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SELECTIONISM AND STAGE CHANGE: THE DYNAMICS OF EVOLUTION, I

MICHAEL LAMPORT COMMONS
Department of Psychiatry, Harvard Medical School, Cambridge, Massachusetts, USA

Selectionism addresses the process of transition or change. In its evolution, Homo Sapiens has demonstrated such transitions to more hierarchically complex stages of performance at the individual, organizational, cultural, and biological levels. Traditionally, changes in biological, cultural, organizational, and individual behavior have been studied separately, with very little overlap. The current theory integrates selectionism across these realms, while noting that in each, selectionism operates through somewhat different mechanisms. Selectionism is comprised of complex processes in which tasks of greater hierarchical complexity may be selected. Increased stages of performance underlie evolution's dynamics of increased complexity.

KEYWORDS: Behavior, biology, culture, evolution, hierarchical complexity, individual, organization, selectionism, stage of performance, transitions.

The notion of stages and the hierarchical complexity of tasks on which stages are based is fundamental in the description of human, organismic, and machine evolution. The focus of this article is to provide a fundamental basis for understanding the dynamics of selectionism that underlie the development of changes to higher stages of hierarchical complexity. This is referred to as stage change. Stage change refers to performing tasks of a higher order of hierarchical complexity. The article addresses how different behaviors occur. In often-dense descriptions, it discusses internal and external events involved in selectionism and reinforcements of task performance. Its premises are based on the finding that every evolutionary process consists of three elements: variation, recurrence, and selection (Baum, 2000).

Selectionism manifests in three ways. In the first two, it characterizes evolution in general and in individual species' existence. It operates in the competitions among organisms, where species capable of more complex stages of performance demolish organisms and entire species at less complex stages of performance. In the last, in behavior within an individual organism's lifetime, selectionism is an essential dimension of explaining transitions in stage of hierarchical complexity, where the amount of reinforcements increases development because the probability of being correct goes up. This is important for explaining stage transitions.

Address correspondence to Michael Lamport Commons, Ph.D., Dare Institute, 234 Huron Ave, Cambridge, MA 02138-1328, USA. E-mail: commos@tiac.net

It is asserted that selectionism addresses the process of transition or change. We argue that while evolution is not necessarily progressive, in the evolution of Homo Sapiens there have been increases in the stages of performance at the individual, organizational, cultural, and biological levels. Some of these changes are represented in the genes of individuals and others are represented in their memes. The biological dimension pertains to individuals and their species. *Meme* refers to a unit of cultural information transferable from one individual to another. Traditionally, changes in biological, cultural, organizational, and individual behavior have been studied separately, with very little overlap. The current theory integrates selectionism across realms, while noting that in each realm, selectionism operates through somewhat different mechanisms.

This article is organized as follows. It begins with an overview of the seven dimensions of behavior selection. The four dimensions of selectionism at the biological, cultural, organizational, and individual levels are then introduced. The dimension of individual development through selectionism is given in depth discussion to cover the confluent, central roles of learning, contingencies, reinforcement, conditioning, and other dynamics enabling individual selection of behaviors at higher orders of hierarchical complexity. These account for the possibility of stage change to happen at all, an understanding that is central to evolutionary dynamics. As the conclusion indicates, this article provides a foundation for understanding the actual steps in transition that comprise stage change dynamics, which are introduced in the subsequent article in this issue.

DIMENSIONS OF TASKS IN BEHAVIORS SELECTED

In all cases, it is behavior that is differentially selected. There is no necessity that certain things in the environment will be a certain way. What behaviors get selected are different for evolution, changes in culture, and learning and development within a life. Biological, cultural, organizational, and individual development are all contextual, chaotic, and historical. They all depend on local chance conditions or context (see Morris, 1988 for a review). Some hold that such contextual factors have more to say about development than grand processes (Gell-Mann, 1994). For example, Laszlo (2003) describes how both universal processes and locally contextual factors are in constant interaction. Without contradicting any of those perspectives, in this article we maintain that the selective characteristics of the environment are those contingencies that select, for example, whether or not an organism reproduces and whether its offspring, in turn, reproduce. At any one time, selective processes are, in and of themselves, under-determined by any deterministic processes. That is, there is no deterministic explanation for which behaviors will survive. Survival depends on a huge array of very local conditions.

