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SPECIAL ISSUE ON
APPLICATIONS OF THE MODEL OF HIERARCHICAL COMPLEXITY

CONTENTS

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The Publisher, Joseph Cautilli may be reached at: jcautilli2003@yahoo.com
For hard copies you may reach the editor, Martha Pelaez at: marthapn@aol.com

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Mission Statement

The mission of the Behavior Development Bulletin journal is to provide behavior analysts with peer reviewed scientific information of interest to the behavior community, including research in cognitive development, child emotional development, developmental theory and socialization. Since its inception, the BDB journal has published articles of an inter - and multidisciplinary nature including areas of socio-biology and behavioral methodology.

The BDB journal is especially relevant to behavior analysts who study the developmental processes responsible for behavior changes and their progressive organization. The BDB journal hopes to provide answers by looking at the biological and environmental factors that affect behavioral development, while maintaining primarily interest in the role of environmental contingencies in behavior change.

Introduction to the Model of Hierarchical Complexity

Michael Lamport Commons

Harvard Medical School

The Model of Hierarchical Complexity presents a framework for scoring reasoning stages in any domain as well as in any cross cultural setting. The scoring is based not upon the content or the participant material, but instead on the mathematical complexity of the hierarchical organization of information. The participant's performance on a task of a given complexity represents the stage of developmental complexity. This paper presents an elaboration of the concepts underlying the Model of Hierarchical Complexity (MHC), discusses the range on applications that have been researched to this point, and summarizes the papers in the rest of the special issue.

This special issue presents a collection of papers based on the Model of Hierarchical Complexity, a non-mentalistic model of developmental stages. The model is different from previous proposals about developmental stage (e.g., Inhelder & Piaget, 1958). Instead of explaining behavior change across age as being due to the development of mental structures or schema, this model instead posits that task sequences form hierarchies that become increasingly complex. Because less complex tasks must be completed and practiced before more complex tasks can be acquired, this accounts for the developmental changes seen. Furthermore, previous theories of stage have confounded the stimulus and response in assessing stage by simply scoring responses and ignoring the task or stimulus. The Model of Hierarchical Complexity separates the task or stimulus from the performance. This short introduction to the special issue will describe this model in some detail, as each of the papers to follow will rely on it.

Tasks

One major basis for this developmental theory is task analysis. The study of ideal tasks, including their instantiation in the real world, has been the basis of the branch of stimulus control called Psychophysics. Tasks are defined as sequences of contingencies, each presenting stimuli and each requiring a behavior or a sequence of behaviors that must occur in some non-arbitrary fashion. In the present use of task analysis, the complexity of behaviors necessary to complete a task can be specified using the complexity definitions described below. One examines behavior with respect to the analytically known complexity of the task.

Model of Hierarchical Complexity

The Model of Hierarchical Complexity (MHC) developed by Commons (Commons, Trudeau, Stein, Richards, & Krause, 1998) quantifies the order of hierarchical complexity of a task based on mathematical principles of how the information is organized (Coombs, Dawes, & Tversky, 1970), and of information science (Commons & Richards, 1984a, 1984b; Lindsay & Norman, 1977; Commons & Rodriguez, 1990, 1993). Specifically, hierarchical complexity refers to the mathematical complexity of the task presented to the participant, but not directly to the complexity of the participant's performance that will successfully complete the given task.

Every task contains a multitude of subtasks (Overton, 1990). When the subtasks are carried out by the participant in a required order, the task in question is successfully completed. Therefore, the model asserts that all tasks fit in some sequence of tasks, making it possible to precisely determine the hierarchical order of task complexity. Tasks vary in complexity in two ways: either as *horizontal* (involving classical information); or as *vertical* (involving hierarchical information).

Horizontal (Classical Information) Complexity

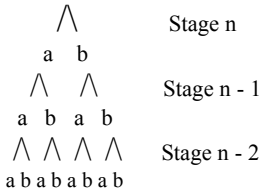
Classical information describes the number of "yes-no" questions it takes to do a task. For example, if one asked a person across the room whether a penny came up heads when they flipped it, their saying "heads" would transmit 1 bit of "horizontal" information. If there were 2 pennies, one would have to ask at least two questions, one about each penny. Hence, each additional 1-bit question would add another bit. Let us say they had a four-faced top with the faces numbered 1, 2, 3, and 4. Instead of spinning it, they tossed it against a backboard as one does with dice in a game. Again, there would be 2 bits. One could ask them whether the face had an even number. If it did, one would then ask if it were a 2. *Horizontal complexity*, then, is the sum of bits required by just such tasks as this.

Vertical (Hierarchical) Complexity

Hierarchical complexity refers to the number of recursions that the coordinating actions must perform on a set of primary elements. Actions at a *higher order of hierarchical complexity:* (a) are *defined* in terms of actions at the *next lower* order of hierarchical complexity; (b) *organize* and *transform* the lower-order actions (see Figure 1); (c) produce organizations of lower-order actions that are new and *not arbitrary,* and cannot be accomplished by those lower-order actions alone. Once these conditions have been met, we say the higher-order action *coordinates* the actions of the next lower order.

To illustrate how lower actions get organized into more hierarchically complex actions, let us turn to a simple example. Completing the entire operation 3 x (4 + 1) constitutes a task requiring the distributive act. That act non-arbitrarily orders adding and multiplying to coordinate them. The distributive act is therefore one order more hierarchically complex than the acts of adding and multiplying alone and it indicates the singular proper sequence of the simpler actions. Although simply adding results in the same answer, people who can do both display a greater freedom of mental functioning. Thus, the order of complexity of the task is determined through analyzing the demands of each task by breaking it down into its constituent parts.

Figure 1. Order of Hierarchical Complexity Tree. Each higher order action organizes two or more lower order actions.



The hierarchical complexity of a task refers to the number of concatenation operations it contains, that is, what is the number of recursions that the coordinating actions must perform? An order-three task has three concatenation operations. A task of order three operates on a task of order two and a task of order two operates on a task of order one (a simple task).

Tasks are also quantal in nature. They are either completed correctly or not completed at all. There is no intermediate state. For this reason, the Model characterizes all stages as hard and distinct. The orders of hierarchical complexity are stepped like the rings around the nucleus. Each task difficulty has an order of hierarchical complexity required to complete it correctly. Since tasks of a given order of hierarchical complexity require actions of a given order of hierarchical complexity to perform them, the stage of the participant's performance is equivalent to the order of complexity of the successfully completed task. The quantal feature of tasks is thus particularly instrumental in stage assessment because the scores obtained for stages are likewise discrete.

Stages

The notion of stages is fundamental in the description of human, organism, and machine evolution. Previously it has been defined in some ad hoc ways. Here we describe it formally in terms of the model of hierarchical complexity. Since actions are defined inductively, so is the function *h*, known as the order of the hierarchical complexity. To each action *A*, we wish to associate a notion of that action's hierarchical complexity, *h(A)*. Given a collection of actions A and a participant *S* performing A, the *stage of performance* of *S* on A is the highest order of the actions in A completed successfully at least once, i.e., it is

$$\text{stage}(S, \mathsf{A}) = \max\{h(A) \mid A \text{ 0 } \mathsf{A} \text{ and } A \text{ completed successfully by } S\}.$$

Thus, the notion of stage is discontinuous, having the same gaps as the orders of hierarchical complexity. This is in agreement with previous definitions (Commons et al., 1998; Commons & Miller, 2001; Commons & Pekker, 2007).

Stages of Development

The MHC specifies 14 orders of hierarchical complexity and their corresponding stages, showing that each of Piaget's substages, in fact, are hard stages. Commons also adds three postformal stages. The sequence is as follows: (0) computory, (1) sensory & motor, (2) circular sensory-motor, (3) sensory-motor, (4) nominal, (5) sentential, (6) preoperational, (7) primary, (8) concrete, (9) abstract, (10) formal, (11) systematic, (12) metasystematic, (13) paradigmatic, and (14) cross-paradigmatic. The first four stages (0-3) correspond to Piaget's sensorimotor stage at which infants and very young children perform. The sentential stage was added at Fischer's suggestion (1981, personal communication). Adolescents and adults can perform at any of the subsequent stages. MHC stages 4 through 5 correspond to Piaget's pre-operational stage; 6 through 8 correspond to his concrete operational stage; and 9 through 11 correspond to his formal operational stage.

The three highest stages in the MHC are not represented in Piaget's model. Few individuals perform at stages above formal operations. More complex behaviors characterize multiple system models (Kallio, 1995; Kallio & Helkama, 1991). Some adults are said to develop alternatives to, and perspectives on, formal operations. They use formal operations within a "higher" system of operations and transcend the limitations of formal operations. In any case, these are all ways in which these theories argue for and present converging evidence that adults are using forms of reasoning that are more complex than formal operations with which Piaget's model ended.

Because MHC stages are conceptualized in terms of the hierarchical complexity of tasks rather than in terms of mental representations (as are Piaget's stages), the highest stage represents successful performances on the most hierarchically complex tasks rather than intellectual maturity. Table 1 gives descriptions of each stage.

Table 1. Stages described in the Model of Hierarchical Complexity

Order or Stage		What they do	How they do it	End result
0	calculatory	Exact–no generalization, computer computations	Human made program manipulate 0, 1	None
1	sensory or motor	Discriminate in a rote fashion, stimuli generalization, move	Move limbs, lips, eyes, head View objects or move	Discriminative and condition stimuli
2	circular sensory-motor	Form open-ended classes	Reach, touch, grab, shake objects, babble	Open ended classes, phonemes
3	sensory-motor	Form concepts	Respond to stimuli in a class successfully	Morphemes, concepts
4	nominal	Find relations among concepts Use names	Use names and other words as successful commands	Single words: ejaculatives & exclamations, verbs, nouns, number names, letter names

	Order or Stage	What they do	How they do it	End result
5	sentential	Imitate and acquire sequences Follows short sequential acts	Generalize match-dependent task actions. Chain words	Pronouns: my, mine, I; yours, you; we, ours; they, them
6	preoperational	Make simple deductions Follows lists of sequential acts Tell stories	Count random events and objects Combine numbers and simple propositions	Connectives: as, when, then, why, before; products of simple operations
7	primary	Simple logical deduction and empirical rules involving time sequence Simple arithmetic	Adds, subtracts, multiplies, divides, counts, proves, does series of tasks on own	Times, places, counts acts, actors, arithmetic outcome from calculation
8	concrete	Carry out full arithmetic, form cliques, plan deals	Does long division, follows complex social rules, takes and coordinates perspective of other and self	Interrelations, social events, what happened among others, reasonable deals,
9	abstract	Discriminate variables such as Stereotypes; logical quanti-fication; (none, some, all)	Form variables out of finite classes Make and quantify propositions	Variable time, place, act, actor, state, type; quantifiers (all, none, some); categorical assertions (e.g., "We all die")
10	formal	Argue using empirical or logical evidence Logic is linear, 1 dimensional	Solve problems with one unknown using algebra, logic and empiricism	Relationships are formed out of variables; words: linear, logical, one dimensional, if then, thus, therefore, because; correct scientific solutions
11	systematic	Construct multivariate systems and matrices	Coordinates more than one variable as input Consider relationships in contexts	Events and concepts situated in a multivariate context; systems are formed out of relations; systems: legal, societal, corporate, economic, national
12	metasystematic	Construct multi-systems and metasystems out of disparate systems	Create metasystems out of systems Compare systems and perspectives Name properties of systems: e.g. homomorphic, isomorphic, complete, consistent, commensurable	Metasystems and supersystems are formed out of systems of relationships
13	paradigmatic	Fit metasystems together to form new paradigms	Synthesize metasystems	Paradigms are formed out of multiple metasystems
14	cross-paradigmatic	Fit paradigms together to form new fields	Form new fields by crossing paradigms	New fields are formed out of multiple paradigms

Relationship Between Piaget's Theory and Notions From the Model of Hierarchical Complexity

There are some commonalities between the Piagetian and Commons' notions of stage and many more that are different. In both one finds:

1. Higher order actions defined in terms of lower order actions. This forces the hierarchical nature of the relations and makes the higher order tasks include the lower ones
2. Higher order of complexity actions organize those lower order actions. This makes them more powerful

What Commons et al. (1998) have added includes:

3. Higher order of complexity actions organize those lower order actions in an non-arbitrary way.

This makes it possible for the organization to meet real world requirements, including the empirical and analytic.

1. Task and performance are separated
2. All tasks have an order of hierarchical complexity
3. There is only one sequence of orders of hierarchical complexity.
4. Hence, there is structure of the whole for ideal task actions
5. There are gaps between the orders of hierarchical complexity
6. Stage is defined as the most hierarchically complex task solved.
7. There are gaps in Rasch Scaled Stage of Performance.
8. Performance stage is different task area to task area.
9. There is no structure of the whole—horizontal decalage—for performance. It is not inconsistency in thinking within a developmental stage. Decalage is the normal modal state of affairs.

Empirical Research Using the Model of Hierarchical Complexity

The MHC has a broad range of applicability. The mathematical foundation of the model makes it an excellent research tool to be used by anyone examining performance that is organized into stages. It is designed simply to assess development based on the order of complexity which the individual utilizes to organize information. The MHC offers a singular mathematical method of measuring stages in any domain because the tasks presented can contain any kind of information. The model thus allows for a standard quantitative analysis of developmental complexity in any cultural setting. Other advantages of this model include its avoidance of mentalistic or contextual explanations, as well as its use of purely quantitative principles which are universally applicable in any context. Cross-cultural developmentalists and animal developmentalists; evolutionary psychologists, organizational psychologists, and developmental political psychologists; learning theorists, perception researchers, and history of science historians; as well as educators, therapists, and anthropologists can use the MHC to quantitatively assess developmental stages.

Table 2 shows the large range of domains to which the model has been applied. In one representative study, Commons, Goodheart, and Dawson (1997) found, using Rasch (1980) analysis, that hierarchical complexity of a given task predicts stage of a performance, the correlation being $r = .92$. Correlations of similar magnitude have been found in a number of the studies.

Table 2. Examples of tasks studied using the Model of Hierarchical Complexity or Fischer's Skill Theory (1980)

Algebra (Commons, in preparation)	Language stages (Commons, et al., 2007)
Animal stages (Commons & Miller, 2004)	Leadership before and after crises (Oliver, 2004)
Atheism (Commons-Miller, 2005)	Loevinger=s Sentence Completion task (Cook-Greuter, 1990)
Attachment and Loss (Commons, 1991; Miller & Lee, 2000)	Moral Judgment, (Armon & Dawson, 1997; Dawson, 2000)
Balance beam and pendulum (Commons, Goodheart, & Bresette, 1995; Commons, Pekker, et al, 2007)	Music (Beethoven) (Funk, 1989)
Contingencies of reinforcement (Commons, in preparation)	Orienteering (Commons, in preparation)
Counselor stages (Lovell, 2004)	Physics tasks (Inhelder & Piaget, 1958)
Empathy of Hominids (Commons & Wolfsont, 2002)	Political development (Sonnert & Commons, 1994)
Epistemology (Kitchener & King, 1990; Kitchener & Fischer, 1990)	Relationships (Armon, 1984a, 1984b)
Evaluative reasoning (Dawson, 2000)	Report patient=s prior crimes (Commons, Lee, Gutheil, et. al., 1995)
Four Story problem (Commons, Richards & Kuhn, 1982; Kallio & Helkama, 1991)	Social perspective-taking (Commons & Rodriguez, 1990; 1993)
Good Education (Dawson-Tunik, 2004)	Spirituality (Miller & Cook-Greuter, 2000)
Good Interpersonal (Armon, 1989)	Tool Making of Hominids (Commons & Miller 2002)
Good Work (Armon, 1993)	Views of the Agood life@ (Armon, 1984c; Danaher, 1993; Dawson, 2000; Lam, 1995)
Honesty and Kindness (Lamborn, Fischer & Pipp, 1994)	Workplace culture (Commons, Krause, Fayer, & Meaney, 1993)
Informed consent (Commons & Rodriguez, 1990, 1993; Commons, Goodheart, Rodriguez, & Gutheil, 2006; Commons, Rodriguez, Adams, Goodheart, Gutheil, & Cyr, 2007).	Workplace organization (Bowman, 1996a, 1996b)
	Writing (Commons & DeVos, 1985)

Conclusion

In the current issue, the Model of Hierarchical Complexity is applied to a variety of domains: (a) the development of attachment, both in terms of what are the expected, normative developments and in terms of what outcomes might result from negative, abusive or traumatic early experiences, (b) the development of game playing and social interaction skills in infants, (c) a description of how processes of acquisition of new skills differ across developmental stages, (d) an application of the model to teaching and teacher behavior, (e) an explanation of the influence of hierarchical complexity within organizations, and (f) a comparison of two different models of complexity, showing how each can be used to assess college students' behavior. The choice of this wide range of applications is designed to show, most importantly, that the model of hierarchical complexity can be applied in a very large range of domains. It is not limited to problem solving, or to cognition, but also explains social and emotional development, and behavior within organizations.

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Adult Behavioral Developmental Stages of Attachment

Patrice Marie Miller

Salem State College and Harvard Medical School

Suzanne Lee

Massachusetts General Hospital

The current paper examines individuals' understanding of relationships with significant others in terms of the increase in complexity of tasks that is posited to occur in the Model of Hierarchical Complexity (Commons et al., 1998). We interviewed 8 to 10 year old children, and adults, about losses of attachment objects, including people, pets, objects, places, events and ideals. Statements that children and adults made about these attachment objects were scored used the Model of Hierarchical Complexity. It was found that children's statements were primarily scored as primary or concrete. Adults' statements ranged from primary to systematic, but were more often scored as abstract, formal and systematic (not primary or concrete). Illustrative examples of statements at each of the orders of complexity for both children and adults are provided. It will be important to extend these findings by examining whether the verbal behavior of individuals with respect to relationships is related to the kinds of relationships they appear to have.

The current notion of attachment was originally systematized by Mary Ainsworth and her colleagues (Ainsworth, Blehar, Waters & Wall, 1978) in work conducted with infants and their parents. The notion was one that, at the beginning, was meant to capture the infant's attachment to a primary caregiver, usually the mother. The current paper starts by discussing this original notion of attachment and how it has been generalized beyond infancy, to adults. It will then discuss the possibility of extending and expanding upon attachment theory to better accommodate what is known about adult development.

Classical attachment theory is embodied in the work done with the *strange situation* as developed by Mary Ainsworth (Ainsworth, et al., 1978). The strange situation measures how infants and young children behave during a reunion after having been separated from their mother (or other primary caregiver). Securely attached infants seek contact with their mothers. Insecurely attached infants are classified as either avoidant or ambivalent. Avoidant infants do not seek contact with their mothers during reunion. Ambivalent infants become upset upon separation, seek contact during reunion, but usually also push away or fail to be consoled by the mother.

Beginning in 1985, researchers (Hazan & Shaver, 1987; Main, Kaplan & Cassidy, 1985) began to extend to adults the basic ideas from the work on infant attachment. The work by Main et al. began with a study of the parents of children whose attachment patterns were already being studied. They interviewed parents about their own, remembered attachment experiences, which became the basis for the Adult Attachment Interview (AAI). Hazan and Shaver's (1987) work began by assessing attachment in adults using questionnaire-like instruments. Hesse (1999) summarizes a large number of studies that used the AAI, while Rothbard and Shaver (1994) and Hazan and Zeifman (1999) summarize some of the work using this other methods.

In this work on attachment in adults, the features of attachment described for infants are directly applied to adults. For example in both the work by Main and colleagues and the work by Hazan and colleagues, adults are classified into the three major types: secure, avoidant and ambivalent. It is assumed that an adult's attachment status is related to their earlier experiences of sensitive care, just as with infants. Adults are assumed to have an "internal working model" of both themselves and their caretakers. According to the overall theory, these working models have developed as a result of interactional experiences with the caregiver.

What the theories do not do is incorporate aspects of development that may have occurred since infancy. Such aspects would include: (a) experience with multiple, significant relationships that might be very different from an individual's earlier experience with caregivers, (b) an increasing tendency, starting in adolescence and into adulthood, of reflecting on experiences. Increasingly the effects of an experience can be as much due to how an individual evaluates that experience as to what happened, and (c) most importantly, an increase in the complexity of tasks that individuals can solve as they develop. It is this latter aspect that this paper will examine.

The current paper examines aspects of this increase in complexity from the point of view of the Model of Hierarchical Complexity. As described in the Introduction to this special issue, the Model of Hierarchical Complexity (Commons et al., 1998; Commons & Miller, 1998) posits that developmental changes result not from changes in mental structures or schemas as Piaget argued, but instead result from the fact that the tasks that people must solve as they develop become more hierarchically complex. Specifically, a task is more hierarchically complex if: (a) the task and its required action is *defined* in terms of two or more less hierarchically complex tasks and their required task actions (note that actions here may be observable behaviors or mental actions); (b) the more hierarchically complex task organizes or coordinates two or more less complex actions; and (c) the coordination of actions that occurs has to be non-arbitrary; it can't be just any chain of actions.

The task to be examined in the current study is the task of understanding relationships with significant others, or attachment relationships. In an earlier paper, Commons (1991) proposed Stages of Attachment starting in infancy and continuing to adulthood. The current paper will revisit this question by giving updated material (Table 1) and by examining ways in which attachment-related statements might differ in children and adults. Because attachment theory has focused upon reactions to separation as the most productive context for eliciting attachment

behavior, we looked for an analogous situation to ask participants about. It seemed as if asking participants about losses of attachment objects, and their reported feelings as a result of these losses, would be an analogous context.

