The Behavior Analyst 2004, 27, 133–151 No. 2 (Fall)

Individual Behavior, Culture, and Social Change

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The principle of operant selection is examined as a prototype of cultural selection, and the role of the social environment is suggested as the critical element in the emergence of cultural phenomena. Operant contingencies are compared to cultural selection contingencies, designated as metacontingencies. Both of these types of contingency relations result in evolving lineages of recurrences that can become increasingly complex in the number and organization of their elements. In addition to its role in the recurring interlocking behavioral contingencies that constitute cultural organization, operant behavior plays another role in cultures. Although the operants of individuals are functionally independent of one another, the behavior of each person may contribute to a cumulative effect that is relevant to the well-being of many people. Similarly, the outcomes of metacontingencies may also contribute to a cumulative effect. The relation between independently evolving operant lineages, or between independently evolving cultural lineages, and their cumulative effect is identified as a macrocontingency. Macrocontingencies do not involve cultural-level selection per se. Effective cultural engineering requires identifying the macrocontingencies that produce less than desirable effects and altering the relevant operant contingencies or metacontingencies to produce change in the cumulative effects.

Key words: operant contingencies, macrocontingencies, metacontingencies, cultural selection, operant selection

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Learned behavior is the substructure of human cultures, and the transmission of learned behavior powers the evolution of human cultures. Human behavior produces cumulative change in human environments, and continually changing environments require continuing behavioral adjustments. Successful adjustments can become embedded in cultural practices and transmitted to later generations.

Increasingly complex cultures have emerged from the interplay among the human capacity for learning, the contingencies of reinforcement that account for the learned behavior of individuals, and the cultural transmission of learned behavior—all in the formative context of physical features of local environments. Over a period of little more than 10,000 years, human cultures have evolved from small bands of hunter-gatherers, presumably showing one another how to produce fire and to fashion simple tools, to huge nation-states in which the integrated activities of hundreds of people participate in producing the fabric used to make clothing sold as Brand X or to make the laws by which millions of people live. Decades of education, formal and informal, are now required to develop and maintain the behavioral repertoires needed to participate in the vast webs of interrelated human behavior that constitute modern culture.[1]

Most of the features of modern cultures were not planned. Rather they simply emerged as a result of the contingencies of selection that supported the behavior of individuals (cf. Johnson, 2001). Systematic planning seems to begin when cultural practices have unpredicted, undesired, or belatedly recognized suboptimal results. Unintended and culturally damaging results of ongoing human behavior are first identified, then bemoaned and, sometimes, finally dealt with. But can they

I am deeply indebted to Leslie Burkett for her multiple readings of the manuscript while it was in preparation. Her critical feedback was invaluable.

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[1] The foregoing paragraphs draw on the work of Bonner (1980), Harris (1989), and Diamond (1997).

be dealt with fast enough to ensure survival?

Almost 20 years ago, B. F. Skinner (1987) asked why we were not acting to save the world. His answer was that the cultural practices of most of the human race did not include the verbal behavior required to properly analyze the problems and plan the changes in the environment needed to promote cultural (and possibly species) survival. The missing verbal cultural practice, Skinner suggested, was the language of the experimental analysis of behavior—specifically, the practice of analyzing the contingencies of reinforcement that support the behavior of members of a culture and predict the results of changing those contingencies. He further suggested that the experimental analysis of behavior would support a theory of cultural evolution in the same way that Darwin's theory of biological evolution is supported by the experimental science of genetics.

Skinner's (1987) analogy offers a starting point for exploring in this paper at least one way of using the language of the experimental analysis of behavior to support an interpretive theory of culture. Although Skinner's ultimate interest was in bringing about changes that would improve the lives of people, the point of his paper was that the path to effective action begins with effective verbal practices. In 2004, the 100th anniversary of his birth, humans need more than ever a language that will help them to analyze their problems in ways that guide effective action.

In the sections below, I review the principle of *operant selection* and the role of human social environments in behavioral contingencies. I then define *culture* and *cultural practices* and consider the role of operant behavior in them. Two types of cultural-level relations—*macrocontingencies* and *metacontingencies*—are distinguished, and the role of behavioral contingencies in each type is explained as a prelude to accomplishing social change. Finally, I return to Skinner's views on the relation between the verbal practices of the experimental analysis of behavior and a theoretical interpretation of culture.

THE PRINCIPLE OF OPERANT SELECTION

Behavioral principles describe the relations between behavior and environment that account for the acquisition and maintenance of learned behavior. The principle of operant selection is the bedrock on which other behavioral principles rest. Like other scientific principles, its simple form masks the complexity of the universe it describes. The principle of operant selection is sometimes stated as "behavior is a function of its consequences." Such a bald statement makes no mention of the different roles played by time in the selection process described by the principle. The statement also obscures the fact that the words *behavior* and *its,* which appear to refer to the same thing, actually refer to different things. Let us unpack the statement in order to lay the groundwork for a similar unpacking of cultural selection. Figure 1 is a schematic of operant selection as it goes on in time.[2]

The schematic shows, first, that the universe in which behavioral selection occurs is localized in the actions and events outside those actions (environment) of a single organism (let us say a young child learning to stack blocks). Of course, we would not be particularly interested in this universe if operant selection affected only this organism's behavior. As it turns out, the process appeared early enough in the evolutionary history of the earth to predate humans by millions of years and therefore is a behavioral characteristic

[2] This example is made as simple as possible and is not meant to suggest that the principle requires simple responses, that instances are instantaneous, that bouts or sequences of responses cannot undergo selection, and so on. The function of S1 is not discussed because the schematic does not show differential control over R1.

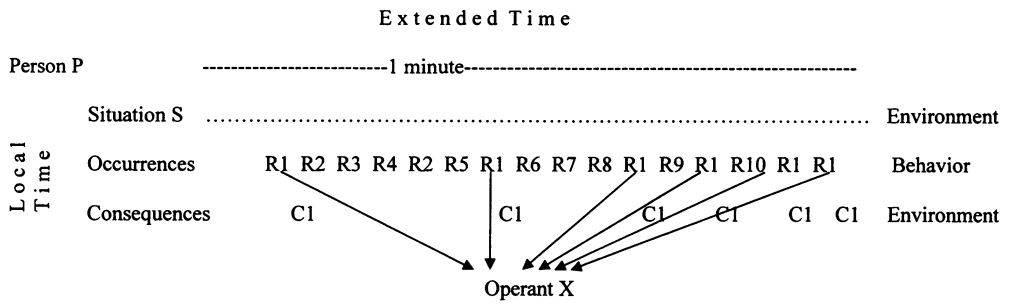

Figure 1. Recurrences of R1 that occur with increasing frequency as a result of the operant contingency.

shared by many species, perhaps humans most significantly.

