Nativist Constraints on Cognitive Processes Called into Question

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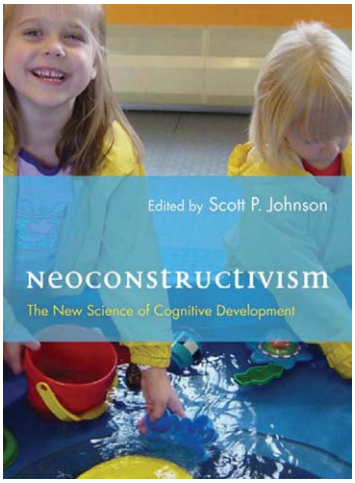
> Upshot • Recent research on young children's cognitive development supports the viability of a neoconstructivist model of learning. These new approaches support a bottom-up account of knowledge acquisition that incorporates many constructivist principles and does not support top-down nativist models.



Review of "Neoconstructivism. The New Science of Cognitive Development" edited by Scott Johnson. Oxford University Press, Oxford, 2009.
ISBN: 978-0-19-533105-9.
284 pages.

Scott Johnson organised symposia at conferences in the USA in 2004 and 2007 designed to discuss mechanisms in human developmental cognition. This book is the result of that work and draws together research supporting a neoconstructivist account of cognitive development.

In the foreword, Nora Newcombe considers the alternatives to Piaget's theoretical framework. They include nativist theories, Vygotsky's sociocultural approach and a series of recent non-nativist alternatives such as connectionism and dynamic systems theory. Newcombe's hope is that neoconstructivism will form the basis for a new science of cognitive development. It should include the following elements: assigning an important place for action in learning and development, recognition of the adaptive and anticipatory nature of thought and the use of probabilistic learning models supporting experienced expectancies. In terms of causal mechanisms (deferring to Aristotle), there is a need to describe change (formal cause), while understanding how change emerges neurologically (material cause), understanding change in its adaptive or evolutionary context (final cause), and understanding the interaction of "input" with the individual neurally and conceptually (efficient cause). In the book, the chapters' authors apply these features to a variety of domains, in most cases opting for a general learning model and often showing how recent research does not support nativist alternatives. In what follows I give an indication of some of the research presented in each chapter.

The first four chapters are about understanding objects and space. Richards (Ch. 1) introduces the way that brain development influences deployment of attention. MRI imaging is being used to measure brain development in infants of different ages, relating cognitive activity to brain function. Studies of shifts in attention at 3 and 6 months support the view that there are increases in cortical control of visual attention during this period. Improvements in the techniques used are likely to lead to an increased understanding of the neurological development of more sophisticated ways of attending. Kirkham (Ch. 2) outlines a theory of cross-(sensory) modal transfer that provides insight into ways in which infants increasingly use multiple cues during their first year in understanding location and temporal order. In Chapter 3, Johnson examines object perception. Piaget's observation was that initially infants see the world as a set of unrelated pictures. While there is some evidence of neurological developments in the first two months that may affect perceptual completion, the evidence for learning is clear. Nativist accounts of early neonatal understanding of object permanence that rely on habituation studies (often noticing impossible events) do not meet Piaget's criteria for permanence. Piaget's criteria are criticised for requiring too much manual dexterity for very young infants. However, nativist accounts fail to account for mechanisms of object completion. Johnson focuses on ways in which infants learn to fill in gaps entailed by occlusion. Three dimensional object completion occurs following self-directed visual-hand manipulations that are possible when self-sitting develops at about four or five months.

Moore and Meltzoff (Ch. 4) have collaborated on object permanence for over 30 years so it is not a surprise to find concepts and criteria so precisely refined, and implications of this work so clearly presented. They propose an "identity development" account of object permanence emphasising discovering how to determine and trace identity. In this process, infants use objects' visible transformations to develop an understanding of the invisible world linking these visible events. Their theory assumes that for adults, permanence and identity are one and the same, whereas for infants, emerging notions of permanence depend on disappearances that preserve identity: infants can link objects and representations of them. Permanence requires understanding that objects continue to exist when invisible.