Table 1. Stages of Attachment

Stage 1. Sensory-motor (reflexes and tropisms) Infants are dependent on their caregivers. Habituation and positive and negative reinforcement are the main attachment contingencies. Both positive and negative reinforcement increase or maintain the frequency of behavior that they follow. Infants can discriminate their primary caregivers from others. There is a small preference for that primary caregiver, which seems to be partially based on familiarity. The familiar caregiver is more effective at pacification than others. Decreasing distress serves as a negative reinforcer. Much of infant's behavior maintains a simple positive feeling and seeks comfort from distress. Infants fail to maintain that feeling by discriminating that the attachment object is not available during some distress episodes and others cannot alleviate it as well. Some activities and games are preferred. There seems to be little preference for place. Toys preferred on the basis of function and form. Peers are objects to be manipulated. There is a recognition of babies midway. Imitation is mostly reflexive, such as smiling to smiles.
Stage 2. Circular sensory-motor (conditional and other complex discriminations) Infants imitate on an operant basis. They follow hidden objects. They discriminate separation from attachment figures. They develop a clear preference for one or at most two attachment objects. These three facts results in there being degree of separation protest. Gewirtz and Pelaez-Nogueras (1991) find that the separation protest can be conditioned further. The appearance of and, imitations by, smiles and laughs from the primary caregiver are more reinforcing of behavior then when they emanate from others. Infants can recognize familiar people in mirrors, looking first at person and then the image. They do not recognize themselves. They have favorite toys. Operant laughing and crying clearly appear. Reaching towards the main caregiver develops as one of the attachment behaviors.
Stage 3. Sensory-motor (concepts) There is generalized imitation and beginning identification with increased matching to similar category objects. There is a recognition of self (in a mirror for instance) without explicit training. This indicates a further separation of self from others. Because they can name themselves and others, there is categorical separation. Gender labels can be attached to the sex categories. The infant begins to become mobile and can act independently in a broader arena. This leads to some independence from the primary attachment figures.
Stage 4. Nominal (named concepts) Pervasive imitation and identification develops. They use objects that the attachment objects use. Children discriminate the effects of acts on others. They act like an executive and manipulate others without discriminating what the others' goals are. They give verbal opposition, quite often saying "no" (Terrible twos). They fail to control caretakers and are unable to obtain their planned objects on their own. They see peers as individuals to be manipulated but are attached to them (Field, 1991). There are clear favorite toys. Children clearly associate peer relations and routines with place (Field, 1991). The place is discriminative for the activities. The child who remains misses the one that moves and not visa versa. Hence there is really only partial attachment to friends and it is conditional on the environment. Routine is important. If a mother leaves the area for a trip, the child is less upset when routine is maintained. Words have a literal meaning and quite often even a name like orange juice can be taken as an instruction to drink the orange juice. Demands are followed. There is no independent rule-governed behavior. Words take on social-reinforcing value. Perceptions of monsters are real.
Stage 5. Sentential (sequences of named concepts) Instructions in sentence form are followed. There are simple rules. The child can state a rule as well as follow them. Rules have the form of role of description, explanation and moral imperative. Children select children who are somewhat similar as playmates. Children verbalize about what they like and want. Often they do not understand the difference between their own orders and those given by adults. The superiority of rules of adults is only partially understood. Only bits and pieces of adult behavior can be imitated. Being someone and their opposite comes into play. One may be the bad person as well as the good one. Possible selves are explored thorough imitation. Monsters can be fought and subdued.
Stage 6. Preoperational (sequences of sequences of named concepts – paragraphs) Longer sequences of instructions can be followed. The instructions may have the form of paragraphs. By the end of this period, a child in this culture has formed a group identity; they have a sex-role preference (Kohlberg, 1966; Miller & Commons, 1973). There is strong pervasive imitation of same sex parents and figures. The person begins to follow older person. The pervasive imitation of the older is identification. It is seen in role playing. There is no distinction between a personal interpretation of another's action and what the true perspective. There is no sense of a shared self yet there is some empathy. Abstractions of superiority of the adult caretaker is now partially but not consistently discriminated. There is still complete dependence. Pervasive imitation can be reinforced by producing similar appearing outcomes. The observed appearance of similarity to the adult model may make those outcomes reinforcing.
Stage 7. Primary, Moral Attachment Stage (reality-verified objects) There is actual rule governed behavior in addition to pervasive imitation. The verbal behavior of attachment objects is vocalized as rules. The children follow rules accurately across time. Children can coordinate their actions with attachment objects. Children recognize their own dependence on the parent. They can discriminate the greater power and competence of the attachment object. If children are

asked who is better, they reply that the attachment object is better. Also authority in general is seen as better, more competent, more virtuous. Children compare themselves to the attachment object--this social comparison requiring primary operations.

The perspective of the parent can be seen in the form of rules that the parent states. Insofar as there is moral attachment, feedback from the attachment object affects not only specific behaviors but mood as well. The discriminated value of the self changes with such evaluation. Producing pervasively matched behavior is reinforced not only by the usual reinforcing properties associated with the outcomes produced by such behaviors but by the appearance of similarity, which is valued in itself. Outcomes delivered to the parents may reinforce behavior of the child, because of the shared self.

Stage 8. Concrete (concrete others)

Two new sources of attachment objects appear. The attachment objects increasingly can be peers. While with peers, people ignore the basic attachment figure to some degree. Immediate social reinforcement from peers is sometimes more effective than more general rules in controlling behavior. Hence, parental authority is sometimes ignored. While in the preoperational and primary stages, children will act out what they see in the adult world or hear, during concrete operations the shared-self may extend to models that appear in written or spoken stories. These are models that appear quite real as opposed to the mythical figures from the earlier two stages.

Shared activity with some degree of compatibility is the basis of peer attachment. People change the way they behave with different friends. The perspective of the other is discriminated by considering how one's own behavior will affect another's behavior, the other person's behavior possibly reinforcing ones own. Such perspective taking makes it possible to have for attachment objects named peer groups, such as cub scouts, brownies, camp fire girls. The school has a name and so do the teachers. Authority figures in general are good. There is a strong sense of shared self, the objects now being extended to informal local organizations. Rules are good and to be followed.

Stage 9. Abstract (abstract others)

Actors can take the perspective of another abstract rather than actual-concrete person (viewing the actor). Rules are so well discriminated and followed that in implicit rules of groups become important. People select attachment figures other than caregivers. Group identification develops along with serious attachment to groups (imitation of group behavior). People see themselves as belonging to one of the acceptable groups or an out group. People, who do not attach to groups appear distinct to themselves and others. One sees nationalism and parochialism. The group's displayed view of themselves can serve as reinforcers and punishers. When caught breaking rules by new attachment figures there is rage and shame. There is opposition to parental figures with the rules of peers used as challenges. Formal groups are important. Following the rules makes one good. There are multiple sources for the rules.

Stage 10. Formal (subsystems of others)

The perspective is that each sector of the world consists of a number of relationships, the rules that guide them have to be discovered or learned by the person. Hence, with respect to social perspective taking, how abstract others will behave can be experimentally and logically examined. The sectors of the world seems to be fixed. Subgroups are to be affiliated with. One subgroup, usually the one is in is superior to all others. Its rules and definitions are superior to others. The costs of being in some outside group are high. There is opposition to norms of basic attachment figures, rebellion, weakening of interdependence. People can figure out what to do to influence other people. The rules are abstract, and in some sense are like general principle, they just have not been applied widely. There is increasing opposition to parents but conformity to age-appropriate groups, not in just superficial ways as in the abstract sate but in terms of the effectiveness of the group to use rule governed behavior to subtly define the relationship between the person and the system. The person is seen as subordinate to the system.

Stage 11. Systematic – Independence and dependence (ordered subsystems of others)

The person takes the perspective that there are a number of possible systems to which one might affiliate. At the later levels of this stage, although these systems have relative validity the person must choose among them (Perry, 1970, 1981). People can see interrelationships between the actions of one person and another and how that interaction affects the system. The rules that govern identity are arbitrary and may be reconstructed by the group. There is independence but with conformity to group norms. People view themselves as individuals. A change in a system most often appears as a new ordering individual and subgroup status. The new order is the one a person has to live with and care about. The attachment to the system makes it likely that people, whether liked or not, will be afforded the procedures of the system. In the later part of this stage, tolerance of others who are different from oneself develops as one of the main positive attachment behaviors. Cynicism towards the system develops as one of the main negative attachment behaviors.

Stage 12. Metasystematic (system of universal others)

People attain autonomy (Armon, 1989). They respect others and value them as human beings irrespective of agreeing them. The opposition of the previous stage that may have required some hostility towards controlling objects, has dissipated. The perspective taking ability allows the person to see the other in more similar terms to the other. They can not only stand in their shoes, view the relationship from a third person perspective, and see how that relationship fits into the system, but they can assume the perspective of the other to the extent that they are informed. They also discriminate the inability to do so fully. Dependency is acknowledged.

Stage 13. Paradigmatic operations (differentiated universal others)

Perspective-taking now not only includes an integrated self and other but self and nature (Sonnert & Commons, 1994). People see that they are part of nature, not in opposition to it. They see that there is no way to transcend nature or impose themselves on it. There is recognition that human endeavors have limited complexity in the face of the possibly infinite complexity of the universe. The mappings between self and other, self and society, self and nature formed at stage 5b are transformed so that people are just part of nature. The attachment objects include universal entities, such as everyone and all of nature. There is unconditional respect for everything in nature including ones place in it.

Method

Research Participants

There were 40 participants. Of these, 18 were children (9 girls and 9 boys), mean age = 8.38 years, *SD* = .70. Children were recruited from summer camp and school programs in the Cambridge and Boston areas. There were 22 adults (13 female and 9 male), ranging in age from 18 to 60, with a mean age of 30.52, *SD* = 10.38. Adults were recruited from a variety of settings, but a large subset of them was graduate students and employees of a large private northeastern university. Responses from a small subset of children and of adults will be presented in part of the Results section, to illustrate the stages.

Materials and Procedure

Individuals in both age groups were interviewed using the same combination of open-ended and closed format questions. The interview was pretested using the grammar-checking feature of Word Perfect® and all vocabulary was appropriate for the third grade reading level. At the beginning of the interview, individuals were told that we wanted to talk to them about caring. They were asked to give a definition of "caring" for something. There was some discussion of their definition and an elicitation of examples to make sure that the individual understood the topic. Only then were participants asked: "Sometimes a person or a thing that you care for might go away or get lost. Has that ever happened to you? Can you tell me about that?" At this point, the task of the interviewer was not so much to discuss any one loss in depth, but to elicit as many losses as possible, first in a non-directive fashion, by asking simply "anything else?" The losses that participants remembered on their own are called "uncued." The interviewer then cued them as to whether they had ever lost any of six specific entities not already mentioned (people, objects, pets, places, events, or abstract entities, such as ideals). Once a set of losses had been elicited in this manner, participants were asked to respond to further questions about three types of losses: (a) their most important loss, (b) the loss of a person (if not the same as their most important loss), and (c) the loss of an object. Interviews were conducted by several graduate and undergraduate students, who were employed as research assistants. Students had some training in interviewing.

Individual statements that children and adults made about the losses of attachment objects were then scored in terms of their hierarchical complexity. The scoring was based upon a scoring manual developed by Commons and colleagues (Commons, Danaher-Gilpin, Miller, & Goodheart, 2002). All scoring was done by two scorers together. If they disagreed or were unclear about how to score, a third scorer who had considerably more experience with the scoring scheme was consulted. Each statement in a narration was scored individually, so separate statements of an individual could represent different orders of hierarchical complexity. While a single individual's statements will show a range of complexity, children's statements, in general will be scored within a lower range of orders of complexity.

Results

The purpose of the current paper is to illustrate what statements about relationships at different orders of complexity are like, and also to discuss differences between children and adults in the orders of complexity that they typically used to discuss their loss experiences. In the items below, gender, age, participant statements, and scoring descriptions are provided.

Primary-stage statements

Primary stage statements tended to be simple, single-action statements about what had happened. These statements can be chained together, for example, in a temporal order. They generally focused on subjects themselves or on the other person, but did not suggest coordination between the two (Rodriguez & Commons, 1991). If two people were mentioned, then it was only incidentally, or as part of the chain of statements. Primary stage statements were often shorter than other types of statements; it was common, however, to see a chain of primary stage statements. In addition to how short primary stage statements were, their content was never abstract in nature. They referred to specific, one-time events in a story.

(M, age 8) And I lost my favorite toy. Actually I lost two of my GAG. Those were my favorite toys. [*Three sentences, in a chain that could occur in any order about losses of these toys*.]

(F, age 9) I[t] was good in the fact that like, she was dead and it couldn't be helped because she was an old cat and her kidneys had failed and, I mean, not even people live through kidneys usually and so... [*This is a story of how she felt after her cat died. She also seems to be repeating things she has been told that the death of the cat was inevitable, and "not even people" live through kidney disease.*]

(F, age 25) *Primary Step 4.* My crystal jewelry box. Last Friday. I didn't lose it. But it's gone. It crashed. [*There is only one role here, that of the jewelry box and one causal statement, I didn't lose it. It is factual*.]

(F, age 25) *Primary Step 4.* I went out in the rain, and walked around in the rain and wept. [*Just a story about herself and her feelings.*]

(M, age 23) *Primary Step 4.* He was my clarinet teacher and I was, I think I was in fifth or sixth grade. [*Telling details about the clarinet teacher; note that while there are two people, it is really just two phrases chained together.*]

(M, age 23) *Primary Step 4.* I sat down on the stairs and cried until my mom got there. [*Details about what happened when he found out about the death of his clarinet teacher.*]

(M, age 41) *Primary Step 4.* I lost several, three to be exact. [*Part of a story with specific information about the number of motorcycles he has lost over time, but it does not show or bring in more than one person or more than one role - just himself.*]

(M, age 41) *Primary Step 4.* Well I felt angry and ripped off!! [*Expressing his emotions upon the loss of the motorcycles.*]

Concrete-stage statements

Concrete-stage statements were also story-telling statements; however, they either showed the basic coordination between two people, or between two attachment entities.

(M, age 8) When I was like 2 years he walked away cause he didn't like me right from the beginning 'cause we always got in fights [*"He didn't like me because we always got in fights" - a very tangible reason why "he didn't like me."*]

(F, age 9) I guess when I lost my friend Jill, when she moved away I guess that was kind of a loss right then 'cause she had been my best friend since like, kindergarten and like, I was always over her house and everything and we slept over each other's houses a lot. [*The basis for friendship is spending time together and sleeping over at each other's houses.*]

(F, age 25) I guess right when I left college there were a series of losses because I went straight from college to work out West and worked out West with some people for about 6 months and then after that, at the end of that 6 months, we all left each other again. [*At this point this is a story about her and these other people and what was happening with them; leaving each other is concrete, there is mutuality.*]

(F, age 25) Yeah, I wrote for awhile, and we planned a trip, uhm, some of us. They left in the middle of September...at the end of August, and I met them in uhm, California for two weeks at the beginning of October. [*A story with at least two perspectives fully coordinated in it.*]

(M, age 23) D... is the name of the young woman I've been going out with for the last two years. She is a senior at Yale now, and it looks like we'll be together for a very long time now. [*A story with a specified time mentioned, and a relationship between two people; an agreement between two people with mutual perspective taking.*]

(M, age 41) I think because there were interactions that I missed with my father. [*There were specific interactions that he missed with that specific father that shows mutuality and coordination of perspective. There is no description of those interactions.*]

Abstract-stage statements

In abstract-stage statements, individuals often quantified their emotions following a loss. Although abstract-stage statements were often relatively short, the statements differed from primary- or concrete-stage statements because they contained some kind of recognition that the reaction to an event could have been different or could be variable under different circumstances.

(F, age 8) I just wasn't afraid. Because, I don't get afraid when I lose something. But if it's something very, very special to me, really, really important and I always loved it, then I would be a little more scared and worried that I lost it. I'll never see it again. [*She seems to have two ideas: some things that are not very important do not make her get very afraid; other things that are very, very important would make her get more afraid - she seems to be beginning to deal with different values of "importance" and of "fear" and relating them to each other - she also seems to be thinking hypothetically - she doesn't have a specific thing in mind but just says "If it's something..."*]

(F, age 41) I didn't have, there was nothing adversarial between her and me. [*There was nothing at all here that was adversarial is a quantification statement; adversarial is a value of the kinds of interactions that can range from adversarial to cooperative.*]

(F, age 41) All I wanted was to have a quiet life. [*All is quantification, quiet is a value of a variable.*]

(F, age 25) And it was just a continual saying goodbye. [*A continual is an abstract quantification statement.*]

(M, age 23) I'm trying to be specific - instead of talking in vague generalizations. [*Value=vague, of a variable that can range from vague to specific.*]

(M, age 23) I have moments of elation [*There is quantification, "moments" of elation; elation is variable.*] and moments of depression.

(M, age 23) This is probably the most painful loss I ever experienced. [*Quantifying the experience*.]

(M, age 41) It was stolen once. I felt bad but that was more a sense of economic loss. [*This little piece here "more ... an economic loss" is a kind of quantification of loss, so that statement is Abstract – 9.*]

(M, age 41) All Americans [*quantification*] had a sort of slow anger at the enemy.

Formal-stage statements

Formal-stage statements about relationships mentioned relationships between two variables or propositions. It can often be discerned that they relate two abstract-stage entities. There is linear logic, which also is embodied in blaming others for what goes wrong.

(F, age 41) It was very abrupt, yes. And at the time there wasn't much people could do about cancer, so it was a really day-to-day deterioration that you could follow. [*At one time treatment used to have that other kind of outcome, now it has this kind of outcome - so this is a statement about things varying over time. But what makes it formal is that there is a function described - day-to-day deterioration - is a formal statement, increases in deterioration with time.*]

(F, age 41) Well, at the time - she died in '71 - at the time even here I think she wouldn't have lived. [*Variable, being here or there - could have an effect on the outcome (living or dying) - so this is formal.*]

(F, age 25) Attachment to things or people would be something like wanting to be near it, them. [*If you are attached then you want to be close - a formal statement of a rule.*]

(F, age 25) Being able to absolve myself from feeling guilty, for not loving him like he loved me. [*Not loving him caused me to feel guilty - and this event, whatever it is, would absolve me.*]

(M, age 23) I guess the main point would be that someone else is important enough to you that they become a high priority in your life. [*If they become important to you, then they become a high priority: relationship between variables.*]

(M, age 23) When you lose something in a relationship, like with a girl friend, that's lost opportunity and lost self esteem in some cases. [*Relationship between variables.*]

(M, age 23) Well, I think that when you grow up it's a natural process to have an idealized portrait of your parents. [*A relationship between a) how old you are and b) your view of your parents*.]

(M, age 41) Yah, I mean at that time I was mad because I remember part of my anger was directed at Japanese, at the enemy who had killed him. [*They killed him, so I was mad at them, and I now know that was wrong - it is an implicit explanation, looking back, of why he felt that way and how those two events, his father's disappearance and his anger - were related.*]

(M, age 41) You know a kid growing up he wants to play ball with his father. [*Being a "kid" is causal of wanting to play ball with one's father.*]

(M, age 41) I guess if it was a really crummy motorcycle [*9 - abstract - one type of a motorcycle*] or I really hated it in some way [*9 - abstract*] and somebody stole it, I might be potentially happy. [*10 - formal - starts with "if" so the statement as a whole is hypothetical; also it's a chain of events, one leading to the other*

or causing the other, and even though some can "stand in" for others (like, either it's a crummy motorcycle or I hated it in some way), they don't appear to interact in any real way.]

Systematic-stage statements

Systematic stage statements about relationships went beyond talking about linear causal relationships between two variables to either explicitly discussing multivariate systems or to referring to such systems. The problems or loss were seen to be part of a system.

(F, age 41) Yeah, you can care for a pet. It's more universal than just an attachment to a person or several people. [*Because it suggests that there is a system of caring that is made up of attachment to specific persons, to several people and potentially to pets or other objects.*]

(F, age 41) I realized that, for instance I was left alone with my dad, and I realized that all my relationship with him was through her, and I had to reestablish my relationship with him and that took long years. [*11 -systematic - I had a certain kind of relationship with him before her death and it was totally dependent on her being there. After she died I had to reestablish that relationship on different grounds. This seems to be referring to the different types of relationships as systems.*]

(F, age 25) Because I just graduated from college and I was sort of looking at, my road maps had run out and I was gonna have to start making them myself. [*She is thinking or reflecting on her "road maps" or life plan or plans - therefore this is systematic - a road map, in this sense, is a system.*]

(M, age 23) Well, I think that when you grow up it's a natural process to have an idealized portrait of your parents [*a relationship between a) how old you are and b) your view of your parents*] and then when you become an adolescent I think that's the time you start to judge [*10-relationship between variables* when *and* then] and there's a certain loss associated with that [*11-there are two variables here: X is the age that you are, Y is how you see your parents (idealize/judge). How you see or view your parents is a relation - between what you see or perceive and what they actually are like. You are therefore looking at a relationship between a variable (age) and a relation (the perception/actuality relation) and that is what makes it systematic.*]

(M, age 23) ...but I think that as far as trustworthiness and being able to follow through on one's word, my capital "I" - integrity has been ok. [*System of relations. He seems to be saying here that there are two systems of integrity and each one has a different set of things that you have to do in order to compromise your integrity and also that even if you do some of those things you don't necessarily lose all your integrity - there are degrees of losing your integrity*.]

(M, age 41) Oh yeah, I had pets, I sometimes think that losing pets is the way we learn to deal with loss in general. [*There is a system of dealing with loss, and one of the ways that this system develops is through early losses of things like pets - Systematic 11*.]

