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Cultural Selection: Theoretical Aspects and an Empirical Study

Kulturell Seleksjon: Teoretiske Aspekter og et Empirisk Forsøk

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Abstract

The first article of this thesis seeks empirical evidence supporting cultural selection. Select works included are written by scholars from a wide range of academic fields. Analyzing the articles utilizing the theoretical framework of Sigrid S. Glenn evidence of cultural selection is found. The author concludes that there is a need for more empirical research on cultural selection. The second article reports on an experiment conducted by the author. In the experiment variables were selected with the framework of Glenn in mind. The experiment utilized a theoretical entity of behavior at group level denoted interlocking behavioral contingency (IBC). A behavioral lineage of IBCs was created in the experiment. Results indicate that the lineage came under control of the independent variable. The author concludes that there is a need for further research on cultural selection and emphasize the need for more research with a contextual materialistic approach.

Keywords: Cultural selection, cultural evolution, interlocking behavioral contingency

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Running Head: Empirical Work on Cultural Selection

Empirical Work on Cultural Selection

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Abstract

Viewing cultural change as a selection process the author sought empirical evidence on cultural selection. Drawing on theory from the field of radical behaviorism and in particular the theoretical work of Sigrid S. Glenn; cultural selection was defined as a selection process working on behavior in the form of culturo behavior lineages (CBL), and interlocking behavioral contingencies (IBC). The articles discussed here are written by scholars from a wide range of academic fields. The author interpreted the articles utilizing the framework of Glenn. Evidence supports the theoretical assumptions of cultural selection. The author concludes that future experimental research on cultural selection should use arbitrary variables and emphasize the culture-environment relation.

Keywords: cultural selection, cultural evolution, cultural change, culture, selection

Human culture takes on many forms and has implications for all of us. It can change in front of our eyes like fashion changes with the season, while norms and values, on the other hand, can remain largely the same over generations. The nature of cultural change is an issue investigated by many fields of science and with different frameworks (e.g. Efferson, Lalive, Richerson, McElreath, & Lubell, 2008; Ehrlich & Levin, 2005; Mesoudi, 2008). Theoretical overviews are plentiful and arguments are largely theoretical about the nature of the change process and the entities involved (Baum, 2000; Nelson, 2004; Walter, 2007). The present paper treats cultural change as an evolutionary process, a selection of cultural behavior (Glenn, 1991). Researchers inspired by the success of biology in explaining evolutionary change in natural selection are especially inclined to take this view, and utilize concepts and methods commonly applied to the study of natural selection in the study of culture. This paper reviews select literature looking for empirical evidence supporting the theoretical assumption that cultural behavior is selected for by its environment, as described by Sigrid S. Glenn (1988, 1991, 2003). No review of empirical work within this framework was found. Empirical articles are interpreted within the framework outlined by Glenn.

Empirical articles included are matched to the concepts defined in this article. Some empirical work will fit these definitions better than others, but all included works shed some light on the process of cultural selection. Of particular interest are: groups or individuals replaced to mimic the effect of generations; measurements of a replicated property of cultural behavior; and how individual behavior contribute to group behavior when only group behavior bring the individuals into contact with environmental contingencies.

The method employed by the author to find relevant articles was a search in relevant databases. Search words for online search: Cultural selection, cultural transmission and cultural evolution. The author further sought for relevant articles in references from the articles matching the search. In addition to the online search the following online journals of

specific interest were subjected to a manual search: Evolution and Human Behavior and Behavior and social Issues. Issues from the year 2000 to present were screened, and by reading abstracts, relevant articles sought. The articles included are arranged chronologically.

Definitions

Radical Behaviorism

Radical behaviorism is a philosophy of science; it is a set of ideas about the science of behavior. The science of behavior is behavior analysis. A behavior analyst tries to find lawfulness in relations between the environment and the behavior of organisms. Two major classes of behavior can be distinguished: respondent and operant. The distinguishing feature is the relation to the environment. Respondent behaviors are behavioral responses made available to the organism by natural selection: these behaviors are elicited by a preceding stimulus in a stimulus-response relation. Responses come under control of novel stimuli through respondent conditioning. Operant behavior is defined by the relation between the behavior and the environmental consequences following the behavior. The capacity for operant behavior is considered an evolved trait. Natural selection favors organisms able to survive in their environment. Operant behavior is said to operate on the environment to produce favorable consequences. The role of a stimulus preceding the response is that of context e.g.: when rain occurs (stimulus), I will open my umbrella (response) and remain dry (consequence). The preceding stimulus does not elicit a response but can increase the likelihood of a response following the stimulus, this is called stimulus control. The rain does not make me open my umbrella, staying dry (as a consequence of opening my umbrella) makes the behavior more likely in the context of rain. Consequences can either have the effect of increasing or decreasing the frequency of the response: reinforcement or punishment respectively. These three terms stimulus–response–consequence are called a behavioral

contingency. Most behavioral scientists believe that the time interval has to be short for the contingency to function as a behavioral control. Stimuli in operant behavior are called discriminative stimuli; this means that a particular behavioral response occurs significantly more frequent after a particular stimulus. Discrimination occurs because of previous history of reinforcement. Cultural behavior is functionally the same as operant behavior (Skinner, 1984). Unlike operant behavior most cultural responses rely on compound discrimination (Baum, 2005).

