

Formal Operations from a Twenty-First Century Perspective Author(s): Deanna Kuhn

Source: *Human Development*, Vol. 51, No. 1, 50th Anniversary Special Issue: Celebrating a Legacy of Theory with New Directions for Research on Human Development (2008), pp. 48-55

Published by: S. Karger AG

Stable URL: <https://www.jstor.org/stable/10.2307/26763967>

REFERENCES

Linked references are available on JSTOR for this article:

https://www.jstor.org/stable/10.2307/26763967?seq=1&cid=pdf-reference#references_tab_contents

You may need to log in to JSTOR to access the linked references.

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <https://about.jstor.org/terms>



S. Karger AG is collaborating with JSTOR to digitize, preserve and extend access to *Human Development*

JSTOR

Formal Operations from a Twenty-First Century Perspective

Deanna Kuhn

Teachers College, Columbia University, New York, N.Y., USA

Key Words

Adolescent cognition · Formal operations · Metacognition

Abstract

The author reflects on Piaget's 1972 article, 'Intellectual evolution from adolescence to adulthood,' addressed to questions regarding what he alleged to be the final, most advanced level of cognition in his developmental stage theory – formal operations, as described in his 1958 volume coauthored with Inhelder, *The growth of logical thinking from childhood to adolescence*. It is asked here whether, from a contemporary perspective, Piaget's ideas regarding formal operations appear to have been right, and whether they have any current relevance, in particular concerning how best to support the development of intellectual potential during the second decade of life.

Copyright © 2008 S. Karger AG, Basel

Piaget's article, 'Intellectual evolution from adolescence to adulthood,' published in this journal in 1972, is a historically significant one in a number of respects. It is only the second of two of his extensive writings addressed to cognitive development beyond middle childhood. The other is the 1958 volume, *The growth of logical thinking from childhood to adolescence*, coauthored with Inhelder. It is this volume that gave rise to the set of questions that are addressed in the 1972 article. The relatively little attention paid to cognitive development during the second decade of life extends well beyond Piaget's works. Indeed, it remains apparent today, as contemporary cognitive development research more than ever focuses on early origins of cognitive competencies. Adolescence as a field of study is thriving, yet the multitude of adolescence texts contain at most a slim chapter or part of a chapter on adolescent cognitive development [Kuhn, 2006; for an important exception, see Moshman, 2005].

KARGER

Fax +41 61 306 12 34
E-Mail karger@karger.ch
www.karger.com

© 2008 S. Karger AG, Basel
0018-716X/08/0511-0048\$24.50/0

Accessible online at:
www.karger.com/hde

Deanna Kuhn
Teachers College, Columbia University
New York, N.Y. (USA)
Tel. +1 212 678 3885
E-Mail dk100@columbia.edu

Piaget's 1972 article is significant in a further respect, however, beyond its attention to a largely neglected period in studies of the developing intellect. This significance is in relation to Piaget's own earlier and by 1972 formidable body of published work. Over the preceding five decades, Piaget had gradually articulated an increasingly systematic developmental theory whose major tenets had become widely known. The functionally invariant mechanism of adaptation, comprising the complementary processes of assimilation and accommodation, yields a sequence of cognitive structures of predictable form, despite a less predictable rate of construction.

In their 1958 volume, Inhelder and Piaget described in detail what they characterized as the final structure in this evolution, the structure of formal operations. This volume and theoretical advance attracted substantial attention on the part of an English-speaking audience, including efforts to replicate the phenomena that provided evidence of an adolescent transition from a concrete operational to a formal operational level of cognitive functioning. These efforts led to Piaget's finding himself in a new position. Prior to this time, efforts to replicate Piaget's findings with respect to his early stages of sensorimotor intelligence, preoperations, and concrete operations had generally proven to be supportive of Piaget's claims. The timing might vary, but across the disparate cultures that were investigated, children appeared to progress through more or less the sequence of ways of understanding the world that Piaget had described.

In the case of formal operations, in contrast, reports came in that many older adolescents and even adults performed in a nonformal operational manner on Inhelder and Piaget's tasks (for the two major reviews of research of that period, see Keating [1980] and Neimark [1975]). In his 1972 article, then, Piaget for the first time was faced with evidence that appeared to be at odds with his theoretical model. In the article, he acknowledges this fact and undertakes to examine its implications.

