Rethinking the Innateness of Numerical Competence

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The current decade has witnessed a dramatic reconceptualization of the origins of cognitive competence. Much of this change is due to work on infants' ability to reason about events involving inanimate physical objects (Baillargeon, 1995; Spelke et al., 1992). However, along with new discoveries of cognitive competence and neural plasticity, an important debate has emerged about how best to characterize these early forms of competence and their implications for development.

Much of that debate has centered on questions of innate specifications and the nature of the change they undergo. More recently, the issue of what innateness really means has arisen in relation to human cognitive competence, and a new form of empirical constructivism is being proposed (e.g. Elman et al., 1996). This debate is cogent in reference to competence with language and physical laws, because of the stability and survival value of these domains in the human genotype. Other domains, like numerical competence, fit such descriptions less well and so should be treated with a greater degree of skepticism when evaluating a nativist, modular view of their origins.

The Origins of Numerical Competence

Wynn (1995) has proposed that infants posses an innately specified system of numerical knowledge containing cardinal and ordinal concepts. This interpretation is based on studies where babies exhibit expectation violations to impossible situations where dolls hidden behind a screen vanish or appear unexpectedly. In contrast, I (Simon, in press), have presented an alternative interpretation of those findings. I suggest that a small set of well-established, fairly general infant abilities is co-opted into constructing numerical representations and processes when presented with tasks that we recognize as numerical. In this way, I attempt to both explain the behaviors in question, and provide a basis for the construction of numerically-specific representations, processes and knowledge.

The basic premise of my claim is that the behaviors observed in these infant studies are based upon the ability to make simple one-to-one discriminations. The foundational competence necessary for such behavior includes the basic memory and conceptual abilities required for habituation. Also necessary is that infants individuate small sets of objects in a way consistent with subitizing; a process which has recently been associated with preattentive visual processes (Trick & Pylyshyn, 1994). Such attentional processes appear to be present in 5-months-olds (Johnson, 1994). Another component is early physical reasoning, as described above. A final requirement is the tendency for infants to preferentially code entities by spatiotemporal, rather than their identity, characteristics under certain circumstances (e.g. Xu & Carey, 1996). Thus the development of numerical competence requires the construction of domain-specific representations and processes from a set of non-numerical starting conditions. I shall present results from a computational model which, based solely on the above competencies, reproduces infants' looking times in a published study.

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