

Defining the 'Radical Middle'

**Essay Review of *Rethinking Innateness: A Connectionist Perspective on Development*¹
by Jeffrey L. Elman, Elizabeth A. Bates, Mark H. Johnson,
Annette Karmiloff-Smith, Domenico Parisi, and Kim Plunkett**

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For the last 20 or more years, perhaps 30 or 40 years if one goes back to Chomsky, radical nativism has more or less had its way with the study of cognitive development. Traditional Piagetians have been in retreat, studies of the amazing capabilities of infants have reached the pages of LIFE and Newsweek magazines, and formal arguments about learnability have been extended from syntax to semantics and thence to many other domains of cognitive development (becoming a little less formal at each step). The proposition that babies are born knowing essentially everything of consequence they need to function in the world has achieved not only intellectual respectability but a considerable degree of public acceptance.

The only alternative to nativism, in the wake of the abandonment of Piagetian constructivism, has often seemed to be radical empiricism. Indeed, empiricists joined with nativists in the wholesale attack on Piaget which occupied many cognitive developmentalists throughout the 70s and 80s. Empiricists argued that children could *learn anything* rather than that they already *knew everything*, but the bottom line – that Piaget was wrong – often seemed to be the same for both camps. And, indeed, once we give up on some version of constructivism, nativism and empiricism are probably the only positions left to us. We are forced to make the unpalatable choice between the all-knowing infant in need of a little parameter-setting and the proposition that children acquire knowledge fact by fact, through trial-and-error testing, as they progress from being universal novices to being universal experts.

In the past several years, though, there has been a mounting backlash against nativist dogma, as well as a continuing suspicion about simple empiricism. There is a feeling of excitement and competition abroad, as investigators vie to define a view of cognitive development neither radically nativist nor radically empiricist – a possibility I have

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heard called the 'radical middle'. Karmiloff-Smith's [1992] *Beyond Modularity* arguably began this race, followed by Thelen and Smith's [1994] *Dynamic Systems Approach to the Development of Cognition and Action*. The past year has seen three new entrants in this contest: Siegler's [1996] *Emerging Minds*, Gopnik and Meltzoff's [1997] *Words, Thoughts and Theories*, and the subject of this review, *Rethinking Innateness*, by Jeffrey Elman, Elizabeth Bates, Mark Johnson, Annette Karmiloff-Smith, Domenico Parisi and Kim Plunkett.

The central point of *Rethinking Innateness* is its argument against assuming that what it means to be innate is to have specific, content-laden information prewired into the nervous system, a possibility termed 'representational nativism'. Instead, the book emphasizes how the architecture of the nervous system and the timing of development can create constrained and universal outcomes without the need for an assumption of explicit representations being genetically coded, possibilities termed 'architectural nativism' and 'chronotopic nativism'. The authors argue forcefully for a thesis that we present all the time to introductory students but honor ourselves more in the breach than the observance: the idea that the conflict between nature and nurture is a false dichotomy.

This way of thinking is captured in the memorable phrase 'interactions all the way down', and much of the book is taken up with showing how little of what we think of as biological is purely biological, and how intertwined biology and environment can be. The authors discuss many cases of intertwined processes to give life to their approach. Three examples are: (1) early neurological development proceeds at the cellular level in a fashion set to a great extent by the surrounding environment of other cells; (2) ocular dominance patterns emerge in the visual cortex in response to external stimulation, and (3) when limbs are amputated, even in adult organisms, firing patterns in somatosensory cortex change in response to altered patterns of input.

Rethinking Innateness does not rest with addressing the old chestnut of nature versus nurture. It also deals with a second long-standing dichotomy in thinking about development, namely whether change is quantitative or qualitative. While prior authors in the traditions of dynamical systems and chaos theory have done much to show how this opposition is a false one, *Rethinking Innateness* contains convincing mathematical demonstrations of how it is possible to use definable inputs, incrementing in a quantitative fashion, submitted to definable cognitive architectures, to get simple structures to transform into more complex and qualitatively different ones – sometimes in a fairly sudden fashion.

