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Original Article

Piaget, Pedagogy, and Evolutionary Psychology

Jeremy E. C. Genovese, College of Education, Cleveland State University, 2121 Euclid Avenue, Cleveland, Ohio 44115, USA. Email: j.genovese@csuohio.edu.

Abstract: Constructivist pedagogy draws on Piaget's developmental theory. Because Piaget depicted the emergence of formal reasoning skills in adolescence as part of the normal developmental pattern, many constructivists have assumed that intrinsic motivation is possible for all academic tasks. This paper argues that Piaget's concept of a formal operational stage has not been empirically verified and that the cognitive skills associated with that stage are in fact "biologically secondary abilities" (Geary and Bjorklund, 2000) culturally determined abilities that are difficult to acquire. Thus, it is unreasonable to expect that intrinsic motivation will suffice for most students for most higher level academic tasks.

In addition, a case is made that educational psychology must incorporate the insights of evolutionary psychology.

Keywords: Piaget, developmental theory, formal operational stage, evolutionary psychology.

Piaget in the Light of Evolutionary Psychology

> Of course the most fruitful, most obvious field of study would be reconstituting human history – the history of human thinking in prehistoric man. Unfortunately, we are not very well informed about the psychology of Neanderthal man or about the psychology of *Homo siniensis* of Teilhard de Chardin. Since this field of biogenesis is not available to us, we shall do as biologists do and turn to ontogenesis (Piaget, 1970, p. 13).

Textbooks on child development and educational psychology often take Piaget as the starting point for discussing cognitive development (e.g. Ormrod, 2003).

This is a very reasonable tack because Piaget, more than any other theorist, shaped our understanding of how children's cognition changes in predictable ways. Central to Piaget is the idea that children are able to solve certain problems only at certain ages and that these problems can be organized into a developmental sequence that defines discrete stages of cognitive development. Piaget was clearly extending a notion borrowed from Binet (early in his career Piaget had been employed standardizing intelligence tests, Vidal, 1994), but while Binet focused on individual differences, Piaget found significance in children's similarities (Hoffman, 1982).

Piaget's approach has proved remarkably fruitful. For example, it is now well documented that children across cultures accomplish certain Piagetian tasks approximately at the ages and in the sequence predicted (Brainerd, 1978; De Lemos, 1969). Indeed, some aspects of the Piaget model are so universal that they extend beyond the human species. There is evidence of Piaget like developmental milestones in a number of mammalian species (Parker and McKinney; 1999, Langer, 1998; Dore and Goulet, 1998; Gruber, Girgus, and Banuazizi, 1971) and Piagetian influenced research has become important in ethology (Vauclair, 1996; Parker and McKinney, 1999; Pepperberg, 2002). Another line of research has linked Piagetian tasks to the developmental changes in the brain (e.g. Diamond, 1991).

Yet for all its success, several important elements of Piaget's work have not stood up to empirical scrutiny. There is now abundant evidence that Piaget underestimated the capacities of infants (Ormrod, 2003). Many neo-Piagetians now reject his notion of an overarching logical-mathematical structure as the driving force of development and now think in terms of independent cognitive structures regulated by a generalized developmental capacity (Case, 1992; Pascual-Leone, 1987). In addition, Piaget's model of unified stages, while a convenient heuristic, does not always capture the combined and uneven development of children's cognition (Siegler, 1996; Kuhn, 1988; Hoffman, 1982). Perhaps, his greatest failure was his characterization of the formal operations stage, said to begin in adolescence. It is now abundantly clear that many teenagers and adults do not reason in the ways described by Piaget.

The goal of this paper is to discuss this latter problem with Piaget's work in light of evolutionary psychology. It is argued here not simply that Piaget's model must be modified to incorporate the insights of evolutionary psychology, but that developmental theory should be subsumed into evolutionary psychology. More over, a case is made that absent the insights of evolutionary psychology, Piagetian constructivist pedagogy is fundamentally flawed.

