language acquisition and task-based language teaching*. Hoboken, NJ: John Wiley & Sons.

Long, M. H., & Robinson, P. (1998). Focus on form: Theory, research, and practice. In C. Doughty & J. Williams (Eds.), *Focus on form in classroom second language acquisition* (pp. 15–41). Cambridge: Cambridge University Press.

Long, M. L., & Doughty, C. A. (Eds.). (2009). *The handbook of language teaching*. Malden, MA: Wiley–Blackwell.

Mace, W. M. (1977). James J. Gibson's strategy for perceiving : Ask not what's inside your head, but what's your head inside of. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Towards an ecological psychology* (pp. 43-65). Mahwah, NJ: Lawrence Erlbaum.

Mackey, A. (2012). *Input, interaction, and corrective feedback in L2 learning.* Oxford: Oxford University Press.

MacWhinney, B. (1997). Second language acquisition and the Competition Model. In A. M. B. de Groot & J. F. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 113–142). Mahwah, NJ: Lawrence Erlbaum.

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

McEnery, T., & Hardie, A. (2012). *Corpus linguistics*. Cambridge: Cambridge University Press.

McGaugh, J. L. (2003). *Memory and emotion: The making of lasting memories* New York: Columbia University Press.

McWhorter, J. (2002). *The power of Babel: A natural history of language*. San Franciso, CA: W. H. Freeman & Co.

McWhorter, J. (2004). The story of human language Lecture 24: Language Interrupted. *The Great Courses*: The Teaching Company Limited Partnership.

Merleau–Ponty, M. (1962). *Phenomenology of perception* (C. Smith, Trans.). London: Routledge & Kegan Paul.

Mitchell, T. M., Shinkareva, S. V., Carlson, A., Chang, K.–M., Malave, V. L., Mason, R. A., & Just, M. A. (2008). Predicting human brain activity associated with the meanings of nouns. *Science, 320*, 1191–1195.

Mufwene, S. S. (2001). *The ecology of language evolution*. Cambridge: Cambridge University Press.

Mufwene, S. S. (2008). *Language evolution: Contact, competition and change.* London: Continuum.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*, 231–259.

Norton, B. (2000). *Identity and language learning: Gender, ethnicity and educational change*. Essex, UK: Longman.

Nosek, B. A., Hawkins, C. B., & Frazier, R. S. (2011). Implicit social cognition: From measures to mechanisms. *Trends in Cognitive Sciences 15*, 152-159.

Ortega, L. (2013). SLA for the 21st century: Disciplinary progress, transdisciplinary relevance, and the bi/multilingual turn. *Language Learning, 63*, 1–24.

Ortega, L. (2019). SLA and the study of equitable multilingualism. *Modern Language Journal, 103* (Supplement 2019), xxxx.

Paivio, A. (1990). *Mental representations: A dual coding approach*. Oxford: Oxford University Press.

Pierrehumbert, J. (2016). Phonological representation: Beyond abstract versus episodic. *Annual Review of Linguistics, 2*, 33–52.

Pulvermüller, F., Cappelle, B., & Shtyrov, Y. (2013). Brain basis of meaning, words, constructions, and grammar. *Oxford handbook of construction grammar* (pp. 396–416). Oxford: Oxford University Press.

Quine, W. V. O. (1960). *Word and object*. Cambridge, MA: The MIT Press.

Reber, A. S. (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious*. Oxford: Oxford University Press.

Rebuschat, P. (Ed.). (2015). *Implicit and explicit learning of language*. Amsterdam: John Benjamins.

Rebuschat, P., Meurers, D., & McEnery, T. (Eds.). (2017). *Experimental, computational, and corpus-based approaches to language learning: Evidence and interpretation*. *Language Learning, 67*, S1.

Rebuschat, P., & Williams, J. N. (Eds.). (2012). *Statistical learning and language acquisition*. Berlin: de Gruyter Mouton.

Reisburg, D. (Ed.). (2013). *The Oxford handbook of cognitive psychology*. Oxford: Oxford University Press.

Robbins, P., & Aydede, M. (2009a). A short primer on situated cognition. In P. Robbins & M. Aydede (Eds.), *The Cambridge handbook of situated cognition* (pp. 310). Cambridge: Cambridge University Press.

Robbins, P., & Aydede, M. (Eds.). (2009b). *The Cambridge handbook of situated cognition*. Cambridge: Cambridge University Press.

Robinson, P., & Ellis, N. C. (Eds.). (2008). *Handbook of cognitive linguistics and second language acquisition*. London: Routledge.

Rowlands, M. (2013). *The new science of the mind: From extended mind to embodied phenomenology*. Boston, MA: The MIT Press.

Rumelhart, D. E., & McClelland, J. L. (Eds.). (1986). *Parallel distributed processing: Explorations in the microstructure of cognition* (Vol. 2: Psychological and biological models). Cambridge, MA: The MIT Press.

Saffran, J. R., & Kirkham, N., Z. (2018). Infant statistical learning. *Annual Review of Psychology, 69*, 181–203.

Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 501–518.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding: an inquiry into human knowledge structures*. Hillsdale, NJ: Lawrence Erlbaum.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics, 11*, 129–158.

Schumann, J. H. (2018, March). The brain, nonphysical entities, and SLA. Paper presented at the Annual Meeting of the American Association for Applied Linguistics, Chicago, IL.

Schwieter, J. (Ed.). (2015). *The Cambridge handbook of bilingual processing*. Cambridge: Cambridge University Press.

Segalowitz, N. (2010). *The cognitive bases of second language fluency*. New York: Routledge.