One of the enjoyable parts of reading *Rethinking Innateness* is digesting these two central themes. Another enjoyable aspect is its discussions of various specific topics in development. Two of my favorite passages of this kind were the discussion of how the much-researched vocabulary spurt may essentially be a mathematical artifact rather than a psychological phenomenon, and the unmasking of the 'syntax gene' research as a simple mistake in interpretation of data, seized on by nativists because it seemed to support their point of view.

However, it is one thing to succeed in critiquing existing theories, either local theories of particular phenomena or more general ideas about development, and quite another to propose a viable alternative theory of cognitive development. The authors of this book clearly aimed at the latter, loftier goal, but have they succeeded? I believe their efforts do not take us all the way home yet. Let's consider why not in terms of three issues: how thoroughly they have rejected nativism, whether they have escaped empiri-

cism (closet empiricism being the charge most often leveled against connectionists), and to what extent, in moving away from empiricism, they have preserved some of the better insights of constructivism.

Is *Rethinking Innateness* Soft on Nativism?

Being soft on nativism may seem a strange charge to level at a book to which nativists are reacting with horror and scorn [see for instance, Jerry Fodor's, 1997, review in the *Times Literary Supplement*]. But, in using the term at all, the book does not go far enough in abolishing the nature versus nurture issue. The group should have heeded the advice of one of its members, Mark Johnson, who is noted as having resisted the use of the term 'innateness', suggesting it should be abolished rather than rethought. It is a mistake, I think, to 'give away' to nativism the right to talk about timing and architectural interactions with expectable environments, to agree that such interactions could be considered a form of innateness. One might just as well call architectural and chronological effects a form of environmentalism, given that they depend just as crucially on what happens when in the environmental surround as they do on genetic endowment. What is meant by talk of 'innateness' may be the idea of evolutionary adaptation, but of course adaptation is as much to an environment as it is in the genes, and it is only genes-in-environments which are the target of natural selection. The book could as well be called *Rethinking Environmentalism* as *Rethinking Innateness*, but either is an inaccurate portrayal of the essential message.

I think it's worth asking *why* the terms architectural nativism and chronotopic nativism make sense to people at all. The fundamental idea these terms are intended to capture is, after all, a blend of organism and environment interactions. Why does the starting state seem more interesting than the environmental surround, why does analysis of the neurological substrate seem more interesting than analysis of input? Pictures of babies reacting with interest and surprise to experimental displays and diagrams of the brain lighting up in certain situations make good copy, it is true, but the attractiveness of the biological goes beyond public relations.

One reason for the focus on the biological is that it is hidden. Finding something out about the brain seems more difficult than finding something out about the environment. In fact, pointing out facts about the environment – saying, for instance, that solid objects can't pass through each other – isn't a discovery at all; such facts are too obvious to merit scientific publication. But these facts about the environment may be as important to the intuitive physics of babies as the nature of their perceptual mechanisms. If babies were immersed in a world in which objects could pass through each other, the results for their perceptual development would surely be as startling as the effects of neurological lesions. Or consider an example in the realm of social understanding rather than physical understanding. Recent work on autistic children has emphasized the possibility that these children lack a module (or modules) necessary for the analysis of other people's states of mind and intentions; living in a world in which large entities move and act for no discernible reason may be the terrifying reality for these children. But what if the situation were reversed? What if normal children, prepared to attribute intentions to other acting entities on the basis of their own experiences, lived in a world actually occupied by automata? Their biological preparation would be badly mismatched with their world. They might be a kind of 'reverse autistic'. Because this thought experiment

is impossible – we know of no such world – we are prone to forget that environment is as important as biology in creating effects, that what we are looking at, always, is the match between biological characteristics and an environment.

Another possible reason for the focus on the biological is that it accords with an emphasis on individual agency congenial in our culture. Current industrialized societies celebrate the power of individuals to change the environment and create their own social conditions. In such a society, what is within people is centrally important. Nativism is sometimes accused of being conservative (*Rethinking Innateness* has a passage of this sort towards the end) but this alleged correlation is far from accurate or fair. Cognitive-developmental nativists have almost never discussed the biological determinants of individual differences. The focus of representational nativists has been on analyzing species-wide adaptation, and in doing this, they have followed a tradition which is liberal in the Enlightenment sense of the word: the organism's in charge.