(M, age 41) ...well the incident that I'm describing as lasting for an hour I'm talking about a specific kind of feeling of grief and anger, both combined, that was a sort of release of pent up emotion regarding my father's death. [*This statement has in it several ideas: one is that there can be combinations of emotions; his referring to 'pent-up' emotions suggests that he has an awareness of different kinds of emotions and this is a particular kind - it provides evidence that he views emotions as a system. For example, this kind of very intense emotion may, by its very nature be brief, but the implication is that there are other types of emotional experiences that can last longer and maybe be less intense.*]

(M, age 41) I lost my car, my marriage, my job, my health and a whole lot of other things at that same period of time so I can't say, you know, it was point 0. 0 centimeters of sadness associated with losing my motorcycle. [*Systematic because there was this whole system of losses impacting on him that he cannot point to one event or one variable as the cause of his sadness. It is seen as transitional step 0 because it is just loss with nothing else*.]

(M, age 41) ...maybe I did if I did some childishly seductive things I'm not aware that I did. [*Looking back on his earlier behavior and characterizing it as "childishly seductive" is something an adult would do or would say therefore it goes beyond just retelling what he did - it is a characterization, an analysis of behavior - so we can think of this in terms of two systems - what the child did, and then the whole adult way of interpreting, based on some theories or beliefs of the adult, that behavior*.]

General Comparisons of Statements made by Children and by Adults

Children discussed their losses with language and ideas that were almost always scored as primary or concrete in complexity. Of the 156 statements that were scored for children, 30% (47) were primary, 68% (106) were concrete, and 2% (3) were abstract. In contrast, of the 240 statements that were scored for adults, 7% (17) were primary, 15% (36) were concrete, 23% (56) were abstract, 23% (56) were formal, 29% (70) were systematic and 2% (5) were metasystematic. A Chi Square test of the differences in distribution of the different orders of responses showed a highly significant difference, χ^2 (4) = 214.99, $p < .01$, Cramer's $\Phi = .74$, which suggests a large difference.

Discussion & Conclusions

These data show that, in discussing losses in their lives, whether of people or other entities, the responses of children and of adults can be characterized in terms of their hierarchical complexity. Statements scored at the primary and concrete orders of complexity are characterized by the recounting of personal experiences, especially when that recounting focuses on the individual's own perspective. One major difference between primary and concrete statements is that in concrete statements, more than one person or entity is referred to, and the behavior or thoughts of the two entities is related to each other. At the abstract order of complexity, one sees statements in which individuals are comparing their experiences, implicitly or explicitly, to those of others, or in which they are referring to a scaling of emotions or experience that resembles a variable taking on different values. Statements at the formal operational order of complexity refer to simple (one-variable) causal models of phenomena; unlike the concrete statements, "I did this because he did this", formal operational statements are statements of what are perceived to be general rules or relationships, not just ones that occur in this specific situation. Systematic order statements address the complexity of situations and refer to systems: of relationships, of beliefs. None of the statements by subjects in this study were scored as fully metasystematic, although a number were scored as transitional to metasystematic. These findings will allow us to elaborate on the stages originally proposed by Commons (1991).

It was also found that one can characterize the narrations of children about attachment as different from those of adults. Children's narrations tended to consist almost entirely of primary and concrete order statements about what happened and how they felt. While adults' narrations also contained such statements, the adults would tend to further characterize and reflect on their

experiences using abstract, formal or systematic statements.

There are two interesting directions that we want to pursue in future work. First, how does the fact that adults can reflect upon their experiences in these multiple complex ways impact their relationships? Would being able to think about a relationship from more than one point of view may help individuals improve their relationships? This surely might be one way to conceive of what marital therapists do.

Second, while this study did not attempt to look at individuals as a whole, there might be the possibility of at least characterizing the order of complexity that an individual used to characterize a particular relationship and then to see what might be related to that. A number of variables might account for such differences, including: (a) time since the individual experienced the loss of the relationship, (b) amount of reflection upon the relationship an individual might have been able to do (as measured, for example, by time spent in therapy), (c) age at which the loss took place, (d) type of attachment entity, (e) role that attachment entity played in person's life.

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How Early Negative Caregiving Experiences Relate to Stage of Attachment

Michael Lamport Commons
Harvard Medical School

Patrice Marie Miller
Salem State College

Negative behavioral stages of adult development of attachment can occur given different kinds of early experiences. Extreme negative early experiences, such as abuse, or neglect, often lead to arrested development in the domain, such as the interpersonal domain, in which such experiences occurred. Development may also occur because parents themselves have arrested development and do not provide models for higher stages of behaving. At the Preoperational stage 6, people fail to predict the effects of their own behavior on others and to differentiate between fantasies and reality. They require constant supervision. At the Primary stage 7, people understand that their own behavior may causes others harm but do not understand how others will feel. Adults using primary stage reasoning to solve certain dilemmas, often end up in trouble because they only know what their own behavior obtains but not how the other people might feel about it. At the Concrete operational stage 8, people consider the feelings of others, as well as their own. They fail to discriminate social norms, however, and can end up in trouble for that reason. At the Abstract stage 9, people care not about out-group people and so behave in a prejudicial way toward them. At the Formal stage 10, people apply simple cause and effect models to relationships. Since only one individual is perceived as being responsible, it is difficult to solve relationship dilemmas. At Systematic stage 11, people fail to use available means to settle conflicts, disrespecting their enemy and preferring to use power as legitimized by procedural due process. At the Metasystematic stage 12, people fail to co-construct a reality with all the stakeholders, often harming them. For each of these stages, ways of helping individuals to develop beyond them are suggested.

Commons (1991) and Miller and Lee (1999) have proposed a behavioral-developmental theory of stages of attachment. As described in the preceding article in this issue, these stages were generated using the Model of Hierarchical Complexity. The paper also presented evidence to suggest that there are reliably different ways in which children and adults talk about their attachment relationships, with children primarily talking about them in ways that we have characterized as being at the primary and concrete orders of complexity, and adults being more likely to use abstract, formal and systematic orders of complexity. The description in that earlier paper is of what the progression would look like if development proceeded in an ideal fashion. If that happened, an individual would progress through the stages described, up to some stage at least.

Development in a domain, including the domain of attachment, does not necessarily proceed in an ideal fashion. Based partly on the work of Rodriguez (1997, personal communication), Noam (Noam, Chandler, & LaLonde, 1995), and others, we propose that development through the attachment stages can become arrested. A primary cause of arrested development, and the one the leads to the most serious outcomes, is exposure to traumatic events such as abuse, abandonment, or neglect. Problems in biology (increased or decreased sensitivity to others' emotions and preferences) can also lead to a lack of development through the attachment stages. In some cases, perhaps the less serious ones, individuals may not have been exposed to appropriate models, and so would not have learned the behaviors necessary to move up in stage.

How would such early experiences have an impact on development in this domain? Much research within developmental psychology suggests that there are two ways in which development takes place. The first is engaging with an issue. The second is reflecting upon it (Piaget, 1976). When there is some kind of trauma, it is suggested that the area of their life in which the person was traumatized is the area in which development becomes arrested. Oftentimes this is within their close interpersonal relationships. They are not likely to engage their original care-givers in more positive ways due to their previous negative history. The interaction with others also can recall the original trauma and accompanying painful emotions. This leads to a lack of reflection on their attachment experiences because they are too busy avoiding even thinking about their traumatic experiences.

Another aspect of the Model of Hierarchical Complexity that is important to understanding what might happen here is that there is no necessary uniformity in development across tasks. Each task from a different domain or sequence is tackled separately to some degree. As a result, it is possible for an individual to progress through many of the stages of 'mathematical development,' and so being observed to complete mathematics tasks that are highly complex. At the same time, the same individual might not progress through many of the attachment stages, and as a result might complete attachment tasks at a much less hierarchically complex order.

In this paper we will propose what might happen to arrest development at different stages of attachment, what might happen as a result of such arrested development, and what interventions might help an individual to develop further. In each case of progress from a lower-stage behavior to a higher-stage behavior, it is assumed that change could begin when reinforcement for

behaving at the lower-stage is perceived to decreases markedly. This aspect of the stage transition is not discussed in detail, but is assumed.

Impairments at Different Attachment Stages

Preoperational Stage

We estimate about .5% of people who are not otherwise recognized as being developmentally delayed may not progress beyond this stage in the attachment domain. Even though adults, such individuals fail to predict the effects of their own behavior on others and do not differentiate between fantasies and reality. The reasons for this include abandonment, abuse or neglect during infancy or very early childhood. It is also possible that a severe mental illness, including a delusional belief system that keeps individuals from distinguishing fantasy from reality (i.e. schizophrenia, extreme bipolar, severely disturbed borderline, and severely deteriorated alcoholics or drug abusers) could also cause regression to the preoperational stage of attachment.

Preoperational to Primary

People functioning at the preoperational stage are like nursery school children but with large stature and strong muscles. In order to move from preoperations, one has to teach them to talk about what they want rather than grabbing it. Authority gives them rules to follow which increasingly makes it possible for them to behave in socially acceptable ways. As an authority, one has to interact with them and to supervise them. For this to be effective, they must also have at least some positive emotions toward the authority figure in addition to receiving some form of effective reinforcement. Otherwise it is likely that they will simply learn to behave appropriately in the presence of the authority, but not behave appropriately otherwise. The positive emotions will make pervasive imitation more likely. By providing stability and structure, the authority helps individuals to increasingly distinguish reality from fantasy.

Primary Stage

We estimate about 2% of people may not progress beyond this stage. Such individuals would have an understanding of their own perspective and an understanding of another's perspective, but would not integrate the two. These individuals see attachment in terms of their own needs or the needs of another, but not both together. We speculate that the trauma or negative interpersonal experience may happen somewhat later, though typically between the ages of two and ten. The reasons for the lack of development are that the individual's experiences or biology prevent them from engaging with an issue. An important aspect of such early experience would be whether caretakers model perspective-taking with the child. Individuals behaving at the primary stage do think about what causes them harm, rendering them somewhat realistic. However, their idea of right and wrong would be based only on the consequences of their actions. For example, at the primary stage, a man might rape a 13 year-old. This individual knows what they are doing, but not how the other person might feel.

Primary to Concrete

The use of standard cognitive-behavior interventions are one main way to move from primary to concrete. In children, this transition moves them from being more directly controlled by outside circumstances, such as consequences of their own behavior, to anticipating how what they prefer to do will be perceived by specific others, such and family and associates. Cognitive behavior therapy works on making these predictions more salient and also in adjusting them better to reality. Reinforcement of cooperation and fair dealing might also be effective.

Concrete Operational Stage

We estimate about 5% of adults in a modern society would be found to reason primarily at this stage. At this stage, the individual integrates the perspective of another with their own perspective, and so they can make a deal in which both people benefit. A hallmark of the concrete operational period is to know who cares and who does not. Many of the people in jail (drug dealers, pimps, prostitutes) perform at the concrete operational stage of attachment. Prostitutes functioning at this stage engage in quid pro quo (money for sex). These individuals know the deal, but they do not understand the social norms that forbid such deals even though they can state such norms. That is, their social behavior is based on deals with individuals, but they do not think more generally of what others, even in their own social group, might think. Another example of a concrete person is an individual who has sex with an underage girl. The girl might agree to the sexual encounter, but they do not understand that they are breaking the social norm against sex with underage people. This type of conception of attachment relationships can also be seen in at least some narcissists and psychopaths.

Concrete to Abstract

In order to move from the concrete stage to the abstract stage, people may learn that the group as a whole has a sense of the social norms. They can come to see that it is a property of groups of people, not just the people with whom they deal directly. An example of moving from concrete to abstract are 12-step programs, which seem to work in moving individuals from one stage to the other. In addition, the programs provide clear social norms and social reinforcement systems.

Abstract Stage

We estimate about 20% of adults are at this stage in their attachment relationships. They will know the social norms and these norms will be important in regulating what happens in their relationships. When the identification is with socially appropriate groups and norms, this can lead to a lot of socially accepted, although perhaps rigid behaviors. When impaired, individuals behaving at the abstract stage may belong to the "out group" and therefore act against the norms of the "in group." This may occur because an important model in the person's life has had a strong "identification" with anti-social norms. It may be due to being maltreated. Some may be in the negative step of the transition from abstract to formal – the anti norms. During stage transition (Commons & Richards, 2002) the first step of leaving the earlier stage adaptation is to negate the actions of that stage. People who are performing at this step of the transition may go against the social norms, though this is also expected in at least some adolescents. It is when this kind of thinking persists beyond adolescence that there can be a problem. For example, individuals who belong to an "out group" can engage in a great deal of negative behavior directed against others in society. This can harm both themselves and others. Others not in their group will get

pejorative names and this is seen as justifying being able to treat them badly.

Abstract to Formal

In order to move from the abstract stage to the formal stage, individuals have to learn an empirical approach to understanding how to behave with respect to another. One has to see what is effective in making relationships work and getting others to care.

Formal Stage

We estimate about 30% of adults will be at this stage in their attachment relationships. At the formal stage, individuals understand that causality is linear and univariate. Since each problem can only have one cause, this can lead someone in a relationship to blame the other for the problems in the relationship. The difference between the abstract stage view and the formal stage is that evidence and logic are brought to bear in the formal stage. During the transition to systematic, therefore, when the failures in the relationship are discussed, the statements of blame do not consist of unsupported accusations. Instead, they are supported with evidence and with logic. The problem develops because simple, one-variable causal models lead to the blame being perceived as belonging to only one party in the relationship. Because the formal stage action is found in a large number of adults, it cannot in a normative sense be considered impaired. It does, however, because of the single variable reasoning, lead to impaired relationships in which conflicts cannot usually be resolved in a manner that is satisfactory to both participants.

The formal stage is also the stage in which social norms are captured in bureaucracies of formalized rules. People acting as part of a bureaucracy may justify destroying certain groups of people because of formalization. Such formal operational bureaucrats could include people who work in the genocide machines of various states. They may put into place policies that result in the killing of a great number of people, not because they are angry, but because they "are just doing their job," as Kohlberg (1984) argued and was shown by Milgram (1974). This sort of behavior may not be associated with disordered attachment at the individual level. The two domains can be completely separate. An example of this is actors and actresses who play roles in adult movies; they are performing at the formal stage. They are playing well defined roles, following explicit direction of the director, who is in turn following a script.

Formal to Systematic

For formal behaving individuals, effective interventions might concentrate on helping individuals understand a more complex view of a relationship that includes both participants as sharing responsibility for both positive and negative aspects of the relationship. The role of each person in the web of interaction would be discussed. This would take place in repeated discussions, in which the two individuals' views that the other was to blame were put into conflict with each other. The interdependence of each role would be shown.

Systematic Stage

We estimate about 20% of adults operate in this stage. When in it, both caring and failure of caring in individual relationships are seen as mutual. There begins to be the perception of real conflicts between ourselves, our individual relationships and the overall system in which we are embedded. Individuals become more involved with and more invested in work and other institutions. For example, a person may be focused on their job and their company, but no longer pay as much attention to their family. People may also fail to make room for taking care of themselves due to these other competing demands. These competing demands all seem to have equal priority and begin to be seen as pitted against one another. Due to these feelings, an individual might reject work and focus on family. However, it is also possible that they might completely subjugate self to either of these other concerns in a destructive way.

The systematic stage also includes an inability to use effective means available for settling conflicts. In relation to our enemies, we do not see any attachment to them. This is because we still see our enemies as belonging to another, alien system. As a result, we would rather use power than ways of engaging them. These actions are usually legitimized by something like a vote. Unfortunately, we do not say that our enemy are sick and should be asked if they need help; we do not see that these people are "underdeveloped;" we do not ask if they would like help becoming more developed. Instead, we say that they are bad and we need to punish them.

Systematic to Metasystematic

Individuals work to understand their own systems of thinking, as well as understand those of significant partners. One also has to learn unconditional respect for other people, including one's enemies. It is also necessary to develop a positive interdependency rather than being stuck in endless independence (rights) versus dependence (duties) struggles.

Metasystematic Stage

From our studies of postformal thought (Commons, Miller & Kuhn, 1982), about 2% of adults operate at this stage. At this stage, there is a universal respect for all persons, even enemies. The respect for enemies exists only in a projective way, though. The exception is that when one is actually involved with someone on a day-to-day basis. People may actually co-construct the reality of relationships directly with the parties concerned, especially in cases of conflict. Failure of the metasystematic stage is that we do not co-construct a reality that would allow us to solve some of these conflicts. As a society, we have begun to co-construct partially over a few issues. For example, we no longer want to run "secret" revolutions in other nations.

Implications for Improving Relationships

In order to improve attachment relationships, it is important to move up in stage. At each higher stage, one has a greater opportunity to eliminate the negative side of the previous stage of development and more fully meet the needs and concerns of all participants. The question is, how best to promote further development?

There have been two points of view as to why a person engages in elevated frequencies of undesirable behaviors and low frequency of desirable behaviors. One explanation has been the utility aspect (the expected value of the behavior). The other is the developmental aspect (the probability that the behavior itself or the discernment of contingencies is in the repertoire of the person). Our contention is that the utility aspect is dependent upon the developmental aspect. For example, requiring a behavior that is too developmentally advanced for a person in order to avoid

punishment, will fail to obtain that behavior. This is commonly seen when observing parents or others interacting with children. Some parents may repeatedly try to get their child to do something, using both positive reinforcement and/or punishment and repeatedly fail. Often, parents are requiring a behavior that is simply too developmentally complex for a child. When a behavior is too developmentally complex or the contingencies surrounding that behavior are too complex, they are simply not discriminated by the individual (whether child or adult).

Therefore, moving individuals from each stage to the next differs, depending on the stage at which they begin. Generally, adults who function at stages generally seen in childhood (for example, preoperational, primary or concrete) are the most impaired. Such adults would need a great deal of intervention in order to be able to move up in stage. This is often complicated by the fact that their lack of development results from seriously impaired early attachment relationships, including relationships that may not have promoted the early development of empathy and perspective-taking. Some of the sites that such adults end up in - such as prisons - are not set up to promote empathy and perspective taking, and so may fail to rehabilitate individuals. Such individuals may also be suffering from serious forms of mental illness or other biologically-based challenges that would make moving up in stage difficult.

For adults who function at stages that are seen in adolescence or sometimes early adulthood (e.g., abstract or formal) there are different stumbling blocks to change. For one thing, they might be able to locate a social group and relationship partners that function close to their own stage and so this way of thinking may not be challenged in most cases. Such individuals might show a pattern of repeated relationship failure, but not be exposed to contingencies that would promote stage change. The way for such individuals to change would be for them to spend time in a context, such as a therapeutic context, that would lead to their abandoning lower stage strategies. Since few, if any, therapies take a systematic developmental point of view, this would be a hit or miss proposition.

For individuals who function at the systematic stage within relationships, the challenges to move beyond the systematic stage would be daunting. Finding a therapist qualified to help two individuals co-construct a metasystematic level relationship would be difficult.

At all the stages, one thing that is not really tried as often but seems to be useful is coaching from trained professionals. Many people who function at the lower stages need advice on how to behave. They need to be coached as to how to try different ways of behaving and to see the effects on others of what they try. It is especially useful for people who are high functioning in other domains. Coaching of this type would be based on transmitting successful practices in the relationship domain.

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Stages of Infant Development, as Illustrated by Responses to the Peek-a-boo Game

Patrice Marie Miller
Salem State College

Michael Lamport Commons
Harvard Medical School

Infants' responses to different peek-a-boo stimuli presented by experimenters illustrate three infant non-mentalistic stages of development (Commons et al., 1998). Results showed that for the youngest infants (sensory and motor stage), almost any kind of interactive contact with another human (as long as it included vocalization with smiling and eye-contact) produced responses such as smiling. Between roughly 4 and 8 months (circular sensory motor stage), the specific version of the game that was played became important. Games that included hiding, coming out and saying peek-a-boo in an animated voice obtained maximum responses; games more divergent produced less responding. For older infants (sensory motor stage) games that diverged from the standard in specific ways could sometimes produce even higher rates of responsiveness, although this depended on the particular circumstances.

Parent-infant interactions have been the topic of literally thousands of studies. Studies have examined infants and their parents in very structured situations (e.g., Brazelton, Koslowski & Main, 1974) or more naturalistic situations (LeVine et al., 1994; Stern, 1977; Trevarthen, 1980. Many studies of interactions have focused on attachment or attachment-related processes (e.g., Ainsworth et al., 1978 and others). The current study examines responses to the game of peek-a-boo in infants up to 2 years of age.

Because peek-a-boo has such a definite structure, it provides a framework with which to study the ways in which infants' participation in interactions changes during the first two years of life. It has been related to linguistic interactions; Ratner & Bruner (1978) argued that it could assist in language development because of its highly structured and repetitive structure. It also is a form of game-playing and has often been studied from that perspective. Rome-Flanders et al. (1995) videotaped naturalistically-occurring peek-a-boo interactions between infants 6 to 24 months of age and their mothers. They found significant changes across age in the gestures used and the emotional reactions observed, and evidence that infants increasingly understood the 'rules of the game.' Parrott (1989) found that infants as young as 6 months of age had developed expectations of what would happen at certain times in the game, and when he switched the expected components in some way, they showed less responsiveness. The peek-a-boo game has also been used as a framework within which to study emotion regulation in infants. Stifter & Moyer (1991), for example, found that young infants (5-month olds) use gaze aversion during the peek-a-boo game to regulate their arousal. Hodapp & Goldfield (1985) found that infant and mother regulation seemed to function in a complementary fashion in pairs studied between 8 and 15 months of age, and that the mother's structuring of the situation was an essential part of the development of self-regulation.

In all of the above studies, developmental changes are referred to in a general way. The changes in behavior are not related to developmental stages. In the current study, 15 variations of the peek-a-boo game were played with the infants. These 15 variations were generated by separating the game into 5 components: hiding, coming out, smiling, saying peek-a-boo, and using an animated voice. The reactions of infants to the different variations of the game will be examined and related to changes in infant developmental stages, as these have been proposed by the Model of Hierarchical Complexity (Commons, Trudeau et al., 1998).