Segalowitz, N., & Lightbown, P. M. (1999). Psycholinguistic approaches to SLA. *Annual Review of Applied Linguistics, 19*, 43–63.

Simon, H. A. (1962). *The sciences of the artificial*. Cambridge, MA: The MIT Press.

Slobin, D. I. (1997). The origins of grammaticizable notions: Beyond the individual mind. In D. I. Slobin (Ed.), *The crosslinguistic study of language acquisition* (Vol. 5, pp. 265–323). Mahwah, NJ: Lawrence Erlbaum.

Smith, S. M., & Vela, E. (2001). Environmental context-dependent memory: A review and meta-analysis. *Psychonomic Bulletin & Review, 8*, 203–220.

Snow, M. A., Met, M., & Genesee, F. (1992). A conceptual framework for the integration of language and content instruction. In P. A. Richard–Amato & M. A. Snow (Eds.), *The multicultural classroom: Readings for content-area teachers*. Reading, MA: Addison–Wesley.

Spada, N. (2011). Beyond form-focused instruction: Reflections on past, present and future research. *Language Teaching, 44*, 225–236.

Staats, C., Capatosto, K, Wright, R. A., & Contractor, D. (2015). *State of the science: Implicit bias review 2015*. Ohio State University, Kirwan Institute for the Study or Race and Ethnicity.

Stepney, R. (2018). A path is the wisdom of many feet. In A. Lancini, E. Fenton, J. Lanyon, & R. Stepney (Eds.), *Words go out to play* (pp. 30–31). Charlbury, Oxfordshire: The Charlbury Press.

Sternberg, R. J., Fiske, S. T., & Foss, D. J. (Eds.). (2016). *Scientists making a difference: One hundred eminent behavioral and brain scientists talk about their most important contributions*. Cambridge: Cambridge University Press.

Sutton, J. (2009). Remembering. In M. Aydede & P. Robbins (Eds.), *The Cambridge handbook of situated cognition* (pp. 217–235). Cambridge: Cambridge University Press,.

Tarone, E. (2007). Sociolinguistic approaches to second language acquisition research: 1997–2007. *Modern Language Journal, 91(s1)*, 837–848.

Thompson, E. (2005). Sensorimotor subjectivity and the enactive approach to experience. *Phenomenology and the Cognitive Sciences, 4*, 407–427.

Thorne, S. L. (2018, March). *Technologies, morphologies of communicative action, and the rewilding of language education*. Paper presented at the American Association for Applied Linguistics, Chicago, IL.

Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*. Boston, MA: Harvard University Press.

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

Tomasello, M. (Ed.). (1998). *The new psychology of language: Cognitive and functional approaches to language structure*. Mahwah, NJ: Lawrence Erlbaum.

Trousdale, G., & Hoffmann, T. (Eds.). (2013). *Oxford handbook of construction grammar*. Oxford: Oxford University Press.

Trudgill, P. (2002a). Linguistic and social typology. In J. K. Chambers, P. Trudgill, & N. Schilling–Estes (Eds.), *The handbook of language variation and change* (pp. 707–728). Oxford: Blackwell.

Trudgill, P. (2002b). *Sociolinguistic variation and change*. Edinburgh: Edinburgh University Press.

Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior, 5,* 381–391.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*, 359–380.

Tyler, A. (2012). *Cognitive linguistics and second language learning: Theoretical basics and experimental evidence*. Abingdon, UK: Routledge.

Tyler, A., Ortega, L., Uno, M. and In Park, H. (Eds). (2018). *Usage-inspired L2 instruction: Researched pedagogy.* Amsterdam: John Benjamins Publishing Company.

Ungerer, F., & Schmid, H. J. (1996). *An introduction to cognitive linguistics*. London: Longman.

Varela, F., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive Science and human experience*. Boston, MA: The MIT Press.

Vygotsky, L. S. (1980). *Mind in society: The development of higher mental processes*. Boston, MA: Harvard University Press.

Wagner, J. (2015). Designing for language learning in the wild: Creating social infrastructures for second language learning. In T. Cadierno & S. W. Eskildsen (Eds.), *Usage-based perspectives on second language learning* (pp. 75–101). Berlin: de Gruyter Mouton.

Ward, D., & Stapleton, M. (2012). Es are good: Cognition as enacted, embodied, embedded, affective and extended. In F. Pagileri (Ed.), *Consciousness in interaction: The role of the natural and social context in shaping consciousness*. Amsterdam: John Benjamins.

Watts, A. (1989). *The book: On the taboo against knowing who you are*. New York: Vintage Books.

Williams, J., & Gullberg, M. (2012). Cognitive second language acquisition: Overview. In C. A. Chapelle (Ed.), *The encyclopedia of applied linguistics*. Boston, MA: John Wiley.

Wilson, R. A., & Foglia, L. (2017). Embodied cognition. In E. N. Zalta (Ed.), *The Stanford encyclopedia of philosophy* (Spring 2017 Edition). Accessed 16 April 2018 at <https://plato.stanford.edu/archives/spr2017/entries/embodied-cognition/>.

Wong, W., & VanPatten, B. (2003). The evidence is IN: Drills are OUT. *Foreign Language Annals, 36*, 403–423.

Wulff, S., & Ellis, N. C. (2018). Usage-based approaches to SLA. In D. Miller, F. Bayram, J. Rothman, & L. Serratrice (Eds.), *Bilingual cognition and language: The state of the science across its subfields* (pp. 37–56). Amsterdam: John Benjamins.

Yeats, W. B. (1989). *Yeats's poems*. London: Macmillan.