# ADULT COGNITIVE DEVELOPMENT

## METHODS AND MODELS

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# 8

# Methodological Considerations in Young Adult Cognitive Development Research

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The chapters in this book represent a wide array of theoretical models and phases of research on young adult intellectual development. This concluding chapter discusses the psychometric and design issues that warrant consideration in future research endeavors. Statistical application and issues have been recently reviewed (Applebaum and McCall, 1984) and are not presented in this chapter.

## THEORETICAL CONSIDERATIONS

The majority of the models in this volume are based on stage assumptions (chapters, Arlin, Basseches, King, Kitchener, Rest). The model presented by Fischer and Kenny and the perspective provided by Gruber are not stage models per se; however, many of the theoretical considerations discussed in this section are still applicable. A number of theoretical issues surrounding stage concepts in developmental psychology are recapitulated in the subfield of young adult cognitive development. The list of issues includes, but is not limited to:

1. Presence and direction of change (Wohlwill, 1973),
2. Rate of change (Wohlwill, 1973),
3. Continuity versus discontinuity of change (Fischer, this volume),
4. Sequences of unequal length (Wohlwill, 1973),
5. Age/educational level confounding (Wohlwill, 1973),
6. Quantitative versus qualitative change (Applebaum and McCall, 1984),
7. Hierarchical arrangement of stages (Commons and Richards, 1984).

### Presence and Direction of Change

Cognitive stage models assume that change in level or stage occurs in a theoretically predictable direction. Examples of the presence and direction of change

include more complexity, better problem-finding skills, higher levels of abstraction, dialectical reasoning, more complexity of metaphysical or epistemological assumptions, and postconventional moral reasoning.

The possibility that developmental change may be occurring is established in the initial phase of a research program with cross-sectional designs. The presence and direction of change is established with longitudinal data. The Reflective Judgment (Kitchener, this volume) and Moral Reasoning (Rest, this volume) models have the only longitudinal data to date. Change does occur, albeit slowly and in small increments, within these two models. Longitudinal research is under way on some of the other models (e.g., Arlin, Fischer). It is necessary to establish the presence and direction of change along the lines predicted by the model as a basic premise of development.

## Rate of Change

The rate of change allows for the establishment of the optimal and typical time spent at a given stage or level. Rate of change information is obtained through longitudinal data collection. The rate of change information has applied implications. For example, programs designed to accelerate stage progression may not be successful because of natural limits to the rate of change. This issue is discussed further in the section on optimal versus natural functioning.

The rate of change from one stage or level to another also has direct implications for young adult cognitive development research. The rate of change may cover a longer time frame than that studied using young adults. Research on models where the rate of change is slow will need to expand the data base to include older adults in order to establish the rate of change through the stages. In addition, rate of change will affect the timing of repeated measures. If the rates of change are slow, then developmental spurts may be missed on some longitudinal designs.

## Continuity versus Discontinuity

Some suggest that a basic premise of cognitive stage models is that the stages are discrete reasoning processes in which the upper levels incorporate the elements of the lower level (Commons and Richards, 1984). They argue, stages should be discontinuous rather than continuous. An alternative point of view, presented by Davison, King, Kitchener, and Parker (1980) suggests that "stage sequence can be represented as a continuous developmental dimension of individual differences in reasoning." Furthermore, they argue that as an individual's developmental level increases, the probability of giving a particular stage response increases until it reaches a maximum at that stage, at which point it begins to decrease.

Some models presented in this volume provide data from which one could infer that aspects of young adult cognitive development may be continuous (i.e.,

Reflective Judgment, Moral Judment). On the other hand, discontinuities have also been demonstrated in Fischer's research. These differences in the data on continuity versus discontinuity can be accounted for in various ways:

1. Some aspects of young adult cognitive development may actually be continuous, some discontinuous.
2. The differences may be an artifact of the assessment methodology and data reduction techniques used since authors develop their assessment techniques and scoring procedures based on their assumptions of continuity and discontinuity. For example, if there is a trend toward more complexity in the phenomena of interest and the model is based on a continuous assumption, the assessment methodology will represent the data as continuous, when, in fact, it may be discontinuous. To clarify the continuity/discontinuity aspects of a given model, the researchers should develop both continuity and discontinuity methodologies to adequately test their assumptions.
3. The differences may be due to content familiarity and extent of skills in a given content area (Fischer, this volume). Davison et al. (1980) proposed that the individual uses given stage responses with increasing probabilities until an equilibrium is reached. In other words, as familiarity with content increases, so does the probability that the response will occur, assuming the individual has initially attained the necessary stage structure. This point of view rests on the assumption that the individual is familiar with the content and has the skills inherent in reasoning about a given test item with said content. Fischer's work indicates that differences in skills and content familiarity can account for variation in developmental test performance. The skill and content familiarity differences need to be controlled in order to assume the longitudinal or cross-sectional results are due to developmental differences.
4. The differences in the data could be a function of the timing of assessment. For example, in longitudinal designs, discontinuities may be occurring and the researchers are not finding them due to infrequent assessment.

The continuity/discontinuity assumptions have a direct bearing on the selection of the scales used in the assessment techniques used to study the models. The assumptions the theorists make about continuity/discontinuity also lead to different statistical treatment of the data obtained. These issues are discussed further in the psychometric section.

## Sequences of Unequal Length

Are all the stages or levels of a given model equal in terms of time required to consolidate the stage, or equal in terms of the theoretical "distance" between the stages? The time and distance issues affect measurement and design selection as well as having theoretical implications regarding the continuity/discontinuity issue. The length of time required for acquisition of a stage poses no difficulty if all of the intervals are equal. This is highly unlikely and presents

a problem for longitudinal research designs, as the timing of the repeated measures is typically standardized (e.g., one year; two year intervals). Variation in the timing of development between stages may be artificially obscured through standardized assessment intervals. We may need more flexibility in our longitudinal designs in order to find whether maturational consolidation differences exist. For example, subgroups of a sample could be assessed at different intervals rather than assessing the entire sample at once.

The theoretical distance between the stage levels has a direct bearing on scale development. The stages or skills probably do not represent equal amounts of psychological phenomena. None of the theorists in this volume assume the stages or skills represent equal distances. This leaves the researcher with nominal or ordinal scales as possibilities for instrument development. The advantages and disadvantages of these two scale choices are discussed in the psychometric section.

## Age/Educational Level Confounding

The young adult cognitive development research is directly confounded along age and education levels in most studies. This confounding is a result of studying samples who are in an educational setting, such as undergraduate and graduate schools, where age is typically associated with a given educational level. It is only at the upper ends of the models (Kitchener, King, Rest, this volume) that preliminary data have been acquired to separate the effects of these variables. Another way to look at the age and education confounding is to view it as a natural versus optimal environment interaction effect. The individuals who attend college or graduate school could be considered as having exposure to an optimal environment for developing higher level reasoning processes. Those individuals with equal intellectual ability who have not attended college or graduate school should not demonstrate higher levels of reasoning, as the natural environment typically does not provide demands for complex reasoning. This results in a lower stage functioning than would probably occur under optimal environmental conditions. (See Fischer's chapter for an extended discussion of natural versus optimal condition effects.) In fact, the data presented in this book provides support for the view that adults who have been in environments (i.e., higher education) that require the skills measured by these models are further advanced than those adults having gone into other environments after high school.

## Quantitative versus Qualitative Change

By definition, changes in stages or levels are qualitative. The qualitative assumption has scaling implications. Wohlwill (1973) stated the quantitative/qualitative issue in the form of the question of whether or not a behavior is measurable along a quantitative scale. The models of young adult cognitive develop-

ment (with the exception of Fischer) presented in this volume typically do not meet the quantitative behavior criteria because the structure of the stage is imposed on any set of content. It is the manner in which the individual reasons about a problem that is of interest, not the answer per se. Often the quantitative approach assumes that right and wrong answers exist, in the scoring systems used, when many of the assessment situations present problems that have better or worse answers which are not subject to strict quantitative scoring assumptions. They may fit a more or less of something quantitative assumption or may be qualitative in nature. Thus, treating the data from these models as if they were quantitative may have problems. Wohlwill (1973) noted that attempts to quantify qualitative data through the use of group incidence scores obscures the abruptness or smoothness of stage change, as well as rate and time of change. The quantification of qualitative data may artificially present a picture of continuity.

## Hierarchical Arrangement of Stages

The models which define the cognitive processes as stages or levels have the burden of demonstrating that the stages are hierarchically arranged. The ordering of the stages in the models should have an internal coherence that can be demonstrated conceptually first and then tested empirically. Commons and Richards (1984) propose that cognitive models meeting the criteria for stages have a "discrete, irreflexive, inclusive order" consisting of task demands arranged hierarchically that become qualitatively more complex.

The demonstration of hierarchical arrangement includes three phases. The first phase is based on the theoretical and logical consistency of the stages or levels of descriptions. It should be apparent from reading the theoretical explication of the logic of the stage order that the order is sequential and hierarchical. If the order is not apparent then testing for a hierarchical arrangement is questionable. The second phase employs the use of cross-sectional or experimental designs which test for differences between groups that theoretically should be at different stages. The cross-sectional and experimental design methodologies provide intergroup difference data on the hierarchical arrangement of the stages. The groups who are predicted to score higher actually do score higher. Davison (1977) has described and tested an alternative method for demonstrating the sequentiality of stages using a qualitative unfolding model. It has been used to test the sequentiality of the models of Harvey, Hunt, and Schroeder, and Loevinger (Davison, et al., 1980) and Reflective Judgment (King, Kitchener, Davison, Parker and Wood, 1983). It allows the researcher to compare the strength of the stage ordering across the model. The methodologies in the second phase allow the researcher to determine if theoretically predicted differences occur between groups or if there is a coherence to the stage responses within an individual (e.g., Davison et al., 1980).