Method

Participants

The participants in this study were 51 infants between 15 and 650 days old (24 female, M = 212 (S.D. = 123); 27 males, M = 183 ($S.D.$ = 147). All subjects resided in an urban area of Manitoba, a Western Canadian province. Experimenters and observers were persons enrolled in an undergraduate psychology course and mothers and fathers of the infants. Experimenters were the persons playing the actual peek-a-boo game with the infant. Observers were the persons recording infant responses under the prescribed categories. The only information given to either was limited to the experimental protocol necessary to carry out the procedure. The group members recruited participants from among people that they knew in the community.

Procedure

Groups of two to five members worked together in recruiting infants and carrying out the experiment. Group members alternated as experimenters and observers. The experiment was carried out in the infant's home.

The infant was placed directly in front of the experimenter, with the observer off to one side. The experimenter played with the infant as long as he/she could obtain eye-contact with the infant within approximately three seconds of making a noise or

calling the infant's name.

Fifteen versions of the peek-a-boo game, each lasting approximately 10 seconds, served as stimuli for infant responses. The versions of the game are shown in Table 1.

Table 1. 15 Games of Peek-A-Boo

Game #	Hiding	Coming Out	Smiling	"Peek-A-Boo" in a Flat Voice	"Peek-A-Boo" in an Animated Voice
1	X	X	X		X
2	X	X	X	X	
3	X	X	X		
4	X	X			X
5	X	X		X	
6	X	X			
7	X				X
8	X			X	
9	X				
10			X		X
11			X	X	
12			X		
13					X
14				X	
15					

The order of games was randomized and presented according to five thirty-game data sheets. In this manner, 150 games could be played without the same sequence being repeated. Each game started with the experimenter obtaining eye contact with the infant. Games continued until one of the criteria for stopping was met. Stopping criteria included:

1. The infant failed to establish eye-contact for three out of five consecutive trials.
2. The infant interrupted the game by crying, falling asleep, etc. for three out of five consecutive trials.
3. A distraction was introduced into the environment.
4. The parents requested the termination of the session.

Each infant engaged in a different number of trials, although generally no more than sixty trials were run on any one day.

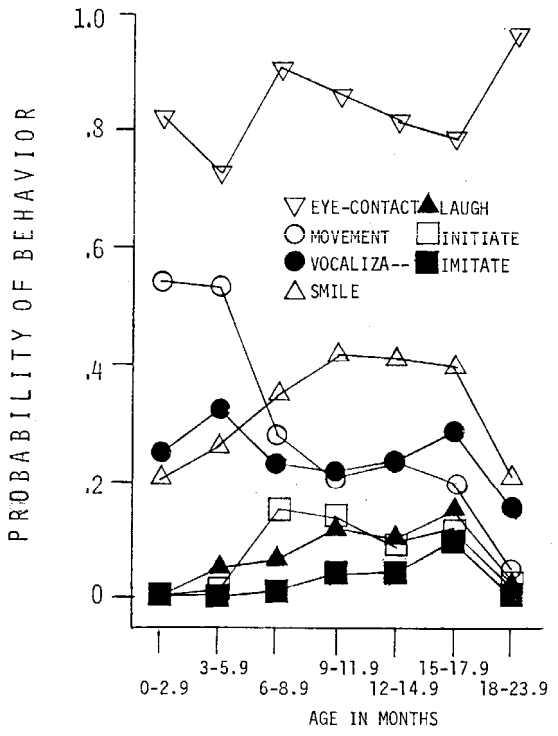
Observers recorded infant responses to each game according to seven response categories: eye contact, smiling, laughing, vocalizing, gross motor movements, imitating and initiating. Infants were given ten seconds to respond. Responses were not interrupted by the start of another game. The total number of trials for all infants was 15,029.

Results

General age differences in responses to the game

To understand the sequence of the development of behavior and what events control behavior, we examine changes in specific behaviors over time. Figure 1 shows that the earliest response, eye contact, was clearly the most frequent response recorded.

Figure 1. Infants' responses (eye contact, physical movement, vocalizing, smiling, laughing, imitating and initiating) in response to peek-a-boo across the first 2 years



Usually 80% or more of the time, an infant would at least look in response to a version of a peek-a-boo game. Vocalizing in response to a peek-a-boo game tended to stay between about 20% and 30% of the time across age, other than at the last age period in which it dropped. Other behaviors tended to show differences across developmental periods. Motor movements were highest during the first two age periods and then dropped. Smiling showed an increase up until the end of the first year, then remained reasonably stable until the last age group. Laughing increased somewhat up until the 15 month age group. Imitation and initiation, while low in frequency began to increase from 6 months onward. All of the responses, except eye contact, dropped off in the last age group.

How do individual responses group together?

In the previous section, we examined individual infant responses: eye contact, gross motor movement, vocalizing, smiling, laughing, imitating and initiating. Because groups of responses appeared to change in a similar fashion across time, a factor analysis was performed for the data as a whole, across age groups. The seven individual responses could be grouped into three factors. Table 2 shows the results of the factor analysis.

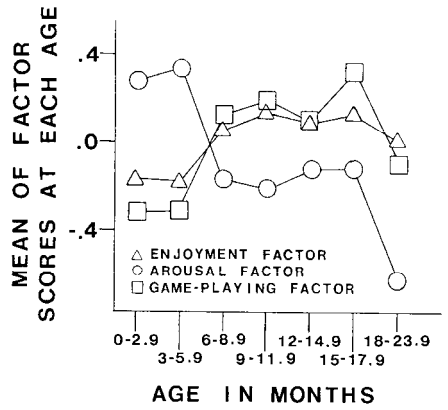
Table 2. Factor analysis results showing group of individual responses[1]

	Factor 1 Enjoyment	Factor 2 Arousal	Factor 3 Active Play
Eye Contact	.51921		
Smiling	.69403		
Laughing	.65673		
Vocalizing		.76200	
Movement		.72123	
Imitating			.69009
Initiating			.76293

The first 3 responses – eye-contact, smile, and laugh -- loaded on Factor 1. We have called this the enjoyment factor. The responses vocalize and gross body movement loaded on Factor 2. We have called this the physical arousal factor. Imitate and initiate loaded on Factor 3, which we have called the "active game-playing" factor.

Figure 2 shows the mean of the factors scores, for each of the three factors, across age and across all games. As can be seen, general physical arousal is highest during the first six months of life and decreases thereafter. The Arousal Factor, which consisted of gross motor movements and vocalizing by the infants, may reflect general eliciting properties of the interaction. Young infants, in particular, wriggle, move and vocalize when people talk to them. From 6 months onward, these kinds of responses decrease. These changes over age were significantly different from chance ($F(6,15,023) = 46,996$, $p < .0001$.).

Figure 2. Age differences in factor scores based on three factors: Enjoyment, physical arousal and game-playing



[1] Factor analysis conducted using Principal Components Analysis, with a Varimax rotation

Both enjoyment and game playing increase at 6 months, and remain near the same level until the last age period (18 to 23.9 months), at which time they decreased. Both of these factors showed significant changes across age as well ($F(6,15,023) = 174.261$, $p < .0001$ and $F(6,15,023) = 60.317$, $p < .0001$, respectively.

Patterns of responses to different types of games

The above analyses examined infant responses irrespective of the type of peek-a-boo game that was being played. The next step was to look at the response functions for different types of peek-a-boo games? Seven overall types of games were created, as shown in Table 3.

If the function for each component showed exactly the same form of the respective factor as the overall pattern for that factor which was described in Figure 2, but differed in height, we would conclude that adding components changed only the degree of excitation. If different components resulted in different functional forms, we would conclude that the overall pattern of results cannot be explained by a simple summative model, but that individual components may control responding in way different from the overall game.

Table 3. Games that were collapsed to form composite games

Game	Actions
The Full Game	Hide - Come out - Say Peek-a-boo - Animated - Smile
Hide Only	Games 7, 8, 9
Hide and Come out	Games 2, 3, 4, 5, 6
Smile Only	Games 2, 3, 10, 11, 12
Say Peek-a-boo in an Animated Voice Only	Games 4, 7, 10, 13
Say Peek-a-boo in a Flat Voice Only	Games 2, 5, 8, 11, 14
Do Nothing	Game 15

In Figures 3, 4, and 5 the means of the factor scores from a particular factor were calculated for each single component across all age groups. This value of the mean of the factor scores across age, shown by the vertical lines at the right hand side of each of the figures, gives an idea of the relative size of the factor scores obtained in response to each of the single components; larger means suggest higher responsiveness to that component. In order to illustrate the forms of the response functions separately from their heights, the mean calculated for each component across age was subtracted from the mean of the factor scores for a component of each age. These deviations from the mean are represented by the curves seen in the three figures.

Figure 3 shows that for the physical arousal factor, the components produce a much more uniform pattern of responding, with high mean responding from 0 to 6 months, and then a U - shaped pattern with another peak at 18 months, suggesting that individual components did simply sum to produce the function seen for the full game, and that responses to the components are relatively undifferentiated. Overall, the full game shows the highest mean score, followed by smile and animated peek-a-boo.

Figure 4 shows that for the enjoyment factor, different components do result in different patterns of responding. Because

2 major patterns were detected, two separate groups of curves are shown on the graph for ease of reading. A third pattern, for the nothing game, is included in the top set of curves. The top set of curves includes the fill game, the hide/comeout game, and the animated peek-a-boo game. Responses to these games all show a steady rise from the first age group (0 to 3 months) to 9 to 12 months and shown a relatively flat function thereafter. The pattern for the nothing game resembles neither of the 2 major patterns.

Figure 3. Deviation from the mean of the enjoyment factor score at each age, in response to seven different versions of the peek-a-boo game

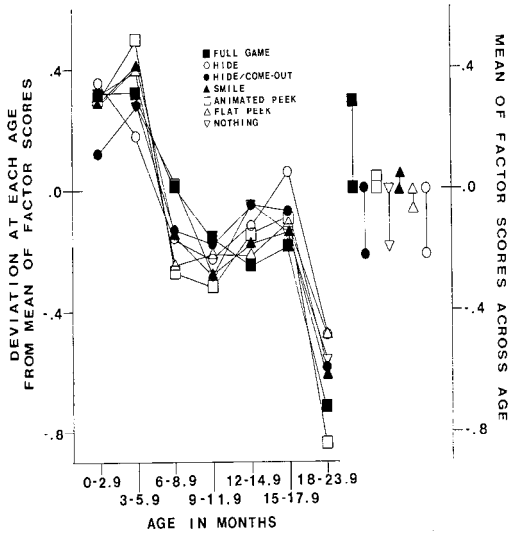
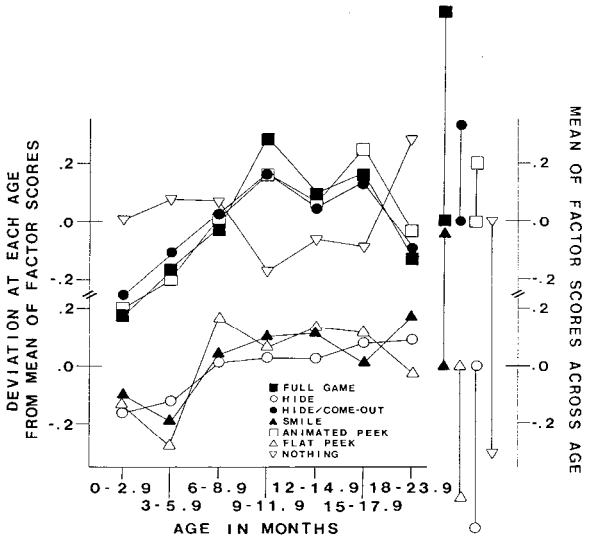


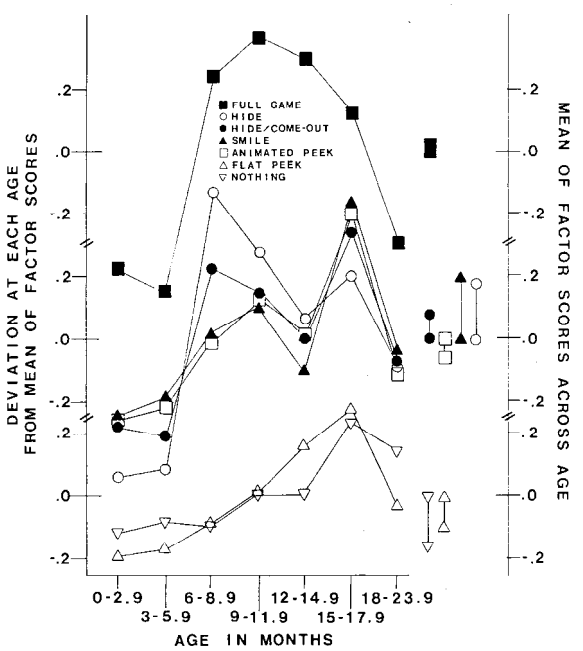
Figure 4. Deviation from the mean of the physical arousal factor score at each age, in response to seven different versions of the peek-a-boo game



The mean factor scores on the right side of the graph can be ordered from largest to smallest as follows: the full game, then the smile game, then the hide/comeout game, then animated peek-a-boo. The discrepant components, hide-only, flat peek-a-boo, and the nothing game produced negative mean factor scores. From this pattern of results it does not seem as if the functions for the single components, shown at the bottom of the graph, merely sum to produce the function for the full game, shown at the top of the graph. Combinations of as few as two of the components look very similar to the full game, while games with single components do not.

In Figure 5, which summarizes the results for the game-playing factor, we see three separate functional forms. Here, the flat peek-a-boo game and the nothing game seem to produce equivalent functions - a gradual rise of active game-playing in response to them, which peaks at 15 to 18 months. All the remaining games, except for the full game, produce a two-peak pattern. In this pattern, the first peak appears at 6 to 9 months for the games containing hide, but at 9 to 12 months for the games containing smiling and animated peek-a-boo. All these games show a dip at 12 to 15 months and a second peak at 15 to 18 months. The full game, by contrast, shows the same first rise, at 6 to 9 months, remains high until 12 to 15 months and then decreases at the same time that the single components are showing a peak of responding.

Figure 5: Deviation from the mean of the game playing factor score at each age, in response to seven different versions of the peek-a-boo game



These patterns suggest that different components lead to active game-playing at different ages; hiding games seem to produce such game-playing earlier than games without hide, and the full game produces more such active game-playing. The rise in game playing in response to simple component games at 15 to 18 months, at the same time that such game playing is being reduced for the full game may reflect the fact that by the time, the

truncated versions of the game are either more discrepant, or may serve as a cue for infants to begun to fill in the missing components.

Discussion

The responses found in this situation, both at the individual level and when grouped together as factors are consistent with three infant stages, as described in the Model of Hierarchical Complexity. The discussion that follows, and Table 4, discusses a possible stage sequence for peek-a-boo, and compares it with stage sequences of other infant behavior.

Sensory or Motor Actions

In the sensory or motor stage, infants' responses to stimuli tend to be relatively fixed and reflex-based, with only some generalization. In peek-a-boo, passive responses are seen: looking, motor movements (denoting excitement), and vocalization. Infants show a generalized response to an interactive stimulus, but not necessarily specific comprehension of that stimulus. This is seen in the fact that violations of the standard peek-a-boo game were responded to in the same way as was the standard game.

Circular Sensory-Motor Actions

In the Circular Sensory stage, infants may coordinate their movement with their perceptions. Their vocalizations begin to consist of phonemes that occur in the language they typically hear. They engage in turn-taking in verbal and other games, recognizing the characteristic utterances and gestures of a particular game. They can follow simple, one-act directions. They can communicate using gestures.

More specific "enjoyment" of peek-a-boo is seen starting around 6 months (as shown in Figure 2). The Enjoyment factor (made up of Eye Contact, Smiling and Laughing) is prototypical emotional behavior associated with game playing, especially because peek-a-boo has been shown to serve as a reinforcer (Watson, 1972). One sees changes at the point that object permanence develops (between 6 and 8 months). The three games that elicited the highest levels of responses were the full game, the hiding and coming out game, and the game in which the experimenter simply says peek-a-boo in an animated voice. The smiling and laughter that occurs in response to peek-a-boo games shows increasing understanding of the meaning of the game. Imitation and initiation also began to increase around the same age period, showing that infants are beginning to take a more active role in interactions, including in the playing of games.

Sensory-Motor

During this third stage, infants have concepts, such as roundness, squareness, more than, plant, people, etc. They have begun to put basic sounds together into meaningful syllables. They can follow simple commands that do not specify individual actions needed (e.g., "Go get your juice.").

Table 4: Infant non-mentalistic stages in several domains

Stage Name	Discriminations	Vocalizations Utterances & Words	Verbal Relationships	Receptive Speech	General Examples	Peek-a-boo Examples
Calculatory	Exact: no generalization	Machine Speech	Those Programmed	Speech Recognition	-	-
Sensory & Motor Actions	Rote, generalized	Babbling, Elicited utterances	Repeated sounds	phoneme discrimination	-	Attention to Stimuli; Generalized responses of excitement
Circular Sensory-Motor Actions	Open-ended classes	Phonemes	Turn taking in verbal games	Follows one-act directions	Gestures, Pronounced "[w]," "[ah]"	Smiles, laughs in response to Coming out, Animated peek-a-boo; Imitates single actions
Sensory-Motor	Concepts	Syllables	Combines phonemes into syllables	Follows simple commands	Holding cup out and saying "Wa"	Hides own face and comes out, saying some part of "peek" or "boo"
Nominal	Relations among concepts. Named concepts	Single words, exclamations, verbs, nouns, number names, letter names	Relationship among morphemes producing words	Follows simple chain of commands: "Go to the table and get the cloth"	Says "Water"	Says "peek, or boo." Hides own face. Comes out, saying "peek", "boo" "peek-a-boo" or "play."

Sentential	Imitates and acquires sentences. Follows short sequential acts.	Pronouns. For example, "My book"	Incomplete sentences; then complete sentences, crude dichotomies, ordered numbers and letters	Follows Instructions: "Turn off VCR when tape is over."	States a rule, "Don't touch"	Says "Play peek-a-boo." Hides own face and comes out, saying "peek-a-boo" and then repeats the game.

Note. Lowest stages do not have examples.

In peek-a-boo, simple enjoyment of the standard game begins to wane. Infants can initiate the complete game, not just components of it. We would speculate also that peek-a-boo playing begins to generalize; play with multiple people, in multiple contexts and multiple ways (e.g. peer around a wall at someone).

In conclusion, while a set of behaviors such as peek-a-boo playing surely forms a developmental sequence of its own, it is also the case that by comparing it to established developmental sequences a more complete understanding can be obtained.

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How are the Processes by Which People Become Attached Influenced by Stage of Development?

Patrice Marie Miller
Salem State College and Harvard Medical School

Michael Lamport Commons
Harvard Medical School

The current paper examines individuals' understanding of relationships with significant others in terms of the increase in complexity of tasks that is posited to occur in the Model of Hierarchical Complexity (Commons et al., 1998). We interviewed 8 to 10 year old children, and adults, about losses of attachment objects, including people, pets, objects, places, events and ideals. Statements that children and adults made about these attachment objects were scored used the Model of Hierarchical Complexity. It was found that children's statements were primarily scored as primary or concrete. Adults' statements ranged from primary to systematic, but were more often scored as abstract, formal and systematic (not primary or concrete). Illustrative examples of statements at each of the orders of complexity for both children and adults are provided. It will be important to extend these findings by examining whether the verbal behavior of individuals with respect to relationships is related to the kinds of relationships they appear to have.

Attachment theory, as proposed originally by Bowlby (1969) and Ainsworth (e.g., Ainsworth, Blehar, Waters, & Wall, 1978) conceived of attachment of infants to their caregivers as a biologically-based system. According to these theories, the most important aspect of attachment was that, as a result of an infant's experiences, the infant would develop a different quality or type of attachment. According to this research, the optimal type is called secure attachment. An infant who is securely attached will appropriately seek contact with a caregiver when upset, fearful or ill. Once consoled, such an infant will be able to get on with exploring the world. Other infants, given other kinds of caregivers, might develop different types of what has been called insecure attachment. Such infants might, for example, avoid and not tend to seek contact when distressed. Others might be resistant or ambivalent, both seeking contact and rejecting it. While the type or quality of attachment an infant developed (e.g., secure vs. insecure) was seen as related to the quality of care that infant received, the fact that an infant would become attached was seen as inevitable and universal, given almost any care environment.

Even if all people become attached, as postulated by Bowlby (1969) and Ainsworth et al. (1978), the processes that are involved in developing attachments both in infancy and beyond may differ. This paper examines possible processes by which humans of all ages may become attached. Attachment processes are those events that are involved in developing and strengthening the attachment behaviors at different stages and those processes involved in shaping which particular attachment behaviors develop. The processes are discussed from the point of view of the developing infant or child. It is assumed that another set of processes is operating on those taking care of that child.

Beyond the Bowlby and Ainsworth theories discussed above, there have been two contrasting views of attachment that have been proposed. Both have proposed processes by which attachment comes about. The first is the social conditioning view of researchers such as Gewirtz (e.g., 1969, 1972, 1991). The second is the stage developmental view of Kohlberg (1969, 1991). In examining attachment processes, this paper takes a different view than the Bowlby-Ainsworth view. This view is more influenced by learning theory on the one hand, and cognitive developmental theory on the other.