It may surprise some to learn that Piaget was deeply committed to an evolutionary view of cognitive development. Textbooks are often silent on this point (e.g. Feldman, 1998) and one has the sense that Piaget has been "debiologized" for presentation to publics not open to biological and evolutionary explanations (although it should be noted there are many excellent exceptions to this phenomenon, e.g. Cole and Cole, 1989).

The notion that evolutionary psychology is the proper framework for continued evaluation of Piaget is perfectly natural. As the epigram for this paper suggests Piaget (1976/1978) himself was motivated by a conviction that cognitive development could only be understood as part of a larger evolutionary model. The limits of Piaget could even be said to reflect the limits of the evolutionary model he embraced. Piaget, while a committed evolutionist, was not a Darwinian and he was deeply influenced by teleological and recapitulationist points of view (Gould, 1977; Messerly, 1996). He saw cognitive evolution as reaching for some kind of telos, a view that is impossible to make consistent with modern evolutionary theory (Williams, 1966; Dawkins, 1986). Evolutionary processes cannot be shaped by some distal endpoint. Rather brains evolve to solve proximal environmental and social challenges. Modern evolutionary psychology suggests that the best understanding of the mind will arise from study of our species' Environment of Evolutionary Adaptedness. Defined by Symons (1992) as "the Pleistocene environment in which the overwhelming majority of human evolution occurred" (p. 143). The structure and development of human cognitive abilities, like all products of selection, can only be fully understood in the context of natural history.

The strength of this approach can be seen in Cummins' (1998) work on deontic reasoning. Cummins notes that humans are particularly good at deontic reasoning, that is reasoning about obligations and rights, because our minds have adapted to negotiate the uncertainties of dominance hierarchy. Cummins observes that "children as young as three years of age organize themselves into dominance hierarchies" (p. 45). Research by Edelman and Omark (1973) not only documents the existence of dominance hierarchies in young children, but links the development of these hierarchies to the child's attainment of the ability to seriate, to rank order objects along some dimension. It was Piaget (1941/1965) who first discussed the ability to seriate as a developmental phenomenon. Because Piaget was unclear on the underlying evolutionary context of cognitive development (although he fully acknowledged that it existed) he limited the explanatory power of his model. Using an evolutionary approach Edelman and Omark were able to see connections that eluded Piaget, in this case "the logical equivalence of seriation and hierarchization" (p. 108).

Formal Operations

Kuhn (1979) has argued, "that Piaget's stage of formal operations is the single stage in his sequence having the most profound and far reading implications for education" (p. 34). The stage was first described by Inhelder and Piaget in 1958. The formal operational abilities include prepositional logic, inductive logic, hypothesis testing, and reasoning about proportions, combinations, probabilities, and correlations.

The name for the formal operations stage comes from the belief that younger children cannot disregard the content of an argument and pay attention to its formal structure. Phillips (1969) gives this example of a syllogism

All children like spinach;
Boys are children
Therefore boys like spinach (p. 103)

He goes on to note that "the younger child will respond to the context (particularly if he is a boy who doesn't like spinach!), but the adolescent can follow the argument because he is impressed by its form" (p. 103). But in a footnote, Phillips mentions a 1944 study by Morgan and Morton where most college students could not distinguish between the form and content of a syllogism. Morgan and Morton found "that even when a subject is presented with a syllogism in which the terms are abstract symbols or concrete terms which have little or no personal significance, he has difficulty in selecting the correct conclusion" (p. 39). When the content was personally significant they found that

> distortion becomes much more marked when the terms in the syllogism are related to the personal convictions of the reasoner. A person is likely to accept a conclusion which expresses his convictions with little regard for the correctness or incompleteness of the inference involved (p. 39).

Thus, contrary to Piaget's predictions, not only were adults not able to separate form from content, they had difficulty with syllogistic reasoning itself. This observation is consistent with experimental results that show that humans have great difficulty solving normative deductive reasoning problems (Evens, 2002; Stanovich and West, 2000).