Three of the chapters deal with issues in language development. There is a chicken

and egg problem in learning syntax. The rules depend on knowing the grammatical categories of words, which in turn depend on how these categories support the rules. Using neural network simulation techniques, Christiansen, Dale and Reali (Ch. 5) provide evidence of the efficacy of multiple cue integration as a method of learning syntax, integrating internally constrained probabilistic cues (phonological, prosodic and distributional). In Chapter 6, Smith and Pereira examine the interdependence of object substitution in play, representation of shape and naming objects. Naming influences attention to shape and shape perception leads to symbolic play. How do children develop abstract representations of object shape? It seems sparse representations support object recognition. Where do these representations come from? Maybe they emerge from the dynamic interactions of all these processes under the constraints of viability. Saffran (Ch. 9) is critical of the use of statistical learning algorithms as a way of approaching natural language processing. However, the idea that children approach language equipped to notice patterns has currency and she proposes that children come to language learning with inbuilt language learning mechanisms rather than innate knowledge.

Evidence that musical representations emerge from perceptual experience organised by a general statistical learning model is summarised in Chapter 7 by Hannon. The only constraints assumed are due to sense organ and neural properties. It is apparent that infants use other modalities such as movement and vision in constructing these representations. Further, in the domains of music, face-recognition and language perception, infants lose discrimination acuity after six months when they have learned to perceive culturally-specific patterns.

Sobel (Ch. 8) guides us through two approaches to the development of children's causal understandings: the bottom-up method using modelling techniques and the top-down method that relies on children's interpretations of causal structure using children's prior knowledge. Assumptions developed for the modelling techniques are then tested, revealing the complexity of the causal reasoning of two- to three-year old children.

In the post-Piaget period it was argued that early skills imply innate knowledge. Gomez (Ch. 10) shows that this view is being eclipsed in a variety of domains and that modular theories that assumed innate knowledge are being superseded. Gomez reports research showing that learning is not constrained internally but rather that learning is a function of the interaction of internal biases and "external" structures of language. Similarly, infants learn from inconsistent input by separating relevant from irrelevant structure. Mareschal and Westermann (Ch. 11) present two computational modelling approaches (Bayesian and connectionist) to show how children integrate new information into old. The Bayesian approach at present fails to account for cognitive errors, whereas it is argued that the connectionist account provides explicit learning mechanisms, access to knowledge representations and a model of cognitive change.

There are three chapters on inductive processes. Induction is a problem for infants as they have so little experience and using inference often does not entail feedback. Rakison and Cicchino (Ch. 12) challenge the top-down view of infant induction and argue that infants learn about objects using general learning mechanisms. Quinn (Ch. 13) suggests that "training and transfer of perceptual expertise" may be a model for cognitive development: what infants know about animals is like what novices know about generic categories, and what they know about humans is like what experts know about their expertise. Sloutsky's chapter (Ch. 14) examines the evidence for top-down and bottom-up constraints on learning, focussing on novelty. Sloutsky presents a bottom-up model of inductive generalization and phenomena it predicted, emphasising the role of labels and information on appearance.

Gerson and Woodward (Ch. 15) report on the emergence of intentional knowledge through hand use. This is an affirmation of the importance of action in the development of thought. There is evidence that infants can extrapolate from acting themselves to understanding intention in others' actions and further that this ability develops over time. So as infants acquire new ways of acting, they attain representations of these actions. Structural mapping is a way for infants to discern common structure across actions, so providing a step in separating goals from actions in which they are embedded.

Simion and Leo (Ch. 16) present models and data from experiments indicating that face perception is not pre-wired but arises from general learning mechanisms that become progressively attuned to the human face. In the first month, infants orient to properties that faces share with other stimuli, however the processes change so that by three months infants have learned to respond to characteristics that distinguish faces from other stimuli.

This book puts our understanding of the role of learning on a new level, in particular in terms of moving back the boundaries of unlearned constraints. Frontiers are exciting places and here are new vistas, new approaches and new ideas about knowledge. There is a richness of data discussed in these chapters which does the field a service by presenting in one volume such a wide variety of scholarship on recent research on cognition. Finally, this book shows how important constructivism is as a model in mainstream psychology; there is no mention here of radical or social constructivism - no references either to constructivist thinkers such as Ernst von Glasersfeld, Humberto Maturana, Heinz von Foerster or Gregory Bateson. I wondered occasionally whether some of their insights might be helpful. As signalled in the foreword, chapters vary in the extent to which they are recognizably constructivist. The chapters that used many elements of constructivist theory included those dealing with space and objects in infancy (Ch. 1–4) and the chapters on social cognition (Ch. 15 & 16). As an introduction to this neoconstructivist project, I recommend the work on the development of musical thought (Ch. 7). This book merits being read carefully by people interested in cognitive development.