Traditionally, learning and cognitive developmental theories have been seen as being in opposition. For example, traditional learning theory views most aspects of attachment as remaining constant over the life span, including the processes by which attachment takes place. Cognitive and moral developmental theories instead see fundamental changes taking place at each stage in life, even if the process of stage change may have commonalities. Commons (1991), however, synthesized the two theories, demonstrating that they share a number of notions with regard to attachment. First, both Kohlberg (1991) and Gewirtz (1991) see attachment as something that occurs over the lifetime, and is not confined to, nor primarily based upon, processes in infancy. A second commonality is that both theorists see attachment as a set of processes, not as traits such as "being securely attached." When examining these processes, Kohlberg and Gewirtz concentrate on stage-change and conditioning processes, respectively. Third, they share the notion that the attachment processes involve more behaviors than just seeking to be physically close to an attachment object. They examine a wide variety of behaviors that are directed toward individuals to whom someone is attached.

A Hierarchical-Complexity View of Attachment

This paper proposes an integration of some of the ideas from traditional learning theories and some from traditional cognitive developmental theories. A central part of this integration is embodied in the Model of Hierarchical Complexity, which is described in the Introduction to this issue.

In the view proposed here, there are two basic assumptions with regard to attachment processes. The first is that attachment processes operate throughout the life span (Gewirtz, 1976, 1991;

Greenberg, Siegel, & Leitch, 1983; Kahn & Antonucci, 1982; Kalish & Knudtson, 1976; Kohlberg, 1991; Lerner & Ryff, 1978; Levitt, 1991; Main, Kaplan, & Cassidy, 1985; Troll & Smith, 1976; Weiss, 1982). The second is that as individuals develop, different types of attachment processes will become important, although the old ones do not disappear.

The Model of Hierarchical Complexity provides a rationale for specifying the order of development of attachment processes. Which particular kinds of attachment processes will predominate depend on a number of factors. These include: (a) the order of hierarchical complexity of the actions and interactions of the people involved in a relationship; (b) other contingencies in the situation; and (c) how discriminable the contingencies are in the situation at each given order of hierarchical complexity. Discriminability, however, is only part of what would actually determine attachment processes and behavior. Such processes will also be influenced by a person's current interaction with the environment including what the current contingencies are and what has been that person's conditioning history. Depending on (a) the discriminability, (b) the environmental contingencies, and (c) the person's history, a person will perform at a certain stage. The stage numbers used are generally equivalent to the numbers used in the Model of Hierarchical Complexity. The difference is that, given different conditions, an individual may perform at a stage lower than the order of complexity that they can, at other times, discriminate. Biologically-based maturational processes, such as critical periods, independent locomotion in young children, or puberty during adolescence, may also affect the events that are most salient in the development of attachment behavior.

The paper will use the Model of Hierarchical Complexity to trace out the processes at each stage, beginning with early infancy and continuing to the formal operational stage. Following the infancy period, a number of general trends can be seen. The attachment relationship with the parent, for example, begins to decrease in importance relative to the growing relationships with peers. While this is by no means an overnight occurrence, it is important to recognize that in a very real sense there are increasingly two kinds of attachment relationships that are developing and interacting during childhood and into adolescence and beyond. At the beginning of adolescence, and relating to pubertal changes, a third kind of attachment relationship becomes possible, that is, a romantic relationship that will eventually lead to establishment of a marriage partner or mate. The discussion will stop with the formal operational stage because of the complexity in writing about three or more different kinds of relationships at a time.

Stage 1: Sensory or Motor Stage

During the Sensory or Motor Stage, responsiveness to distress through touching, holding, feeding, or changing is the major attachment process or mechanism. Infants engage either in actions or in perceptions, but do not coordinate the two. The main processes by which attachment can develop and be expressed are respondent conditioning within comforting interactions, habituation to aversive and other stimuli, positive reinforcement of orienting and exploring the environment through the various senses, and negative reinforcement. Distress is mainly elicited and responsive to operant conditioning only in the short term. Negative reinforcement decreases all kinds of distress. As a result, those who are associated with consoling infants become conditioned, comforting stimuli. There is a small preference for a primary caregiver, which seems to be partially based on familiarity (Miller, 1989); the familiar caregiver is more effective at pacification than others. In addition to the caregiver's role in effectively decreasing distress, habituation may account for a portion of the preference for behaviors or aspects of specific familiar caregivers.

Stage 2: Circular Sensory-Motor Stage

Circular Sensory-Motor actions generally begin sometime after 3 to 6 months of age. As far as the development of attachment is concerned, during this period, positive and playful interactions become an important additional mechanism. During this time the consoling of distress continues to be an important mechanism in the development of attachment. Crying also becomes subject to conditioning. In order for crying to become operantly conditioned, however, it first must occur and then it must be reinforced. A prototypical interaction that might reinforce crying would be for a caregiver to wait until crying has been occurring for some time and only then to respond to it. If caregivers regularly anticipate when crying is about to occur and respond before that happens as much as possible, operant crying will be less likely to develop. Such anticipatory responses might include the removal of stimuli or deprivation states that lead to crying. At the same time, the infant's repertoire of positive behaviors, such as smiling, laughing, and vocalizing, becomes much more likely to occur. This gives ample opportunities for caregivers to use differential reinforcement of alternative behaviors in situations that might otherwise be moving towards distress.

Positive interactional behaviors from the caregiver become reinforcing for the infant, who responds in kind, leading to interactional bouts with pleasure (smiling and laughter) on both sides, including game playing (as discussed in the paper on peek-a-boo in this issue). The pleasure experienced in these interactions adds an additional reinforcing set of events into developing attachment relationships. Simple back and forth interactions are augmented by the presence of imitation. Imitation may be reinforced by the person being imitated by social attention and emotional response. The imitation of smiles and laughs by the primary caregiver are more reinforcing of behavior than when such imitations emanate from others. Therefore, mutual imitation becomes another process involved in strengthening attachment relationships. As the infant develops basic object permanence, caregivers become less substitutable one for the other. Infants develop a clear preference for one or a small number of attachment figures. They begin to have favorite toys, and especially, favorite comfort objects. In contexts where there are multiple attachment figures, infants will develop multiple attachment relationships (Tronick, Morelli & Ivey, 1992), suggesting that any of the processes discussed can be seen in multiple relationships. Infants can and do also discriminate separation from attachment figures. Protest at such separations may appear, although as Gewirtz and Pelaez-Nogueras (1991) have shown this protest can be conditioned. Infants can recognize familiar people in mirrors, looking first at the person and then the image. There is no evidence that infants recognize themselves at this point.

Stage 3: Sensory-motor Stage

Sensory-motor actions begin to be seen around the age when attachment is usually assessed in the "Strange Situation" (8 to 12 months). The infant begins to become mobile and simply because of the increased mobility begins to act independently in a broader arena. Infants can now imitate new behaviors, that they have not performed themselves, although this is most likely if the new behavior is somewhat similar to something the infant already does (Meltzoff, 1988). This is another mechanism that allows the rapid development of many new behaviors. During this time period, the presence of a preferred caregiver can itself serve as a stimulus for exploration of objects and of new people and situations. Infants move back and forth between seeking contact with the caregiver(s), and exploring away from the caregiver(s). The way in which this back and forth movement is responded to by the caregiver(s) is an important mechanism that can either promote more optimal behavior patterns in the infant or may make it less likely for the infant to be able to explore and move away from the caregiver. Infants use social referencing (Hornik & Gunnar, 1988) as a cue to what is safe to do. Distress becomes a more elaborated set of behaviors, such as uncertainty in a new situation becoming outright crying if the uncertainty cannot be resolved.

The infant has an ever increasing repertoire of different behaviors with respect to the caregiver and with respect to exploring the environment. In particular, infants increasingly make active efforts to engage the caregiver and, if uncertain, to get close to the caregiver. Infants begin to use gestures in interactions with others, such as pointing or reaching (e.g., Fogel & Melson, 1988). Infants also begin to use word-like utterances that caregivers (and researchers) observe as being consistently associated with the same or similar objects or situations (Fogel & Melson, 1988). But these words do not name concepts. These and other new behaviors introduce a major new set of attachment processes: how the infants' active behaviors toward the caregiver are responded to. There are also increasing individual differences in what behaviors an infant will preferentially use. This is what may lead to development of behaviors consistent with the typologies proposed by Ainsworth and colleagues (Ainsworth et al., 1978), although it is still uncertain that characterizing an individual child in terms of one dimension (such as security) makes sense.

Stage 4: Nominal Stage

As the more tentative and less efficient locomotion and motor movements of the previous stage become more practiced and efficient, infants at the nominal stage (from about 12 to 18 months) begin to explore their environments even more intensively. They will both use familiar behaviors in new situations, and also begin to try out variations of behaviors that are not the result of direct imitation. They will show pervasive imitation, being able to imitate many kinds of behavior. This seeming explosion in 'trying things out' brings about a change in the parent-infant relationship in that parents must increasingly attend to their child's safety and to setting limits (e.g., see Fogel, 2001). This introduces a new element into this developing attachment relationship. A parent that sets too many limits may increase the chance that an infant will fail, either by not inhibiting a parental-expected behavior or by failing to perform an expected behavior. Potentially they may end up with a relationship with a great deal of oppositional behavior.

Along with the infant's increased and focused exploratory behavior comes a change in communicative behavior. Infants now are learning to communicate in a more conventional way, that is, to use words as consistent symbols for their referents, as seen in naming or labeling things. Linguistic interactions with parents and others form a large part of the interactions with others, and again can contribute further to the attachment relationship. For example, the infant now not only relies on the parent as a source of physical security, but increasingly a source of useful information and guidance about the world. Infants also have an increasing sense of themselves, as shown by behaviors such as showing off, intentional communication and social referencing (Fogel, 2001). Parents' appreciation of such behaviors can serve to further reinforce them. Finally, some of the first evidence exists for the development of relationships with peers, instead of adults. This begins the process of development of a new set of attachment relationships. While a great deal of each interactions and play with peers is parallel play (Howes & Matheson, 1992), some occasional responses to a verbal request or a visual regard from the other are seen (Mueller & Lucas, 1975). Field, Vega-Lahr, and Jagadish (1984) have also reported evidence of increased stress when 15-month old infants were transferred from an infant nursery to a toddler nursery. Those transferred along with close friends showed much less disruption.

Stage 5: Sentential Stage

At the sentential stage, there is an ever increasing use of symbols, as seen in such developments as increased and elaborated pretend play and in language use. For example, infants begin to use sentences, typically two-word sentences at first. They, therefore, relate two symbols together. Infants show self-recognition, in a mirror, for example. They begin to refer to themselves (I, my) and also to label themselves (boy, baby). These are all examples of relating two symbols together. The growing sense of self is accompanied by a higher frequency of behaving independently. This can challenge the parent, who again must adjust their behavior to accommodate these changes. If the parent behaves in such a way as to reinforce early attempts at autonomy, while at the same time preventing the child from getting into dangerous situations, this will affect the development of a positive attachment relationship. Adults also play an important role in emotional regulation with infants at this age (Dunsmore & Halberstadt, 1997). Shared emotional experiences, such as helping the child to confront fears, play an important role in the parent-child attachment relationship.

Relationships with peers continue to develop. Some simple turn-taking interactions begin to be observed (Howes & Matheson, 1992). Children select children who are somewhat similar as playmates, and tend to direct mostly positive behaviors towards those children (Ross, Conant, Cheyne & Alevizos, 1992). Attachment processes previously discussed, such as shared interactions that are pleasurable, begin to be important in these relationships.

Stage 6: Preoperational Stage

At the preoperational stage, the child begins to engage in generalized imitation (Gewirtz & Stingle, 1968) and follow what

older people in the group do with whom they share an identity, such as same sex parents or attachment figures. Individuals self-labeling, putting themselves into categories, such as gender (Kohlberg, 1966; Miller & Commons, 1973), has effects on their relationships with others. Generalized imitation has been described by Bandura (1986) and Gewirtz and Pelaez-Nogueras (1991). One of the results of such a group identity, such as a sex-role preference (e.g., Kohlberg, 1966; Miller & Commons, 1973) is that not only is there attachment to the group, but behaviors of members of the group serve as reinforcers. Generalized imitation itself can be reinforced when outcomes that are similar to those exhibited by the model are produced. In this case, it is behaviors by the model that reinforce such generalized imitation, for example, laughing upon seeing their own behavior imitated. Generalized imitation means that the model does not have to be present at the time, for example, the modality of the stimuli can be through the media.

Preoperational stage individuals still cannot take another's perspective nor even understand what causes their own behavior beyond the simplest cases. As a result, there cannot yet be any truly reciprocal behavior. There is no sense of a shared self yet there is some empathy. Children may play together but do not play traditional games with rules such as dodge ball, kick ball, hop-scotch, four square or jump rope. They play with toys but do not use them in a way that demands cooperation. Relationships are asymmetrical. For example, in one preschool, everyone liked a boy because he was the smallest (E. Bett, personal communication, 2007).

Stage 7: Primary Stage

Beginning at the primary stage, individuals can understand and report their own perspective. They can also understand and report the perspective of another person. But, they do not relate these two at the same time (Commons & Rodriguez, 1990). There is actual rule-governed behavior in addition to pervasive imitation. The verbal behavior of attachment objects is vocalized as rules. The children follow rules accurately across time. Children can coordinate their actions with attachment objects. Children recognize their own dependence on the parent. They can discriminate the greater power and competence of the attachment object. If children are asked who is better, they reply that the attachment object is better. Also authority in general is seen as better, more competent, more virtuous. Children compare themselves to the attachment object, a social comparison that requires primary operations.

The perspective of the parent can be seen in the form of rules that the parent states. Insofar as there is moral attachment, feedback from the attachment object affects not only specific behaviors but mood as well. Such evaluations change the discriminated value of the self as well. Producing pervasively matched behavior is reinforced not only by the usual reinforcing events associated with the outcomes produced by such behaviors but also by the appearance of similarity, which is valued in itself. One can be very pleased to wear dad's shoes or mom's hats whether they are around and reinforce the behavior, or not. Outcomes delivered to the parents may reinforce behavior of the child, because of the shared self.

Many children refer to the teacher as just "teacher." They have friends only in the most curious way. They like a child because of the toys the child has, or the activity they can engage in with that child. The "friend" is a means to an end (Selman, 1981).

Stage 8: Concrete Stage

At the concrete stage, individuals coordinate the perspective of the other person with their own (Commons, Danaher-Gilpin, Miller & Goodheart, 2007). Two new sources of attachment objects appear: immediately propinquitous peers and small groups such as local teams. With peers, friendship is now mutual (Selman, 1981), and relationships in general are discussed in terms of exchanges between people, in which the exchanges are seen as being based in actual physical actions, objects, or other concrete instantiations. Shared activity with some degree of compatibility is the basis of peer attachment. Small groups of friends can form very small cliques, of two to four members. Relationships are seen in terms of the activities and behaviors of the people involved (mother-child; male-female), rather than as being between individuals.

While with peers, people can ignore the basic attachment figure to some degree. Immediate social reinforcement from peers is sometimes more effective than more general rules in controlling behavior. Hence, parental authority is sometimes ignored. While in the preoperational and primary stages, children will act out what they see or hear in the adult world, during concrete operations the shared-self may extend to models that appear in written or spoken stories. These are models that appear quite real as opposed to the mythical figures from the earlier two stages.

People change the way they behave with different friends. The perspective of the other is discriminated by considering how one's own behavior will affect another's behavior, the other person's behavior possibly reinforcing one's own. With such perspective taking, it possible to form attachments to named peer groups, such as cub scouts, brownies, camp fire girls. The attachment is to the authority embodied in that group. For example, at this stage, one might root for the Saint Louis Cardinals because they are the local team. But one might not feel like a kindred fan with someone else who also likes the Cardinals. Teachers become real authorities, not just directors of activities and providers. One needs to placate them to gain favor. Teachers and other such authorities are treated as individuals. Hence the school has a name and so do each of the teachers. Authority figures in general are good. There is a strong sense of shared self, the objects now being extended to informal local organizations. Rules are good and to be followed.

Stage 9: Abstract Stage

When they reach the abstract stage and can form abstractions, individuals can take the perspective of another abstract person, in addition to an actual or concrete person. For this reason, relationships become based more on social norms than on specific agreements between individuals. People do not, however, interrelate two variables or abstractions. They can only focus on one variable at a time. New attachment objects are learned. For example, group identification develops along with serious attachment to groups and group members. This attachment results in imitation of group members' behaviors. This includes nationalism (but in a local sense), allegiance to teams, schools, companies, religions and mates. People see themselves as belonging to one of the "socially acceptable" groups or to an out

group. People have circles of friends, quite often different sets depending on the activities. Friends try to act harmoniously. The group members' displayed view of themselves can serve as a reinforcer or punisher. Following the rules of a group makes one good. Nevertheless, there are multiple sources for the rules, since there can be multiple groups.

At this stage, people select attachment figures other than caregivers and immediate peers. Marriages tend to follow social norms. Having a harmonious marriage is most important (Armon, 1984). At this stage, one might begin to see attachment to certain abstract ideals, such as the idea of harmony. This stage is illustrated by some abstract-stage statements about relationships in which the relationship, emotions within the relationship, or a person's reaction are explicitly or implicitly quantified along a dimension.

Stage 10: Formal Stage

At the formal stage, individuals coordinate two abstract variables and thereby begin to understand logical, empirical relationships between those variables. For example, they may learn to relate the values of the variable of what a person does to the variable consisting of the different outcomes that follow. This gets applied both to the subdomain of interpersonal relationships, and to the subdomain of groups. The perspective is that within each subdomain consistent, logically-based relationships between behaviors and outcomes can be learned.

In the subdomain of interpersonal relationships, for example, how others-in-the abstract will behave can be experimentally and logically examined. This consists of a more advanced form of social perspective taking. People may figure out what to do to influence other people. The individual may now try varying their own behavior to see if they can have a positive impact on a particular attachment relationship. But they do not understand the circular nature of causality. That is they do not discriminate how their own behavior affects the occurrence of the behaviors of others which in turn, comes back to affect them.

There may be increased opposition to norms of basic attachment figures based on attachment to peer figures other than just parents and relatives. There is a concomitant weakening of dependence on those family figures. Despite the possible increasing opposition to parents and to other authority figures, there is conformity to age-appropriate peer groups. This is not in just superficial ways as in the abstract stage but in terms of the effectiveness of the group to use rule-governed behavior to subtly define the relationship between the person and the system. The resistance to authority figures is a direct result of the new reliance on empirical evidence, especially when the behavior of authority figures does not conform to the empirical evidence obtained. For many, attachment to romantic partners from the peer group introduces a new set of attachment processes. For example, physical and sexual pleasure are seen empirically and logically to reinforce and increase attachment.

Subgroups are to be affiliated with. One subgroup, usually the one that one is in, is seen as superior to all others. The perception is that its rules, regulations and notions are superior to others. This is different from group affiliation at the abstract stage because the characteristics of groups are empirically validated. The costs of being in some outside group are perceived as being high.

The rule governed behavior becomes formalized in the form of regulations. The rules lead people to have an idealization of the leadership of their chosen group. The regulations are just part of the ways in which roles become more formally delineated. This also leads to attachments to such figures as presidents of organizations. Such people are seen as fair, sensible, reasonable and caring.

Conclusion

Attachment processes begin with a simple set of behaviors. Different kinds of distress of infants are responded to, and these responses, if effective in decreasing distress, strengthen attachment. Infants at the beginning do not play a very active role in the formation of attachment. Three major trends can be seen as individuals develop. First, as the infant develops into a toddler, then a child, then an adolescent, they become more active in the interaction.

Second, throughout development, reinforcement contingencies and respondent conditioning play an important role in the development of relationships. For example, at the circular sensory motor stage, infants' smiling, laughing and vocalizing in interactions with caregivers results in mutual pleasure. As infants become more independent and start exploring the world, the caregiver responds by allowing for these new behaviors in a safe way. In each case, the underlying respondent association of the outcome produced by the caregiver gets associated with that caregiver, thereby changing the caregiver's value. The caregiver or other attachment object is seen not only as a source of reinforcement and comfort, but as a powerful figure. Just as surely as the value can become more positive, for caregivers who do not behave in an ideal way, this value can become more negative.

Third, as was discussed above, although the fundamental learning processes stay the same, the specific behaviors, the interactions within which they take place and the kinds of attachment objects that are involved change. The learning that takes place in these new interactions does not necessarily replace the old ways of interacting. For example, some degree of distress reduction is part of any relationship. What does seem true is that as individuals get older there will most typically be a number of co-occurring situations in which attachment behaviors with a particular attachment object are either reinforced or not.

Implicit in this discussion is also the idea that some individuals, for a variety of reasons, may not progress through this stage sequence to the same point. As discussed in our paper on early negative caregiving experiences, this may be because of caregiving that is negative rather than positive.

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Changing Stage for Students, Teachers and Schools

Michael Lamport Commons

Harvard Medical School

Productivity and therefore income depends on education. But education is suffering world wide. The problems with education are not with the lack of effective pedagogy. It is with the failure of the educational system to use what is known to be extremely effect pedagogy. Here, we present pedagogical ideas that may help educational systems end their poor performance. Two ideas address these pedagogical issues and include two variables that are essential in efforts to improve education including: the actual stages of performance of teaching and learning; and the set of motivational conditions that support increases in the stage of performance to meet task demands. This paper situates the discussion of these variables in the context of a sequence of the minimum behavioral-developmental stages observed in teaching. It supports the benefit of (a) a developmental framework for individualizing instruction and (b) plans for motivating for students, teachers and administrators. Individualized instruction and reinforced successful performances tailored to teachers, students and administrators are two of the general methods introduced. Another is a computerized Reading Teacher based on stacked neural networks, an approach to a behavior-based flexible artificial intelligence. Attending to individual patterns of development on specific tasks along with the use of reinforcement for immediate performance should make it possible for up to 95% of the children to learn to read.

