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DEVELOPING SCAFFOLDS IN EVOLUTION, CULTURE, AND COGNITION

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Developing Scaffolds in Evolution, Culture and Cognition

Linnda R. Caporael, James R. Griesemer, and William C. Wimsatt (eds)

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This collection of essays explores 'scaffolding' as a concept, metaphor, and shared feature of developmental processes in different scientific domains. The essays were originally presented in a collaborative workshop at the Konrad Lorenz Institute for Evolution and Cognition Research (KLI) by scholars of various, sometimes multidisciplinary, backgrounds. The methodologically and thematically diverse contributions explore theoretical alternatives, as well as complementary approaches, to neo-Darwinian accounts of development, taking a critical stance on extrapolating from traditional evolutionary models to other domains. Linnda R. Caporael, James R. Griesemer, and William C. Wimsatt have gathered together a rich collection of approaches to biological evolution, culture, and cognition that should

motivate readers across various disciplines to develop new research strategies and rethink some of the underlying conceptual models guiding their scientific work.

The editors acknowledge in their introduction the dual nature of the term 'scaffolding' as a noun and a verb, a structure and a process—an ambiguity foreshadowed in the work of psychologist Lev Vygotsky (p. 7). They also recognize Andy Clark's pioneering work on scaffolding, as well as the opposition to the 'gene's eye view' from developmental system theorists. Scaffolding is introduced as a widespread feature that facilitates or supports development in scenarios where growth or the acquisition of new capacities would otherwise be much costlier or even impossible. They propose a three-by-three cross-classification of scaffolding: artefacts such as tools or vehicles that are typically used temporarily; more persistent infrastructures, such as buildings or institutions; and cooperative developmental agents such as teachers or mentors, who are capable of supporting or enabling maintenance, growth, or development by scaffolding interactions. This matrix is useful for the reader, offering an initial orientation in the scaffolding landscape, although the contributors do not rigorously adhere to it. How the case studies raised in the book fit into this scheme is explored in the editors' introduction of each of the book's five parts and in their epilogue chapter.

The collaborators neither defend scaffolding for its own sake nor merely exemplify it; each chapter demonstrates the concept's usability and reveals new facets, without following a rigorous theoretical framework. All the authors pursue specific theoretical goals and address problems in their field of interest by applying the scaffolding concept in different ways. Some diverging interpretations of the concept are thus inevitable, but as the editors note, these kinds of 'productive resistances' (p. 17) fuel engagements between scholars, which may produce shared understandings of biological, cognitive, and cultural processes.

These three domains—evolution, culture, and cognition—are not intended as strict demarcations and the book is not structured by them. The editors explain that they 'move between domains of evolutionary biology, culture, and cognition as naturalists who wonder at the marvellous intricacy and complexity of socio-cognitive-developmental systems, not imperialists seeking colonial domination' (p. 367–8). Neither domain takes precedence over another. As Griesemer writes in his chapter, 'there is nothing intrinsically biological about scaffolding or the general concept of development' (p. 47). The editors see an urge for a reorientation of theoretical approaches, away from 'standard narratives' (p. 363) that are guided by theories of biological phenomena towards 'an empirically grounded approach to theory that is sensitive to the dynamic, self-organizing, self-stabilizing character of developmental systems' (p. 387).

The first part of the book ('Toward Materiality: Three Perspectives') contains three substantial chapters by the editors, which relate the scaffolding concept to the editors' previous scholarly work on biological reproduction (Griesemer), repeated assembly of core configurations (Caporael), and generative entrenchment (Wimsatt), respectively. These starting points are picked up in several chapters and demonstrate the fruitfulness of cross-disciplinary collaborations that employ shared concepts.

Griesemer addresses the conceptual absence of development in existing philosophical accounts of heredity by discussing reproduction processes and the role of hybrids (entities that have formed from various material sources and resist canonical system–environment boundaries and distinctions). Hybrids figure as individuals and as central subjects in Griesemer's narrative of reproduction. In his example—the

replication of HIV-1—hybrid RNA–DNA individuals ‘confer developmental capacities to subsequent stages of virus development by means of the material overlap of parts’ (p. 44). This account fits into Griesemer’s ‘reproducer perspective’, in which material continuity in a transfer of developmental capacities from parent to offspring is central. By arguing that a host cell functions as a scaffold for virus development and reproduction, Griesemer shifts traditional system–environment boundaries; he further explores how hybrids and material reproduction could figure in cultural development, and integrates his account of hybrids as individuals and ‘reproducers’ with the other editors’ perspectives, which rightly positions his contribution as the book’s first chapter. This tracking of alternative units of investigation is implicit in many of the book’s chapters, and these choices complement the conception of scaffolding and offer new tools for ‘broadened eco-evo-devo’ perspectives, as the editors explain in the epilogue (p. 387).