In the schematic, three types of events are shown to be occurring in relation to one another in local time. One type of event comprises the actions of Person P, whose responses are designated by the letter R followed by a number. Each numbered R is a different way of manipulating a block. To make the example as simple as possible, all Rs occur during a 1-min period in a stable Situation S, which is present when each R occurs (blocks are on a flat surface and everything in the playroom remains constant). In that situation, the actions that an observer identifies as R1 (e.g., placing a block squarely on top of another) are reliably followed by a particular type of stimulus change, C1 (a tower appears). That consequence does not follow the other actions occurring in Situation S. Situation S and the consequences represented by C1 are environmental variables.

The local temporal arrangements between each occurrence of R1 and the subsequent C1 in Situation S are shown in the diagonal arrangements of those letters. The recurring temporal relation between instances of R1 (but not other Rs) and C1 is typically designated as a *two-term contingency*. The behavior identified as R1 is shown to occur several times. Only one other behavior occurs more than once (R2), and it occurs only twice. Within the 1-min period of observation, R1 can be seen to occur with increasing frequency and by the end of the minute, R1 predominates in Person P's behavior stream.

Assume that R1 has rarely, if ever, occurred previously in Person P's behavior stream. The schematic represents the acquisition of an operant we have labeled Operant X (in this case a "block-stacking" operant). The reliable temporal relation between R1 and C1 (together with the absence of such a temporal relation between other Rs and C1) is the contingency that is causing an increase in the frequency with which R1 occurs in Person P's behavior stream in a stable environment.

Recall the principle "behavior is a function of its consequences." The particular behavior that is a function of consequences in this example is Operant X (a *lineage* of R1 responses). The "it" that is followed by a consequence is occurrences of R1 (each stacking response). The temporal (and usually causal) relation between occurrences of R1 and occurrences of C1 has generated a lineage of R1 that we have labeled X. Both the lineage (the child's block-stacking operant) and the individual responses (each instance of stacking) are behavior—specifically, the behavior of Person P. But they are two different kinds of things. Moreover, the principle itself is content free and refers to any and all lineages, and their component responses, that have been generated by contingencies between responses and consequences. The value of the principle as a scientific generality depends on the variety

of the content that fits the formula and the variety of organisms whose behavior can be predicted, changed, or usefully interpreted in terms of the principle.

The 1-min slice of a behavior stream portrayed in Figure 1 shows a stable situation that is present when all the responses occur, and it shows a certain kind of environmental change following some of the responses. Changing the situation to S2 during the next minute and ensuring that no responses are followed by C1 in Situation S2 can add a level of complexity. Let us say that in Situation S2, the surface on which the blocks rest is not flat. Alternation of S1 and S2 at varying intervals, with C1 occurring after R1 only in S1, typically results in high frequencies of R1 in S1 and low frequencies of R1 in S2. The relation among S1-R1-C1 is then specified as a *three-term contingency.* In this case, the particulars of the three-term contingency are "on flat surfaces (but not on sloping surfaces), placing blocks squarely on top of one another results in towers."

In a more dynamic and complete portrayal of a behavior stream, elements of the situation are usually changing moment to moment and most responses would be followed by a stimulus change of some kind (cf. Ray, Upson, & Henderson, 1977). The resulting interplay between environmental changes and moment-to-moment changes in a behavior stream is identified as Person P's *behavior.*[3]

[3] Specific or particularized operant lineages (and their component occurrences) often are identified colloquially as *behaviors,* implicitly signifying their ontological status as individually identifiable. For example, "The child engaged in two problem behaviors" could mean he was observed repeatedly to hit other kids at lunch and also to scream when recess ended. On the other hand, everything one or all organisms do is designated as *behavior* (a mass noun). Friman (2004) eloquently defended both usages on practical grounds. Here it is suggested that the different usages also respect an ontological distinction. Specifically, the mass noun refers to a type of empirical phenomenon (i.e., activity) and the plural usage suggests localization with respect to a specific person.

The actions that recur in operant lineages change over time as the contingencies of selection develop and change. One way the operant lineages change is that the component actions become more complex. For example, a child may learn to plug cords into wall sockets, and to turn dials such as on the kitchen timer, and to press handkerchiefs when his dad has finished ironing his shirt. In a situation calling for a pressed shirt, variations of the three responses may occur in a novel sequence, resulting in a pressed shirt. This coming together of responses from operant lineages learned at different times has been termed *contingency coadduction* (Layng & Andronis, 1984). The relation between the novel (adduced) response sequence and the environmental consequence may increase the likelihood of repetitions of the sequence, eventually resulting in a new operant lineage in the child's repertoire. Call it *ironing.* The ironing lineage is a recurring sequence of actions, each instance of the sequence composed of elements originally recruited from earlier acquired operant lineages. Because all the components of the sequence are required in each occurrence to produce the consequence, the sequence of components acquires a functional integrity of its own. The nesting or embedding of occurrences of one lineage in more complex occurrences of another lineage is a highly consistent characteristic of human behavior. An example of such nesting is shown in Figure 2. Note that the lineage is always composed of recurring events, and the increasing complexity is seen in the increasing number of components in the occurrences of the hierarchical lineages.

ENVIRONMENTAL CONTENT IN OPERANT CONTINGENCIES

The only necessary feature of the environmental events in three-term contingencies is that they be empirical events. For everyday purposes, humans have found it useful to categorize em-

	Operant Lineages *(Recurring operant acts)*	*Elements of Each Occurrence*
Person A	***Press <Enter>***	Place digit on key Depress key
	Open MS Word	Locate program icon on desktop Place cursor on icon ***Press <Enter>***
	Copy email text into a *Word* document	***Open MS Word*** Open email Highlight text to be copied Click "copy" icon Switch to page in Word document Click "paste" icon

Figure 2. The components of occurrences in earlier lineages become integrated with the components of occurrences in later lineages of more complex occurrences.

pirical events in myriad ways: visual or auditory, temporally extended or punctate, verbal or nonverbal, social or nonsocial, and so on. Any single event can be categorized in many different ways. Lightning as an event in one's environment is visual, punctate, nonverbal, and nonsocial. In a child's environment, my humming a tune can be categorized as auditory, extended, nonverbal, and social. Another way that empirical events can be categorized is in terms of their temporal relation to the behavior of a learner or performer. The lightning may be a situation (antecedent) in which the behavior of asking "lightning?" results in the consequence of "yes." My humming may be the situation in which the child's humming results in the sound of our duet (consequence). Whether the "yes" or the sound of the duet functions like C1 in Figure 1 is an empirical question. If they do, we consider them as belonging to yet another category: reinforcer.