Fischer, Hand, and Russell (1984) and Commons and Richards (1984) pro-

vide a third means of demonstrating the hierarchical arrangement. They have proposed changing the task demands so that each level or stage is assessed by an increasingly more complex task designed specifically for the stage or level. Wohlwill (1973) discussed this approach as a Guttman scale in which the individual should be able to pass items or tasks up to the level of functioning.

The most conservative test of hierarchical arrangement is to study individual changes over time, therefore, phase three involves the longitudinal study of the individual's progression through the stages. Without longitudinal data, one cannot say that intergroup differences are due to developmental factors nor can one say that the cluster of stage scores is due to the hierarchical arrangement of the scores. It is only from the study of individual change over time that sequentiality and hierarchical arrangement can be attributed with confidence.

## Summary

To what extent have the models in this book addressed the theoretical issues or met the theoretical assumptions? It is clear that the data from all of the models point to the conclusion that young adults reason more complexly, use increasingly abstract categories, exhibit a progression in the assumptions about knowledge used in justifying beliefs, and to a lesser extent, use dialectical concepts, indicating that the theoretical requirements regarding concepts, sequentiality, and hierarchical arrangement have been met to varying degrees.

The continuity/discontinuity issue is based on the assumption that the demonstration of discontinuity confirms that qualitative differences exist between levels. The continuity/discontinuity requirement has been addressed in different ways by the theorists. Kitchener, Rest, and Basseches assume their data is ordinal and represents varying degrees of stage usage, arranged sequentially and hierarchically. On the other hand, Fischer provides a methodology and supporting data for a discontinuity interpretation of his model. The continuity/discontinuity component to the models may be accounted for in different ways.

First, the continuity data may be an actual reflection of the complexity of adult reasoning and discontinuity assumptions are unnecessary. At any given time, an adult will exhibit a variety of responses in thinking through a problem which would support a continuity perspective. Second, the complex stage responses may be an artifact of imprecise scoring criteria, resulting in various stage responses exhibited in a subject's data set leading to the erroneous conclusion that the model is continuous. This point can be determined by looking at the levels of agreement among raters of the data.

Imprecise scoring categories or scoring rules will result in mediocre or poor interrater agreement and reliability. The raters end up assigning more than one stage response to a subject. Resolving the scoring differences through the use of a mean for example, will give the impression of continuity when the result is due to scoring rule or category imprecision.

Third, the complex stage models may also have a discontinuity aspect to

them, however, to date, discontinuity methodologies have not been applied to the complex stage models, thus, the continuity conclusions may be premature.

The "rate of change" is a subset of the continuity/discontinuity problem. On the one hand, a slow gradual rate of change appears to occur in the reflective judgment and moral reasoning longitudinal research. On the other hand, Fischer's (this volume) model provides evidence of plateaus and spurts in specific cognitive skill domains. It would be quite interesting to test the slow change models with a "discontinuity methodology" such as Fischer's, to see if the slow, gradual change data continued to hold up. If the slow, gradual change models are not supported, then the previous differences may have been due to the optimal/natural testing condition differences.

The length of time it takes to move through a stage or an entire model is in many respects, not critical to demonstrate in the validation phase of a research model. The length of time becomes more important in applied research once the theory has validity data to support it. In addition, individual differences in intelligence may set floor and ceiling effects on stage acquisition and rate of progression through the stages. At this time, based on Kitchener's work (this volume), it appears the length of time for change to occur is long (one or two years) and is probably incomplete at the mid-twenties, even among intelligent, highly educated people.

Age/education level confounding is found throughout the young adult cognitive development research. Where data exist which empirically separate the age versus education level and controls for intelligence (Lawson, 1980; Strange, 1978), it appears that higher cognitive processes develop in the context of optimal environments such as higher education. Those adults in noneducational environments apparently are not challenged nor taught more complex reasoning processes in order to solve problems in those settings.

It is very difficult, if not impossible, to separate theoretical issues from psychometric and methodological issues. The burden of verifying or disconfirming the theoretical issues falls in the psychometric and methodology domains. As noted in the theoretical section, many of the issues could not be clearly resolved because of psychometric or methodological confounding. The next section focuses on psychometric issues related to young adult cognitive development research.

## PSYCHOMETRIC CONSIDERATIONS

The psychometric qualities of the instruments used to assess the models of young adult cognitive development form the foundation on which the models are refined and built. Without a careful consideration of the psychometric issues, the validity of the models may never be adequately established. The following content areas are discussed in this section:

1. Unit of analysis
2. Scales of measurement (quantitative vs qualitative)
3. Scoring methods
4. Measurement task (preference, production)
5. Natural versus optimal conditions for assessment.

## Unit of Analysis

What is the unit of analysis? The models in this book have used a variety of units of analysis. The units of analysis have included specific skills (Fischer), categorization of subsets of a process (Basseches), endorsement of stage prototypic responses (Rest), qualitative differences in responses (Arlin), qualitative differences in subsections of protocols (Kitchener), and an entire body of writing including notes and published work (Gruber). The unit of analysis should be consistent with the theoretical coherence of the model, the assumption of continuity/discontinuity, and assumptions regarding quantitative versus qualitative scaling.

The unit of analysis can become a source of error in interpreting data if it has been defined in a manner which is inconsistent with the theoretical coherence of the model. For example, if the model is descriptive of an entire sequence of thought, such as dialectical reasoning, then the entire response should be evaluated as a whole rather than broken down into subcategories. Breaking the unit of analysis into subcategories rather than using the whole response leads to tenuous interpretations within the context of the theory because it is the gestalt of the response that forms the qualitative aspect of the process.

In some cases, other units of analysis may also be of value, even though they may not be theoretically consistent. A good example is the use of the P-score in the moral reasoning research. The P-score has been used to show the percent of principled stage usage in cross-sectional and longitudinal research. This type of data allows inferences to be made about stage change and sequential progression.

## Scales of Measurement

The type of scaling chosen to measure cognitive development should follow directly from the assumptions about the unit of analysis and nature of the data (i.e., quantitative versus qualitative). Two types of scaling, nominal and ordinal, warrant consideration in assessing young adult cognitive development. The use of nominal categories in a Guttman-type scale is a conservative approach to demonstrating the sequencing and hierarchical arrangement of stages. It is assumed that the cognitive processes can be defined precisely and discretely in order to develop a Guttman-type scale. Fischer (this volume) uses highly specific skills with Guttman-type scaling to demonstrate discontinuities, sequencing, and hierarchical arrangement.

Models that have multifaceted stage descriptions may sacrifice precision in terms of scaling for richness in terms of the complexity of the subject's response. It has been a common practice to treat multifaceted data as if the scales were at least ordinal. The ordinal data can be used to demonstrate sequencing and the hierarchical arrangment of the model. For example, Davison et al.'s (1980) unfolding model for analyzing predominate and adjacent stage usage is one technique for demonstrating the hierarchical arrangement and sequencing of complex stage data derived from ordinal scales.

The Guttman-type scale, however, offers greater precision and certainty about the sequencing and hierarchical arrangement of the stages. On the other hand, it is very difficult to find cognitive reasoning models than can be defined so the Guttman-type scales can be used. The ordinal scaling offers more flexibility for obtaining and analyzing data on complex models while sacrificing some degree of certainty about the sequencing and arrangement because of the individual differences and measurement error that exist when assessing multifaceted stage phenomena.

## Scoring Methods

In addition to identifying the unit of analysis and appropriate scaling procedures, the researcher must decide how to represent the responses for analysis purposes. The scoring method has a direct impact on the inferences regarding stage or level. To date, the methods which have been used include the highest stage response, the model stage response, the mean level of stage usage, the percentage of highest stage exhibited, the use of cutting scores, strong scalograms procedures, and nominal-descriptive methods (Mines, 1982).

These methods all have merits and limitations. Using the highest stage response or percentage of highest stage utilized is acceptable when a stage can be clearly exhibited and the subject's motivation to produce the highest stage can be assured. Cognitive stage acquisition may be uneven or vary by content domain, thus, the use of the highest responses or percentage of highest stage may lead to interpretation problems if a subject's motivation to perform is not optimal or if the highest stage is interpreted as typical rather than maximal functioning.

The use of the mean or the mode underestimates the highest stage or level and assumes that the scaling meets the criteria for continuity and quantifiability. The mean eliminates the stage or level variance, resulting in a conservative estimate of stage functioning. The use of the mean or mode obscures decalage problems across test items, as well as motivation to produce on a given item. Complex cognitive stage models will not be adequately represented by a mean or a modal score.

The ogive rules of cumulative distribution have not been applied to the models discussed in this book, although Loevinger (1976) used ogive rules with

her model. The ogive rules use the distribution of responses rather than the mean, median, or mode. The ogive rules take the distribution of scores into account and yet represent the distribution of scores with a single stage that does not convey the stage or level variance exhibited in the assessment. The ogive rules give a picture of stage usage that is higher than the typical performance, but lower than the optimal performance (Davison et al., 1980).

Fischer, Hand, and Russell (1984) suggested that the data reduction problem could be minimized through the use of a strong scalogram analysis. This procedure specifies a skill or task that a young adult at a higher cognitive stage or level should be able to demonstrate and a young adult at a lower level should not be able to demonstrate. A separate task is designed for each level. This eliminates many of the scoring method problems described previously as the criterion for acquisition as defined in a yes/no dichotomy. It also eliminates the problem of using one task or test to describe the entire range of a cognitive development model. This approach is appropriate for investigating specifically defined skills. It would be difficult to use it on a global reasoning process model without redefining the stages in terms of specific skills.