Behaviors are selected in the context of events. Relationships among events are accidental at first. Those between the correct stimulus and response are selected through increases in the frequency of reinforcement. Behaviors lead to outcomes and consequences that, in turn, select behaviors. Outcomes must be present that reinforce next-stage behavior in order for there to be development of a new stage

behavior. New stage behaviors may just be discriminations among which lower stage behaviors should be chosen. Discriminative stimuli are the key to selection. New stage behaviors obtain more reinforcement than lower stage behaviors because they work in more situations.

How well an individual performs a task is postulated to be controlled by: (1) at least seven dimensions of tasks; (2) aspects of the situations in which tasks are presented; and (3) the reinforcement history of the individual. As Table 1 shows, we characterize tasks in terms of five stimulus and response dimensions. We characterize two performance dimensions. The first part of the discussion introduces the dimensions of tasks because it is these dimensions, and particularly the first one (hierarchical complexity) that determine the sequence in which development takes place. These sequences, which follow the orders of hierarchical complexity, occur in this order no matter how the reinforcement contingencies may favor out-of-sequence acquisition.

Other articles in this special issue develop some of these dimensions. The first two dimensions are discussed in "Introduction to the Model of Hierarchical Complexity" and "Presenting the Formal Theory of Hierarchical Complexity," as is behavior stage in the sixth dimension. The third dimension, level of support, is discussed in two articles, "Domain-Specific Increases in Stage of Performance in a Complete Theory of the Evolution of Human Intelligence" and "Cultural Progress is the Result of Developmental Level of Support." The transition step of performance dimension is discussed in "Fractal Transition Steps to Fractal Stages: The Dynamics of Evolution, II." Reflectivity, the fourth dimension, increases with the individual's stage of hierarchical complexity of performance.

Table 1
Stimulus, Response, and Performance Dimensions of Tasks

Name of Dimension	Dimension	Definition
1. Hierarchical complexity	Stimulus	The number of times task-related actions act on the output of lower complexity actions in a chain of actions
2. Horizontal complexity	Stimulus	Number of stimuli and corresponding actions
3. Level of support	Stimulus	Transfer of stimulus control (level of support)
4. Reflectivity	Response	Degree of reflectivity of actions (from no reflectivity to reflections on methods for judgments)
5. Implicit or explicit control	Response	Form of control over the operant responses
6. Behavioral stage and transition step of performance	Performance	Sensitivity to relationships in a task of given hierarchical complexity. A Rasch scaled score may also be found.
7. Bias	Performance	Tendency to assert relationship occurs

SELECTIONISM AT THE BIOLOGICAL DIMENSION

Behavioral and cultural notions of selectionism are ultimately based on the biological notion (Baum, 1995, 2000). The results of biological evolution are represented in individuals by their genotype, which is encoded in the DNA (Ridley, 1996). The genotype represents all the biological evolutionary material that will be passed on through successive generations. For this material to be passed on, an individual must survive and reproduce. While existing traits are assumed to have facilitated propagation, there is a time lag between reduced functionality and disappearance of a gene. There are also traits, which on the surface, do not seem to be of survival value. The gene for sickle cell anemia protects against malaria, for example, as long as one inherits one but not two of the genes for this trait and thus does not develop the illness itself. Selectionism at the biological dimension is covered extensively in other literature and is not further developed here. The main point is to assert the intimate relation, not segregation, of the behavioral and cultural dimensions with the biological.

SELECTIONISM AT THE CULTURAL DIMENSION

The results of cultural evolution are represented in individuals by their behavioral patterns in specific situations. Dawkins (1989) calls these patterns *memes*. Like biology, culture partially determines who reproduces and whose offspring survive to reproduce. For example, women who are deemed to be good looking are more likely to have children. They are very young looking (e.g., have little facial hair) and are relatively slender and have hourglass figures (Buss, 1999). At any one time, both biological and cultural evolution are represented in the individual. Evolutionary processes may be indifferent as to whether the information is passed on through biological or cultural mechanisms (Trivers, 1985). The two types of information may interact with each other. Biological information in the form of DNA that determines genes may confer advantages within a particular cultural environment. From an evolutionary perspective, engaging in behaviors that best meet situational demands increases the likelihood that information contained in both the genes and memes will be passed on (Petrovich and Gewirtz, 1985).