In his doing so, we can observe another feature new to Piaget's writings to this point. Much of the earlier work tended to be instructive to the point of being dogmatic: this is what we can expect to see in the child's thinking at a given stage and this is the underlying structure that accounts for it. In discussing the formal operational stage in his 1972 article, in contrast, Piaget lays out and leaves open significantly different alternative accounts of how intellectual development proceeds through the second and into the third decade of life.

His position remains firm that the same universal sequence of cognitive structures is constructed by each individual, culminating in the formal operations structure. Moreover, the pace of this evolution is affected by the quality and frequency of opportunity individuals are afforded to engage these intellectual structures. In sharp contrast to his position regarding earlier stage structures, however, for the first time Piaget puts forward the thesis that the formal operations structure may not be manifested across all intellectual domains. He recognizes that by adolescence, individual aptitudes and interests become more important, with the result that individual intellectual profiles become more differentiated. This variability across individuals increases with time and experience, such that by the later part of the second decade, adolescents are likely to have reached their full intellectual potential in only some – perhaps only one or two – of the potential areas of endeavor in which they might have done so. It is in these domains, then, that we must look for and expect to find a formal operational reasoning structure. But even within this formulation,

Piaget leaves open multiple theoretical possibilities. Most likely, he says, the formal operational structure can be identified across a whole range of intellectual domains (although, in most cases, not within the same individual). But he raises the possibility that new, more specialized structures will be identified that are specific to particular domains of human endeavor. Such a proposal, note, takes Piaget a long way from the universalist theory with which he is most closely associated.

In addition, Piaget leaves open multiple possibilities with respect to the fate of the individual subject. Perhaps some individuals never attain a formal operational level of development, he suggests, implicitly acknowledging the replication data pointing to this conclusion. Alternatively, he proposes, formal operations retain their status as a universally achieved stage structure, although perhaps not attained until the end of adolescence or beginning of adulthood, and then only in the particular domains in which the individual has experience and has undertaken to develop these advanced, formal modes of thought – what Gelman [2002] describes as the ‘noncore domains’ that only some individuals choose to explore.

These are quite different alternatives – indeed, even today the available evidence is insufficient to choose between them. Let us turn, then, to where Piaget’s ideas stand some three decades later, with a new century underway.

Is Piaget’s Account of Formal Operations Right?

In the decades after Piaget’s ideas captured the interest of a North American audience, his work was criticized, and in some circles discounted, for what were arguably some of the wrong reasons. First, his age norms were off. Second, his tasks were not ‘pure,’ with numerous extraneous factors influencing task performance. Third, and most seriously, ‘horizontal decalage’ was too vague a construct to account for the substantial asynchrony in attainment of allegedly equivalent competencies. And – seemingly, the final blow – Piaget even got the logic wrong in undertaking to characterize the structure of this stage in formal, logical terms.

All of these charges have been made with respect to Piaget’s stage of formal operations, perhaps most prominently the last one, which addresses Piaget’s effort to identify the intellectual ‘glue’ that holds together the various competencies that he alleged to be manifestations of the underlying operational structure. In reading many of the innumerable secondary-source descriptions of Piaget’s formal operational stage, I have been struck by how rarely the author gets right, or even makes the attempt to get right, a connection among the alleged behavioral ‘markers’ of formal operations – reasoning with contrary-to-fact propositions, isolation and control of variables, systematic combination, correlation, proportion, and a few others. Instead, what typically appears is a listing of cognitive skills bearing no clear relation to one another that taken together serve as a set of markers of the attainment of this stage.