The social environment is defined, for present purposes, as the behavior of other people as it relates to the behavior of a learner or performer. Your question "What is your name?" is part of my social environment. My answering with my name is a social event in your environment. For any particular occurrence of an operant response, the situation may involve social and nonsocial events. One or more consequences also may be either social or nonsocial. Figure 3 provides examples of three-term contingencies in which various combinations of social and nonsocial events might function as sit-

Situation	*Response*	*Consequence*
Drink machine	Deposit coins	*Cold drink*
Five cups on table	"One-two-three-four-five cups"	***Teacher nods and smiles***
Friend says "turn left"	Turn left	*Arrive at destination*
Friend asks "What time is it?"	"Six-fifteen"	***Friend says "Thanks"***

Figure 3. Antecedent (situation) and consequent events may be nonsocial (italicized) or social (boldface) or a combination of social and nonsocial for responses in an operant lineage.

uation and reinforcing consequence in operant contingencies. Environmental events are italicized, and boldface identifies social events.

The everyday distinction between social and nonsocial events has encouraged some authors to distinguish between "social learning" and "individual learning," the implication being that they involve different learning processes (e.g., Box, 1984). But such implication is not warranted because it confuses process and content. All learning is individual learning (Galef, 1988); that is, the locus of learning comprises the events in the behavior stream of an individual organism as they relate to environmental events. The social character of some or all environmental events in behavioral contingencies distinguishes the content of the environment, not the process by which that environment affects behavior. The behavioral processes are the same, whether the environment that functions to select the behavior is social or nonsocial, and those processes are a biological given.

The social content in the contingencies that support most of the learning accomplished by humans is a defining feature of human cultures. Although rudimentary cultures are seen in other species (Bonner, 1980; Harris, 1989), only humans depend almost entirely on cultural transmission of behavioral content for the survival of their species. How could natural selection have lost so much direct control over the survival of one of its creations? And what genetically transmitted human characteristics lengthened the leash of natural selection so dramatically?

BIOLOGICAL INHERITANCE AND CULTURE

In addition to a distinct combination of anatomical and physiological characteristics—such as opposable thumbs, bipedal locomotion, acute hearing and vision, a highly plastic brain, and an intricate and flexible vocal apparatus—the human species has several genetically transmitted behavioral characteristics that appear to have underpinned the emergence of culture. The first behavioral characteristic that made human cultures possible is their sociality—the strong tendency of humans to spend most of their time in close proximity to one another. Without this tendency, there would be little possibility for social events (i.e., the behavior of conspecifics) to serve as environmental events having function with respect to human behavior.

Skinner (1984b) identified two other behavioral characteristics that together constitute what may be called, somewhat vaguely, "learning potential." First, humans are born with a repertoire of "uncommitted behavior," which distinguishes them from social species such as ants, whose specific behavior–environment interactions are

highly constrained by inheritance. Whereas ants, for example, inherit specific behavioral patterns in response to specific social events, human behavior becomes related to any of a wide variety of environmental events, depending on the particulars of the social and nonsocial environment in which the human lives. To be sure, human action is constrained by human biology; but in each generation, humans have to learn all over again what their ancestors learned—a laborious process indeed, but one that allows the behavior of each generation to become adapted to current environmental events. And those environmental events can change from generation to generation and have done so at a steadily increasing pace.

By outfitting humans with a largely uncommitted behavioral repertoire, natural selection gave our species a long leash for local behavioral adaptations. But the uncommitted repertoire of humans would be lethal without the second characteristic of human learning potential—the susceptibility of human behavior to operant selection. Although this behavioral characteristic is shared by many species, humans appear to be most exquisitely sensitive to behavioral contingencies of selection (Schwartz, 1974). This characteristic does not depend on whether the environmental events in the behavioral selection contingencies are social or nonsocial, but the preponderance of social events in the behavioral contingencies all but guarantees the emergence of cultural phenomena.

EMERGENCE OF CULTURAL PHENOMENA

The combination in humans of learning potential and sociality set the stage for the emergence of culture—a novel kind of phenomenon. Like the word *behavior, culture* is a mass noun, a category word, and also a word that refers to the particulars that are members of that category (specific cultures). As a category of phenomena, we will define *culture* here as "patterns of learned behavior transmitted socially, as well as the products of that behavior (objects, technologies, organizations, etc.)."

Culture begins with the transmission of behavioral content, learned by one organism during its lifetime, to the repertoires of other organisms. Thus, the locus of cultural phenomena is supraorganismic. Unlike learning, which is localized in repeated temporal relations between the actions of a single organism and other empirical events, the locus of cultural things is supraorganismic because it involves repetitions of the interrelated behavior of two or more organisms; one organism's behavior functions as the situation or consequences in the operant contingencies accounting for the behavior of the other. Such transmission requires no new biological trait or behavioral process, but it does initiate a new kind of lineage: a culturo-behavioral lineage (Glenn, 2003).

Culturo-behavioral lineages extend deeply into human history, and they also occur in rudimentary form among nonhuman species (Kawamura, 1959). A curious fact about human cultures is that after anatomically modern humans spent tens of thousands of years in rudimentary cultures, human cultures became quite complex in little more than 10,000 years—an extraordinarily short period of evolutionary time (Harris, 1989). This suggests that long before cultural takeoff, humans had the anatomical, physiological, and behavioral characteristics (delineated above) that they needed for the emergence and evolution of complex cultures. Missing were the changes in environmental events (social and material) that could enter into operant contingencies across generations, supporting individual behavior that differed from generation to generation.

Cultural Practices and Macrocontingencies

Much of the behavioral content of individual human repertoires is similar

to the content of many other humans. The term *cultural practices* refers to similar patterns of behavioral content, usually resulting from similarities in environments. The term *metabehavior* has been suggested to identify the class of behaviors that constitute a cultural practice (Mawhinney, 1995). The need for a term subsuming a supraorganismic class of behaviors is recognized, but we will use the term *macrobehavior* here because it is consistent with the other terminology in this paper.