The selection of a scoring method is directly related to the phase of research a model is in, as well as the specific purpose of a given study. The simple versus complex stage assumptions of the model have direct bearing on the scoring method. Simple stage models are amenable to Guttman-type representations. Complex models can be represented as a mean, percentage of stage usage, or ogive rules depending on what the researcher is interested in (e.g., a conservative estimate of functioning, optimal functioning). If the researcher is interested in investigating exceptional cognitive development, then a process description is sufficient as a score would be meaningless. The scoring method should be selected to represent the phenomena of interest as accurately as possible.

## Measurement Task Differences

Rest (1979c) discussed the differences between production and recognition tasks. Production tasks (e.g., reflective judgment interview, dialectical reasoning interview) are designed so the subject must produce the stage or level reasoning. They give a conservative estimate of level of functioning and are limited by the young adult's motivation to perform at his/her highest level. If the subject is fatigued or not motivated to do well, a production task will more frequently underestimate the young adult's cognitive development level. The recognition task allows the subject to mark a prototypic response that most closely agrees with his/her point of view on the issue (e.g., Defining Issues Test). Rest (1979c) noted that the subject can recognize or understand higher stage responses before he/she is capable of producing the response. The recognition task provides data that is a liberal estimate of the subject's functioning.

Fischer (this volume) suggested that the type of measurement task (verbal

response, written response, object manipulation), familiarity with the task, and length of the task affects the subject's response. For example, in the Mines (1980) study, mathematics and psychology/sociology students were compared on the Reflective Judgment Interview (RJI) (see Kitchener, this book). The mathematics students had higher academic ability scores than the psychology/sociology students. After statistically controlling for the academic ability, the psychology/sociology students scored significantly higher on reflective judgment. One interpretation was the psychology/sociology students were further advanced on the Reflective Judgment model than one would predict, based on their academic ability. An alternative explanation was that RJI elicits a verbal response, requiring a subject to think out loud in a complex manner about an ill-structured problem. It was informally observed that the psychology/sociology students had better verbal communication skills than the mathematics students. The results, therefore, could have been an artifact of verbal facility. It is possible that the outcome may have been different if the student was able to write a response or if the student were given adequate time to research the problem and present a response.

Task familiarity contributes to variation in subject performance (Fischer, this volume). On any of the cognitive models on which a subject is asked to respond to an unfamiliar question or task, the subject may not perform as well as she/he is capable of because of information deficits, memory capacity, skill deficits, or performance anxiety. None of these may have a developmental stage or level basis to them. The usual interpretation would be that subject A was performing at a given developmental level, when other factors may be operating.

The length of the task, in terms of the response required or latency of response allowed, has a direct effect on the richness of the response. The models presented in this book address complex thinking processes; allowing fifteen minutes to an hour to respond to the task may not allow the subject an adequate time frame or response length to exhibit a complex thinking process. How many times in one's professional capacity does one have only one hour to analyze, evaluate, and present a synthesis on a complex or ill-structured problem? Thus, the attentuated time or format may hinder the subject's ability to respond in a manner comparable to the upper levels of the model.

In order to establish the upper limits of these models, it would be interesting to vary the test formats and time frames. Gruber's (see Chapter 7, this book) intensive case study approach is an example of one techinque that does allow the upper ends to be examined.

## Natural versus Optimal Test Conditions

Fischer (this book) addressed the problem of task familiarity and the recognition versus production problem from the standpoint of natural versus optimal conditions. Under natural conditions, the subject is given a task or problem without any practice allowed or instruction as to what type of response is expected.

Under optimal conditions, the subject is first given the task and then instructed as to the better procedure for working on the task or problem and then retested. Then if the subject performs at a lower stage or level, it can be concluded with greater certainty that the performance was not an artifact of the assessment process. In fact, Fischer has compelling data on arithmetic skills, in which he is able to demonstrate performance differences due to natural versus optimal environments. The majority of the data reported in this book was obtained under natural conditions, in which the subjects did not necessarily have prior information concerning the processes involved, the nature of the problem, or the task expectations. Thus, the results may be underestimates of the performance levels of the samples.

## Summary

The models in this book have defined the unit of analysis in a variety of ways. In certain cases (e.g., dialectical reasoning, reflective judgment) the unit has been defined as a paragraph or a statement when the actual theoretical description includes the entire thought process used in thinking about a problem. Using smaller thought units is a questionable strategy because the raters must infer the smaller unit is related to a more complex process, thus, increasing the potential for error. This type of rater error can be minimized by articulating the decision rules for scoring smaller thought units and demonstrating the thought units' relationship to the entire thought sequence. Gruber's (this book) "evolving systems" approach takes entire lines of reasoning as the unit of analysis, thus avoiding the problem of defining the unit of analysis in a manner inconsistent with a model's theoretical assumptions. In looking at specific skills, Fischer (this book) also has defined the unit of analysis in a manner which is observable, descriptive, and replicable.

The quantitative/qualitative scale of measurement issue is directly related to the demonstration of the hierarchical arrangement of the stages or levels. Future research will need to define the levels with sufficient precision to allow qualitative scales to be derived in order to minimize other sources of measurement error.

The scoring procedures and the task requirements used to represent and assess the models should follow directly from the model's description of the process. Creativity and innovation may be needed to find ways to adequately sample complex reasoning processes. For example, Gruber's methodology has promise in this regard.

Finally, the optimal versus natural testing conditions issue has a direct bearing on the validation of the model. Each approach provides a different view of a model and the incidence of different stages in the sample. Another way of considering the use of optimal or natural conditions relates to whether one is interested in the best performance a subject is capable of or an estimate of how

a subject might perform in naturally occurring situations. Continued research on the models in this volume should consider the use of both optimal and natural methodologies as a means of extending our understanding of the young adult cognitive processes.

## CONCLUSIONS

The study of young adult cognitive development is still in its infancy. On the theoretical level, the models and techniques presented in this volume represent a variety of cognitive skills and processes. The array of skills and processes offers a richness to the study and understanding of young adult cognitive development that has been related to the Piagetian perspective, yet has gone beyond it.

The state of the art on the empirical level indicates that within the traditional paradigm, the majority of research is still in the descriptive, cross-sectional phase. The moral reasoning and reflective judgment research have longitudinal data as well. Gruber and Fischer have challenged researchers within the traditional paradigm to reconsider the assumption of linear development. Fischer provides microsequence data on discontinuities across domains as one view. Gruber presents a challenge to consider multiple lines of development interacting with a variety of environments as another view.

Psychometrically, the young adult cognitive development researchers should re-examine the assumptions about the unit of analysis, methods of representing the data, and the statistical treatment of the data derived from nominal scales. The line of work (Fischer) on optimal versus natural environments, and task familiarity provides a direct method of eliminating error due to the absence of task familiarity or knowledge.

The ecological validity of the models needs to be investigated. Ultimately, the important question that influences all of our lives is how adults think about complex problems such as nuclear war, relationships, careers, and so on. Without ecological validity, we may end up fiddling while Rome burns. Psychology is replete with examples of research exhibiting strong internal validity while studying trivial phenomena. We need to work to insure that this criticism will not be made of the young adult cognitive development research.

The work on the models presented in this book has moved beyond the purely speculative or theoretical phase. In order for the models in this book to be seriously considered in developmental psychology, however, the researchers must attend as much to the empirical validation as they have attended to theory building because the data base on most of the models is limited. The Piagetian tradition provided the foundation for the work presented in this book. The post-Piagetian research is well underway, but with a great deal to be done before we can answer Gruber's question, "Which way is up?" (Gruber, this volume).

# *Bibliography*


Ackerman, S.P. 1978. "Relationship of Dogmatism for Formal Operations." Ph.D. dissertation, University of Georgia, *Dissertation Abstracts International 39*, 3460A.

Adelson, J. 1972. "The Political Imagination of the Adolescent." In *Twelve to Sixteen: Early Adolescence*, edited by J. Kagan and R. Coles. New York: Norton.

Adorno, T.W. and Horkheimer, M. 1979. *Dialectic of Enlightenment*. Translated by John Cumming. London: NLB.

Apostle, L. 1979. "Construction and Validation in Contemporary Epistemology." Paper presented at the Archives de Jean Piaget, Geneva, *6*, #47.

Applebaum, M.I. and McCall, R.B. 1984. "Design and Analysis in Developmental Psychology." In *Handbook of Child Psychology*, edited by P.H. Mussen. New York: Wiley and Sons.

Arlin, P.K. 1974. "Problem Finding: The Relation Between Selected Cognitive Process Variables and Problem Finding Performance." Unpublished Ph.D. dissertation, University of Chicago.

—— 1975. "Cognitive Development in Adulthood: A Fifth Stage?" *Developmental Psychology 11*, pp. 602–6.

—— 1975–76. "A Cognitive Process Model of Problem Finding." *Educational Horizons 54*, pp. 99–106.

—— 1977. "Piagetian Operations in Problem-Finding." *Developmental Psychology 13*, pp. 247–98.

—— 1984a. "Adolescent and Adult Thought: A Structural Interpretation." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development*, edited by M.L. Commons, F.A. Richards, and C. Armon, pp. 258–71. New York: Praeger.

—— 1984b. *The Arlin Test of Formal Reasoning*. New York: Slosson Educational Publishers.

Armstrong, M. 1980. *Closely Observed Children*. London: Writers and Readers.

Aronfreed, J. 1968. *Conduct and Conscience*. New York: Academic Press.

Bandura, A. 1977. *Social Learning Theory*. Englewood Cliffs, N.J.: Prentice-Hall.

Barrett, D.E. and Yarrow, M.R. 1977. "Prosocial Behavior, Social Inferential Ability, and Assertiveness in Children." *Child Development 48*, pp. 475–81.

Barron, F. and Harrington, D.M. 1981. "Creativity, Intelligence, and Personality." *Annual Review of Psychology 32*, pp. 439–76.

Bart, W., Frey, S. and Baxter, J. 1979. "Generalizability of the Ordering Among Five Formal Reasoning Tasks by an Ordering-Theoretic Method." *Child Study Journal 9*, pp. 251–59.