Periodically, agencies of the federal government issue reports on the state of education in the United States (U.S.). For example, in a report issued by the National Center for Education Statistics (NCES), the following quote appears: "While our younger students are making progress on national assessments and are ahead on some international measures the same can not be said at the high school level", Schneider (2006), NCES Commissioner. "U.S. students compare relatively well in reading literacy when compared to their international peers, but they are outperformed in mathematics and science and our 15-year-old students trail behind many of our competitors in math and science literacy." Despite multiple national efforts undertaken from different perspectives over a number of years, education continues to fail many students. As a result, there is a continual need for new ideas to improve teaching and methods to obtain learning and development. The current paper presents a set of new ideas to achieve these aims.

These ideas address issues in pedagogy alone. Nothing else has been shown to be very important. There are two variables that must be examined in improving education. The first is actual stage of teaching performance and of performances of students, administrators and the like. Discussed below are three aspects of stage of performance: minimum stage demands to be successful at teaching material at a given grade; what is normative now; how computer assisted instruction based on stacked neural networks might solve these problems. The second is the set of motivational conditions that support stage change as the hierarchical complexity of problems demand more complex tasks.

The purpose of this paper then is to present a sequence of minimal behavioral developmental stages at which teaching takes place. It also describes the activities engaged in at that specific stage and presents the pedagogical problems with low-stage teaching. Low-stage teaching is supported by two conditions: (a) there are not enough higher stage teachers in the system and (b) teachers that are at a high enough stage are not receiving the support they need for teaching at the appropriate stage. In Table 1, the minimal observed-stage teaching skills of teachers at that stage are listed. Note that these are not the minimal skills needed to teach successfully but a description of what one typically finds.

Problems and Methods to Ameliorate Them

There are serious problems that may occur at the three lowest stages of teaching. For example, at the primary stage, teachers fail to integrate the perspective of the student and their own to allow for negotiated contingency setting and only authority is used. At the concrete stage, people do not benefit from the social norms of the teaching activities. In effect, the teacher just talks "at" the students, rather than "with" them. This describes rigid and unresponsive application of rules given by authorities. At the abstract stage, teachers do not understand what works or not for a particular student or group of students. These are problems with teachers acting at the primary, concrete and abstract stages, where they do not treat students as individuals with individual needs.

Despite the potential for these serious problems to arise at the three lowest stage of teaching, it is entirely possible for teachers to be effective at each stage if the technology they apply is adequate for the teaching task, or if they receive other kinds of support for their teaching activities. Supports may consist of step by step manuals or procedures they are to follow. For example, at the concrete stage, the teacher might only administer computer-aided instruction that automatically adjusts its content for student stage of performance on each task sequence. At the abstract stage, teachers could receive extensive training and support, which may allow them to learn skills to provide empirically-based solutions. Even at some of the higher stages of teaching, some additional support may improve outcomes. For example, at the formal stage, the teacher could be provided with support to generate more effective empirically-based solutions to individual student problems.

Another approach is to increase the stage of teaching of the teachers. There is an overall behavioral acquisition model of how to bring about stage transition (Commons & Richards, 2002). This model proposes a series of transition steps between stages that may occur during the acquisition of the next stage behavior. An understanding of an individual's current transition step influences the choice of intervention to be used. At step 0, failure of individuals' current strategies of doing things sets the conditions for them to increase their behavioral variability. They try different

Table 1. General Stage of Performance Required for Teaching at Different Levels

Stage	Teaching Level	Action	Students' Grade
Primary 7	Teacher's Aides	Follow instructions and imitate modeled behavior	Grade 1-3
Concrete 8	Teachers in early grades of Elementary School K-4	Follow a manual and effectively carry out procedures	Grade 4-6
Abstract 9	Late Elementary School Grades; and Junior High 5-9	Carry out the normative teacher behaviors	Grade 7-10
Formal 10	High School teachers 10-12	Graph student performance and adjust tasks to fit student performance	Grade 11-16
Systematic 11	Four and five-year college professors	See multivariate determinants of student performance	Graduate School
Metasystematic 12	Professors at research universities	Design an entire educational enterprise that works well such as computer-aided instruction	

behaviors. Stage change may take place if new behaviors are modeled, reinforced, or automated as in computer-assisted instruction. At step 1, teachers try a new behavior, often after having seen another teacher do it, or after attending a workshop. At step 2, they alternate between these two behaviors, sometimes using the old one and sometimes using the new one. At step 3, they fit these two behaviors together, much like a 4th grader learning how to fit multiplication and addition together in long multiplication. That new combination of behaviors may be at the next stage if it is defined in terms of two or more lower-stage behaviors, organizes their order of execution, and that order is not arbitrary.

How teachers are selected by schools and states can have the effect of frequently selecting for teachers who perform at the lower stages. Teachers also may not prefer to work with students acting at more than one stage lower than them. As a result, this may limit the stage of individuals choosing to work at particular grade levels as shown in Table 1. For example, by performing at a higher stage, teachers' effectiveness may increase but their level of interest in the teaching activities may decrease because the students' ages and stages do not need higher stage teaching capacities. Stage change, therefore, may lead individuals to leave teaching for better opportunities. Those teachers who have experienced a stage change may not fit in with other teachers, which could also precipitate a change of career. Conversely, performing below the lowest stages described in Table 1 may also lead to teachers leaving the profession. Their performance would be considered a failure by their peers.

Creating an effective educational system

In order to create an effective educational system, there are a few basic requirements. Compared to the system in place, the new system would have to

1. Cost the same or less
2. Utilize current teachers and move teachers or administrators up in stage of performance
3. Require the same or less effort or time by anyone involved.

Such a system would include group and individual contingencies at all levels, as well as reinforcers that matter to the least-motivated performers. This system would also need to include assessment of gains and losses in performance at all levels. Another major contributor in such a system would be automation. This idea of automation would need to include dynamic feedback at all levels, be able to easily accept revisions, and be sensitive to the stage of performance of everyone.

Assessment

The core of assessment is to look at student *changes in performance* on different time scales. It is important to look at how each student performs in each subject. There are two reasonable ways to complete this analysis: (a) chart the behavior as in precision teaching (Graf & Lindsley, 2002; Pennypacker, Gutierrez, & Lindsley, 2003); (b) give both pretests and posttests for every subject every year (this yields difference scores). One might also give stage assessments to each student for every subject, as well as conducting long term follow-ups. One can assess the order of hierarchical complexity for each test item, the level of support to derive the overall task demand (Crone-Todd, 2007). The Task Demand is the order of hierarchical complexity minus the level of support.

When conducting assessments it is important to use an absolute scale. Stage of performance on tasks from a behavioral sequence is an absolute behavioral measurement scale. This is because it is based on the order of hierarchical complexity of the task successfully addressed. The stage achieved in each academic area yields a profile and the average stage divided by the highest stage yields the breath of performance.

Effective Methods

There are some things that do not seem to affect assessments much, if at all. One is school structure, which accounts for a minuscule amount of change (Richards, 2002, personal communication). The curriculum is a second variable that also produces very small amounts of change. Two things (Walberg, 1984) that do seem to contribute are individualized curriculum and the motivational contingencies (Flora, 2004; Flora & Flora, 1999). Herbert Walberg (1984), in his review of the research literature, concluded unambiguously that Skinnerian reinforcement or reward for correct performance has the largest overall average effect: 1.17 standard deviations (p. 23). A review of Walberg's results by Bloom (1984) found that only one-to-one tutoring had a greater effect on student achievement than reinforcement. Note that one-to-one tutoring probably involved reinforcement as well. The individualization of what a student works on should be based on stage and step-in-stage-transition

sequence where the student is performing. The motivational contingencies that are effective for individual teachers themselves are part of having contingencies at all levels. In order to be maximally effective, contingencies should apply at all levels and be based on behavior. The levels would be the students, teachers, departments, schools, districts, states, and countries.

The motivation and individualization of material while paying attention to stage are matters of concern to the teaching process. This motivational analysis grows out of our experiences at Dubnoff School for Educational Therapy in North Hollywood, CA, Project Giant Step in the community school Ocean Hill Brownsville in Brooklyn, NY (Littky, Commons, Goodman & Shulman, 1959), and Morse School in Cambridge, MA (Commons, Grotzer, & Davidson, in preparation). Those contingencies were adapted from recess period games, which the children play by themselves without supervision. Recess is the most preferred part of the school day. Therefore it was assumed that the activities and games within it were highly reinforcing. Note that they play the same games all the time (Goodman, 2006, personal communication. Competition is another variable that can be used to produce large amounts of learning. This occurs by using group contingencies based on everyone's individual performance. At the same time, each individual's performance adds to the group total, creating both individual and additive effects to learning. This contingency provides an equal opportunity and equal duty to contribute, which closely mimics the real world and includes a natural weighting system.

In our own research, we have used such group-individual contingencies to produce marked improvement in teaching and learning. At the impoverished Ocean Hill Brownsville School, Project Giant Step produced an improvement in reading performance from an average of 0.4 years per year to 1.8 years per year in the student participants. At the Morse School in Cambridge, we hoped to facilitate a progression from the concrete stage to the formal stage in the 5th and 6th grade participants. After 16 sets of interventions, 75% of the students performed at the formal stage, which represented an increase of 55% from their pre-intervention ability. There are some contingencies that do not work as well as the aforementioned ones and the examples given previously. One is the traditional use of individual competition, which does not develop cooperation and fails to get children or adults to teach each other. A second contingency that often does not work well is using groups without attending to individual performance (Cooperative Learning). This contingency is common in schools, but typically results in one or two people doing all of the work. Thus, there becomes no reason for the students engaging in social loafing to perform; their learning of the material is severely compromised. Another example is using groups, but weighting the contributions of the top five to ten performers. This is often done in sport settings. Using this contingency often provides a disincentive to the weak performers, while at the same time labeling them negatively and making them feel as if they do not contribute at all.

Another important aspect of facilitating a positive change in performance for students, teachers, departments, schools, etc., is simply observing when a negative performance is occurring. When this is recognized, someone can be assigned to deal with the problems that are occurring by providing modeling and training in an appropriate fashion, as well as initiating supervision to monitor progress. Once a positive change is initiated, it is also helpful to introduce positive payoffs, which produces acceleration in the positive change.

One type of instruction that has been shown by behavior analysis to produce marked improvement is individualized instruction. However, the problem is that using individual teachers and aids to make decisions as to what should be presented often fails. This is because such decisions require formal stage performance, which is typically not reached by lower-stage performing teachers. Besides the lack of formal stage performance in the teachers, there is not often the time to individually teach all students. Yet, it is critical to not lose sight of individualized instruction, as it does occur and is useful for changing stage. When analyzing individual instruction, two variables typically make most of the difference. The first are the stage demands of the task on which the person is working. For example, in learning to read, stage demand is crucial because there are not only stage problems, but also sequencing within stage problems. The second important variable is the current level success on a given task. For short term assessment, one can use the celeration chart (Graf & Lindsley, 2002). For long term assessment, it is more effective to use standardized tests as a way to gauge overall success of the program and of the student.

Hierarchical Analysis

Automatic ways of detecting change in performance exist, such as using computer assisted instruction (CAI) and computer management. By using CAI, it is possible for the computer to continually assess performance. With that assessment, the stage requirements and other sequencing issues can be automatically adjusted. This allows for individualized adjustable, and differential, reinforcement contingencies to be put into place. Another strength of using CAI is that its programs and procedures can be precisely described and constantly improved on the basis of student performance.

In order to account for the impact of various levels of input, it would be important to use a Hierarchical Linear Model. This is because we have hierarchical or nested data structures, which consist of the following pattern:

A country consists of many states
A state consists of many school districts
A district consists of many schools
A school consists of many departments
A department consists of many teachers
A teacher applies many contingencies to the students
A teacher applies a varying degree of mismatch between task order and stage of the student
A group of students in a class have variously performing peers and parents

When an understanding of impact at each level is achieved, one can begin to find out where to intervene and what interventions work. Over time, with the use of scores that represent changes in stage, one can discover what role each level plays in producing the change; and whether it is helping or hindering the change needed to progress within and between stages.

Another benefit of using hierarchical analysis is that it can be used to see what to check when interventions fail. When the failure occurs, hierarchical analysis can determine if it is due to a mismatch in the stage of the student performance and the task at hand, if there is a lack of reinforcement contingencies to promote positive change, or the existence of reinforcement contingencies to maintain the status quo. Unfortunately, a hierarchical analysis will always have to depend on incomplete data, but even this incomplete data ends up being quite robust. During the analysis, one can start with any part of the data and then build out to other levels or analyze other players at each level. This allows for increasingly helpful comparisons and greater accountability.

By finding the hierarchical complexity of the items, it might be possible to predict the Rasch (1980) scores of both the items

and of the participants. This would allow for pretest-posttest difference scores to be analyzed for test items, tests, or groups of tests. Difference scores are important for making assessments.

Last, very little research has gone into applying stacked neural networksh [1] to teaching problems. An example follows as to how stacked neural networks could be applied to the most difficult teaching task, the teaching of reading. The rest of this paper will address the usefulness of such networks in terms of teaching reading.

Using Stacked Neural Networks in Teaching Reading

Because tutoring is the single most effective form of teaching (Walberg, 1984), especially for reading, it is important to conceive a means for providing every child with his or her own tutor without requiring a roomful of tutors or a tutoring service. In the future, reading may be extremely efficiently taught using stacked neural networksh without the need for teachers or tutors. At present, the reason teachers are necessary is that they can tell if the student is reading correctly. But it is possible to have this function done by trained stacked neural networks. To teach reading, the following stacked neural networks are presented on a computer. Stacked neural networks simulate some of the functions of the nervous system. Each level corresponds to a given layer in the organism and at the same time a given stage of development. The outputs from one layer are fed into the next layer above even though all the layers are interconnected to some extent. Each stacked neural network level consists of multiple neural networks. Each layer is trained by having it interact with the real world rather than with a programmer. It learns from consequences produced by its choices. For the example presented here, we restrict this to learning to read letters and words out loud. This might be called a behavior-based flexible artificial intelligence.

We begin at the level of presenting stimulus material. First, a letter is displayed on the screen. The stacked neural network says the name of the letter. Out loud, it asks the participant to say it. The stacked neural network is set to discriminate varying degrees of proximity to what the participant utters. The stacked neural network is able to shape what the participant says when presented. It starts with rather large deviations. If they are in the bounds, they are scored as correct, and the participant receives a point. If not, they receive nothing and go on to the next item.

An artificial intelligence (AI) program that teaches reading may evolve because of programmer interventions. It may even learn in an interactive way in real time from what the participants do. But such programs are relatively inflexible. What they accept is usually predefined. AI programs are relatively insensitive to variations that are not in their database. The users are the ones who have to adjust their search words to get a program that teaches reading to find what the users want. Often there is failure. In contrast, each of the stacked neural networks incorporate the work describing the previous networks which are stacked neural network in and of themselves. In each of the levels, stacked neural networks have different goals. Many work together because they work on the output of the previous layer and tasks partially accomplished at that layer. The stacked neural network of interest here is the Teaching Reading Programh.[2]

To teach reading, there are at least two broad, compatible approaches. One is to teach writing at the same time so that the computer receives letters keyed in by the participant. The other way is for the participant to speak and the computer to recognize what has been said. Neural networks have been applied to both character and voice recognition. It is not difficult to train neural networks to recognize a few words. The problem is trying to train them to learn hundreds of thousands of words and ensuring that the strings of words make sense. Stacked neural networks approach the problem of editing at different levels, making a solution tractable. In all cases, a large number of paragraphs written by a large number of writers would be fed to the stacked neural networks. This is standard procedure in character recognition and voice recognition. What will be different is that meaning will be developed in the higher levels of the stacked neural networks, making the choice of words more accurate and the spelling more correct. In general, because each layer will provide output to the user, the user can also provide input to the next layer. This concept is introduced in the following examples, which present only the first three layers of such a network.

Stage and Layer 1: Character and Phoneme Identification

The first layer of neural networks recognizes phonemes or characters. One would create 256 neural networks, each tuned to recognize just one character or phoneme. The phonemes and characters would produce letters and series of letters. If there are identification conflicts, such as between “g” and “q” or “t” and “I,” the next higher level network would process both possibilities. There is also misreading by the student reader. The neural networks would provide feedback internally to the program regarding whether these vocalizations of letters was correct or not, and if not they would scale how far off the response is from the correct one. This information would be used to decide whether to give a point for the vocalization. The goal would be to keep the percent of reinforcement at about 85 to 90%. Therefore, there would be a slight tightening of the criteria over trials for a given set of characters. These character identification networks would also detect spaces and punctuation that mark end of words, phrases and sentences as well as pauses in speech. The vision is that the output would then be fed to a spell Teacher network layer. One form of training for each neural network at this stage would consist of providing a large number of representations of the same character in different fonts and in different handwritten form or the same vocalized phoneme from different people and presenting cases that might be confused, such as similar characters or sounds. Another would be to provide a large number of written documents with words containing the letter or representation of the phonemes for each neural network and presenting distracters as well. Order is preserved, and characters and symbols are passed forward to the next layer.

Stage and Layer 2: The Reading Teacher word identifier

The Reading Teacher will recognize single spoken or written words built out of the character strings passed from the character identification network. It will also recognize the new reader’s utterances. Ambiguity in character identification and phoneme recognition in Stage 1 creates multiple possible character strings, now considered as words. At this point there is no meaning to a word. The neural networks begin with lists of characters and lists of possible words. They learn to identify the unique word sought, given the context of the word’s usage. Note that identifying the correct word (and spelling) is not error-free at this point because there are not enough constraints, such as context. If the neural network finds a match between what was presented visually with what was said, it would display that the person earned a point. The neural network can ask the reader if this is what they are saying in response to what the reader said. Training consists of presenting

[1] Michael Lamport Commons and Mitzi Sturgeon White

[2] Michael Lamport Commons with Leonard Sidney Miller

many documents or speech samples composed of the same words, distracter words, and slightly different words. It could pass on good word possibilities both to the user and the next layer.

Stage and Layer 3 A Reading Teacher

Common errors are made in English usage and detection of what has been said out loud. Examples include misuse of articles "a" and "the" and words, such as "real good" versus "really good." Other mistakes arise from homonyms: "reign" versus "rain," or "to" versus "two" or "too," "principle" versus "principal," or "who" versus "whom." etc. A word usage Teacher would teach correct word pronunciation. The neural network would be trained by presenting words with the same or similar sounds from the written letters, and output could be fed to the next layer.

Conclusion

Attending to individual patterns of development on specific tasks along with the use of reinforcement for immediate performance should make it possible for up to 95% of the children to learn to read. Although stage of development on individual tasks is assessable, it is almost never done. Placing children on teams and reinforcing individual performance immediately is also almost never done. The problem is not how to teach reading as much as how to get the educational system to use what is effective in teaching reading. With the invention of stacked neural networks, there will be a way to make the process of assessment, individualization and motivation available to all students independent of the quality and training of teachers.

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Bringing About Changes in Workplace Behavior

Michael Lamport Commons

Harvard Medical School

The Model of Hierarchical Complexity provides the basis to introduce and define how task actions are sequenced. It is applied to organizational and institutional atmosphere and its developmental relationship with individuals. We define and discuss stages of development as well as contingencies in workplace settings. We explain how a particular workplace's atmosphere specifies contingencies. Research is introduced to illuminate the concepts. We characterize the hierarchical complexity of peoples' work and of organizations in which they work. Formal stage organizations are characterized by bureaucracy, and one-dimensional logically-understood regulations. Systematic stage organizations look to the purpose of regulations, balance multiple relationships to achieve goals. Metasystematic stage organizations value creativity over conformity. We propose that the hierarchical complexity of the contingencies that constitute a particular workplace atmosphere affects how the individuals within it behave. Individuals' stage of performance is described by the hierarchical complexity of the task demands and contingencies that they discriminate and prefer. "Power" is explained as the behavioral control of contingencies that distribute reinforcement and reinforcement opportunity. We discuss the role of power in setting favorable conditions that reinforce individuals' development. Preliminary results of this research indicate that workplace atmosphere typically places a ceiling on individual moral development rather than encouraging development to the highest stages. The concepts are applied to the future of institutions such as research universities and organizations. Many companies have short lives because they become less creative over time. Their present "successful" culture resists innovation. Research universities and start-ups are the exceptional organizations. Some of the new start-ups are organized using Metasystematic principles such as Google.

Behavior analysis now addresses a number of useful organizational issues, such as getting people to work faster, more efficiently, and reducing worker turnover. Organizational behavior modification improves/maintains individual or organizational performance. Improving performance necessitates an increase in the quantity, quality, and timeliness of training. In turn, an improvement in performance increases customer, client, and investor satisfaction, implementation of mission objectives, and safety.

From a systems analysis perspective, improving performance effectively changes several things about a job. One is increasing the efficiency of the way in which work gets done. Another is that improving performance often necessitates an alteration of what individuals do in their jobs. This can result independently in the development of measurement systems for various units in the organization, which assists appropriate levels of organization to determine measurable goals for performance.

Hierarchical Complexity of People's Work and of Organizations in Which They Work

Commons, Krause, Fayer, & Meaney (1993) originally set forth a behavioral developmental account of stages of atmosphere in organizations. In this paper, we update this account and analyze what might affect the survival and reinvention of organizations. This paper presents a method for characterizing the relationship between individuals and their workplace environment with respect to individual development in a variety of domains on a various tasks. We hypothesize that this is a dynamic, two-way relationship, and that connections exist between individual development and the stage of development embodied in the workplace environment. We construe development as the developmental stage of performance on tasks of importance in the workplace. Using a scoring scheme derived from the Model of Hierarchical Complexity (Commons & Richards, 1984a, 1984b, Commons, Trudeau, et. al, 1998), we have scored sample individual responses and compared the stage of individual responses to the stage of response required or embodied in organizational decision making, both formal and informal. We are particularly interested in identifying the contingencies by which this relationship is governed and the reinforcement mechanisms (Skinner, 1938) through which they are enforced. This paper describes a method for investigating and characterizing these relations that is nonarbitrary and highly precise.