In the second chapter, Caporael draws attention to the repeated assembly of face-to-face groups throughout human history. Core configurations such as the mother–infant dyad or hunting groups scaffold human development, cognition, and culture across generations. Caporael emphasizes the evolutionary–developmental context of human behaviour and highlights the role of group activities in the scaffolding of knowledge production. Core configurations in science range from dyads to whole research institutions and, Caporael explains, isolated individuals would likely struggle to persist, just as isolated hunter-gatherers struggled. Scaffolding knowledge, in what she terms ‘epistemic projects’, are coordinating processes that can be performed by humans (for example, scientists), but also by groups of animals that may coordinate direction and purpose in their movement.

Wimsatt relates scaffolding to the entrenchment of cultural development, stating that ‘entrenched features commonly act as scaffolding (though scaffolding is not always entrenched)’ (p. 77). The analysis of cultural evolution needs a more elaborate account of different kinds of entrenchment, Wimsatt argues, and his chapter offers initial distinctions. What Wimsatt calls ‘combinatorial entrenchment’ is perhaps the most important in facilitating innovation. Manufacturing and machine parts in the nineteenth century figure in Wimsatt’s account as an example of standardization and combinatorial entrenchment processes that have scaffolded cultural development.

The three chapters of the second part (‘Scope and Scale’) display the range and diversity of scaffolding processes. Cell biologist Stuart A. Newman focuses on the physics of cellular processes. He argues that morphological development of complex animal forms is scaffolded by the physics of mesoscale materials acting on gene products that regulate interactions between cells. Sociologist James E. Evans explains the scaffolding of cognition, knowledge, and culture by communication protocols such as natural language or the TCP/IP standard. He reflects on the quality and quantity of scientists’ internet communication by considering how various protocol mechanisms scaffold knowledge production. Jeffrey Schank, Christopher J. May, and Sanjay S. Joshi discuss how a succession of models scaffold scientific understanding. In school education or in the construction of a building, scaffolding tends to follow a certain plan. By contrast, they argue, plans in science are often revised and sometimes abandoned entirely in light of new modelling results.

The book’s third part (‘Generativity, Entrenchment, and Boundaries’) contains chapters that exemplify the tracking of alternative units of investigation, which often involves crossing traditional disciplinary boundaries. Pamela Lyon, a multidisciplinary scholar, shows that recent findings in cognitive science

suggest that responses to existential challenges and stress—such as fire, diseases, and droughts—have significantly shaped and scaffolded the evolution of human cognition. The scaffolding concept is a ‘useful heuristic’, as Lyon writes, for rethinking the interdependency of two systems that were long believed to be separate: the brain and the immune system (p. 186).

Philosopher Georg Theiner articulates a view of collective epistemic action with novel functions or functional gains, such as group decision-making or judgement aggregation. Our cognitive performance is scaffolded by social interaction in a way that actively shapes social organization to form new cognitive systems. Theiner investigates alternative units by focusing on extended minds consisting of multiple individual cognitive systems—interactions between people and people rather than between people and tools. Yet he argues against an ontological boundary between individual and collective cognition on the grounds that the collective cognitive system cannot exist without social interactions on the individual level.

Christophe Heintz, a cognitive scientist, extends the editors’ notion of scaffolding by arguing that innate cognitive abilities scaffold cultural evolution just as much as material or social interactions with artefacts, infrastructures, or developmental agents. He argues that conceptual changes in culture are more likely to take hold if they appeal to widely shared inferential mechanisms, such as cognitive abilities. He illustrates this process with respect to science and mathematics: acquiring new concepts by Quinian bootstrapping relies on core cognition and on transmission of knowledge, and therefore employs a ‘multiplicity of scaffolds’ (p. 223).

In part four (‘Granularity and Reciprocity’), cultural and cognitive development are examined at different levels and with different perspectives on reciprocally related entities, such as individuals and institutions. Philosopher Colin Allen cites cognitive experiments with consistent and inconsistent spacing in arithmetic equations and reflects on methods of sequential teaching of addition to first grade students. He argues that cognitive capacities are scaffolded not only by the symbols themselves but also by the larger context in which they occur. These kinds of experiments, Allen suggests, may help philosophers and philosophically minded scientists to bridge certain gaps in the sciences that are caught up in ‘cross-disciplinary tribal warfare’, such as the study of cognitive development (p. 244).