Basseches, M. 1979. "Beyond Closed-System Problem Solving: A Study of Metasystematic Aspects of Mature Thought." Ph.D. dissertation, Harvard University. *University Microfilms International*, Ann Arbor, MI.

—— 1980. "Dialectical Schemata: A Framework for the Empirical Study of the Development of Dialectical Thinking." *Human Development 23*, pp. 400–421.

—— 1984. *Dialectical Thinking and Adult Development*, Norwood: Ablex.

Bayley, N. 1970. "Development of Mental Abilities." In *Carmichael's Manual of Child Psychology*, edited by P.H. Mussen. New York: Wiley.

Bebeau, M.J., Rest, J.R. and Yamoor, C.M. 1983. "Profession-Specific Tests of Ethical Sensitivity: An Example in Dentistry." Paper presented at the Annual Convention of the American Educational Research Association, Montreal, Canada.

Biggs, D.A., Schomberg, S.F. and Brown, J. 1977. "Moral Judgment Development of Freshmen and Their Pre-College Experiences." *OSA Research Bulletin 17*, University of Minnesota Press.

Biggs, J. and Collis, K. 1982. *A System for Evaluating Learning Outcomes: The SOLO Taxonomy*. New York: Academic Press.

Blasi, A. 1980. "Bridging Moral Cognition and Moral Action: A Critical Review of the Literature." *Psychological Bulletin 88*, pp. 1–45.

Bohr, N. 1934. *Atomic Theory and the Description of Nature*. New York: Macmillan.

Brabeck, M. 1983. "Critical Thinking Skills and Reflective Judgment Development: Redefining the Aims of Higher Education." *Journal of Applied Developmental Psychology 4*, pp. 23–24.

—— in press. "Longitudinal Studies of Intellectual Development During Adulthood: Theoretical and Research Models." *Journal of Research and Development in Education.*

Brabeck, M. and Wood, P.K. 1983. "A Longitudinal Study of Well and Ill-Structured Problem Solving in College Age Women." Unpublished manuscript.

Braine, D.S. and Rumain, B. 1983. "Logical Reasoning." In *Cognitive Development*, edited by J.H. Flavell and E.M. Markman, vol. 3, 4th ed. pp. 231–62. New York: Wiley.

Brainerd, C.J. 1978. "The Stage Question in Cognitive-Developmental Theory." *Behavioral and Brain Services 2*, pp. 173–213.

Bransford, C. 1973. "Moral Development in College Students." Unpublished manuscript, St. Olaf College.

Broadhurst, B.P. 1980. "Report: Defining Issues Test." Unpublished manuscript, Colorado State University.

Broughton, J.M. 1975. "The Development of Natural Epistemology in Years 10–16." Ph.D. dissertation, Harvard University.

—— 1978. "Development of Concepts of Self, Mind, Reality, and Knowledge." In *Social Cognition*, edited by W. Damon, In *New Directions for Child Development*, No. 1, pp. 75–100, San Francisco: Jossey Bass.

—— 1981. "Piaget's Structural Developmental Psychology: Function and the Problem of Knowledge." *Human Development 24*, pp. 257–85.

—— 1984. "Not Beyond Formal Operations But Beyond Piaget." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development*, edited by M.L. Commons, F.A. Richards, and C. Armon, pp. 395–411. New York: Praeger.

Brown, A.L., Bransfors, J.D., Ferrara, R.A. and Campione, J.C. 1983. "Learning, Remembering, and Understanding." In *Handbook of Child Psychology* vol. 3, 4th ed. edited by P.H. Mussen, In *Cognitive Development*, edited by J.H. Flavell and E.M. Markman. New York: Wiley.

Bullinger, A. and Chatillon, J.F. 1983. "Recent Theory and Research of Genevan School." In *Handbook of Child Psychology*, vol. 3, 4th ed. edited by P.H. Mussen, In *Cognitive Development*, pp. 231–62. New York: Wiley.

Carlson, R. 1970. "Where is the Person in Personality Research?" *Psychological Review 67*, pp. 203–19.

Case, R. 1978. "Intellectual Development from Birth to Adulthood: Neo-Piagetian Perspective." In *Children's Thinking: What Develops?* edited by R.S. Siegler. Hillsdale, N.J.: Erlbaum.

—— 1980. "The Underlying Mechanism of Intellectual Development." In *Cognition, Development, and Instruction*, edited by J.R. Kirby and J.B. Gibbs. New York: Academic Press.

Cattell, R.B. 1963. "Theory of Fluid and Crystallized Intelligence: A Critical Experiment." *Journal of Educational Psychology 54*, pp. 1–22.

Chap, J.B. and Sinnott, J.D. 1977–78. "Performance of Institutionalized and Community-Active Old Persons on Concrete and Formal Piagetian Tasks." *International Journal of Aging and Human Development 8*, pp. 269–78.

Chi, M.T.H. 1978. "Knowledge Structures and Memory Development." In *Children's Thinking: What Develops?* edited by R.S. Siegler. Hillsdale, N.J.: Erlbaum.

Churchman, C.W. 1971. *The Design of Inquiring Systems: Basic Concepts of Systems and Organizations*. New York: Basic Books.

Clayton, V. and Overton, W.F. 1976. "Concrete and Formal Operational Thought Processes in Young Adulthood and Old Age." *International Journal of Aging and Human Development 7*, pp. 237–45.

Coder, R. 1975. "Moral Judgment in Adults." Unpublished Ph.D. dissertation, University of Minnesota.

Colby, A., Kohlberg, L., Gibbs, J. and Lieberman, M. 1983. "A Longitudinal Study of Moral Judgment." *Monographs of the Society for Research in Child Development 48*.

Colby, A. and Kohlberg, L. in press. *The Measurement of Moral Judgment: A Manual and Its Results*. New York: Cambridge Press.

Commons, M.L. and Richards, F.A. 1984a. "A General Model of Stage Theory." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development*, edited by M. Commons, F.A. Richards and C. Armon, pp. 226–34. New York: Praeger.

—— 1984b. "Systematic, Metasystematic and Cross-Paradigmatic Reasoning: A Case for Stages of Reasoning Beyond Formal Operations." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development*, pp. 92–119. New York: Praeger.

Commons, M.L., Richards, F.A. and Armon, C. 1984. *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development.* New York: Praeger.

Commons, M.L., Richards F.A. and Kuhn, D. 1982. "Metasystematic Reasoning: A Case for Levels of Reasoning Beyond Piaget's Stage of Formal Operations." *Child Development 53*, pp. 1058–69.

Crowder, J.W. 1976. "The Defining Issues Test and Correlates of Moral Judgment." Unpublished M.A. Thesis, University of Maryland.

Damon, W. 1977. *The Social World of the Child.* San Francisco: Jossey Bass.

Davison, M.L. 1977. "On a Metric, Unidimensional, Qualitative Unfolding Model for Attitudinal or Developmental Data." *Psychometrika 42*, pp. 523–48.

—— 1979. "Testing a Unidimensional, Qualitative Unfolding Model for Attitudinal or Developmental Data." *Psychometrika 44*, pp. 179–94.

Davison, M.L., King, P.M., Kitchener, K.S. and Parker, C.A. 1980. "The Stage Sequence Concept in Cognitive Social Development." *Developmental Psychology 16*, pp. 121–31.

DeLisi, R. and Staudt, J. 1980. "Individual Differences in College Students' Performance on Formal Operations Task." *Journal of Applied Developmental Psychology 1*, pp. 201–8.

Demetriou, A. and Efklides, A. 1979. "Formal Operational Thinking in Young Adults as a Function of Education and Sex." *International Journal of Psychology 14*, pp. 241–53.

Dewey, J. 1959. *Moral Principle in Education.* New York: Philosophical Library.

Dispoto, R. 1974. "Socio-Moral Reasoning and Environmental Activity Emotionality and Knowledge." Unpublished Ph.D. dissertation, Rutgers University.

Dortzbach, J.R. 1975. "Moral Judgment and Perceived Locus of Control: A Cross-Sectional Developmental Study of Adults, Ages 25–74." Unpublished Ph.D. dissertation, University of Oregon.

Dulit, E. 1972. "Adolescent Thinking à la Piaget: The Formal Stage." *Journal of Youth and Adolescence 1*, pp. 281–301.

Dunker, K. 1945. "On Problem Solving." *Psychological Monograph 58,* Whole No. 270.

Durkheim, E. 1961. *Moral Education.* New York: The Free Press.

Edwards, C.P. 1978. "Social Experiences and Moral Judgment in Kenyan Young Adults." *Journal of Genetic Psychology 133,* pp. 19–30.

El-Gosbi, A.M. 1982. "A Study of the Understanding of Science Processes in Relation to Piaget Cognitive Development at the Formal Level, and other Variables Among Prospective Teachers and College Science Majors." Ph.D. dissertation, Universtiy of North Carolina. *Dissertation Abstracts International 43*, 1914A.

Elkind, D. 1962. "Quantity Conceptions in College Students." *Journal of Social Psychology 57*, pp. 459–65.

Ellis, W.T. 1978. "Piagetian Development Level and Sex-Role Identification as Factors in Problem-Solving Performance and Cognitive Style." Ph.D. dissertation, Southern Illinois University. *Dissertation Abstracts International, 38,* 6008A.

El-Sowygh, H.I.Z. 1982. "Performance of a Piagetian Test by Saudi Arabian Students in Colorado Colleges and Universities in Relation to Selected Sociodemographic and Academic Data." Ph.D. dissertation, University of New Mexico. *Dissertation Abstracts International 42*, 3532A-3533A.

Engels, F. 1940. *Dialectics of Nature.* New York: International Publishers.

Ennis, R.H. 1975. "Children's Ability to Handle Piaget's Propositional Logic: A Conceptual Critique." *Review of Educational Research 45*, pp. 1–41.