Cultural practices may be important or unimportant for the survival of a culture. An example of a practice not likely to be critical for cultural survival is hairstyling. Many hairdressers may style hair similarly, and this similarity of behavioral content constitutes a cultural practice. Important to note is that such similarity does not imply that the practice is a functional cultural unit. In other words, the behavior of the various hairdressers is not necessarily functionally related to the behavior of any other hairdressers. Individual hairdressers simply may learn over time to cut certain types of hair in certain ways as a result of the consequent look of the product and approval of their patrons. The resulting products (hairstyles) consequently look alike. Neither the hairstyles nor the behavior of the hairdressers are functionally related to one another, even though the behavior of each hairdresser interrelates with the behavior of each of his or her patrons. In this case, the similar behavior of many individuals constitutes a cultural practice, but there is no evidence of cultural transmission and, therefore, no culturo-behavioral lineage exists.

On the other hand, there may be a point of cultural transmission that links the behavior of two or more hairdressers. For example, Hairdresser A may demonstrate to other hairdressers a way to style hair, and the others may reproduce the style under the watchful eye of the originator and later with their own patrons. If the hair styled by A is featured in a magazine or seen on customers by other hairdressers, some of them may be able to produce a similar result for their own patrons. These cases involve cultural transmission. Any cultural practice may be made up of independently generated behaviors and also socially transmitted behaviors. The point of these two examples is that similarity in behavioral content of many individuals is sufficient to consider the aggregate behavior a cultural practice, but is not sufficient to assume cultural transmission, and is even less sufficient to assume a common origin.

Another way of distinguishing among cultural practices is in terms of the complexity of the behavioral content that constitutes the practice. The macrobehavior that constitutes a specific cultural practice may be straightforwardly identifiable operants such as smoking cigarettes; or multioperant patterns of behavior such as styling hair, driving to work, or recycling; or very complex patterns of interlocking behavior of many individuals, such as that involved in auto manufacturing. Whether comprising simple or complex elements, cultural practices all have two characteristics that are important for the present discussion. First, they involve many people engaged in the same repeated actions (behaving individually or in relation to one another) and, second, those actions have consequences—often several different consequences.

Consider the behavior of driving to work. A consequence essential to its continuing repetition in an individual's behavior stream is arrival at work. But in most cases, there are other behaviors that could result in arriving at work (e.g., carpooling, using mass transportation, bicycling, or walking). The fact that most people drive to work rather than getting there some other way suggests that additional consequences are involved and that they differ for different behaviors. Figure 4 shows some likely consequences of driving to work versus carpooling.

Note that all of the consequences shown in italics depend only on the behavior of the individual worker, and

Behavior	Consequences Likely to Increase Frequency	Consequences Likely to Decrease Frequency	Contribution to Cumulative Effect
Driving to work	*Most convenient* *Takes less time*	*Highest cost*	**More pollution**
Carpooling to Work	*Lower cost*	*Least convenient* *Takes more time*	**Less pollution**

Figure 4. Effects of behavior that can function as behavioral consequences are in italics and those that cannot function as behavioral consequences are in boldface; there is no contingency between the operant and the cumulative effect.

they are experienced within a short time after the behavior occurs. Although the worker does not control the cost of gasoline, he or she does have control over whether more or less of his or her paycheck goes for gasoline, and whether he or she takes more or less time, with more or less convenience, in getting to work. Because of the correlation between the behavior and those consequences, those consequences have some potential to increase or decrease the relative probabilities of driving or carpooling. When multiple consequences have conflicting functions, the overall effect of the consequences may be the algebraic summation of their individual effects (see Skinner, 1953, pp. 218–223). And the effect of each of these consequences is relative. For example, if a worker who drove to work was transferred to a work site much farther from home, the change in relative value of gasoline cost versus convenience might make carpooling more likely than before, especially because the time involved in carpooling versus driving might not differ much for the longer drive.

The effect of our worker's behavior on air pollution, shown in boldface in Figure 4, is a very different kind of consequence. It is not only a matter of the consequence being too small, too delayed, or too cumulative for it to have a behavioral function, although all of that is true and important (see R. W. Malott & Suarez, 2004). There is something else that sets apart the effect on air pollution from the other effects of the two behaviors. To wit, even if, by some magic, we were able to give this consequence a powerful function, the consequence itself can be nullified by the behavior of other people. Our worker, mightily motivated to have cleaner air, can carpool for the next 20 or 30 years, but if a lot of other people do not do the same thing, the air is not going to be any cleaner. In other words, cleaner air is simply not under our worker's control. That is, as Hardin (1968) succinctly put the matter, the tragedy of the commons. No matter how much one behaves for the common good, the behavior of others can undo it all. That is the critical difference between the italicized and boldfaced consequences listed in Figure 4.

Ulman (1998, p. 209) suggested the term *macrocontingency* to define "a set of differing actions (topographies) of different individuals under common postcedent control." The term and the definition suggest the standard definition of an operant writ large. It could be parsed in two ways. Macrocontingencies could refer to commonalities in behavior–consequence relations across many individuals, or it could refer to the control exercised by the cumulative effect of all the topographies on the topographies. Ulman makes it clear that the "common postcedent control" is