We assume that both biological and cultural evolutionary processes operate on behaviors and on the organism's susceptibility to the potentially eliciting and reinforcing properties of events (Commons and Miller, 1998). We assume they do this in ways that are similar to how they operate on such biological characteristics as height, strength, and agility (Baum, 1995; Boyd and Richerson, 1985; Skinner, 1981). Biological evolution requires isolation for speciation to take place. Speciation is the evolutionary process by which new biological species arise. There are different modes of natural speciation, based on the extent to which speciating populations are geographically isolated from one another. Cultural evolution may benefit from a combination of isolation for a period and then contact (LeVine, 1973). However, it is not likely that behaviors are genetically programmed, as much of human behavior may be too complex to be genetically coded. It is more likely it is the elicitors of behavior and the reinforcers for behavior that are

genetically coded. Evidence that reinforcers can be genetically programmed in humans is in the fact that at birth humans have a positive preference for some tastes, so that these tastes are positively reinforcing, and a negative preference for other tastes, so that the removal of these tastes are negatively reinforcing (Lipsitt, 1977). In summary, the reception of the stimuli and the potency of some reinforcers of behaviors, rather than behaviors themselves, are genetically based. An organism's behaviors are selected by the reinforcement contingencies and the situations in which the organism exists. Thus, we assume that if a behavior exists today, then it has facilitated reproduction or genetic propagation (Baum, 1994; Buss, 1995; Wilson and Lumsden, 1991). Behaviors that do not facilitate reproduction will become extinct (Skinner, 1981). Reproduction issues are the most fundamental for observing that selectionism operates at the cultural level. They indicate the integration of the biological and the cultural.

Although more hierarchically complex behaviors may often be more adaptive (i.e., they offer an advantage to an organism in terms of reproductive success), they come at the cost of a larger brain that requires more calories. Over time there is a tendency for more complex behaviors to develop in some groups of species and across some species. This tendency is not inevitable. It may be that higher orders of hierarchical complexity at some times and in some situations have conferred advantages. However, many organisms are "well enough adapted" to their particular niche and their success in dealing with greater hierarchical complexity would not confer an extra advantage.

In the transition from apes to humans, more hierarchically complex behavior may have developed when a member of a community, through minor trial and error variations in behavior, developed a new, more complex behavior (or a meme). This either may have happened randomly in only one individual who may have been more likely to discriminate contingencies for more hierarchically complex behaviors or engage in them. The concept "discriminate contingencies" may be useful in understanding selectionism and stage change. It means that organisms respond to differences in contingencies of an order of hierarchical complexity that does not exceed their stage of performance and do not differentiate the differences in contingencies when the contingencies are too hierarchically complex. Such a tendency could arise because of an interaction between mutated genes, unusual circumstances, and the contingencies within them. The following is a speculative example. Let us say that a single person had the relatively "hairless" gene. This might have been fine in a warm part of Africa. But when those hominids migrated to a cooler region, they needed clothes. So wearing animal skins increased warmth, and the person discriminated the reinforcing value of wearing such clothes (animal skins). This was a very unusual behavior (i.e., novel, creative at Formal stage 10, at least), indicating that it required more hierarchically complex thinking. The wearing of skins to deal with the cold is a coordination of the abstract notion of "wearing skins" with the outcome of "getting warmer."

These potential memes can become actual memes only if they spread to a large enough group of individuals in the culture. This process has been called *infection by memes* (Commons, Krause, Fayer, and Meaney, 1993; Trivers, 1985). In order for an individual to become infected by the new meme, a particular (new) set of

contingencies must first be discriminated. Then, in actually executing a behavior that is controlled by that set of contingencies, the individual is further infected. Thus, there are degrees of infection by memes. To continue the example, once one person invented the idea of using animal skins for warmth in a cold climate, it is easy to recognize how rapidly that idea spread and resulted in widespread behaviors of other early humans covering themselves in skins to be warm. In the coldest climates, the degree of coverage would be greatest; in less extreme climates, the degree of coverage and possibly the fashioning of skins would be different.