—— 1976. "An Alternative to Piaget's Conceptualization of Logical Competence." *Child Development 47*, pp. 903–19.

Ericsson, L.A., Chase, W.G. and Faloon, S. 1980. "Acquisition of a Memory Skill." *Science 208*, pp. 1181–82.

Erikson, E.H. 1958. *Young Man Luther*. New York: Norton.

—— 1969. *Gandhi's Truth*. New York: Norton.

Eysenck, H.J. 1976. "The Biology of Morality." In *Moral Development and Behavior*, edited by T. Lickona. New York: Holt, Reinhart & Winston.

Falmagne, R.J. 1975. "Deductive Processes in Children." In *Reasoning: Representation and Process in Children and Adults*. Hillsdale, N.J.: Erlbaum.

—— 1980. "The Development of Logical Competence: A Psycholinguistic Perspective." In *Developmental Models of Thinking*, edited by R. Kluwe and H. Spada. New York: Academic Press.

Feldman, D.H. 1980. *Beyond Universals in Cognitive Development*. Norwood, N.J.: Ablex.

Feuerstein, R. 1979. *The Dynamic Assessment of Retarded Performers: The Learning Potential Assessment Device, Theory, Instruments, and Techniques*. Baltimore: University Park Press.

Feyerabend, P. 1975. *Against Method: Outline of an Anarchist Theory of Knowledge*. London: NLB.

Fischer, K.W. 1980. "A Theory of Cognitive Development: The Control and Construction of Hierarchies of Skills." *Psychological Review 87*, pp. 477–531.

Fischer, K.W. and Bullock, D. 1981. "Patterns of Data: Sequence, Synchrony, and Constraint in Cognitive Development." In *Cognitive Development*, edited by K.W. Fischer, In *New Directions for Child Development*, No. 12. San Francisco: Jossey Bass.

—— 1984. "Cognitive Development in Middle Childhood: Conclusions and New Directions." In *Development During Middle Childhood: The Years from Six to Twelve*, edited by W.A. Collins, pp. 70–146. Washington, D.C.: National Academy Press.

Fischer, K.W., Hand, H.H. and Russell, S.L. 1984. "The Development of Abstractions in Adolescence and Adulthood." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development*, edited by M.L. Commons, F.A. Richards, and C. Armon. New York: Praeger.

Fischer, K.W. and Pipp, S.L. 1984. "Process of Cognitive Development: Optimal Level and Skill Acquisition." In *Mechanisms of Cognitive-Development*, edited by R. Sternberg. San Francisco: W.H. Freeman.

Fischer, K.W., Pipp, S.L. and Bullock, D. 1984. "Detecting Discontinuities in Development: Method and Measurement." In *Continuities and Discontinuities in Development*, edited by R. Harmon and R. Emde. New York: Plenum.

Fischer, K.W. & Silvern, L. in press. "Stages and Individual Differences in Cognitive Development." *Annual Review of Psychology.*

Flavell, J.H. 1963. *The Developmental Psychology of Jean Piaget*. New York: Van Nostrand.

—— 1970. "Cognitive Changes in Adulthood." In *Life-Span Developmental Psychology: Research and Theory*, edited by L.R. Goulet and P.B. Baltes. New York: Academic Press.

—— 1971. "Stage Related Properties of Cognitive Development." *Cognitive Psychology 2*, pp. 421–53.

—— 1977. *Cognitive Development*. Englewood Cliffs, N.J.: Prentice-Hall.

—— 1979. "Metacognition and Cognitive Monitoring." *American Psychologist 34*, pp. 906–11.

—— 1982. "Structures, Stages, and Sequences in Cognitive Development." In *Minnesota*

*Symposium on Child Psychology*, edited by W.A. Collins. Hillsdale, N.J.: Erlbaum.

Flavell, J.A. and Markman, E.M. 1983. "Preface to Volume 3." In *Cognitive Development*, edited by J.A. Flavell and E.M. Markman. New York: Wiley.

Flavell, J.H. and Wohlwill, J.F. 1969. "Formal and Functional Aspects of Cognitive Development." In *Studies in Cognitive Development: Essays in Honor of J. Piaget*, edited by D. Elkind and J. Flavell. New York: Oxford University Press.

Fowler, J.W. 1981. *Stages of Faith*. New York: Harper-Row.

Gallagher, J.M. and Reid, D.K. 1981. *The Learning Theory of Piaget and Inhelder*. Monterey: Brooks/Cole.

Gallia, T.J. 1976. "Moral Reasoning in College Science and Humanities Students: Summary of a Pilot Study." Unpublished manuscript, Glassboro State College.

Galton, F. 1883. *Inquiries Into Human Faculty*. London: Macmillan.

Gardner, H. 1983. *Frames of Mind, The Theory of Multiple Intelligence*. New York: Basic Books.

Gardner, H. and Lohman, W. 1975. "Children's Sensitivity to Literary Styles." *Merrill-Palmer Quarterly 21*, pp. 113–26.

Getzels, J.W. 1964. "Creative Thinking, Problem Solving and Instruction." In *The Sixty-Third Yearbook of The National Society for the Study of Education: Theories of Learning and Instruction*, edited by E. Hilgard. Chicago: University of Chicago Press.

Getzels, J.W. and Csikszentmihalyi, M. 1965. *Creative Thinking in Art Students: An Exploratory Study*. U.S. Office of Education Cooperative Research Report S-080. Chicago: University of Chicago Press.

—— 1976. *The Creative Vision : A Longitudinal Study of Problem Finding in Art*. New York: Wiley.

Gibbs, J.C. and Widamon, K.F. 1982. *Social Intelligence: Measuring The Development of Sociomoral Reflection*. Englewood Cliffs, N.J.: Prentice-Hall.

Gilligan, C. 1978. "In a Different Voice: Women's Conception of the Self and Morality." *Harvard Educational Review 7*, pp. 481–517.

—— 1982. *In a Different Voice: Psychological Theory and Women's Development*. Cambridge, Mass.: Harvard University Press.

Gilligan, C. and Murphy, M. 1979. "Development From Adolescence to Adulthood: The Philosopher and the Dilemma of the Fact." In *Intellectual Development Beyond Childhood*, edited by D. Kuhn. In *New Directions for Child Development*, No. 5. San Francisco: Jossey Bass.

Glaserfeld, E. von and Kelley, M.F. 1982. "On the Concepts of Period, Phase, Stage and Level." *Human Development 25*, pp. 152–60.

Glatfelter, M. 1982. *Identity Development, Intellectual Development, and Their Relationship in Reentry Women Students*. Ph.D. dissertation, University of Minnesota.

Globerson, T. in press. "When Do Structural Changes Underlie Stage Changes: The Case of Mental-Capacity Growth." In *Stage and Structure in Development*, edited by I. Levin and S. Strauss. Norwood, N.J.: Ablex.

Goldiamond, I. 1968. "Moral Development: A Functional Analysis." *Psychology Today 2*, pp. 31-70.

Goolishian, H.W. 1981. "Identification and Treatment of Piaget's Cognitive Levels in a Community College Population." Ph.D. dissertation, University of Massachusetts. *Dissertation Abstracts International, 42*, 1058A.

Gould, C. 1978. *Marx's Social Ontology*. Cambridge, Mass.: MIT Press.

Gruber, H.E. 1973. "Courage and Cognitive Growth in Children and Scientists." In *Piaget in the Classroom,* edited by M. Schwebel and J. Raph. New York: Basic Books.

—— 1978. "Darwin's 'Tree of Nature' and Other Images of Wide Scope." In *On Aesthetics in Science,* edited by J. Wechsler. Cambridge, Mass.: MIT Press.

—— 1981. *Darwin On Man: A Psychological Study of Scientific Creativity.* (2nd ed.) Chicago: University of Chicago Press.

—— 1982. "On the Hypothesized Relation Between Giftedness and Creativity." In *Developmental Approaches to Giftedness and Creativity,* edited by D.H. Feldman. San Francisco: Jossey Bass.

—— 1984. "The Emergence of a Sense of Purpose: A Cognitive Case Study of Young Darwin." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development,* edited by M.L. Commons, F.A. Richards, and C. Armon. New York: Praeger.

Gruber, H. & Vonèche, J.J. 1976. "Reflexions sur les opérations formelles de la pensée." *Archives de psychologie 44,* pp. 45–55.

—— 1977. *The Essential Piaget.* New York: Basic Books.

Guilford, J.P. 1959. "Three Faces of Intellect." *American Psychologist,* 14, pp. 469–79.

—— 1967. *The Nature of Human Intelligence.* New York: McGraw-Hill.

Haan, N. 1978. "Two Moralities in Action Contexts: Relationships To Thought, Ego Regulation, and Development." *Journal of Personality and Social Psychology 30,* pp. 286–305.

Hand, H.H. 1981. "The Relation Between Developmental Level and Spontaneous Behavior: The Importance of Sampling Contexts." In *Cognitive Development,* edited by K.W. Fischer. In *New Directions For Child Development,* No 12. San Francisco: Jossey Bass.

Hand, H.H. and Fischer, K.W. 1981. "The Development of Concepts of Intentionality and Responsibility in Adolescence." Paper presented at the Sixth Biennial Meeting of the International Society for the Study of Behavioral Development. Toronto, Canada: August.

Hargrove, R.D. 1977. "A Study of the Relationship Between Piagetian Cognitive Developmental Level and Reading Comprehension in College Science Students." Ph.D. dissertation, Rutgers University. *Dissertation Abstracts International, 37,* 7661A.

Harvey, O.J., Hunt, D.E. and Schroder, H.M. 1961. *Conceptual Systems and Personality Organization.* New York: Wiley.