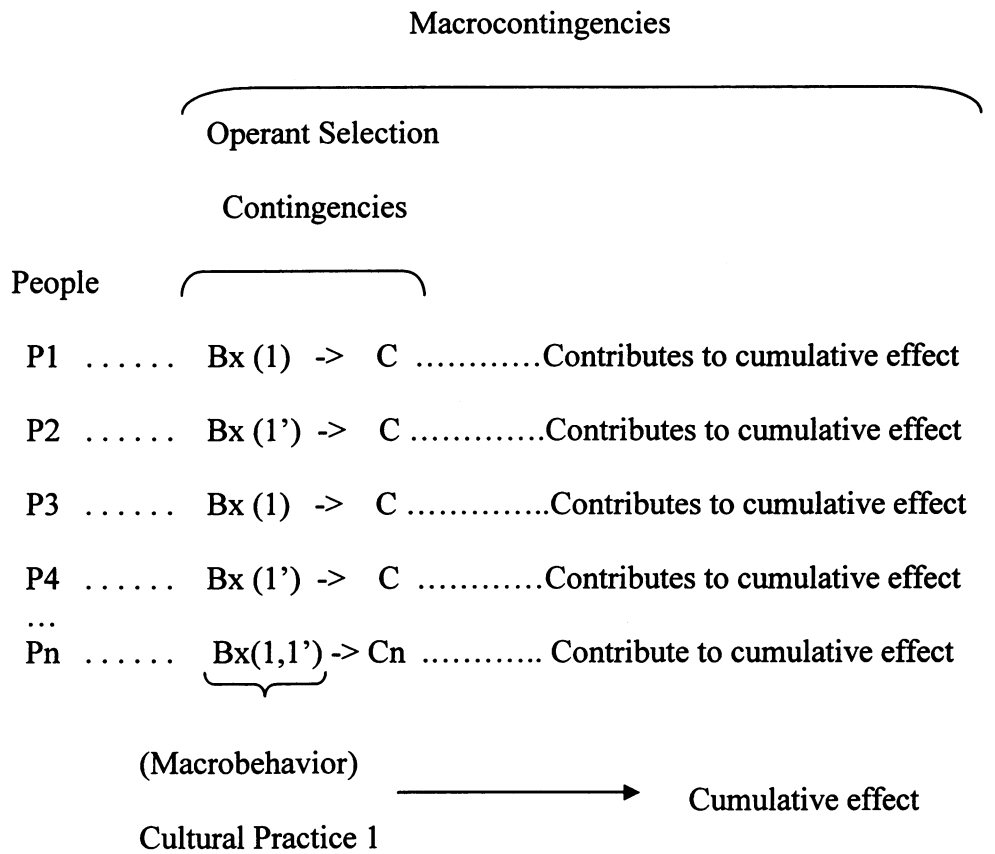

Figure 5. Temporally unrelated operants of different people (macrobehavior) that produce behavioral consequences and also contribute to a cumulative effect.

the cumulative effects of those differing actions. As mentioned above, however, the cumulative effects cannot be in a contingent relation with the behavior of any individual; therefore they cannot control (as operant consequences) the behavior of individuals. And although there may be a contingent relation between the sum of the topographies and the cumulative effect, the summed topographies are not part of a lineage that can wax or wane together as a function of the postcedent. If the postcedent has any effect at all on any operant lineages of individual people, that effect is independent of any effect it may have on operant lineages of other people.[4]

That being said, the notion of some kind of relation that is bigger than operant contingencies seems useful. So I will define a *macrocontingency* as the relation between a cultural practice and the aggregate sum of consequences of the macrobehavior constituting the practice. Figure 5 shows the relations in a macrocontingency as here defined. The recurring behavior of each person has its own effects, and the relation between the behavior and that effect can

[4] Macrocontingencies as here defined can involve different topographies of different people, the aggregate results of which are a change in the environment of many people. Todorov, Moreira, and Moreira (2004) provide examples of such relations. The aggregate results of the differing topographies in their examples, as in the air pollution example here, cannot have a selective function on those topographies because of the poor correlation between the behavior of any individual and the aggregate result.

alter the probability of the recurrence of that individual's behavior (as in Figure 1). For example, if the behavior is driving to work, then each person's driving-to-work operant is a function of the contingency between driving to work and the operant consequences of that behavior. In addition to those individuated consequences, the combined behavior of all the people (the macrobehavior) has a cumulative effect. This effect cannot function as a behavioral consequence because it is not contingent on the behavior of any individual driver. It is contingent on the macrobehavior of the cultural practice.

An important feature of macrocontingencies is that their cumulative effects are additive. The more widespread a practice, the greater its cumulative effects; the greater the cumulative effects, the more important they are to the well-being of large numbers of people. Each person contributing to the cumulative effect contributes in direct proportion to the frequency of his or her behavior. It is the cumulative effect of the behavior in a cultural practice that constitutes a problem for the people of a culture. To continue with the example, the driving behavior of each individual is as it is because of the relative effects of its multiple behavioral consequences: arriving at work in good time with minimum difficulty and the money spent on gasoline. These consequences that maintain the driving behavior contribute to the probability of driving, but they are not the culturally relevant cumulative effects: gasoline consumption and associated environmental effects. Further, the behavior is not a problem for the individuals behaving—rather it is a solution, albeit not an ideal solution, to the problem posed by their distance from work. As in the case of the behavior of individuals, cultural practices also have multiple consequences. For example, two effects of consumer behavior are that it helps to create jobs and it contributes to degradation of the physical environment. Such incompatible effects of cultural practices are even more difficult to reconcile than similar incompatible effects of individual behavior. That is because the multiple cumulative effects of any given cultural practice are likely to be more advantageous to some people and more disadvantageous to others. In the case of individual behavior, at least the costs and benefits affect the same person.

Discussion of macrocontingencies has centered on the cumulative effect of many people "doing the same thing" (allowing for a broad range of topographies). The people could be acting individually (e.g., smoking), or their behavior could be interrelated (e.g., carpooling). Either way, the similarity in operant content of many people is what warrants our calling it a *cultural practice.* Each time the behavior occurs, it adds to the cumulative effect. So the cumulative effect depends on the number of times the act occurs, and that number is a function of the number of people who engage in the act and the frequency of the behavior of each person.

The relation between any particular cultural practice and its cumulative effect may be critically important to the welfare of the people of the culture, and even to the survival of that culture. But a cultural practice (as here defined and as generally, albeit vaguely, understood) cannot participate in a selection process. That is so because a cultural practice is a class of acts that are functionally independent of one another. In other words, recurrences of the acts do not participate in a lineage. They are classified as "the same" in terms of their form and their effects, but the members of the class are not necessarily related by descent, which is a defining feature of evolution by selection (Hull, Langman, & Glenn, 2001). In short, a cultural practice does not evolve as a result of cultural selection, but rather as a result of behavioral contingencies of selection operating on the behavior of many individuals; as a result, a different cultural practice comes to exist. For example, the cul-

tural practice of smoking in public buildings has been replaced in many areas by a practice of going outside public buildings to smoke. The change in the cultural practice is a behavior change of many individuals, each responsive to his or her own social environment. When there is change in the practices that constitute a culture, the change is an emergent side effect of concurrent changes in behavioral lineages of many individuals. The causal mechanism is behavioral selection (i.e., the principle of reinforcement).

If certain human cultural practices, or their cumulative outcomes, threaten the safety of the world, then saving the world will necessarily entail altering the operant contingencies that maintain the behavioral lineages that contribute to those outcomes. Such action requires interpretation of complex phenomena in the language of the experimental analysis of behavior (see Palmer, 1991). Cultural change will be difficult to accomplish, as Skinner (1987) suggested, when the verbal practices of those cultures do not include the language of the experimental analysis of behavior. On the positive side, when that language does guide action designed to bring about changes in macrobehavior, those actions can be quite successful.