SELECTIONISM AT THE ORGANIZATIONAL DIMENSION

Organizations refer to groups that may be as small as families or as large as some countries. The reason organizations are discussed is because most modern cultures are made up of many organizations, all of which have an effect on the behavior of individuals. In a behavioral developmental analysis of organizational behavior, we need to indicate how contingencies at one level set contingencies at another. We also identify the reinforcement mechanisms (Skinner, 1938) through which these contingencies are enforced. We have used the term *institutional atmosphere* to refer to the dynamic relations between institutional behavior at various levels (Commons, Krause et al., 1993). Specifically, atmosphere includes: (a) the *ordered levels of contingencies* that affect individual behavior within an organization (the rules) and (b) the methods by which contingencies are set.

The ordered levels of contingencies include:

1. Contingencies that formed the organization (kinship, propinquity, social, economic, political, and legal systems) (Primary stage 7 to Metasystematic stage 12),
2. rules or by-laws governing policy setting (Concrete stage 8 to Metasystematic stage 12),
3. policy contingencies (authority, customs, regulations, laws), such as role definition and role rules, including how to make regulations (Concrete stage 8 to Metasystematic stage 12),
4. regulation contingencies (regulations), such as how various broad situations will be addressed procedurally and what behavior contingencies will be made (Concrete stage 8 to Metasystematic stage 12),
5. target behavior contingencies, such as what behavior is reinforced and what is punished (Concrete stage 8 to Metasystematic stage 12),
6. raw behavior (all stages).

Atmosphere's Contingencies and Effects on Behavior and Development

We suggest that the hierarchical complexity of the contingencies that constitute a particular workplace atmosphere affects the patterns of individual choice-making within that organization. The general order of complexity of the contingencies available to members of an organization will either allow for or not allow for more hierarchically complex behavior. If primarily lower-order decision making

prevails, individuals' higher-order decision making will not be reinforced. Individuals' decisions within such an institution will then most likely reflect the lower-order contingencies available. For example, organizational decision making that excludes the perspectives of constituent groups may ultimately produce constituent decision-makers who exclude the perspective (and interests) of the larger organization (see Galaz-Fontes, Pacheco-Sanchez, and Commons, 1990; Meaney, 1990). Other studies (Higgins and Gordon, 1985; Johnstone, et al. 1991) have found similar effects of lower-order institutional atmospheres. As the order of complexity increases however, individuals increasingly evaluate and integrate competing perspectives and take the perspectives of others into account (Commons and Rodriguez, 1990; Rodriguez, 1989). The better one's perspective-taking skills, the better one's decision-making and managing skills (Weathersby, 1993), that is, one's selected behaviors in the current context.

An Example of Cultural and Organizational Effects

Biological, cultural, and organizational contingencies co-determine one another to produce effects at the individual level. Ultimately, cultural and organizational contingencies affect individual behavior. Two findings from a study in a Mexican border city illustrate this point (Commons, Galaz-Fontes, and Morse, 2006). First, unschooled, non-literate adult leaders solved more hierarchically complex problems than those who were not leaders. Second, students who were either identified as leaders, or had more cross-border experience, performed at higher orders of complexity. To be an effective leader one must take into account the perspectives of others and be empirical in obtaining results (as opposed to just doing what has traditionally been done). Individuals who have increased cross-border (and cross-cultural) experience learn that the social contingencies (norms) will differ from one culture to the next. In both cases, the use of more hierarchically complex perspectives is reinforced.

SELECTIONISM AT THE INDIVIDUAL DIMENSION

Selectionism at the individual level operates through learning. Learning can address problems of varying horizontal complexity or vertical hierarchical complexity (see "Introduction to the Model of Hierarchical Complexity," this issue). Learning that involves successfully addressing a more hierarchically complex task is stage change. The rules of thumb and proto laws address reflexes and tropisms (a turning movement toward a stimulus), fixed action patterns (a sequence of somewhat reflexive movements), sensitization (acting more sensitively to a stimulus), habituation (becoming used to a stimulus), conditioned reflexes, and operant conditioning (learning from consequences of behavior). Operant conditioning principles that are useful in addressing complex human behavior include melioration (change in behavior when the consequences change), matching (responding so that the rate of consequences match the rate of behaving), maximizing (Rachlin and Laibson, 1997), and behavioral momentum (Nevin, 1988, 1996; Nevin and Grace, 2000).