Hayes, A.B. 1981. "An Investigation of the Effect of Dilemma Content on Level of Reasoning in the Reflective Judgment Interview." Ph.D. dissertation, University of Utah.

Hegel, G.W.F. 1965. *The Philosophy of Right* (translated by T.M. Knox), *The Philosophy of History* (translated by J. Sbree). In *Great Books of the Western World,* Vol. 46. Chicago: Encyclopedia Britannica.

Hiley, D.R. 1979. "Relativism, Dogmatism and Rationality." *International Philosophical Quarterly,* 1984.

Hill, G.L.G. 1981. "Piagetian Cognitive Developmental Level, Receptive Language Processing and Visuospatial Skills Among Learning Disabled and Nonlearning Disabled College Students." Ph.D. dissertation, University of South Carolina.

*Dissertation Abstracts International, 41,* 3490A.

Hoffman, M.L. 1977. "Empathy, Its Development and Prosocial Implications." In *Nebraska Symposium on Motivation,* Vol 25, edited by C. Keasey. Lincoln: University of Nebraska Press.

Honzik, M.P. and McFarlane, J.W. 1973. "Personality Development and Intellectual Functioning from 21 Months to 40 Years." In *Intellectual Functioning in Adults,* edited by C. Eisdorfer and J.E. Blum. New York: Springer.

Horn, J.L. 1976. "Human Abilities: A Review of Research and Theory in the Early 1970s." *Annual Review of Psychology, 27,* pp. 437–86.

—— 1982. "The Aging of Human Abilities." In *Handbook of Developmental Psychology,* edited by B.B. Wolman. Englewood Cliffs, N.J.: Prentice-Hall.

Horz, H., Poltz, H., Parthey, H., Rosenbert, U. and Wessel, K. 1980. *Philosophical Problems in Physical Science.* Minneapolis: Marxist Educational Press.

Inhelder, B. and Piaget, J. 1958. *The Growth of Logical Thinking From Childhood to Adolescence.* London: Routledge & Kegan Paul.

Jameson, F. 1971. *Marxism and Form: 20th Century Dialectical Theories of Literature.* Princeton: Princeton University Press.

Jaques, E., Gibson, R.O. and Isaac, D.J. 1978. *Levels of Abstraction in Logic and Human Action.* London: Heinemann.

Jay, M. 1973. *The Dialectical Imagination.* Boston: Little, Brown & Co.

Jones, E. 1957. *The Life and Work of Sigmund Freud,* Vol. 3. New York: Basic Books.

Kahn, M.K. 1979. *Creation of Computer Animation from Story Descriptions.* Unpublished Ph.D. dissertation, MIT.

Karmiloff-Smith, A. and Inhelder, V. 1974. "If You Want to Get Ahead, Get a Theory." *Cognition 3,* pp. 195–212.

Kaseman, T.C. 1980. *A Longitudinal Study of Moral Development of The West Point Class of 1981.* West Point, NY: Department of Behavioral Sciences and Leadership, U.S. Military Academy.

Keating, D.P. 1980. "Thinking Processes in Adolescence." In *Handbook of Adolescent Development,* edited by J. Adelson, pp. 211–46. New York: Wiley.

Kegan, R.G. 1982. *The Evolving Self.* Cambridge, Mass.: Harvard University Press.

Keller, E.F. 1983. *A Feeling for the Organism: The Life Work of Barbara McClintock.* San Francisco: Freeman.

Kenny, S.L. 1983. "Developmental Discontinuities in Childhood and Adolescence." In *Levels and Transitions in Children's Development,* edited by K.W. Fischer. *New Directions for Child Development,* No. 21. San Francisco: Jossey Bass.

Kilminster, R. 1979. *Praxis and Method: A Sociological Dialogue with Lukacs, Gramsci, and the Early Frankfurt School.* London: Routledge & Kegan Paul.

King, P.M. 1978. "The Development of Reflective Judgment and Formal Operational Thinking in Adolescents and Young Adults." Ph.D. dissertation, University of Minnesota. *Dissertation Abstracts International 38,* 7233A.

—— 1983. *Reflective Judgment Questionnaire.* Technical Report #1. Bowling Green State University.

King, P.M. and Kitchener, K.S. 1984. "Reflective Judgment Theory and Research: Insights into the Process of Knowing in the College Years." Unpublished manuscript.

King, P.M., Kitchener, K.S., Davison, M.L., Parker, C.A. and Wood, P.K. 1983. "The Justification of Beliefs in Young Adults: A Longitudinal Study." *Human Development 26,* pp. 106–16.

King, P.M. and Parker, C.A. 1978. "Assessing Intellectual Development in the College Years." A report of the Instructional Improvement Project, 1976–1977. Unpublished manuscript, University of Minnesota.

Kitchener, K.S. 1978. "Intellectual Development in Late Adolescents and Young Adults: Reflective Judgment and Verbal Reasoning." Ph.D. dissertation, University of Minnesota.

—— 1983a. "Cognition, Metacognition and Epistemic Cognition: A Three-Level Model of Cognitive Processing." *Human Development 4,* pp. 222–32.

—— 1983b. "Educational Goals and Contemporary Models of Reflective Thinking." *Educational Forum 48,* pp. 75–95.

—— 1983c. "Human Development and the College Campus: Sequences and Tasks." In *Measuring Student Development,* edited by G.R. Hanson. *New Directions for Student Services.* San Francisco: Jossey Bass.

Kitchener, K.S. and King, P.M. 1981. "Reflective Judgment: Concepts of Justification and Their Relationship to Age and Education." *Journal of Applied Developmental Psychology 2,* pp. 89–116.

Kitchener, K.S., King, P.M., Davison, M., Parker, C. and Wood, P. in press. "A Longitudinal Study of Moral and Ego Development in Young Adults." *Journal of Youth and Adolescence.*

Kitchener, K.S., King, P.M. and Wood, P.K. 1984. "A Longitudinal Study of Epistemic Cognition in Young Adults." A paper presented at the American Psychological Association meeting, Toronto, Canada.

Kitchener, K.S. and Kitchener, R.F. 1981. "The Development of Natural Rationality: Can Formal Operations Account For It?" In *Social Development in Youth: Structure and Content,* edited by J.A. Meecham and N.R. Santelli. Basel: Karger.

Kitchener, K.S. and Wood, P.K. 1984. "Development of Concept of Justification in German University Students." Unpublished manuscript.

Kohlberg, L. 1969. "Stage and Sequence: The Cognitive-Developmental Approach to Socialization." In *Handbook of Socialization Theory and Research,* edited by D. Goslin. Chicago: Rand McNally.

—— 1973. "Collected Papers on Moral Development and Moral Education." Cambridge, Mass.: Moral Education & Research Foundation.

—— 1971. "Continuities in Childhood and Adult Moral Development Revisited." In *Life-Span Development Psychology: Personality and Socialization,* edited by P.B. Baltes and K.W. Schaie. New York: Academic Press.

—— 1980. "High School Democracy and Educating for A Just Society." In *Moral Education: A First Generation of Research and Development,* edited by R.L. Mosher. New York: Praeger.

Kohlberg, L. and Armon, C. 1984. "Three Types of Stage Models Used in the Study of Adult Development." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development,* edited by M. Commons, F. Richards and C. Armon. New York: Praeger.

Kosok, M. 1972. "The Formalization of Hegel's Dialectical Logic." In *Hegel: A Collection of Critical Essays,* edited by A. MacIntyre. Garden City, N.Y.: Anchor.

Kramer, D.A. 1983. "A Post-Formal Operations? A Need For Further Conceptualization." *Human Development 44,* pp. 45–55.

Krebs, R.L. 1967. "Some Relations Between Moral Judgment, Attention, and Resistance to Temptation." Unpublished Ph.D. dissertation, University of Chicago.

Kuhn, D. and Brannock, J. 1977. "Development of the Isolation of Variables Scheme in Experimental and 'Natural Experiment' Contexts." *Developmental Psychology 13*, pp. 9–14.

Kuhn, D. and Ho, V. 1980. "Self-Directed Activity and Cognitive Development." *Journal of Applied Developmental Psychology 1*, pp. 119–33.

Kuhn, D., Langer, J., Kohlberg, L. and Haan, N.S. 1977. "The Development of Formal Operations in Logical and Moral Judgment." *Genetic Psychology Monographs 95*, pp. 97–188.

Kuhn, T.S. 1962. "The Structure of Scientific Revolutions." In *International Encyclopedia of Unified Science*, vol. 2 no.2. Chicago: University of Chicago Press.

—— 1970. *The Structure of Scientific Revolutions*, 2nd ed. Chicago: University of Chicago Press.

Labouvie-Vief, G. 1982. "Dynamic Development and Mature Autonomy: A Theoretical Prologue." *Human Development 25*, pp. 91–105.

Lakatos, I. 1978. *The Methodology of Scientific Research Programs.* Cambridge: Cambridge University Press.

Lawrence, J.A. 1977. "Review and Rationale for Moral Judgment Process Research Using the Defining Issues Test and the Stimulated Recall Techniques." Unpublished manuscript, University of Minnesota.

Lawson, J.M. 1980. "The Relationship Between Graduate Education and the Development of Reflective Judgment: A Function of Age or Educational Experience." Ph.D. dissertation, University of Minnesota.

Leiser, D. 1982. "Piaget's Logical Formalism for Formal Operations: An Interpretation in Context." *Developmental Review 2*, pp. 87–99.

Loevinger, J. 1976. *Ego Development: Conceptions and Theories.* San Francisco: Jossey Bass.

London, P. 1970. "The Rescuers: Motivational Hypotheses About Christians Who Saved Jews From the Nazis." In *Altruism and Helping Behavior*, edited by J. Macaulay and E.L. Berkowitz. New York: Academic Press.

Lovell, K. 1961. "A Follow-up Study of Inhelder and Piaget's 'The Growth of Logical Thinking.' " *British Journal of Psychology 52*, pp. 143–53.