What about Skinner's (1987) suggestion that the experimental analysis of behavior would support a theory of cultural evolution in the same way that Darwin's theory of biological evolution is supported by the experimental science of genetics? This suggestion needs a great deal of clarification because the relations between genes and the species that carry them are extremely complex, as are the scientific fields of evolutionary biology and experimental genetics. Perhaps most important to the present discussion is the increasing complexity (of organisms' structure and function as well as ecological relations among them) that has characterized the evolution of organic phenomena. It appears that human cultures, too, have been characterized by organizational structures and functions that have become increasingly complex throughout human history. The concept of metacontingencies may help us to understand how that complexity evolved.

METACONTINGENCIES

A clear distinction between the concepts of metacontingencies and macrocontingencies is needed, because early papers introducing the concept of metacontingencies (Glenn, 1986, 1988) combined terminology suitable for discussion of macrocontingencies (as here defined) and metacontingencies (as here defined). The prefix *meta-* together with the root *contingencies* is intended to suggest selection contingencies that are hierarchically related to, and subsume, behavioral contingencies. They represent "a different *kind* of selection," although "no new behavioral process" is involved (Skinner, 1984a, p. 504). Metacontingencies are not a matter of an enlarged class of behavior or more widespread behavioral contingencies; rather, they are the engine of a different *kind* of selection. The metacontingencies of cultural selection emerged only after social events become prevalent in the behavioral environment of a species that has the human combination of physical and behavioral traits.

The concept of metacontingencies addresses evolution by selection when the lineages that evolve are not the recurring acts of individuals (as schematized in Figure 1), but rather are recurring interlocking behavioral contingencies (IBCs) that function as an integrated unit and result in an outcome that affects the probability of future recurrences of the IBCs. Figure 6 is a schematic of the metacontingencies of cultural selection as it goes on in time. The recurring IBCs comprise operant contingencies in which the behavior of two or more people functions as environmental events for the behavior of the others. The outcomes produced by recurrences of the IBCs are not the cu-

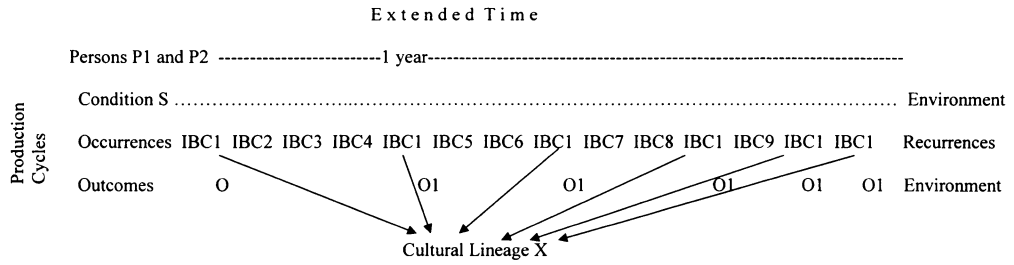

Figure 6. Recurrences of IBC1 that occur with increasing frequency as a result of metacontingency.

mulative effect of the participants behaving individually, but rather the effect of their interrelated behavior. For example, Marta and Todd regularly cook meals together. Marta prepares entrees, sauces, and vegetable dishes with Todd serving as helper, and Todd prepares appetizers and desserts with Marta serving as helper. The timing of each of their activities is based on what they observe the other one doing throughout meal preparation. The outcome of their interrelated behavior is a meal with perfectly timed courses of perfectly prepared dishes. The meal could not be produced by Todd and Marta working in separate kitchens and combining the results of their individual behavior. Thus, it is not the cumulative effect of their individual behaviors. It is the outcome of their interrelated behavior.

Metacontingencies, then, are the contingencies of cultural selection. They give rise to the organized collections of behavioral contingencies that constitute increasingly complex cultural-level entities. Let us continue with the example of the relation between Todd's and Marta's IBCs and the resulting meals. Variations in the features of the IBCs will result in variations in the outcome, and if the difference in outcomes perpetuates some patterns of the IBCs more than others, cultural-level selection has occurred. Note that Todd's behavior is a function of behavioral contingencies that might include the taste of the meals cooked, and Marta's behavior is a function of other behavioral contingencies that might include the taste of the meals cooked. Those behavioral contingencies are necessary for the continuation and evolution of Todd's and Marta's operants, and thus of the IBCs; but they are not necessarily sufficient for the IBCs. The outcome of the IBCs must be more than or different than the meals that either Todd or Marta could produce by themselves to maintain the recurrences of the IBCs. It is this "more than" or "different than" that is the source of cultural evolution and what distinguishes it from behavioral evolution.

CULTURAL COMPLEXITY

Cultural complexity is the outcome of cultural selection that results in nested hierarchies of IBCs (Glenn & Malott, in press). For example, Todd and Marta may open a restaurant where cooking meals is part of a larger pattern of recurring IBCs. Figure 7 shows a nesting of IBC relations in increasingly complex cultural lineages. Whether the larger pattern continues to recur and evolve depends on the outcomes of cooking but also on the outcomes of other IBCs in the situation. The behavior of other people may become part of the larger pattern and contribute substantially to the outcome that maintains the continuing recurrences of the IBC that constitute "the business." Finally, although the IBCs must continue to recur for the cultural lineage to remain in existence, it is not necessary that Todd's or Marta's behavior continues to participate. The behavior of other individuals can replace one or both of theirs as long as that behavior fits well enough into the IBCs

Organisms	Cultural Lineages (Recurring Interlocking Behavioral Contingencies)	Some Elements of Each Occurrence
Todd & Marta	*Cook meals*	Many behaviors of each person having function with respect to behaviors of other
Todd, Marta, 2 waiters, 1 bookkeeper	*Operate a restaurant*	*Cook meals* Serve diners Manage cash flow
Todd, Marta, many waiters, bookkeepers,, other personnel	Run a franchise chain	*Operate restaurants*

Figure 7. The components of occurrences in earlier IBCs become integrated with the components of occurrences in later IBCs of more complex occurrences.

to produce the outcome. Perhaps it is worth noting that such replacement of one participant's behavior for another's in a cultural lineage virtually always causes some adjustments in the IBCs and thus always presents both opportunity and threat to the continuing survival of the lineage.

Like the responses in operant contingencies, the IBCs in metacontingencies can result in both automatic outcomes and socially mediated outcomes that depend on the features of the automatic outcome. For example, Todd's and Marta's IBCs at first had automatic outcomes—meals—that differentially perpetuated some variations of the IBCs. Eventually, the IBCs constituting their restaurant were maintained by the ordering behavior of customers. As in the case of social reinforcers for individual behavior, the socially mediated relation between the IBCs of the restaurant and the sustaining income generated from customer purchases provides a foundation for more complex relations.