Thinking about culture usually makes us think of art, books or music. These are unquestionably among our greatest achievements but not the only meaning of culture. There are many different ways of defining what culture is. Common to all definitions are the notion that one person alone cannot be a culture, it takes two (or more). These people share some common features in most definitions of culture, e.g. living in the same area. Culture is here taken to be the behavior that is established and maintained on account of belonging to a social group (Baum, 2000). Many writers have focused on the reason why humans have the ability to form cultures and not animals. Some trait may be necessary for human cultural behavior: sensitivity to stimuli from other humans (newborn babies can tell human faces apart), the ability to imitate and the ability to react to social reinforcement (smiles, attention, frowns etc.) could be crucial traits (Baum, 2000, 2005). Animals can imitate and their behavior may resemble human cultural behavior, this can be referred to as preculture (Glenn, 2003) or imitation-only culture (Baum, 2005). Humans are able to speak; this gives us the ability to instruct. Learning complex behaviors from our social environment is a distinguishing feature of human culture: Verbal instruction makes us able to access information on environmental contingencies without experiencing these contingencies ourselves. Language gives an individual the ability to store information and make use of it rapidly if needed: reinforcing the cultural behavior of the individual.

Behavior analysts study how the environment of an organism influences that organism's behavior (Skinner, 1953). Behavior changes when the contingencies of reinforcement are changed: Causality is always sought in the environment. Cultural behavior is no exception of this general rule, but is seen as a product of "the special contingencies maintained by an evolved social environment" (Skinner, 1981, p. 55). There is, however, a matter of defining what separates individual behavior from cultural behavior. Using the framework of Glenn two forms of cultural behavior can be discerned. The first form of behavior, *culturo-behavioral lineages* (CBL), is behavior learned by imitating, modeling or given as contingency specifying stimuli (CSS) by the social group. CSS alter the function of other stimuli: e.g. hunters might in the presence of a large prey animal flee or do nothing, the social environment may provide CSS that alter the context of large prey animal, the hunters deploy in a agreed upon formation and start a hunt. In depth discussion and description of CSSs can be found in Blakely and Schlinger (1987) and Schlinger and Blakely (1987). In the present context CSSs can be thought of as rules or instructions, and may function as a means of "inheritance" in cultural selection. CBL depends on group membership although behavior in this form does not require collaboration. As an example, a group of hunters may provide the CSS: you will find rabbits if you hunt in the southern part of the forest. The CSS describe a contingency that does not require more than one individual behaving, but the CCS is available on account of group membership. Individuals are "copying" contingencies from their social environment. CBL's are behavioral lineages, formed when a member copies the behavior of another member of a group. Every instance of rabbit hunting is an environmental interaction and the behavior is discriminated as in operant learning, albeit the learning history is not one individual's history but the history of the group. The second kind of cultural behavior involves more than one individual behaving to make contact with the relevant environmental contingencies. Behaviors that require several individuals interacting as a

cohesive whole to make contact with the environmental contingencies are denoted *interlocking behavioral contingencies* (IBC). As an example a group of hunters can hunt together; the hunters may have different roles, like drivers and catchers. One individual drives an animal towards another member of the hunting group waiting at an agreed upon location. This behavior must be coordinated amongst the members of the group and the individual behavior (waiting or driving) cannot make contact with the environmental consequences (catching the rabbit after a chase).

Selection

Defining selection is an endeavor undertaken at length by numerous other writers. The definition used here is: "Repeated cycles of replication, variation and environmental interaction so structured that environmental interaction causes replication to be differential" (Hull, 2001). Cultural change is seen as a selection process that develops cultural lineages of behavior. Causality is always placed in the environment in a selection process, this also holds true for cultural selection. Unlike natural selection, where the environment selecting is "blind", social environments may be designed. In fact many cultural behaviors are selected only by cultural environments, as an example office workers are promoted when certain criteria have been met. The criteria are created by leaders behaving according to culturally determined criteria, and the workers have to behave under cultural contingencies to be promoted. Within the field of radical behaviorism two levels of selection influencing behavior are recognized in addition to cultural selection: phylogenic- and ontological selection.

First level of selection.

Phylogenic selection is the most widely known selection process, commonly known as natural selection. This is the process where genomes are selected for, by their environment through time, on the basis of their phenotypic trait (Dawkins, 1978). The genome is the replicated entity, replication occurs when parents pass on genetic material to their offspring.