In the metaphor of behavioral momentum, the rate of a behavior in the presence of a cue is analogous to the velocity of a moving body. Resistance to change measures an aspect of behavior that is analogous to its inertial mass. An extension of the metaphor suggests that preference measures an analog to the gravitational mass of that body. The independent functions relating resistance to change and preference to the conditions of reinforcement may be construed as convergent measures of a single construct, analogous to physical mass. That represents the effects of a history of exposure to the signaled conditions of reinforcement, It unifies the traditionally separate notions of the strength of learning and the value of incentives. Research guided by the momentum metaphor encompasses the effects of reinforcement on response rate, resistance to change, and preference and has implications for clinical interventions, drug addiction, and self-control. In addition, its principles can be seen as a modern, quantitative version of Thorndike's (1911) Law of Effect, providing a new perspective on some of the challenges to his postulation of strengthening by reinforcement.

At different orders of hierarchical complexity, we suggest various contingencies may be effective, a point only introduced here, not developed in depth. For example, melioration (Vaughan, 1981) suggests that matching in concurrent schedules occurs because the subjects equalize the local reinforcement rates (reinforcers received for each alternative divided by the time allocated to each alternative). This is operative from Circular Sensory-Motor stage 2 on. The matching law states that organisms allocate their choices in a proportion that matches the relative reinforcement obtained on these choices (Herrnstein, 1961; Rachlin and Laibson, 1997; Williams, 1988). The matching law has been shown to be valid in a variety of task paradigms, and across species (e.g., pigeons, rats, monkeys, humans) (Anderson, Velkey, and Woolverton, 2002; de Villiers and Herrnstein, 1976; Gallistel 1994; Williams, 1988). Maximizing of utility is what rational expectation theory predicts. A choice with the highest utility measured by multiplying rate or probability of reinforcement times the value is always chosen. This is operative at Systematic stage 11 because it is multivariate. It is in the range of maximizing utility that various problems require different stages of performance.

Operant Conditioning Acquisition as Selectionism

In operant conditioning, consequences control the rate or probability of behavior. This main method of selection of behavior, therefore, is through these consequences. The stimulus situation in which the behavior is reinforced is the cue for that behavior. The consequences alter the probability or rate of reinforced behavior. Contingencies may contact with behavior to varying degrees. This contact may depend on the: (a) salience of events in the contingencies (Rescorla and Wagner, 1972); (b) time between the events in the contingencies (the delay after the behavior of the consequences; (c) the responses and stimuli that might come to control the behavior (Fantino, 1981; Fantino, Abarca and Dunn, 1987); (d) the amount of other reinforcement in the present and historical environment, and (e) the hierarchical complexity of the contingency, or in traditional terms, whether the contingency is discriminable.

Hierarchical Complexity and Operant Conditioning

How hierarchically complex a reinforcement contingency is determines its effect on the organism's behavior. First, if a contingency is too hierarchically complex compared to the organism's stage of performance, it may have no effect at all on behavior. Second, there may be some very non-specific effect (e.g., increased arousal, increased resistance to extinction). Third, if organisms only discriminate temporally local gains and losses in reinforcement rather than the overall rate of reinforcement, organisms generally match how much of the time they allocate responses to how much of the time they obtain reinforcers for what they are doing. Fourth, when organisms rapidly discriminate task contingencies of a given order of hierarchical complexity and it is possible to maximize the total amount of reinforcement, they tend to do so (Rachlin and Laibson, 1997). This may occur even more often if the rules in the contingencies are not directly discriminated.

Reinforcement and Increases in the Complexity of Performance

Reinforcement may be sufficient for changes in the stage of performance. Commons, Grotzer and Davidson (2007) demonstrated this in a study of 122 students in the fifth and sixth grades from mixed socioeconomic backgrounds. At the beginning of the study, most of the students reasoned at the Concrete stage 8. All students were asked to solve a series of adult problems (Formal order 10) requiring them to detect a cause. Problems were presented sixteen times, over the course of part of one semester. Group 1 received no feedback about their performance. Group 2 received feedback alone, and Group 3 received both feedback and points toward a possible prize for correct answers. Each member of a Group 3 team that scored the most points received a prize (chosen by the children) at the end of the entire problem sequence. Only students in the reinforcement group (Group 3) group improved their proficiency in detecting causal relations from the pretest to the posttest—75 percent performing at Formal stage 10. This illustrates that even relatively complex behaviors can be acquired if reinforcement is available. Reinforcement, then, is intimately related to selection of behaviors, and stage change depends on selection of more complex behaviors, by definition.