Martinez and Gerson explore in their respective chapters the challenge of accounting for both stability and innovation in culture. Martinez, a philosopher, understands culture and cognition as articulated through mechanisms of artefact representation. He takes stability and innovation capacities as by-products of evolving and interacting scaffolding structures. These structures constitute entrenched, path-dependent processes embodied in the evolution of technological artefacts. As a sociologist, Gerson takes a broader look at problems of conceptualizing cultural change and suggests we understand culture as a ‘system of institutions, each composed of conventional practices’ (p. 266). Such conventions, Gerson argues, are enacted and re-enacted in different contexts so that cultural practices—for example, a jazz performance, a wedding, or school teaching—remain recognizable despite variation.

The criticism of standard evolutionary narratives and their application to domains other than evolutionary biology is most explicit in Gerson’s chapter. He argues that for various reasons, even the terms ‘evolution’ and ‘development’ are misleading as metaphors in the context of cultural change. For example, the architecture that scaffolds development is internal in biological organisms, but external in cultures; and

unlike new cells, which are of the same kind as the mother cell, the structure and conventions of reproduced cultural institutions such as schools or elections are not pre-determined and may be replaced.

In contrast to Gerson, Johann Peter Murmann, a professor of strategic management, argues that despite different underlying mechanisms, the application of some evolutionary models to culture is justified in certain contexts. In the first chapter of the book's final part ('Reproduction and Development'), Murmann suggests that in economics, management, and the design of technologies, scaffolding can account for co-evolving supporting structures that are not explained by evolutionary models based on blind variation, selection, and retention.

Iddo Tavory, Simona Ginsburg, and Eva Jablonka emphasize the longitudinal aspects of repeated scaffolding interactions by employing a developmental system approach to conceptualizing the reproduction of entrenched social phenomena such as urban poverty. They take the integrated, self-stabilizing social system as the unit of analysis and propose the 'social-developmental landscape'—a modified version of C. H. Waddington's epigenetic landscape metaphor. Psychologist Shu-Chen Li also addresses dynamic co-construction, but with regard to the high plasticity and malleability of the human brain. Brain development can be scaffolded by 'enrichment of the developmental context' such as mnemonic training (p. 329). Scientific evidence regarding neural plasticity, which seems to establish the brain as a context-dependent variable, should be taken as a warning against reductionist approaches that are based in genetics, Li concludes.

Barbara Horberg Wimsatt investigates professional cognitive development scaffolded by a mentor-apprentice dyad in medical training. She distinguishes between generatively entrenching career decisions and more transient scaffolds in the form of friendships or mentoring relationships. She further draws attention to a form of gender-sensitive scaffolding. Her sociological research shows that male apprentices receive significantly more career support than female. While positive interactions are beneficial for both apprentice and mentor, she demonstrates that there can also be destructive interactions, which are particularly harmful to the apprentice and more often happen in cases where the trainee is female. The possibility of scaffolding that does not support positive or desirable development but rather obstructs or damages has only been hinted in some of the book's other chapters, for example, the scaffolding of urban poverty (Tavory, Ginsburg, and Jablonka), economic supporting structures that became hindrances for associated firms (Murmann), or the decrease of cultural diversity with the rise of the internet as the primary communication technology (Evans). This 'obstructive' dimension of scaffolding could be further developed in the future, to balance the concept's predominant association with growth and the development of new skills or capacities.

In sum, this book juxtaposes, but also successfully integrates, new approaches to the study of developmental processes that convincingly question the adequacy of neo-Darwinian narratives in their fields. The thread of these approaches is neither one systematic theoretical framework nor a clear disciplinary lineage; rather, coherence stems from focusing on the ubiquity of dynamic developmental processes prevalent in any scientific or cultural domain. As a gateway to an alternative conceptual landscape, the book is useful not only for scholars of biological, cultural, and cognitive development, it also reminds the reader of the multitude of often invisible dynamic processes that entrench science and

the cognitive and cultural foundations thereof. Philosophers working in a wide range of fields—in particular, those who are concerned with epistemology—will benefit from this multidisciplinary assemblage of perspectives. The book exemplifies the promises of ambitious, multidisciplinary collaborative research, which gains theoretical traction and applicability with each new perspective.

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