Institutional atmosphere refers to the dynamic relationship between an institution and those individuals who comprise it. Atmosphere includes the contingencies that affect individual behavior within an organization and the methods by which contingencies are set. We define a *contingency* as a relationship between events (i.e., behaviors or responses) and outcomes. Consequences that increase the likelihood of the event that they follow are termed *reinforcers*. Consequences that decrease the likelihood of the event that they follow are termed *punishers*. What the environment contributes to behavior, we suggest, can be described in terms of contingent relations among events. We also maintain that the reasoning of individual members within any workplace has significant bearing upon organizational atmosphere. As reasoning develops in complexity, individuals are increasingly capable of understanding the perspectives of others, and of evaluating and integrating competing perspectives. These skills are integrated into the formal and informal policymaking and policy enforcement structures of the organization. The explicit statements of perceived organizational contingencies are referred to as *verbalized causal rules* or contingencies (Commons, Kantrowitz, Buhlman, Ellis, & Grotzer, 2007). The implicit perceptions of causality are the *perceived causal rules* or contingencies.

In order to characterize atmosphere at the level of organizational macrostructure, we believe that it is necessary to examine the individual contingencies embodied in atmosphere, which constitute the organizational microstructure (Goffman,

1967). Microstructure and macrostructure are inseparable. Atmosphere is, therefore, a characterization of the sum of individual contingencies operative within an organization and as Kohlberg (1985) emphasized, their justifications. Atmosphere, therefore, refers to the manner in which the institution and individuals either constrain or motivate the development of individuals and the development of the organization.

Background

Because human experience unfolds almost exclusively in fields of activity that are interpersonal, social forces both act upon persons and provide the conceptual frameworks through which people understand the world and themselves. For example, Damon and Hart (1988) characterized self-understanding as basically a social process. This notion is not idiosyncratic, but stands in a strong theoretical tradition. As Mead (1934) and other theorists of the self (e.g., Kohlberg, Hart, & Wertsch, 1987) emphasized, understanding one's self is a social communicative act. Similarly, Durkheim's contention (cited in Thompson, 1985) that social processes fundamentally characterize the individual has found a significant following in theorists who contend that "each kind of community is a thought world...penetrating the minds of its members, defining their experience, and setting the poles of their moral understanding" (Douglas, 1986, p. 128). As Foucault (1979, p. 217) said, "The individual is carefully fabricated" in this interactive system of social structures.

Characterizing the interaction between individuals and their culture, however, has been a central problem. The problem is to account for the large variety of individual and cultural differences, while still providing a coherent framework that can be applied to many groups and individuals. With the exception of Chilton's (1988, 1991) work in political development, most explanatory models have typically fallen into one of two camps; namely, positivistic versus process theories. Positivistic interpretations, in the tradition of British and American analytic philosophy, offer reductionistic models of social processes and their impact on individuals. Such approaches attempt to find a single factor or group of factors to which learning can be reduced. The social world, in this view, is governed by fixed structures that exert a unidirectional force upon individuals. Because the locus of power is seated primarily within environmental factors, little attention is given to the ways in which individuals work a reciprocal influence upon social structures.

In contrast, process models (e.g., Barth, 1966; Moore, 1975) have rejected the notion of a strictly deterministic social world. Instead, they have offered generative models for interpreting the often unpredictable ways in which atmosphere and individuals reciprocally affect one another. Social systems are seen as grounded in the interpersonal interactions of concrete individuals, rather than in necessary, abstract social categories. Barth's (1966) model of transaction characterized this interaction as "the compounded effects which multiple independent actors, each seeking to pursue the transactional optimal course of behavior, have on each other" (p. 11), and social systems as "the gross frequentive patterns of behavior which will tend to emerge in such situations" (p. 11).

Such models contrast sharply with positivistic ones in that the former have located the foundations of social systems in the interactions of concrete individuals and in the shifting contingencies through which individuals impact one another. Social categories, in this view, emerge from particular sets of transactions rather than governing such transactions externally. Process theories have also assumed that change within social systems is both continuous and necessary. Change is construed as a natural feature of social systems with a twofold character. On the one hand, change arises as society responds to the actions of individuals. On the other hand, individuals change as they interact with others and with social institutions. The two sorts of change influence one another. These models, however, provide few resources for understanding the precise nature of this relationship at the microstructural level of individual development.

Positivistic theories tend to reduce complex interactions between society and individuals to a deterministic model. Process theories often lack sufficiently clear explication of the microstructural mechanisms that govern this interaction. Both positivistic and process models of social processes remain incomplete. They remain incomplete so long as they lack the conceptual resources to justify particular nonarbitrary links between the complexity of responses by individuals and the complexity of the atmosphere in which they function. Also, they must account for the real and unpredictable developmental variance observable among individuals at the same time.

The Model of Hierarchical Complexity (MHC), when combined with contingency analysis, provides just such resources. The MHC orders both individual and organizational processes in a nonarbitrary sequence. This sequence both affects and is affected by the contingencies in atmosphere. Further, the model describes formal processes through which individuals and atmosphere interact whether in the workplace, the family, or the state. The MHC also allows for a precise, microstructural analysis of these processes as they impact individual behavior. Moreover, the MHC accounts for a wide variety of individual behaviors and for the creativity and dynamism of organizational behavior as a continuous collective process. At the same time, it provides means for interpreting this relation in a nonreductionistic, nonarbitrary way.

Model of Hierarchical Complexity

The MHC is a universal system that classifies development in terms of the task-required hierarchical organization of response. The scoring of stage derived from the model is related to the first issue of microstructure because the MHC uses the hierarchical complexity of tasks as the basis for the definition of stage. An action is at a given *stage* when it successfully completes a task of a given hierarchical order of complexity. *Hierarchical complexity* refers to the number of recursions that the coordinating actions must perform on set of primary elements. Actions at a *higher order of hierarchical complexity* (a) are *defined* in terms of the actions at the *next lower* order of hierarchical complexity, (b) *organize* and *transform* the lower order actions, and (c) produce organizations of lower order actions that are new and *not arbitrary*. These next order actions cannot be accomplished by those lower order actions alone.

The discussion of atmosphere and its contingencies relates to the second issue of macrostructure. The two are interrelated insofar as reinforcement contingencies determine stage of response. The MHC provides a means for identifying how contingencies are set and transferred within organizations. Therefore, it gives a measure of the sensitivity of individuals to the reinforcement contingencies that shape social systems and individual development. To counter the possible objection of arbitrariness in the definition of stages, the MHC stages are grounded in the hierarchical-complexity stage criteria of mathematical models (Coombs, Dawes, & Tversky, 1970) and information science (Commons & Richards, 1984a, 1984b; Lindsay & Norman, 1977; Rodriguez, 1989). The MHC also posits that individuals perceive the world through conceptual frameworks. These frameworks embody the individual's cultural, educational, religious, political, and social background (as well as many other factors). Such a framework is referred to as one's

perspective. Perspectives differ in terms of hierarchical complexity. As the hierarchical complexity of an individual's response to task demands increases (i.e., as stage of development increases), the individual is increasingly able to take many such perspectives into account (Commons & Rodriguez, 1990, 1993; Rodriguez, 1989).

Typically, the work of individuals and organizations fall within three stages of hierarchical complexity. The first is the formal stage, in which organizations are characterized by bureaucracy, and one-dimensional logically-understood regulations. The second is the systematic stage, in which organizations look to the purpose of regulations and balance multiple relationships to achieve goals. The third is the metasystematic stage, in which organizations have contingencies that tend to be based upon absolute creative achievement alone. This means that the organization is not outwardly trying to conform to local culture or remain in popular favor.

In adult development, and consequently in professional-level workplace interactions, the same three developmental stages predominate: formal operational (MHC Stage 10), systematic (MHC Stage 11), and metasystematic (MHC Stage 12). Following are MHC descriptions of these stages framed in terms most relevant for workplace considerations.

Applying the Model of Hierarchical Complexity to Illustrate Examples

The Hierarchical Complexity Stage Scoring System (HCSS), derived from the MHC, was used to determine the stage of participants' responses to a given task demand. In HCSS, stage of behavior is regarded as a function of the hierarchical complexity of the actions required to solve a task. In distinction to content-based scoring systems, HCSS scoring involves an analysis of the microstructure of participant responses. There are two forms of responses. First, there are responses to items within instruments that embody specific statements constructed at a given order of hierarchical complexity. Second, is the hierarchical complexity of the inferred task that a person solves in a narrative may be found. In applying HCSS, the stage score of responses is usually equivalent (Commons & Grotzer, 1990) to scores determined through other procedures (Armon, 1984a, 1984b; Dawson, 2002; Colby & Kohlberg, 1987; Perry, 1970, 1981). Fewer statements, however, require "guess-scoring," or are designated unscorable. A further advantage of HCSS is that, theoretically, any statement is scorable. Scoring can, therefore, be applied across a range of tasks and is not limited to standardized dilemmas.

Formal Stage 10

Stage 10 responses identify and isolate relations in complex sets of variables as well as label interactions of events abstractly in a linear fashion. For example, in discourse at this stage, the verbalized perceived causal rules are empirical statements of causality and analytic if-then propositions. Such formal-operational statements have the formal structure of an order relationship, "A > B," where A and B are both abstract-stage propositions (MHC Stage 9). In forming justifications, the logical arguments at this stage usually have the form, "A ---> B". That is, the relationship between A and B is made explicit through a causal statement with evidence, a logical statement or by some other clear coordination (e.g., of equivalence, proportionality) of at least two propositions or abstract-stage elements. Logical arguments are used to convince people of the soundness of a deduction from premises. Causal arguments are used to convince people of an empirical relationship between events and outcomes. For an empirical example, "A—If you hope to get a good academic job, then B—you must publish a good deal." "A—Also, if you hope to get a good academic job, then C—you must apply before the advertised deadline." Authority in the form of local norms, rules, and regulations is given preeminence, whereas particular individuals or situations play only a minor role. Reasons and justifications relate to expected behavior, based on these bureaucratic rules, or norms.

Systematic Stage 11

A Stage 11 response is characterized by systematizing formal stage relations into a network. Here, the products of the formal stage actions—coordinated abstract-stage propositions—become the elements to be coordinated. The product of the more hierarchically-complex Stage 11 statement is the coordination of the relations constructed by formal operational actions into a system. A suitable systematic-stage action coordinates two or more relations, for example, System$_1$: "A ----> C and A ----> B." This system could be "If you have a large number of publications, some teaching experience, and a coherent research program then you might get a good academic job." This constitutes a single, unified system, which the participant takes to be comprehensive. For example, social interactions are seen as integrated systems of relationships. Yet the importance of the individuals is determined with respect to their relation to and/or role in the system. Norms, laws, rights, duties, rules, and regulations form a logically coherent system; reasoning centers around how action would impact one's individual role and status within the system and the functioning of the institution.

Metasystematic Stage 12

A Stage 12 statement coordinates and transforms two or more systems according to a principle that is external to both systems. Such metasystematic principles take precedence over the concerns of any particular system. The concern is never to preserve a system or institution for its own sake. Rather, the needs and interests of a number of systems are taken into account without regard to the particular system or institution within which one finds oneself. Systems are compared and contrasted in terms of their properties. The focus is on the similarities and differences in each system's form as well as constituent causal relations and persons within it. At Stage 12, perspective-taking skills are well developed. A wide range of perspectives can be taken into account and coordinated in a non-arbitrary manner. For example, a metasystematic Stage 12 statement might have the form, "A merit system, [S_1]—in which having a large number of publications, some teaching experience, and a coherent research program lead to a good academic job"—can be transformed into a discriminatory system, if "minority students are unable to work with faculty who have grants." The discriminatory system [S_2] entails that "Students who work with faculty who do not have grants have a lower likelihood of publishing and forming a coherent research program than students who work with funded faculty;" and "Minorities are less likely than non-minorities to have an equal opportunity to work with faculty who have grants." By adding these last two formal operational conditions, the system of merit [S_1] is transformed into a discriminatory system [S_2], written as $T_1(S_1)$--> (S_2). In system [S_2] past discrimination influences one of the merit criteria. Likewise, a merit system is transformed into a merit system with politics if active support from an influential person is required, $T_2(S_1)$--> (S_3). Taking all these transformations together, one can build a metasystem out of these systems.

There are some organizations that are exceptions and do not fit into one of the three aforementioned stages of hierarchical

complexity. Research universities and start-ups are the somewhat exceptional organizations. Many of these two entities tend to be organized using metasystematic principles.

Hierarchical Complexity of the Contingencies That Constitute a Particular Workplace Atmosphere

The contingencies that exist in a workplace often affect how the individuals within it behave. Individuals' stage of performance is described by both the hierarchical complexity of the task demands and the contingencies that they discriminate and prefer. Overall, most large organizations operating below the metasystematic stage last for only a short duration of a few to many decades. This is especially true in the technology sector. That is because next quarter earnings so dominate. Such short term vistas make it almost impossible for these organizations to adapt to a dramatically changing world and markets. Systematic stage organizations are quite strategic in their respective short term ways. When a systematic stage organization becomes successful, several ultimately self-defeating actions may take place. They value conformity, productivity, low costs, efficiency of doing what has been successful in the past. There is also a payoff for just improving what is already being done, rather trying new things. The tendency towards low creativity thrives because there tends to be a high rate of payoff for doing the same thing and thereby eschewing creativity. In addition, going off in a new direction is not seen as having a positive outcome, especially if that new direction involves an innovation that might be disruptive to the current flow.

It takes metasystematic stage perspectives to compare what happens to companies and other organizations in the long run. At his stage, the need for disruptive innovation is often understood. Also, there is also recognition that it takes a good deal of time to develop anything requiring real research rather than just development. The innovators have to be protected from the bean counters. But at lower stages, innovation can be seen as disruptive in an organization, especially if the status quo is currently reaping the expected results.

Formal stage organizations as exemplified by many bureaucracies are not oriented to seeing even a complex multivariate world at all. This is due to the fact that conformity is often valued over creativity and they tend to show unchanging allegiance to their found rules and regulations.

Different cultures and different forms of ownership effect whether short or long term contingencies are effective. In the United States, most basic research is done in universities. Universities do not have to sell their professors' research efforts beyond getting some of that research funded. It may be that privately held companies take a longer term view. It also may be that some cultures can take a longer time view, such as might be the case in the Far East.

An example of disruptive innovation is when people left Fairchild Semiconductor to found Intel (computer processors and integrated chips, especially memory). Fairchild was frozen in its approach to the field. Wang developed a very successful word processor that was not an inexpensive PC. But then Apple came along with WordStar running on it and put it out of business. WordPerfect made a WYSIWYG word-processing package that had word wrap and a speller. It put WordStar out of business. When WordPerfect was too slow to make its word processor run under Windows, it lost almost all its market share. Other examples of organizations that have developed and changed include:

1. *Apple Computer and Steve Jobs*: Creation of Apple 2 computer, Mac computer, Pixar films, and the iPod. The iPod along with extremely small MP-3 players have provided a downloadable way of obtaining media content including music at less cost than CDs sold by record stores. This has put out of business most record stores. Our media will come to us either by fiber optic cable or wirelessly in the near future. But Apple continues to innovate.

2. *Motorola*: Developer of car radios, produced semi-conductors on those radios and then all of industry, and finally increased market share in the cell phone industry

3. *IBM* (International Business Machines): Progressed from Card Readers and punches to electric typewriters to mainframe computers to PCs and now to software and system service.

4. *General Electric*: Light bulbs –> Generators –> Appliances –> Locomotives –> Jet Engines –> Finance –> Plastics and silicone products

Development and Propagation of Atmosphere

Although individuals are constrained by the stage of atmosphere, at the same time the stage of individual responses continually reproduces and may revise the stage of atmosphere. This interactive relationship requires the effective transfer of information regarding the operative contingencies in any given situation. The transference of cultural information (Boyd & Richerson, 1982, 1985; Cavalli-Sforza & Feldman, 1981; Cavalli-Sforza, Feldman, Chen, & Dornbusch, 1982) carried by contingencies can be described analogously as *infection* by *memes*. A *meme* is a unit of sociocultural information. It is defined by a single individual dichotomous choice (Dawkins, 1989). Choices are under the control of contingences. Such contingencies specify the stimulus conditions and form of responding that will lead to reinforcement. Memes are released from the atmosphere and carried by particular sets of operative contingencies. Atmosphere constitutes the source of memes insofar as it specifies contingencies. In detecting a set of contingencies that apply in a particular situation, an individual is thereby *infected* with the meme carried by those contingencies. In executing a behavior that is controlled by that set of contingencies, the individual is further infected. Thus, there are degrees of infection by memes. Moreover, because any contingency selects behavior, it can represent one or more memes. The person may learn what the contingencies are from observing what others do and the effect it has, by instruction, by reading, or imitating others without detecting the effects of the others' behavior.

The infecting meme can be identified in the participant's resulting behavior. Because new behaviors set new contingencies, memes are continually being transferred. All effective educating, training and communicating result in a transmission of memes. If such infection did not exist, individual choices would be random or unperformed. The identification and tracking of memes brings precision to the task of describing social conditioning so that it becomes possible to trace the evolution of behaviors. This is why the history of mathematics and science is relatively easier than, for example, understanding the American Civil War. We know that Newton and Leibnitz both invented the Calculus; Archimedes almost did but stopped short. Moreover, because memes may be characterized in terms of stage, they aid in identifying stage development of individuals within interactive frameworks such as the workplace.

The atmosphere of the workplace is sustained and transferred through communication networks. These networks carry the memes. These networks distribute information about the

contingencies that affect individuals (for example, individual advancement) within the organization. Two things define the stage of the atmosphere of the workplace. First is the stage of the actual contingencies. Second is the stage of the reasoning used to justify these contingencies. The detection of contingencies by individuals occurs primarily during acquisition or reacquisition of the stage reinforced by the atmosphere. Contingencies tend to go undetected once the individual and the atmosphere are functioning at the same stage. Contingencies are revealed in stark relief only when the individual is struggling against the atmosphere from the point of view of another stage, or when the individual is excluded from power.

Social forces impact individuals in different combinations and with varying degrees of intensity. Because the variables are numerous and frequently unperceived, the character of this interaction between atmosphere and individual is often obscure. Nevertheless, we would argue that reinforcement contingencies are the immediate controlling relationships for both individual and organizational behavior. In their work on education, for example, Commons and Hallinan (1989) demonstrated that reinforcement helps people form strategies and representations which include both the implicit perceived causal rules, and the explicit verbalized rules. Reinforcement also leads them to select the more successful strategies, and causes them to continue actively solving the problems. By reinforcing more (versus less) developed strategies during students' progression to formal operations, a teacher can reinforce students' more complex reasoning (Commons, Handel, Richard, & Grotzer, 2007; Richard, Unger, & Commons, 1988).

Commons, Grotzer, & Davidson (2007) have recently demonstrated this in a study of a large number of young students from mixed socioeconomic backgrounds. All students were asked to solve a series of adult-stage problems requiring them to detect causes. The students were divided into three groups: one group of students received no feedback about its performance, a second group received feedback alone, and a third group received both feedback and points for correct answers. They were told that their team could accumulate these points to win a prize. A fourth, control group of students took only the pretest and posttest without undergoing the problem-solving task series. Only students in the reinforcement (i.e., in this case, points leading to possible prizes) group improved their proficiency in detecting causal relations from the pretest to the posttest. Students who received no feedback and those who received feedback without reinforcement did not demonstrate this stage development. These students did not learn any more than the control students. The study implies that, even when academic achievement does not motivate some students, all students' reasoning can develop when success receives the appropriate reinforcers.

We suspect that the hierarchical complexity of the contingencies that constitute a particular workplace atmosphere affects the patterns of individual choice making within that organization. As the hierarchical complexity of an individual's response to task demands increases (i.e., as stage of development goes up), the individual is increasingly able to take the perspectives of others into account (Commons & Rodriguez, 1990, 1993; Rodriguez, 1989). Successful decision making in the workplace demands proficiency in taking a variety of perspectives into account, particularly the perspectives of those individuals whom one's decision may affect. In situations involving conflicting viewpoints, individuals need to understand both the perspectives of other people and the frameworks that shape those perspectives. The better one's perspective-taking skills, the better one's managing skills (Weathersby, 1992). When the perspective of an individual or group is excluded from the decision-making process, unresolved tensions often dominate the workplace and may hinder productivity.

Organizations in which decision making is grounded in lower-stage perspective-taking may perpetuate an atmosphere in which individuals' higher stages of perspective-taking are not reinforced. These individuals are likely to demonstrate interest only in how decisions affect themselves. Consequently, organizational decision making that excludes the perspectives of constituent groups may ultimately produce constituent decision makers who exclude the perspective (and interests) of the organization. At the higher stages of perspective-taking, by contrast, organizations reinforce individual behavior that takes the perspectives of others into account. This may include other members of the organization, the organization itself, and even individuals and groups that lie beyond its boundaries.

Reciprocal Effect of Stage of Individual Actions and Atmosphere

It is our contention that the stage of the behavior that sets contingencies has a reciprocal effect on the atmosphere of an organization. For example, when the people who set government policy in the United States have to raise millions of dollars to be elected, the power of the individual relative to the power of the dollar is small. In such circumstances, incumbents—because of access to large amounts of funds—have a great advantage over challengers. Such incumbents set the rules or contingencies for how elections are to be conducted. In a first-past-the-post voting system, rather than a proportional representation system, two parties usually emerge. These dominant parties shut out small ones even though there is no mention of parties in the US constitution. It is curious but true that worker owned companies are not competitive. What happens is that workers have a conflict of interest; one is to keep their jobs, make more money, and work safer and easier. But as owners, they are to reduce the number of workers, keep the pay low, and maximize profits. So the social system has owners, managers and employees. As the stage of the employees' representatives goes up, they less often help put the company into bankruptcies. At the systematic stage, they realize the multivariate nature of the determination of wages: having a job, getting paid a certain amount, and having an increasing level of productivity.