Tamburrini (1982) pointed out that "there is considerable evidence that formal operational thought is contextually bound" (p. 319). This is no small concession; the very point of formal operations is that they go beyond context and content. The failure of adolescents and adults to reason in the ways predicted by Piaget is a serious problem for both the theory and practice of education, for it is precisely the formal reasoning skills that are necessary for mastering academic subjects such as math and science beyond the elementary level.

The literature abounds with evidence that adolescents and adults fail to exhibit the type of reasoning predicted by Piaget. This failure can be found in both academic and non-academic contexts. Capon and Kuhn (1982) in a study of supermarket shoppers found that most could not apply the formal operational skill of proportional reasoning to calculate best buys. They concluded formal operations "appears to be the only stage in Piaget's sequence that is not attained universally" (p. 449).

Evolutionary psychology, on the other hand, does give us a framework for understanding the frequent failure of adolescents and adults to use formal reasoning and master certain academic tasks. Geary (1995) makes a distinction between biologically primary abilities and biologically secondary abilities. Biologically primary abilities refer to those cognitive skills, such as learning language, which are the result of the evolved architecture of the brain (Geary, 1995, 2002). Geary and Bjorklund (2000) note that

> Biologically primary abilities are acquired universally and children typically have high motivation to perform the tasks involving them. In contrast, biologically secondary abilities are culturally determined, and often tedious repetition and external motivation are necessary for their mastery. From this perspective it is understandable that many children have difficulty with reading and higher mathematics (p. 63).

It is important to note that this is not a simple model of biological base and cultural superstructure. Rather as Geary (1995) points out biological secondary abilities entail "the co-optation of primary abilities for purposes other than the original evolution-based function and appear to develop only in specific cultural context" (p. 24).

Using this framework we are now in a position to reinterpret Piaget's contribution. We can understand the Piagetian tasks (at least those that have been empirically verified) that characterize the first 11 years of life as rooted in the biologically primary abilities. For example, Parker and McKinney (1999) in their extensive review of primate cognitive development found that

> First, macaques, cebus, great apes, and humans transverse the same sequence of stages in the development of logical as well as physical cognition during the sensorimotor period.
> Second, both great apes and humans complete all the sensorimotor period stages in logical as well as physical cognition, but macaques and cebus monkeys do not (p. 104)

The sensorimotor period was the first of Piaget's developmental stages that occurs in humans between the ages of birth and two years. In addition, Parker and McKinney found evidence "that great apes may achieve the level of intuitive subperiod of preoperations in the logical-mathematical domains of seriation, classification, conservation, and number" (p. 105). All this suggests a deep phylogenetic history for the ability to perform many of the Piaget tasks and suggests that many are biologically primary abilities. Formal operational tasks, on the other hand, should, like reading, be regarded as biologically secondary abilities. Formal operational skills should not be thought of as skills that naturally unfold over the course of development, instead these are skills that are acquired with considerable effort and often require instruction.

This distinction between biologically primary abilities and biologically secondary abilities allows us to explain results obtained by Goodnow and Bethon (1966). These researchers combined data on schooled and unschooled children in Hong Kong and schooled children in the United States and discovered that "lack of schooling does not upset the conservation of weight, volume, or surface but does upset a task of combinatorial reasoning" (p. 573). It appears that solving the conservation tasks, the hallmark of Piaget's concrete operational stage, relies on biologically primary abilities while the combinatorial task is more related to biologically secondary abilities. Kuhn (1979) in her review of the educational implications of formal operations implicitly recognizes this type of distinction:

> Evidence of the lack of universality in the attainment of a formal operational level of cognitive development suggests that there may be an important potential role for education to play in this attainment. This is a role that is absent in the case of the earlier stages in Piaget's sequence, given the research evidence that all individuals within the normal range of intelligence attain the stage of concrete operations loses its force as a meaningful curriculum objective: and a look at the history of Piaget-based early childhood programs reveals that their curriculum objectives quite rapidly turned away from the teaching of concrete operations and toward other, quite different utilizations of Piaget's theory in an educational context (p. 47).