Formal operations are clearly Piaget’s most complex stage, in terms of both the proposed logic underlying it and the diversity of competencies alleged to be manifestations of it. Yet Piaget, in this 1972 article, in very few words provides an explication of their interconnection. Most fundamentally, with the attainment of this stage, according to Piaget, thought becomes able to take itself as its own object – adolescents become able to think about their own thinking, hence the term ‘operations on

operations,' or, more precisely, mental operations on the elementary operations of classification and relation characteristic of the preceding stage of concrete operations. The formal operational thinker becomes able, for example, not only to categorize animals according to physical characteristics and according to habitats but also to operate on these categorizations, that is, to put the categorizations themselves into categories and on this basis to identify relations that hold among the first-order categories – characteristics and habitats. The formal operational thinker is thus said to reason at the level of *propositions* that specify relations between one category (or relation) and another.

Specifically, the logical intersection of two classes A and B (characteristic type, e.g., fur-covered, and habitat type, e.g., jungle), that is a manifestation of concrete operations, produces the four products A-B, A-notB, notA-B, and notA-notB. The advance that comes with formal operations, Piaget claimed, is the ability to perform operations on these elementary operations (of construction of classes). In logical terms, this means constructing (implicitly) a higher-order set of classes that consist of all of possible combinations of the four elementary classes. Significantly, each of these second-level classes (16 in all) corresponds to a particular relation between the first-level attributes, for example, the absence of A-notB and presence of the other three products of $A \times B$ correspond to a relation of implication: A implies B. It is this implicit recognition of the multiple possibilities, Piaget says, that gives rise to and supports the intention and capability to systematically assess which of these second-order relations (between A and B) holds. Lastly, the relations (of negation and reciprocity) that exist among the 16 second-order possibilities themselves reflect their unity as components of a fully structured system (represented by the logical INRC group).

This brings us finally to the question of whether Piaget was right in his various pronouncements regarding the alleged final, most advanced structure of human thought. There is of course not one but a set of answers to this question, since the theory comprises a varied set of claims, and these answers can be divided into three categories. First are the claims Piaget was clearly wrong about. These are by now well known and the first is indeed a focus of his 1972 article: formal operational thinking does not emerge predictably and universally at a specific point during adolescence. A second claim that the substantial evidence now available has not supported is the claim that the various competencies alleged to be components of formal operational thought, when they do appear, emerge together as a tightly structured whole. Thus, whether or not one accepts critics' claims that Piaget got the logic wrong and the proposed structure lacks logical coherence, empirical evidence does not support the claim that it has psychological unity, i.e., coherence or cohesion from the point of view of the subject.

In a second category are claims for which evidence is insufficient to allow a conclusion. The major question here is the one that would appear to be of greatest practical import. Do all individuals attain the capacity to reason in a formal operational manner in at least *some* domain, and, if not, what proportion of people do attain this capacity? As is now well established [Keating, 2004; Kuhn & Franklin, 2006; Kuhn, Katz, & Dean, 2004; Moshman, 1998], task variance in the assessment of formal operational competencies is as substantial as it has been shown to be in the assessment of the competencies associated with Piaget's earlier stages. Without a well-developed map of *all* the domains of endeavor in which such competencies might manifest

themselves, we are not in a position to make pronouncements as to who is and who is not 'formal operational.' Moreover, the dynamic assessment capability associated with microgenetic methodology suggests that intraindividual variability is likely as substantial as interindividual variability. Most likely, the majority of adults reason in formal operational ways some of the time and not at other times.

In a third category are claims regarding which Piaget appears to have been right, and these have not always been recognized amongst the criticisms. Most prominent here are the basic developmental phenomena. A wide range of replication efforts using many different kinds of tasks with individuals from a number of different societies all support the same broad conclusions. The core formal operational competencies of systematic combination and control of variables are largely absent during the first decade of life but begin to appear in at least some segment of the population during the second decade. (Judgments of proportion, given the different kinds of reasoning that can support them, are a more complex case.) Like the concrete operational competencies that precede them developmentally, it is well to remember, these are competencies whose emergence had for a great many years been there to be observed, but they went largely unnoticed until Piaget and Inhelder pointed them out.

At least as important, however, as the documentation of these fundamental developmental phenomena is another respect in which Piaget appears to have gotten it right, i.e., in identifying second-order cognition – thinking about thinking – as a rapidly expanding aspect of cognition in late childhood and early adolescence. This reflection on, and monitoring and management of, one's thought is more likely today to be referred to as metacognition or executive control. Yet the evidence is growing that the second decade is a period of significant development in metalevel monitoring and management [Kuhn & Pease, 2006] – what we might refer to as developing skill in managing one's own mind.