The nested metacontingencies of cultural selection are the basis for the evolution of cultural complexity as well as the maintenance (survival) of evolving organizational lineages. Just as components of one operant lineage become embedded in operant lineages of more complex components (as in Figure 2), components of one lineage of IBCs can become embedded in IBCs of greater complexity (as in Figure 7). These more complex cultural entities are the individually identifiable evolving units we know as *organizations*: individual companies, their parent corporations, schools, school districts, universities, university departments, government agencies, and so on. Each of these units exists as long as it consists of IBCs that produce an outcome that can increase the likelihood that the IBCs will recur. These are all entities that can change or evolve over time or that can disappear as a whole. They are not themselves cultural practices, because each organization is an entity—an evolving lineage of IBCs.

Before proceeding to the engineer-

ing of cultural change, let us review the similarity in relations that constitute operant contingencies and metacontingencies. Whether or not a behavioral lineage continues to exist and evolve depends on the automatic or socially mediated consequences that follow the recurring behavioral instances. This means that behavior change requires that consequences be variable; that is, the consequences can either occur or not occur, or can occur in differing amounts or after differing time lags, depending on the characteristics of the behavioral instances that produce the changes in the environment. An antecedent event, endogenous or exogenous to the behaving organism, can affect a given occurrence, but *recurrences* are a function of consequences. So behavior changes the environment, and the resulting changes may, in turn, alter the future probability of that kind of behavior. Another way of saying this is that behavioral instances cause environmental changes, and systematic relations between behavior and consequences feed back into the ongoing system, causing changes in the frequency and characteristics of future instances (i.e., continuation and adaptation of the lineage).

The relation between IBCs and their outcomes has functional parallels to the complex relations of behavioral contingencies. The IBCs produce outcomes, variations in instantiations of IBCs cause differential outcomes, and the future frequency of the IBCs as well as their characteristics are a function of the differential relation between instantiations and outcomes. Changes endogenous or exogenous to the IBCs may result in a variation that produces a different outcome, and that outcome can increase or decrease the probability of recurrences of the IBCs.

ENGINEERING CHANGE

Humans have been engaged in behavioral engineering since they began functioning as the environment in the operant contingencies that support the behavior of other humans. Only in the 20th century of the current era, however, has scientific understanding been brought to bear on these engineering practices. Cultural engineering has not yet found sure scientific footing. A necessary first step is to understand the phenomena to be engineered. From the present perspective, engineering can occur with respect to two kinds of phenomena: macrobehavior and metacontingencies.

The macrobehavior of cultural practices can be identified as a problem only when its cumulative effects are recognized, and it often takes a long time to gain understanding of the many effects of specific cultural practices. The only way to do something about the cumulative effects of macrobehavior is to find ways to alter the behavior of as many individual participants as possible. For example, the more individuals who carpool or take public transportation to work rather than drive alone, the greater is the improvement in air quality (or the slower the worsening of air quality). When the number of participants in a practice is large, a change in the behavior of a small percentage of them can make an important difference. If 10% of the drivers in the U.S. carpooled with two other people, a noticeable reduction in air pollution might result. What could bring about such a change in the behavior of 10% of drivers? Considering that each driver's behavior is a function of the operant contingencies in effect, we must consider the consequences of the behavior of driving to work versus the consequences of carpooling, as discussed previously and shown in Figure 4. The assumption is made, for purposes of discussion, that the effects of the behaviors listed in Figure 4 could function as behavioral consequences, with the exception of the effect on air pollution.

As matters now stand, attempts by society to engender alternative macrobehaviors are implemented with little understanding of the potential cumulative effects (Nevin, 1998), and little

attention is paid to the many operant contingencies that may be maintaining the operant behavior of individual participants in the current practice. Because the macrobehavior of cultural practices is a function of operant contingencies that operate independently, but concurrently and similarly, on the behavior of many people, behavior analysts have rightly called for analysis of the contingencies that maintain the behavior that constitutes the practice. Mattaini (1995), in particular, has argued that behavior analysts should be trained specifically to focus on behavior with cumulative effects that affect the viability of the culture. When interventions are designed to alter the cumulative effect of a cultural practice, they must necessarily identify the operant contingencies that account for the behavior of individuals who participate in the practice. The more individuals whose behavior changes, the greater is the impact on the cumulative effect. This method of cultural intervention entails modifying the operant contingencies that are likely to maintain the behavior of large numbers of people. Biglan (1995) described many of the behaviors of modern American cultural practices that result in undesirable cumulative effects, and he identified many of the socially mediated behavioral contingencies that support those behaviors. Other authors (e.g., Goldstein & Pennypacker, 1998; R. W. Malott, 1998) have offered interpretations of various specific macrobehaviors and suggestions regarding intervention. Under the editorial guidance of Richard Rakos, Janet Ellis, and Mark Mattaini, the journal *Behavior and Social Issues* has devoted several issues to analyses of macrobehaviors with highly destructive cumulative effects.

Because much of the operant behavior of modern humans is embedded in organizations that have recurring IBCs, survival of those organizations is, at the very least, important to those humans. The fact that the organizations exist at all, however, suggests that their IBCs were selected by their external environment and, therefore, are an important part of the larger culture, whether or not alternative organizational structures are considered more desirable. Engineering, then, can also occur with respect to the IBCs in metacontingencies.

IBCs can be changed in two ways that are analogous to the two ways that species characteristics can be altered. The first is by altering the external selecting environment and waiting for variations in the IBCs to produce outcomes suitable to the new selection contingencies. This amounts to altering the contingencies of selection and letting the chips fall where they may. The second way is similar to ascertaining and altering the genetic characteristics that are endangering a species' existence given the current selecting environment. This tactic entails altering the components of the IBCs so that they are better adapted to the current selecting environment. Planned variations of the recurring IBCs can be designed to produce outcomes more suitable to the demands of the external environment.

Engineering change to enhance the survival of organizations (recurring arrangements of IBCs) requires analyses of current metacontingencies and also analyses of the specific behavioral contingencies that affect the outcome of IBCs. It should be obvious that all of the IBCs and the operant contingencies in complex organizations cannot be analyzed. There must be some way to distinguish between those that can be ignored and those that must be addressed. M. E. Malott (2003) described an approach to organizational change that combines a behavioral systems engineering model with metacontingency analysis. Her collaborations with the personnel in business organizations as well as in at least one institution of higher education (M. E. Malott & Salas-Martinez, 2004) demonstrate the importance—indeed, the necessity—of isolating the IBCs that fail to meet selection contingencies and then identifying the operant behavior that must be

altered to bring about the kind of changes in IBCs required by the external environment.