Although using a different vocabulary, Kuhn's conclusion is remarkably similar to Geary's and Bjorklund's. Put more simply, many higher-level skills do not come to most of us easily or naturally, rather they must be conquered through a process of schooling.

The distinction between biologically primary and biologically secondary abilities has important educational consequences. Constructivism is a popular educational theory that traces its roots to Piaget (DeVries and Kohlberg, 1987; Pulaski, 1971). Iran-Nejad (2001) provides us with a useful synopsis of the constructivist viewpoint:

> Classroom "learning" is unnatural and something that does not occur in the early years of life when a child learns a language, and something most adults avoid after they have escaped formal education. The implication of constructivism, and of our elaborations on it, are to argue that children must have access to the same natural learning processes they employ before they

> enter school, and later, outside traditional classroom environments where interest and dynamic functions operate. In the unnatural classroom environment this does not occur (p. 24).

By failing to distinguish between biologically primary and biologically secondary abilities, Iran-Nejad deduces that because children acquire some skills easily with little instruction they can acquire all skills that way. Because constructivists assume that all learning unfolds as part of the developmental process they often endorse student-centered approaches to education at all levels, assume that intrinsic motivation is always possible, and downplay the importance of acquiring a knowledge base. For example, Iran-Nejad (2001) calls for classroom activities that:

> permit multiple sources of control to interact with the natural learning process that create knowledge. Attention must be directed and controlled by the individual, as an outgrowth of interest and problem-solving behavior, not controlled by the environment and forced by the teacher. Curiosity must be stimulated for intrinsic learning (p. 27).

Similarly Pulaski (1971) asserts

> Piaget has shown us, in his thorough and painstaking studies of the child, that verbal understanding is superficial and "deforming"; learning, whether for children or their teachers, comes only through the subject's own activity. The ability and eagerness to learn, which is part of every child's birthright, is our greatest educational resource (p. 205).

While no educator would disparage the importance of intrinsic motivation, there is ample evidence that for most students for most academic tasks, intrinsic motivation is insufficient (Steinberg, 1996; Hirsch, 1996; Chall, 2000). The Rousseauian view that Piaget's work is often used to justify contrasts sharply with the evolutionary perspective taken by Pinker (2002):

> Education is neither writing on a blank slate nor allowing the child's nobility to come into flower. Rather, education is a technology that tries to make up for what the human mind is innately bad at. Children don't have to go to school to learn to walk, talk recognize objects, or remember the personalities of their friends, even though these tasks are much harder than reading, adding, or remembering dates in history. They do have to go to school to learn written language, arithmetic, and science because these bodies of knowledge and skill were invented too recently for any species-wide knack for them to have evolved (p. 222).

If this evolutionary view proposed by Pinker is correct, we would expect that as children move through their compulsory schooling and presumably from a curriculum centered on concrete operational / biologically primary abilities to one centered on formal operational / biologically secondary abilities that student motivation would shift from intrinsic to extrinsic. This is exactly the pattern that we find. Steinberg (1996) reports "we know that early on – in preschool, for example - children are highly intrinsically motivated and naturally curious, and they need little in the way of extrinsic rewards to motivate them to participate energetically in classroom activities (p. 73). Steinberg goes on to note that:

> Regardless of what parents and teachers *wish*, intrinsic motivation plays a relatively small role in motivating student performance in adolescence and beyond. In our survey, for example, the most common reason students gave for trying hard in school was not genuine interest in the material, but getting good grades in order to get into the college (p. 74).

Constructivist theorists have contributed many useful ideas to make instruction more interesting and meaningful. However, because they fail to distinguish between biologically primary abilities and biologically secondary abilities they do not recognize that there are situations where these techniques may fall short. They have erred in accepting an inadequate understanding of how cognitive skills develop and they have made the mistake of elevating a delimited set of instructional techniques into an overarching philosophy of teaching. A pedagogy informed by evolutionary psychology will, on the other hand, try to root teaching in a modern evolutionary understanding of cognitive development and recognize that much academic learning will continue to be hard work requiring extrinsic support.

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