In identifying thinking about thought as a hallmark of adolescence, however, Piaget cast a net that was both too narrow and too wide. On the one hand, early forms of this competency are readily observed during the first decade of life. Even preschoolers can be metacognitive when, for example, they recognize an earlier false belief that they no longer hold [Harris, 2006]. On the other hand, second-order cognition is typically highly contextualized and meaning-dependent. What constrained Piaget's treatment of metacognition was his assumption that second-order operations were of the same general form as first-order (concrete) operations, that is, entirely content-neutral, general, and therefore abstract and equally applicable without regard to context, content, or purpose.

In the real world of adolescent thought, in contrast, gradually emerging reflective awareness of one's thought has a number of features that differentiate it from propositional logic, features that make it more flexible and widen its range of application. First, the content and meaning of what is being thought about are of primary importance to the thinker and play a major role in whether, and what kind of, thinking occurs. Second, thinking about thinking implies the potential for management of thinking, not simply reflection on it or rule-governed manipulation of it. This active, self-directed management, in turn, implies the potential for volition and, by implication, some degree of control. Adolescents increasingly take charge of their mental life, choosing what to think about, when and where to do so, and how to allocate their mental effort. They become able to manage and deploy their cognitive

resources in consciously controlled and purposefully chosen ways, even though habitual patterns of thinking and behaving may also be common.

As a result, the extent and range of individual variability greatly increases. Through concentrated engagement in the activities they choose, adolescents get even better at what they are already good at. To a greater extent than children, teens attribute meaning and value (both positive and negative) to what they do and draw on this meaning to define a self. Positively valued activities lead to behavioral investment, which leads to greater expertise and hence greater valuing, in a circular process that has taken hold by early adolescence. By this age, individuals have indeed become producers of their own development [Lerner, 2002]. As a consequence of this self-directed activity and development, we see during the second decade the widening range and diversity of individual pathways that Piaget recognizes in his 1972 article.

A major implication is that competence to execute cognitive operations is no longer the only, or even the most important, factor involved in development. Disposition – to do or not to do x or y – becomes increasingly relevant [Kuhn, 2001; Perkins, Jay, & Tishman, 1993; Stanovich, 1999, 2004]. We thus need to keep well in mind a larger framework that includes metalevel *understanding* of strategic competencies, and these in relation to task *goals*, as well as *values*, as critical links mediating competence and disposition.

Is Piaget's Account of Formal Operations Relevant?

We are left, then, with the question of whether Piaget's account, in particular his account of formal operations as the final achievement of the constructive developmental process he envisioned, has anything to say to us today. The core phenomena and the overarching concept of thought reflecting on itself to my mind remain as important today as they were when Inhelder and Piaget presented them half a century ago. The 'good enough' intellectual environment that suffices to support the transitions common to childhood cognitive development apparently is not good enough to support universal attainment of the cognitive capabilities that have the potential to develop during the second decade of life. The implications are strong ones in terms of both social policy and research. We need to identify the critical components of environments that will support the intellectual development of every individual to full potential.

To do this, we will need to conduct more studies of adolescent cognition in the situated contexts of the activities in which teens choose to invest their intellectual resources. We are certainly taking a risk in drawing conclusions from investigations confined to artificial problems, constructed for research purposes, that bear no clear relation to the kinds of thinking that adolescents do in their daily lives. At the same time, the ability to decontextualize – to extract a generalized representation distinct from its specific context – remains a critical developmental achievement that needs to be studied further [Kuhn & Franklin, 2006; Stanovich, 1999, 2004]. It was this ability to disembed a proposition from its content and meaning and context and operate on it in disembodied form that Piaget saw as fundamental to higher-order cognition.