Mackworth, N.H. 1965. "Orginality." *American Psychologist 20*, pp. 51–56.

Magaña, H.A. 1982. "An Evaluation of the Differential Impact of a Developmental Curriculum on Students with Varying Personality Profiles." In *Character Development in College Students*, edited by J.M. Whiteley, Schenectady, N.Y.: Character Research Press.

Mandel, E. 1973. *An Introduction to Marxist Economic Theory.* New York: Pathfinder Press.

Maqsud, M. 1977. "The Influence of Social Heterogeneity and Sentimental Credibility on Moral Judgments of Nigerian Muslim Adolescents." *Journal of Cross-Cultural Psychology 8*, pp. 113–22.

Martarano, S.C. 1977. "A Developmental Analysis of Performance on Piaget's Formal Operations Tasks." *Developmental Psychology 13*, pp. 666–72.

Maruyama, M. 1963. "The Second Cybernetics: Deviation-Amplifying Mutual Causal Processes." *American Scientist 51*, pp. 164–79 and 250–56.

Marx, K. 1967. "Writings of the Young Marx on Philosophy and Society." edited by L.D. Easton and K.H. Guddat. Garden City: Anchor.

Marx, K. and Engels, F. 1955. *The Communist Manifesto.* New York: Appleton-Centu Crofts.

McCall, R.D., Eichorn, D.H. and Hogarty, P.S. 1977. "Transitions in Early Mer Development." *Monographs of the Society for Research in Child Development*

McCall, R.B., Meyers, E.D. Jr., Hartman, J. and Roche, A.F. 1983. "Developmer Changes in Head Circumferences and Mental Performance Growth Rates: A Test Epstein's Phrenoblysis Hypothesis." *Developmental Psychobiology 16,* pp. 457–

McGeorge, C. 1977. "Some Correlates of Principled Moral Thinking in Young Adult *Journal of Moral Education.*

Meecham, J. 1983. "Wisdom and the Contest of Knowledge: Knowing That One Does Know." In *On The Development of Developmental Psychology,* edited by K. Ku and J.A. Meecham. Basel: Karger.

Mentkowski, M. and Strait, M.J. 1983. "A Longitudinal Study of Student Change Cognitive Development and Generic Abilities in an Outcome-Centered Liberal A Curriculum." Final report to the National Institute of Education.

Merton, R.S. 1945. "Sociology of Knowledge." In *Twentieth Century Sociology,* edi by G. Gurvitch and W.E. Moore. New York: Philosophical Library.

Miller, G.A., Galanter, E. and Pribam, K.H. 1960. *Plans and the Structure of Behavi* New York: Holt, Rinehart & Winston.

Mines, R.A. 1980. "Levels of Intellectual Development and Associated Critical Think Skills in Young Adults." Ph.D. dissertation, University of Iowa.

—— 1982. "Student Development Assessment Techniques." In *Measuring Stud Development,* edited by G.R. Hanson. San Francisco: Jossey Bass.

Minsky, M. 1977. "Game-System Theory." In *Thinking: Readings in Cognitive Scien* edited by P.W. Johnson-Laird and P.C. Wason. Cambridge: Cambridge Univers Press.

Mischel, W. and Mischel, H. 1976. "A Cognitive Social-Learning Approach to Mora and Self-Regulation." In *Moral Development and Behavior,* edited by T. Licko New York: Holt, Rinehart & Winston.

Mortorano, S. 1975. "Formal Operations Thinkings: Now You See It, Now You Don' Paper presented at the Society for Research in Child Development Conventi Denver, Colorado.

Moshman, O. 1979. "Development of Formal Hypothesis-Testing Ability *Developmental Psychology 15,* pp. 104–12.

Muhs, P.J., Hooper, F.H. and Papalia-Finlay, D. 1980. "Cross-Sectional Analysis Cognitive Functioning Across the Life-Span." *International Journal of Aging a Human Development 10,* pp. 311–33.

Murphy, J.M. and Gilligan, C. 1980. "Moral Development in Late Adolescence a Adulthood: A Critique and Reconstruction of Kohlberg's Theory." *Hum Development 23,* pp. 77–104.

Neimark, E.D. 1975a. "Intellectual Development During Adolescence." In *Review Child Development Research,* edited by F.D. Horowitz. Chicago: University Chicago Press.

—— 1975b. "Longitudinal Development of Formal Operations Thought." *Gene Psychology Monographs 91,* pp. 171–225.

—— 1979. "Current Status of Formal Operations Research." *Human Development* pp. 60–67.

Neisser, U. 1976. "General, Academic and Artificial Intelligence." In *The Nature of Intelligence,* edited by L.B. Resnick. Hillsdale, N.J.: Erlbaum.

Nessleroade, J.R. and Baltes, P.B. 1974. "Adolescent Personality Development and Historical Change—1970–1972." *Monographs of the Society for Research in Child Development 39.*

Newell, A., Shaw, J.C. and Simon, H.A. 1962. "The Processes of Creative Thinking." In *Contemporary Approaches to Creative Thinking,* edited by H.E. Gruber, G. Terrell and M. Wertheimer. New York: Atherton.

Nisbett, R.E. and Wilson T.D. 1977. "Telling More Than We Can Know: Verbal Reports on Mental Processes." *Psychological Review 84,* pp. 231–59.

O'Brien, D. and Overton, W.F. 1982. "Conditional Reasoning and the Competence-Performance Issue: A Developmental Analysis of a Training Task." *Journal of Experimental Child Psychology 34,* pp. 274–90.

Ollman, B. 1971. *Alienation.* Cambridge: Cambridge University Press.

Olson, D., Basseches, M. and Richards, F.A. 1981. "Dialectical Thinking as a Post-Formal Operational Level of Cognitive Organization: The Development of a Comprehensive and Preference Instrument." Unpublished research report, Cornell University.

Overton, W.F. 1984. "World Views and Their Influence on Psychological Theory and Research: Kuhn-Lakatos-Lauden." In *Advances in Child Development and Behavior,* edited by H.W. Reese. New York: Academic Press.

Parete, J.D. 1979. "Formal Reasoning Abilities of College Age Students: An Investigation of the Concrete and Formal Reasoning Stages Formulated by Jean Piaget." Ph.D. dissertation, Ohio State University. *Dissertation Abstracts International 39,* 6006A.

Perkins, D.N. 1981. *The Mind's Best Work.* Cambridge, Mass.: Harvard University Press.

Perry, W.G. 1970. *Forms of Intellectual and Ethical Development in the College Years.* New York: Holt, Rinehart & Winston.

Piaget, J. 1941. "Le Mécanisme du Développement Mental et les Lois du Groupement des Opérations." *Archives de Psychologie, Geneve 28,* pp. 215–85.

—— 1952. *The Origins of Intelligence in Children.* New York: Norton.

—— 1953. *Logic and Psychology.* Manchester, U.K.: Manchester University Press.

—— 1957. "Logique et Equilibre Dans les Comportements de Sujet." *Etudes d'Epistemologie Genetique 2,* pp. 27–118.

—— 1955. *The Moral Judgment of the Child.* Translated by M. Gabain. New York: The Free Press. Originally published, 1932.

—— 1970. *Piaget's Theory.* In *Carmichael's Manual of Child Development, Vol. 1,* edited by R.H. Mussen. New York: Wiley.

—— 1971. *Biology and Knowledge.* Chicago: University of Chicago Press. Originally published, 1967.

—— 1972. "Intellectual Evolution From Adolescence to Adulthood." *Human Development 15,* pp. 1–12.

—— 1978. *The Development of Thought.* Oxford: Blackwell.

Piaget, J. and Inhelder, B. 1969. *The Psychology of the Child.* New York: Basic Books.

Podgoretskaya, N.A. 1979. "A Study of Spontaneous Logical Thinking in Adults." *Soviet Psychology 17,* pp. 70–84.

Polkinghorne, D.E. 1983. *Methodology for The Human Sciences: Systems of Inquiry.* Albany, N.Y.: State University of New York Press.

Popper, K. 1959. *The Logic of Scientific Discovery.* New York: Basic Books.

—— 1963. *Conjectures and Refutations: The Growth of Scientific Knowledge.* New York: Harper & Row.

Provine, W. 1971. *The Origins of Theoretical Population Genetics.* Chicago: University of Chicago Press.

Rawls, J. 1971. *A Theory of Justice.* Cambridge, Mass.: Harvard University Press.

Rest, J. 1973. "Patterns and Preferences in Moral Judgment." *Journal of Personality 41,* pp. 86–109.

—— 1975. "Longitudinal Study of the Defining Issues Test: A Strategy for Analyzing Developmental Change." *Developmental Psychology 11,* pp. 738–48.

—— 1977. "Development in Moral Reasoning, Liberal-Conservative Ideology, and Conceptualizing Politics." Unpublished manuscript, Stanford University.

—— 1979a. *Development in Judging Moral Issues.* Minneapolis: University of Minneapolis.

—— 1979b. "The Impact of Higher Education on Moral Judgement Development." Minnesota Moral Research Project (330 Burton Hall, University of Minnesota, Minneapolis, MN 55455).

—— 1979c. "Revised Manual for the Defining Issues Test." Minnesota Moral Research Project.

—— 1981. "The Impact of Higher Education on Moral Judgment Education." Paper presented at the convention of the American Educational Research Association, Los Angeles, April.

—— 1983. "Morality." In *Cognitive Development,* edited by J.H. Flavell. In *Handbook of Child Psychology,* edited by P.H. Mussen, New York: Wiley.

Rest, J.R., Cooper, D., Coder, R., Masanz, J. and Anderson, D. 1974. "Judging the Important Issues in Moral Dilemmas—An Objective Test of Development." *Developmental Psychology 10,* pp. 491–501.