Likewise, within the workplace of the university, the transmission of knowledge and values is controlled by a network of contingencies. These contingencies begin with the persons who pay for the university. Then there is the structure of the channels through which funds are allocated to universities and then distributed within them. The stage of the justifications given for accreditation and for the form of governance partly determines the stage of the institutional atmosphere. This includes a ceiling on the stage of development of the institution's top decision makers. The ceiling is set very high (metasystematic) from our data collected by undergraduates and graduates (Johnstone et al., 1991) on the presidents of Harvard and similar institutions. This is because the presidents have to meld many different perspectives of the different fields and schools. They also have to relate their own system to the system of the big donors and providers. They have to attract students and faculty. The boards replace presidents who fail at any of these tasks. The transmission of knowledge and values to students within the university can be traced through a series of steps: (a) through the contingencies that describe how the top decision makers are chosen and how a ceiling is set on the developmental complexity of their behavior; (b) through the contingencies that describe how money is distributed to the various sections of the university, how staff are chosen in those areas, and how power is distributed within them; and (c) the contingencies that establish the rules (both implicit and explicit)

themselves that govern how future contingencies develop. We believe that similar processes govern the transmission of knowledge and values, and influence the developmental stage of individuals within any workplace.

In most universities, the control of funds is inaccessible to students, such that students can influence decision making only by attending or not attending school. In rare cases they protest. Faculty members, on the other hand, represent long lasting human capital that uses and, indirectly, produces funds. Their power is derived from the fact that they exercise some control over these resources as well as influence the perceived value of the university experience. *Power*, from our viewpoint, is the behavioral control of contingencies that distribute reinforcement and reinforcement opportunity. To say that Person A "has power over" Person B in a given situation is, then, to say that Person A controls more reinforcing outcomes and punishers with respect to Person B's behavior than the reverse. If Person B behaves inappropriately according to Person A, reinforcement may be withdrawn from B by A. The implicit or explicit rule that A follows is contained within the network of contingencies operative within the organization. The sum total of such rules and the rules by which they are set constitutes the atmosphere.

In their empirical study of moral development in worker-owned companies, Higgins and Gordon (1985) found that the organizational structure of a workplace (i.e., atmosphere) may facilitate the sociomoral development of its members. Similarly, in an exploratory study of atmosphere and moral development in the academic setting, researchers (Johnstone et al., 1991) found that the atmosphere of the university may constrain the developmental complexity with which its members respond to ethical dilemmas. For example, one participant reported that the perceived compromise of values by administrators "very much tells the students that, well, this is all very interesting, but what really counts is big bucks, and what really counts is.... And kids get the message, and kids will go over exactly where they see the reward of the society as being exemplified." Similar processes set contingencies for faculty members, staff, and administrators as well. In fact, the study revealed that the reasoning of most ethics professors fails to achieve the metasystematic developmental stage. Johnstone et al. explained this finding by arguing that the institutional atmosphere of the university fails to reward more complex reasoning that may challenge its norms and system needs. Such metasystematic-acting individuals would base their decisions on universal abstract principles.

There are multiple layers of contingencies operating at different stages for individual responses within such complex organizations as the modern workplace. The hierarchical structure of stages of development, as given by the MHC, suggests that lower stage tasks and responses must be adequately integrated into the contingencies that constitute atmosphere in order for higher stage responses to develop. By the same token, some tasks do not require higher stage solutions yet are necessary for the functioning of the institution. Contingencies and stage of response will be perceived differently by individuals functioning at different stages within the same workplace. This means that people functioning at the concrete stage may help clean buildings or other tasks where they get direct supervision and authority is absolutely clear. They may work for supervisors that function at the abstract stage following the established norms for the quality of work and the speed of its completion. These people may be supervised by bureaucrats functioning at the formal stage. The organization as a whole might have very open communication not only from the top down but from the bottom up. Responsibility for high quality task completion might be placed as low as possible. The organization, company, or business that reinforces higher stage responses fosters allegiance to its own causes and interests.

Table 1. Classification of organizations, and positions minimally requiring the following stages

Stage	Type of Organization Activity	Positions Person	Social Structure
Primary 7	Individual who works for others and is closely supervised	Cleaning person, Errand runner	Individual
Concrete 8	Individual vendors	Individual physical laborer	Clique
Abstract 9	Family or small number of individual's company	Filing Clerks, Typists, Elementary School Teachers	Small Group
Formal 10	Single niche company	Secretaries, Technicians, High School Teachers, Whistle Blowers	Bureaucracy
Systematic 11	Regular small to large companies and organizations	Managers, Professionals, College Professors	Institution
Metasystematic 12	Learning and developing companies and organizations (See Morris, 1992, 1995)	Innovators & Leaders, Research Scientists and Professors, Major Artists, Appellate Court Judges	Universal
Paradigmatic 13	Organizations that reinvent themselves by adopting new paradigms	-	-

Note: We have no knowledge of positions or social structures at stage 13.

Stage assignments can be made for the overall network of contingencies and responses that constitute the atmosphere of the organization. In other words, the atmosphere of the organization can be scored for its stage. We believe that the reinforcement contingencies set by organizational activity play a vital role in the development of individuals within the workplace. We believe that the organizational atmosphere largely controls the reinforcement contingencies impacting upon individuals within a particular

workplace. The setting of contingencies is the exercise of *power*. The atmosphere can either assist in the developmental process of individuals and the organization or impede them. Using the MHC, we can characterize this interaction with a high degree of precision.

Does Atmosphere Place a Ceiling on Individual Development?

The preliminary results of this research indicate that workplace atmosphere typically places a ceiling on individual development rather than encouraging development to the highest stages. The ceiling identified in the samples from the Mexicali Medical School study was at the formal stage (Galaz-Fontes, Pacheco-Sanchez, & Commons, 1989; Meaney, 1990). In the samples from the Harvard study, transitional reasoning between Stage 11 and Stage 12 predominated, at least in the social domains investigated. We suspect that in less politically charged arenas many reasoned at the fully metasystematic Stage 12. This suggests that behavior beyond the systematic stage is reinforced in some domains and not in others. For instance, in the university, one's postconventional (metasystematic) thinking in one's research might be reinforced, but not one's postconventional thinking with regard to policy decisions involving the university itself. This theme was clearly brought out in many of the interviews.

At the metasystematic stage, individuals in the workplace are not simply defined in terms of their position or status within the organization. Individuals are considered in terms of a wide range of perspectives, all of which may be taken into account in the decision-making process. Metasystematic responses typically challenge the existing norms and policies of a workplace by integrating perspectives that fall outside of the organizational bureaucracy. For this reason, organizations tend not to reinforce responses at the metasystematic stage. We contend, however, that the failure of systematic stage reasoning to integrate a range of workplace perspectives is contrary to organizational interests. Someone in an organization that reinforces higher stage responses to dilemmas thereby increases the perspective-taking abilities of its members. The better the perspective taking skills of individuals within an organization, the more likely they will be to integrate the organization's perspectives into their own decisions. In practical terms, this may be called loyalty or allegiance.

Conclusion

We have provided a framework for research on the interaction between workplace atmosphere and the development of individuals within it. The applications of this model extend far beyond the workplace. This model may be applied to forms of social interaction as various as families, religious groups, street gangs, and governments. We believe that contemporary challenges in all of these spheres increasingly call for postconventional responses on the part of both individuals and organizations. The Model of Hierarchical Complexity provides a model for understanding the developmental processes involved in creating these challenges and some types of interventions through which these challenges may be met.

Despite our discussion on workplace behavior, there are still many unknowns involving organizations such as universities. Will universities expand their distance learning program to the maximum? What happens to the research role of the professor? Will Harvard, Yale, Princeton, Stanford, and the like establish franchises like the UC system did to remain competitive utilizing their brand name? Will cross-disciplinary research become the norm? There are also questions about the future of behavior analysis. Will it be like single culture companies that go extinct? Will it continue its orthodoxy? Will it learn that single participant design is good for science and intervention but bad for policy decisions? Will it accept group statistics for policy decisions? Will it embrace disruptive ideas such as development? Will it integrate its quantitative side into its practice side? Will it be part of psychology?

Organizations do not change without a change of leadership and then change is still very unlikely. When the organization is about to fail is the most likely time for change to occur. So we are left with evidence the organizations are changing but with a possible myth that there is internal change. What is more likely the case is the new organizations with higher-stage atmosphere replace older lower-stage-of-atmosphere organizations. This process of change feels glacially slow to people within organizations. yet in historical terms, it is very rapid.

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Assessment of Thinking in Adult Learners

Darlene Eleanor Crone-Todd

Salem State College

Higher-order thinking is one of the defining characteristics of higher education, yet the rating of such behavior has been neither reliable nor valid. Recent research involving the use of categories has yielded relatively high inter-rater reliability, with nominal categories of behavior identified. The current study applies an ordinal-scale model of hierarchical complexity (MHC) to educational tasks. The initial results suggest that the MHC can be used to score questions with varying degrees of complexity and support, and that future research should concentrate on determining the reliability and validity of this scoring system for educational purposes.

In higher adult education, the attainment of higher-order thinking (HOT) skills is an expected, integral part of a liberal arts education (Halpern, 1998). However, the reliability and validity of HOT skills is not well established (Williams, 1999). The current state of the research suggests that there are many different ways to define and assess HOT skills, such as "reasoned argumentation" (Newman, 1991a, 1991b), comparison of similar elements (Carnine, 1991), application (Hohn, Gallagher, & Byrne, 1990; Semb & Spencer, 1976), or effective judgments (Paul & Heaslip, 1995) within a discipline. Despite the variety of such summary labels and definitions, so far little has been done to operationally define and rate the complexity of both the educational task, and the type of response provided by students.

Behavioral Research in Higher Order Thinking

Early categorical assessment

Within the last few decades, there has been movement on the part of behavior analysts to find more reliable methods of evaluating higher-order thinking. First, Semb and Spencer divided the behaviors into recall (point-to-point correspondence to media) versus more complex tasks. The more complex tasks included problem-solving in which students either had to identify a principle or concept in a novel example, or generate a novel example of a principle or concept. Johnson and Chase also broke down the lower-level and higher-level thinking behavior into elementary versus conceptual, respectively. The Elementary category was considered lower-level, and the conceptual category was higher-level that seemed to again require students to apply principles and concepts in a novel way through the use of examples. In both cases, the researchers were able to obtain high levels of inter-rater agreement. This is perhaps a testament to having two dichotomous, nominal, categories of behavior, in which the levels are clearly far apart: either the answer is already in the media presented, or it is not. Such a definition would make scoring much more reliable. However, finer discriminations between levels of higher-order thinking are needed to more precisely state goals and objectives involved in higher education.

Recent categorical assessment

In the past decade, there has been some attempt to now provide more precise definitions for the values between the two extreme categories. The first line involves attempting to modify Bloom's (1956) Taxonomy of Educational Objectives in the Cognitive Domain. The taxonomy has six general categories (see Table 1), as modified by Joseph Pear, myself, and several of our colleagues at the University of Manitoba (Crone-Todd, Pear & Read, 2000; Pear, Crone-Todd, Wirth, & Simister, 2001).

Table 1. Lower- and Higher-Level Categories in Higher Order Thinking

Lower-Level: Answers found in Instructional Media	Higher-Level: Going Beyond Instructional Media
Rote Manner Knowledge	Application
Comprehension	Analysis
	Synthesis
	Evaluation

This taxonomy is further delineated by two major categories: (a) based on material presented (either in lecture, text, or other media), and (b) based on going beyond the material presented. The first category consists of material that can be learned in a rote manner (Knowledge), or put in one's own words (Comprehension). The second has four sub-categories. The first is Application, in which an original example is provided, or a particular concept, principle, or procedure is identified in a new example. The second is Analysis, which involves comparison and contrast, including comparing an example to a definition. The third is Synthesis, which involves more complex application (i.e., combining several principles, concepts, or procedures) to solve a unique problem, or classifying several examples into classes. Finally, Evaluation involves all of the previous categories, in a manner consistent with developing one's own argument.

The research (Crone-Todd et al., 2000; Pear et al., 2001) shows that good inter-rater and inter-group reliability can be obtained with the first four Knowledge, Comprehension, Application, and Analysis.

However, thus far there have been too few exemplars of Synthesis and Evaluation to adequately determine Reliability for those categories. In addition, the research is divided in terms of whether the taxonomy is truly hierarchical or not. At best, one might suppose that the lower-level and perhaps the higher-level Application and Analysis categories may be ordinal measures. However, the lack of reliable measures for the Synthesis and Evaluation categories makes it difficult to assess the measurement scale involved.

Although beyond the scope of the present paper, it must be acknowledged that all of this complex human behavior involves the use of verbal behavior (Skinner, 1957). As the level of complexity increases, the student moves through echoic and tact

behaviors, and then to more and more complex intraverbal behavior, which involves learning concepts (i.e., stimulus classes) and equivalence relations, as well as relational frames (see Crone-Todd & Pear, 2002, Hayes, 1994, and Sidman, 1994 for a more discussion of these concepts).

One issue that is especially relevant to the current research on he modified taxonomy is whether in fact there are more difficult levels of each of the categories. For example, it might be relatively simple to demonstrate memorization or comprehension of a simple definition or fact. However, demonstrating memorization or comprehension of more complex definitions or facts would be more difficult.

Assessment of behavioral hierarchical complexity

Another line of research that may shed light on the complexity level is by Commons and his colleagues (e.g., Commons & Miller, 1998; Commons, Miller, Goodheart, & Danaher-Gilpin, 2005; Commons, Trudeau, et al., 1998) in the Model of Hierarchical Complexity (MHC). This yields a stage theory that has some initial similarity to Piaget's work, but goes beyond Formal Operations and divides task properties from performance properties. A property of tasks is that they can be described by orders of hierarchical complexity. Stages of performance are the corresponding numbers when a task of a given order has been successfully completed. Systematic stage is the first stage beyond Formal stage. Actions at that stage essentially organize two or more relationships among variables. Evidence of this stage is inferred from demonstration of an understanding of multivariate causation, for example. Metasystematic is the next stage, in which one can compare, contrast, and synthesize systems of formal relations. At the Paradigmatic stage, one synthesizes systems of systems (metasystems) into new fields based on new paradigms. A further synthesis across fields may result in an entirely new field emerging, or old ones being substantially revised. When this occurs, the person can be said to be operating at a cross-paradigmatic stage. Since the model appears to increase in complexity, it would be considered an ordinal measure.

The Relationship between Categories and Hierarchical Complexity

As one contemplates the stages in the complexity model, one can formulate some theories about how Bloom's and the hierarchical complexity model are related to one another. For example, the Systematic order task would require that one can demonstrate knowledge and comprehension of two relationships among variables and how they interact to form a system. To go onto the Metasystematic order, it seems reasonable to postulate that one must apply and analyze the properties of two or more systems, and how the nature of the variables within the system produce differences and similarities in the systems. It may also be the case that there is a synthesis needed to truly demonstrate understanding of an interaction effect. Arguing for why there is a main effect or interaction would surely indicate that this is the case at the systematic stage. The very wording (see above) of the Paradigmatic Order would imply synthesis, and if one wishes to establish and keep the new field alive, they must evaluate the new field, and argue for its existence. The Paradigmatic order necessarily involves all of the categories in Bloom's taxonomy, because one would have to analyze the metasystems involved, and then synthesize elements of those metasystems into a new one. According to the research, it is very rare to find people at the Paradigmatic or Cross-Paradigmatic stages.

One question that might arise is as follows: Why use both Bloom's taxonomy and the MHC if the phrases and definitions in the hierarchical complexity model are so similar? After all, perhaps the hierarchical complexity model itself would suffice to conduct research and to better define stages of complex behavior. However, research also suggests that at the various orders of complexity, individuals can only demonstrate understanding of a stage that is one or two above where they are currently scoring. If this is the case, then the use of the taxonomy may be a useful tool for describing the levels of support for engaging in increasingly more complex behavior.

There are seven levels of support identified (Commons & Miller, 1998; Commons, Danaher-Gilpin, Miller, & Goodheart, 2002) to help individuals move from one stage to the next one. They are identified in Table 2 below, with the associated Bloom's taxonomy categories.

Table 2. MCH level of support, action, and associated Bloom's taxonomy

MHC Level of Support	Action	Bloom's Taxonomy Category
Manipulation	Student performs with guided help	N/A
Transfer of Stimulus Control	Student performs with cue	Knowledge
Pervasive Imitation	Student can imitate	Knowledge
Direct	No support	Comprehension
Problem Finding	Discover task, give example	Application
Question Finding	Find and solve problems with stimuli	Synthesis/ Evaluation
Phoneme Finding	Discover new phenomenon without stimulus	Synthesis/ Evaluation

The purpose of this research, then, is to show how the MHC might be applied to questions that have already been rated reliably using the modified Bloom's taxonomy (i.e., Crone-Todd, et al., 2000). What follows is an application of this approach to demonstrate that despite lower-level assessments using a categorical system, that greater complexity may be required of students.

Scoring Questions Using MHC

Method

Two raters scored each of the following questions, which are taken verbatim from Martin & Pear (2003). All of the questions have previously been reliably assessed using the modified version of Bloom's taxonomy (Crone-Todd et al, 2000), and have been used extensively in a computer-aided personalized system of instruction (CAPSI, see Pear & Crone-Todd, 1999) in Canada and the United State of America.

The first rater assessed the questions, and then compared scoring with the second rater. The first rater was a novice, and the second rater was skilled in scoring using the MHC. Overall rates

of agreement were high (87.50%).

The questions were chosen on the basis of being previously assessed as being in the Knowledge or Comprehension categories. In all cases, the answers to the questions could be found by reading the textbook (Martin & Pear, 2003).

Definitions

The items assessed refer to the components of questions asked relating to the material presented in the text. The modified Bloom's taxonomy category is the level at which the item was previously scored. The MHC order is the stage at which the question, *prima facie*, would be scored (see above). The level of support provided by the text refers to whether or not the answer is contained in the text (one level of support), or not (none). Finally, the functional stage of behavioral complexity is arrived at by subtracting the level of support from the MHC order. This effectively results in a scored stage of behavioral complexity for the task.

Results & Discussion

The scored items (see Table 3) reveal that there are varying levels of complexity, despite only two previously assessed categories. What is suggested here is that what Bloom and his colleagues identified was perhaps summary labels that are related both to the level of complexity and to the levels of support that were responsible for moving students through the process of a particular stage related to the educational level at which they were, and could be, functioning. This also suggests that other behavioral researchers (e.g., Johnson & Chase, 1981; Semb & Spencer, 1976) also broke down complex tasks into categories in which they could specify the behaviors that must be performed. However, none of the previous approaches speak to the complexity of the task.

Table 3. Comparison of a modified Bloom's taxonomy and the MHC scoring system

Item from Martin & Pear (2003)	Modified Bloom's category	MHC Order	Level of Support Provided by Text	Functional Stage of Behavioral Complexity
What is PSI?	Comprehension	Abstract	Pervasive imitation	Concrete
Who was its founder?	Rote Knowledge	Concrete	Pervasive imitation	Concrete
State at least five characteristics of PSI	Comprehension	Systematic	Pervasive imitation	Formal
Briefly describe how PSI has made use of computer technology	Comprehension	Systematic	Pervasive imitation	Formal
Which is more effective for teaching undergraduates, the traditional lecturing approach or PSI?	Rote knowledge	Concrete	Pervasive imitation	Concrete
Justify your answer.	Evaluation	Metasystematic	Pervasive imitation	Formal
What is a positive reinforcer?	Rote Knowledge	Formal	Pervasive imitation	Abstract
In what way is positive reinforcement like gravity?	Comprehension	Metasystematic	Pervasive imitation	Systematic

One interesting aspect of using a scoring system that considers the hierarchical complexity of the task is that it may lead educators to consider the current skill complexity shown by students, and what the final goal would be for the educational level. For example, sometimes students struggle with course material, which may produce punishment or extinction, leading to less interest in the material (see Crone-Todd, Eyre, Hutchens, Jones, & Pear, in press). This problem might be alleviated by allowing for more support in developing the more complex skill, which could lead to more reinforcement and higher-order thinking.

The process involved in providing levels of support is consistent with both the behavioral and constructivist literature (see Pear & Crone-Todd, 2002 for a discussion of similarities between constructivism and behaviorism). The behavioral approach would call the initial support and cues, followed by removal of these supports, fading. As students engage in more and more independent actions (direct, problem finding, question finding, and phoneme finding), their behavior is being shaped and chained through the use of both extinction for lower-level performance, and reinforcement for closer approximations up through the levels of support. The constructivist approach would call this process the scaffolding that takes place to move the student through their zone of proximal development (Arlin, 1975, 1984; Fischer et al., 1984; Vygotsky, 1978).

An approach that considers the behavioral aspects involved in the order of hierarchical complexity should be useful to both stage theorists and to constructivists. An integrated approach should allow both educators and researchers to formulate individualized plans that are tailored to the student's current level of complex skill development, and would also allow for a more precise method to support movement to the next stage. Future

research should center on further determining the reliability and validity of the MHC system in this context, which would include extending it to both instructor-led and computer-based environments. Such an approach should be encouraged to make educational practices more systematic, if not metasystematic.

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Miami, FL 33199

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Martha Pelaez, Ph.D., Editor
Department of Educational & Psychological Studies
College of Education 213
Florida International University
Miami, FL 33199