In rereading Piaget's 1972 article, I was struck by the extent to which the issues he grapples with there resemble the ones that now occupy the attention of those concerned with life's second decade. What develops? Current interest centers on the second-decade brain developments that appear to be more profound than we realized, but we need to understand the mental transitions and transformations that occur with them [Keating, 2004; Kuhn, 2006]. These, most likely, will be found to have both universal and differential aspects, the latter magnified by experience-based neurological change. Early adolescence is increasingly being recognized as a second critical period, one marked by diverging developmental pathways. How do these universal and individual trajectories intersect? And how can each best be supported? The latter question, involving mechanism, remains largely still to be answered, although it now appears clear that disposition, interest, and mental self-regulation and management will figure prominently – all entities that Piaget was grappling with in 1972.

These questions readily link to some of the key questions being debated today with respect to education during the second decade. How is the maximization of intellectual and personal life potential best supported? Should junior and senior high schools follow a standard curriculum of general education? Or should 'specialization' be moved further down the educational ladder, offering junior as well as senior high school students the opportunity to immerse in specialized interests in the hope of engaging them and preventing their becoming 'turned off' to education at an early age? In several US states, students are required to choose a 'major,' at the beginning of their high school careers, from choices as varied as world cultures, technology, and fashion design. In some European countries, students are channeled into vocational and prevocational tracks at even earlier ages. What are the long-term costs and benefits of such practices? The arguments are plentiful on both sides [Kuhn, 2005], and hard evidence scarce. As in Piaget's day, we are not yet in a position that would allow us to rule out one developmental scenario in favor of another.

References

- Gelman, R. (2002). Cognitive development. In H. Pashler & D. Medin (Eds.), *Stevens' handbook of experimental psychology*. Vol. 2 (3rd ed., pp. 533–559). New York: Wiley.
- Harris, P. (2006). Social cognition. In D. Kuhn & R. Siegler (Eds.), *Handbook of child psychology*. Vol. 2: *Cognition, perception, and language* (6th ed., pp. 811–858). New York: Wiley.
- Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence*. New York: Basic books.
- Keating, D. (1980). Thinking processes in adolescence. In J. Adelson (Ed.), *Handbook of adolescent psychology* (pp. 211–246). New York: Wiley.
- Keating, D. (2004). Cognitive and brain development. In R. Lerner & L. Steinberg (Eds.), *Handbook of adolescent psychology* (pp. 159–187). Chichester: Wiley.
- Kuhn, D. (2001). How do people know? *Psychological Science*, 12, 1–8.
- Kuhn, D. (2005). *Education for thinking*. Cambridge: Harvard University Press.
- Kuhn, D. (2006). Do cognitive changes accompany developments in the adolescent brain? *Perspectives on Psychological Science*, 1, 59–67.
- Kuhn, D., & Franklin, S. (2006). The second decade: What develops (and how)? In D. Kuhn & R. Siegler (Eds.), *Handbook of child psychology*. Vol. 2: *Cognition, perception, and language* (6th ed., pp. 953–994). New York: Wiley.
- Kuhn, D., Katz, J., & Dean, D. (2004). Developing reason. *Thinking & Reasoning*, 10, 197–219.
- Kuhn, D., & Pease, M. (2006). Do children and adults learn differently? *Journal of Cognition and Development*, 7, 279–293.

- Lerner, R. (2002). *Concepts and theories of human development* (3rd ed.). Mahwah: Erlbaum.
- Moshman, D. (1998). Cognitive development beyond childhood. In D. Kuhn & R. Siegler (Eds.), *Handbook of child psychology. Vol. 2: Cognition, perception, and language* (pp. 947–978). New York: Wiley.
- Moshman, D. (2005). *Adolescent psychological development: Rationality, morality, and identity* (2nd ed.). Mahwah: Erlbaum.
- Neimark, E. (1975). Intellectual development during adolescence. In F. Horowitz (Ed.), *Review of child development research. Vol. 4* (pp. 541–594). Chicago: Chicago University Press.
- Perkins, D., Jay, E., & Tishman, S. (1993). Beyond abilities: A dispositional theory of thinking. *Merrill-Palmer Quarterly*, 39, 1–21.
- Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. *Human Development*, 15, 1–12.
- Stanovich, K. (1999). *Who is rational? Studies of individual differences in reasoning*. Mahwah: Erlbaum.
- Stanovich, K. (2004). *The robot's rebellion*. Chicago: University of Chicago Press.