Richards, F.A. and Commons, M.L. 1984. "Systematic, Metasystematic, and Cross-Paradigmatic Reasoning: A Case for Stages of Reasoning Beyond Formal Operations." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development.* New York: Praeger.

Riegel, K.F. 1973. "Dialectic Operations: The Final Period of Cognitive Development." *Human Development 16,* pp. 346–70..

Roberge, J.J. and Flexer, B.K. 1979. "Further Examination of Formal Operational Reasoning Abilities." *Child Development 50,* pp. 478–84.

Ross, R.J. 1973. "Some Empirical Parameters of Formal Thinking." *Journal of Youth and Adolescence 2,* pp. 167–77.

Sakalys, J.A. 1982. "Effects of a Research Methods Course on Nursing Students' Research Attitudes and Cognitive Development." Ph.D. dissertation, University of Denver.

Schmidt, J.A. 1983. "The Intellectual Development of Traditionally and Nontraditionally Aged College Students: A Cross-Sectional Study with Longitudinal Follow-up." Ph.D. dissertation, University of Minnesota.

Schomberg, S.F. 1975. "Some Personality Correlates of Moral Maturity Among Community College Students." Unpublished manuscript, University of Minnesota.

Schon, D. 1963. *The Displacement of Concepts.* Cambridge: Tavistock Press.

Schroeder, H., Driver, J. and Steufert, S. 1967. *Human Information Processing.* New

York: Holt, Rinehart & Winston.

Schwartz, S.H. 1977. "Normative Influences on Altruism." In *Advances in Experimental Social Psychology, Vol.10,* edited by L. Berkowitz. New York: Academic Press.

Schwebel, M. 1972. *Logical Thinking in College Freshmen.* Final Report, Project No O-B-105 (Grant No OEG-2-7-0039, 509).

—— 1975. "Formal Operations in First-Year College Students." *The Journal of Psychology 91,* pp. 133–41.

Selman, R.L. 1980. *The Growth of Interpersonal Understanding.* New York: Academic Press.

Shaklee, H. 1979. "Bounded Rationality and Cognitive Development: Upper Limits on Growth?" *Cognitive Psychology 11,* pp. 327–45.

Shantz, C.U. 1983. "Social Cognition." In *Cognitive Development,* edited by J.H. Flavell and E.M. Markman, in *Handbook of Child Psychology, 4th ed.,* edited by P.H. Mussen. New York: Wiley.

Sheehan, N.W. 1977. "An Examination of Selected Performance Factors and Correlates of Piagetian Logical Functioning in Elderly Women." Ph.D. dissertation, University of Wisconsin-Madison. *Dissertation Abstracts International 37,* 4656B-4657B.

Shoff, S.P. 1979. "The Significance of Age, Sex, and Type of Education on the Development of Reasoning in Adults." Ph.D. dissertation, University of Utah.

Siegler, R.S. 1976. "Three Aspects of Cognitive Development." *Cognitive Psychology 8,* pp. 481–520.

Simon, H.A. 1957. *Models of Man.* New York: Wiley.

—— 1978. "Information-Processing Theory of Human Problem Solving." In *Handbook of Learning and Cognitive Processes, Vol. 5: Human Information Processing,* edited by W.K. Estes. Hillsdale, N.Y.: Erlbaum.

—— 1979. "Information Processing Models of Cognition." *Annual Review of Psychology 30,* pp. 363–96.

Sinclair, H. 1977. "Recent Developments in Genetic Epistemology." *The Genetic Epistemologist: Quarterly Newsletter of the Jean Piaget Society 6,* pp. 1–3.

Sinnott, J.D. 1975. "Everyday Thinking and Piagetian Operativity in Adults." *Human Development 18,* pp. 430–43.

—— 1981. "The Theory of Relativity: A Metatheory for Development?" *Human Development 24,* pp. 293–311.

—— 1984. "Post-Formal Reasoning: The Relativistic Stage." In *Beyond Formal Operations: Late Adolescent and Adult Cognitive Development,* edited by M.L. Commons, F.A. Richards and C. Armon. New York: Praeger.

Sinnott, J.D. and Guttmann, D. 1978. "Piagetian Logical Abilities and Older Adults' Abilities to Solve Everyday Problems." *Human Development 21,* pp. 327–33.

Slovic, P., Fischoff, M. and Lichtenstein, S. 1977. "Behavioral Decision Theory." *Annual Review of Psychology 28,* pp. 1–39.

Smith, A. 1937. *An Inquiry into the Nature and Causes of the Wealth of Nations.* New York: Modern Library.

Spearman, C.E. 1927. *The Nature of Intelligence and the Principles of Cognition.* London: Macmillan.

Spelke, E., Hirst, W. and Neisser, U. 1976. "Skills of Divided Attention." *Cognition 4,* pp. 215–30.

Staub, E. 1978, 1979. *Positive Social Behavior and Morality, Vol. I and II.* New York: Academic Press.

Sternberg, R.J. and Davidson, J.E. 1983. "Insight in the Gifted." *Educational Psychology 18,* pp. 51-57.

Stone, C.A. and Day, M.C. 1978. "Levels of Availability of a Formal Operational Strategy." *Child Development 49,* pp. 1054–65.

Strange, C.C. 1978. "Intellectual Development, Motive for Education, and Learning Styles During the College Years: A Comparison of Adult and Traditionally Age College Students." Ph.D. dissertation, University of Iowa.

Strange, C.C. and King, P.M. 1981. "Intellectual Development and Its Relationship to Maturation During the College Years." *Journal of Applied Developmental Psychology 2,* pp. 281–95.

Suppe, F. 1977. "The Search for Philosophical Understanding of Scientific Theories." In *Structure of Scientific Theories,* edited by F. Suppe. Chicago: University of Illinois.

Terman, L.M. 1973. *Concept Mastery Test Manual.* New York: Psychological Corporation.

Thoma, S.J. and Davison, M.L. 1983. "Moral Reasoning Development in Graduate Eduation." *Journal of Applied Developmental Psychology 4,* pp. 227–38.

Thurston, L.L. 1936. *Primary Mental Abilities.* Chicago: University of Chicago Press.

Tomlinson-Keasey, C. 1972. "Formal Operations in Females From Eleven to Fifty-Four Years of Age." *Developmental Psychology 6,* p. 364.

Tomlinson-Keasey, C. and Keasey, G.B. 1974. "The Mediating Role of Cognitive Development in Moral Judgment." *Child Development 45,* pp. 291–99.

Turiel, E. 1969. "Developmental Processes in the Child's Moral Thinking." In *Trends and Issues in Developmental Psychology,* edited by P. Mussen, J. Langer and E. Covington. New York: Holt, Rinehart & Winston.

Volker, J. 1980. *Moral Reasoning and College Experience.* Unpublished M.A. thesis, University of Minnesota.

—— 1984. *Moral Sensitivity in Counseling-Psychology Students.* Ph.D. dissertation, University of Minnesota.

Vu, N.V. 1978. "Piaget's Formal Operations and the Acquisition of the Probability and Correlation Concepts of Graduate Students." Ph.D. dissertation, Southern Illinois University. *Dissertation Abstracts International 38,* 6030A–6031A.

Waddington, C.H. 1957. *The Strategy of the Genes.* London: Allen & Unwin.

Wechsler, D. 1958. *The Measurement and Appraisal of Adult Intelligence.* Baltimore: Williams & Wilkins.

Welfel, E.R. 1982. "How Students Make Judgments: Do Educational Level and Academic Major Make a Difference?" *Journal of College Student Personnel 23,* pp. 430–97.

Welfel, E.R. and Davison, M.L. 1983. "Four Years Later: A Longitudinal Study of the Development of Reflective Judgment During The College Years." Unpublished manuscript.

Werner, H. 1957. "The Concept of Development From a Comparative and Organismic Point of View." In *The Concept of Development,* edited by D.B. Harris. Minneapolis: University of Minnesota.

Wertheimer, M. 1945. *Productive Thinking.* New York: Harper & Row.

Westfall, R.S. 1980a. *Never At Rest: A Biography of Isaac Newton.* Cambridge:

Cambridge University Press.

—— 1980b. "Newton's Marvelous Years of Discovery and Their Aftermath: Myth versus Manuscript." *Isis 71,* pp. 109–21.

White, K.M. and Ferstenberg, A. 1978. "Professional Specialization and Formal Operations: The Balance Task." *The Journal of Genetic Psychology 133,* pp. 97–104.

Whitehead, A.N. and Russell, B. 1925–1927. *Principia Mathematica.* Cambridge: Cambridge University Press.

Whiteley, J. 1982. *Character Development in College Students.* Schenectady, N.Y.: Character Education Press.

Wilson, E.O. 1975. *Sociobiology: The New Synthesis.* Cambridge, Mass.: Harvard University Press, Belknap Press.

Wittkower, R. and Wittkower, M. 1963. *Born Under Saturn: The Character and Conduct of Artists, A Documented History from Antiquity to the French Revolution.* New York: Norton.

Wohlwill, J. 1973. *The Study of Behavioral Development.* New York: Academic Press.

Wood, P.K. 1983. "Inquiring Systems and Problem Structure: Implications for Cognitive Development." *Human Development 26,* pp. 249–65.

Woodward, C. in preparation. "The Aesthetic of Science: Robert B. Woodward, Organic Chemist." In *Creative People at Work: 12 Cognitive Case Studies,* edited by D.B. Wallace and H.E. Gruber.

Yamoor, C.M., Bebeau, M.J. and Rest, J.R. 1983. "Preliminary Estimates of the Reliability and Validity of a Dental Ethical Sensitivity Test." Paper presented at the Annual Convention of the American Educational Research Association, Montreal, Canada.

Zajonc, R.B. 1980. "Feeling and Thinking: Preferences Need No Inferences." *American Psychologist 35,* pp. 151–75.