In summary, to bring about changes in the organized IBCs that function as evolving cultural units, it is necessary to identify the IBCs that contribute to an outcome and to identify the function of the outcome in sustaining (or not) recurrences of the IBC. Variations can be made in the IBCs by systematically manipulating the behavioral contingencies within them, and the variations may increase or decrease the probability of producing an outcome with a sustaining function.

RELATION OF METACONTINGENCIES TO OPERANT CONTINGENCIES AND MACROCONTINGENCIES

Metacontingencies, like behavioral contingencies, involve two kinds of causality, as can be seen by comparing Figures 1 and 3. First, the recurrences of IBCs produce outcomes (analogous to consequences produced by recurrences of operant responses). Second, the outcomes affect the future frequency and other measures of the future recurrences of those IBCs. The contingencies of selection in metacontingencies are between cultural-level units (IBCs) and their selecting environments. Evolving cultural units are recurring cycles of IBCs. Like operants in a repertoire, the recurring entities may become part of increasingly complex entities that form a lineage of their own (see Figure 7). The outcomes produced by a cycle of IBCs can affect future cycles of IBCs, just as the consequences of a behavioral occurrence can affect future occurrences of that behavior. If one is interested in altering the recurrences of IBCs, one can do so by altering the components of IBCs to better meet current selection requirements or by altering the selecting environment. The former strategy would be comparable to genetic alteration and the latter to artificial selection.

The IBCs in metacontingencies, like the individual behavior in operant contingencies, recur in lineages that evolve and change as a function of their selecting environments. They are also alike in their relation to macrocontingencies. Just as the similar operant behaviors of many people can contribute to a cumulative outcome, the IBCs of several different organizations may also contribute to a cumulative outcome, as shown in Figure 8. The behavioral lineages of the different people who participate in a cultural practice evolve independently, as do the IBC lineages of the different organizations. But both the behaviors and the IBCs may also contribute to a cumulative outcome that plays no direct role in selection but nevertheless may be important indicators of the viability of the culture.

The organizations in Figure 8 could be programs comprising IBCs that produce graduates trained as behavior analysts. Each program produces graduates (among other things) whose performance contributes directly and indirectly to the selection of the recurring IBCs that produce cohort after cohort of graduates. The IBCs that produce behavior analysis graduates constitute a cultural practice and they have cumulative effects, including the number of people prepared for academic appointments, the number of individuals who can be served by professional behavior analysts, the amount of federal funding likely to go to behavior-analytic researchers, and so on. Although individual behavior analysts and the program faculty of individual programs can be moved to action by data on the cumulative effects of the summed behavior or summed IBCs, those effects cannot select any of the individual operant lineages or the individual lineages of IBCs, because there is no lineage of recurring entities that produces those effects. If one is interested in altering the cumulative outcomes of a cultural practice, one must find a way to alter the behavioral contingencies of macrobehaviors or the metacontingencies supporting the IBCs of organized

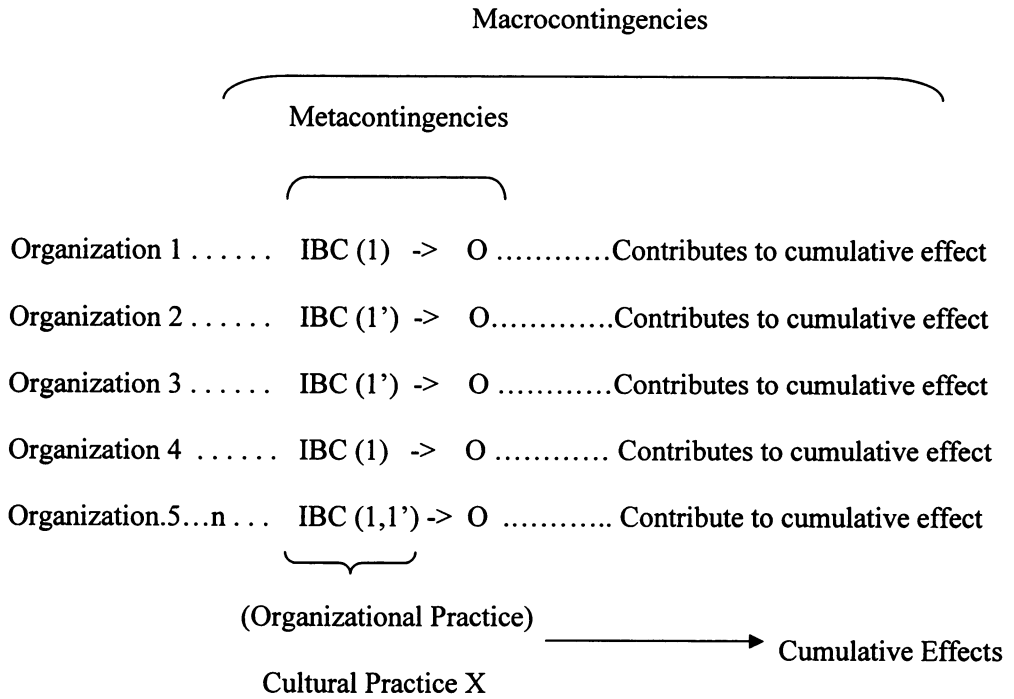

Figure 8. Temporally unrelated IBCs of different organizations (organizational practices) that produce behavioral consequences and also contribute to a cumulative effect.

cultural complexity. The more individual contingencies or organizational metacontingencies that are altered, the greater the potential change in the cumulative outcome.

The larger the number of organizations characterized by the same kinds of IBCs, the more likely we are to consider those kinds of IBCs a cultural practice. Statements such as "the cultural practices of Japanese businesses are different from the cultural practices of American businesses" refer to similarities in the IBCs that characterize American companies and similarities in the IBCs that characterize Japanese companies, as well as the differences between the American and the Japanese companies.

CONCLUSION

The distinctions made herein among behavioral contingencies, macrocontingencies, and metacontingencies represent an attempt to clarify the complex ways that selection works with respect to the behavior of individual humans and to organizations of IBCs in which much human behavior is embedded. Cultural practices per se cannot evolve. The constituent members of cultural practices do evolve, however, whether they are the operants of individuals or the IBCs of organizational entities with a life of their own, above and beyond the behavior of the particular people who participate in them.

Because cultures are human constructions, and their increasing complexity arises from the increasing complexity of the entities that participate in metacontingenices, it seems highly likely that humans can alter at least some elements of their cultures. Unless we understand how cultures arise and evolve, however, it will be difficult to make wise choices regarding what can be changed or should be changed.

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