The Relationship between Operant and Respondent Conditioning

The current theory views development as a joint product of task characteristics (such as hierarchical complexity) and of selection of behaviors at all orders of task complexity. Because the vast majority of the learning that takes place is due to operant contingencies, it is important to communicate our view of the underlying mechanism of operant conditioning (Commons and Hallinan, 1990; Commons, as cited in Pear and Eldridge, 1984).

We posit that operant conditioning begins when an initial, internal but potentially observable response produces an internal unconditioned stimulus (us) that then *elicits* the operant behavior (R). For this stimulus, us, to be conditionable to the previous environmental stimulus or stimuli (potential discriminative stimulus S^D or cue), it must be salient. That is, the organism must detect it. What makes the

little us salient and detectable is that it is paired with the operant reinforcer. After the little us has become salient, it can be successfully paired with an environmental stimulus. That environmental stimulus will become the discriminative stimulus.

Operant Conditioning Explanations of Selected Human Behaviors

This view of operant conditioning allows us to more easily explain three phenomena because it suggests why: (a) humans increasingly see the internally mediated causes (rules) for their own behavior; (b) the free will illusion persists throughout development, even for a behaviorist; (c) punishment strengthens alternative behavior. Each of these will be discussed in turn in what follows.

In people, the response that produces the little us may be implicit or explicit verbalizations. There are three conditions when these rules may be implicit: during early acquisition—the sequence of behaviors they organize has not been verbalized; after overlearning; or when memetic performances are being imitated. As the required behaviors become more hierarchically complex, the rules still may be implicit as in the "presolution" period of problem solving. If the responses are explicit verbalizations, they may first be words and later rules (Gewirtz and Pelaez, 1991). As complexity of the effective contingencies increases, implicit rules, verbal behavior, and rule-governed behavior become increasingly powerful in controlling behavior. Contingencies reinforce the greater stage of those rules.

If the us is salient enough, people may report they are "conscious of it." The fact that it precedes behavior leads to the illusion of free will. When discriminations are very difficult or not made, humans do not report a sense of free will. What an organism senses as consciousness is dramatically affected by the orders of hierarchical complexity that they discriminate. It is in that sense that humans have the highest level of consciousness. As intraverbal rule-governed behavior increases in hierarchical complexity, we increasingly report our "conscious thought" as directing out behavior.

We assert that operant learning, including punishment, works in all cases by strengthening behavior. This is true because the consequence that follows the response can only strengthen the us–response relationship. This makes it impossible for punishment to have its own mechanism. We would argue that punishment works by negatively reinforcing alternative behavior. This leads to a different understanding of the role of trauma in development. Traumatic events may reinforce various kinds of behaviors, including thinking about things unrelated to the traumatic event rather than facing them, viewing oneself in disembodied form (dissociation), breaking off relationships, thinking about how hapless, incompetent, and bad one is, and how hopeless life is.

CONCLUSION

This traverse through the dense descriptions of selection processes had the objective of indicating the thorough integration and concurrent operation of the biological, cultural, organizational, and individual dimensions in selectionism. It emphasized learning as what happens in stage change, and the roles of various

kinds of contingencies, reinforcement, and conditioning on the selection of behaviors. These were shown to be not linear cause and effect relationships, but intricate systems of interactions involved in selecting any behaviors. The environmental metasystem in which organisms exist in any particular situation co-determines the selection of behavior in that situation. As factors within the biological, cultural, and organizational dimensions become more complex, the individual has conditions in which selection of more complex tasks is possible and reinforced. More complex task performance is stage change. Selectionism and stage change are central dynamics of evolution. The behavioral tasks of moving from one stage of hierarchical complexity to another occur in empirically defined transition steps. These transitions are the subject of the following article in this issue.

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