Is Connectionism Closet Empiricism?

Although the authors are very aware that connectionist models are often seen as variants of radical empiricism rather than as examples of interactionism, and offer disclaimers and counterarguments, the charge is not without validity. Consider the connectionist model advanced by Jay McClelland (and discussed in this book) for how children acquire understanding of the workings of a balance beam. As nativists will be quick to point out, the model is programmed to focus on only weight and distance in the balance beam situation, begging the question of why those dimensions are seen as relevant in the first place. After all, there are many other things to notice when one looks at a balance beam: the substances of which the apparatus is constructed, its height off the floor, its color, and so on. The model even assumes that weight is noticed more than distance, motivating this crucial assumption only with casual discussion of the idea that children probably have a lot more experience with objects of varying weight than with hanging objects at varying distances from a fulcrum.

The nativist way out of these problems is to suggest constraints on what children notice with respect to certain problems, a move which, if not exactly representational nativism, at least comes very close. But this move may not be the only way out. The problem with the connectionists' approach to questions such as these isn't that it's obviously wrong, but that it's not obviously right. McClelland's informal comments, about what children's experiences in balancing situations are likely to have been, need substantiation. One kind of investigation would be detailed work on children's ecologies and experiences to provide motivation for the crucial assumptions: what happens when children play on teeter-totters? Another kind of investigation would be experiments in which children's experiences are manipulated and the consequences for development assessed and matched with the predicted consequences given the models.

Such analyses and experiments could be done, from a practical standpoint, but I worry that they won't be. Modelling, including connectionist modelling, has a life and a world of its own, and, too often, the empirical work that modelling should inspire and from which it will benefit just ends up being shortchanged. But, without such work, I think the charge commonly levied against connectionism, that of closet empiricism, will continue to have at least surface validity.

What Is the Relation of Connectionism to Piaget?

One of Piaget's most maligned claims was his insistence on qualitative change. As we have seen, *Rethinking Innateness* is one of several recent works to show that qualitative change from quantitatively varying parameters is not only possible but likely. But does this work vindicate this aspect of Piaget's thought? Clearly not. Work on how qualitative change can emerge from quantitatively varying input is important in its clearing away of conceptual brush – any opposition which has been endlessly debated for decades without resolution is likely a false one. But it is important to remember also that the demonstrations regarding qualitative change are nothing more (although also nothing less) than an existence proof – development *could* happen this way. What is now needed are behavioral data to show that it *does* happen this way. Coming up with psychologically real models to map onto the mathematics is clearly vital to the success of the connectionist agenda, and to any claim that connectionism can be an instantiation of constructivism [Mareschal and Shultz, 1996].

Aside from their existence proofs on the possibility of qualitative change, do current connectionists subscribe to other central tenets of Piaget, most notably, seeing children as active agents in their own cognitive growth? If they choose to work on psychologically real models of cognitive development, connectionists will have to confront head-on the problem of how children learn about the world. Current connectionist models contemplate organisms which get told things – they cannot ask questions or set up experiments. So, while connectionism may be interactionist, in the sense that it gives central roles to both a biological starting state and to environmental input, it is dubious whether it is currently constructivist in the traditional 'child as scientist' sense (recently discussed at length in the 'theory theory' approach advocated in the Gopnik and Meltzoff book). It might be possible to devise a connectionist model which looked more like an active organism, but currently the models are simply fed information, in classic passive-organism fashion.

In summary, *Rethinking Innateness* is a must-read book for cognitive developmentalists and cognitive scientists. But it's also a promissory note. The race to define the radical middle is a marathon, not a sprint, and connectionists, while they have a good start, will need to show that they can go the distance – that they can eschew nativism altogether, escape convincingly and completely from the elements of empiricism which remain in their approach, and incorporate into their models elements which simulate the active, question-asking nature of childhood.

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