Genes are said to have phenotypic effects on the organism, this effect on the organism is the environmental interaction. The organism is the vehicle for the genes, a survival machine that bring the genes on to the next generation. Only the genes within an organism able to pass on its genetic material are replicated, this give rise to adaptation at the population level. A population will after several generations have a higher number of organisms possessing genes selected for by the environment. Variation stems from processes such as recombination and mutation as well as other processes. One major difference between cultural selection and natural selection is the time scale. Natural selection operates on the genetic material over a very long time scale: Variation in natural selection is not affected by the environment in one individual's lifespan. It requires a considerable amount of time to see the effect of this kind of selection, whereas the behavior of an individual can change within seconds of experiencing an environmental consequence, or having the contingency described as a CSS.

Second level of selection.

Ontological selection refers to an individual's learning history, and the process of selection works on the individual's operant behavior (Skinner, 1984). The operant behavior of an individual is selected by the environmental consequences: The environmental consequence of the behavior cause a change in the probability of the behavior's future occurrence in the particular individual (Catania, 2007). Ontological selection is denoted the second level of selection as the species must first have evolved and operant behavior must be an evolved trait of the organism behaving. An operant has properties (e.g. duration, force and latency) that are measurable and are selected upon by the environment. Variation is a property of an operant, all operants exhibits some variation, and the amount of variation in an operant lineage can be controlled by contingent reinforcement (Page & Neuringer, 1985). Selection requires cycles of environmental interaction: Environmental interaction occurs every time properties of the operant behavior are either reinforced or punished.

Third level of selection.

The third level of selection is the result of several individual's operant behavior; it is less understood and thus less formalized. The interaction is still a response but this response is not only a part of a single individual's behavioral repertoire but also a group's behavioral repertoire (Glenn, 1991; Skinner, 1984). The nature of the response in a CBL follows ontological selection, with one clear exception: the stimulus preceding the response is dependent on group membership (e.g. understanding the language the rule is given in). Discriminating social stimuli of a group is the result of ontological selection, and the social environment reinforces such behavior. The environmental interaction of the IBC is that of an interlocking chain of individual responses. The chain only interacts with its environment, the environment reinforcing or punishing the behavior, when the whole chain can be considered one response. Properties are replicated differentially to produce cultural lineages. Every organism has a lot of uncommitted behavior inherently (e.g. when a baby moves at first) and some behavior that is more organized, e.g. a fish can swim when born (Skinner, 1984, p. 219). These behaviors form the early history of all operant lineages: as aquatic life forms are ancestors of all vertebrates. Cultural lineages are considered functionally alike to operant lineages. The third level of selection is referred to as cultural selection, applying the definition of culture above in this context gives a selection process that may operate on groups. Group selection though is a concept from biology and refers to how group level mechanisms can be included in phylogenic selection, thus group survival. The group is seen as a *vehicle,* a mean to differentially replicate genetic material (Wilson & Sober, 1994). Group selection can explain why we form groups. Cultural selection on the other hand can explain our behavior as groups: operant behavior comes under control of contingencies only available at the level of the group. Behaving as a group is selected for when doing so is reinforced to a larger degree than behaving alone. "It is the effect on the group, not the reinforcing

consequences for individual members, which is responsible for the evolution of culture (Skinner, 1981 p. 502)". CBL's and IBC's form contingencies with the environment called macrocontingencies and metacontingencies respectively. Macrocontingencies arise when the aggregate of several individuals behave similarly like in CBL. As an example, in a group that hunts mammoths several individuals have to drive the mammoth towards a trap. Their behavior is screaming and making movements that frighten the creature so that it moves in the desired direction. Such behavior is imitated, modeled or given by CSSs forming a lineage. Individuals can be replaced and the behavior will still be a property of the group, as a part of that group's culture. When encountering a mammoth the properties (e.g. screaming intensity, special sounds etc.) of the aggregated response (several individual together mammoth driving) are selected upon by the group's environment (eating mammoth or not eating mammoth). The behavior is reinforced or punished in a macrocontingecy. The same phenomena can be seen as group selection, one group competing against others over the same resource where the best mammoth drivers proliferate. Viewing the phenomena as a CBL can explain how this behavior is transferred to new members of the group.

A group behaving under the macrocontingecy of mammoth driving may only experience the consequence of trapped mammoth. What is needed is working in concert with another part of the group. The other part of the group may hide in a place agreed upon by the group as whole throwing big stones down at the mammoth. The two behaviors, driving and throwing, together complete a metacontingency. The group experiences the consequence of a successful hunt. The whole group, drivers and throwers, becomes part of a behavioral chain: their behavior depending on each other to make contact with the environmental contingencies. Metacontingencies are formed when responses belonging to different individuals behaving are selected for by the environment as a cohesive whole, creating a cultural lineage. Properties (e.g. timing of drivers and throwers) of the interlocking response (driving the mammoth to the

throwers and throwing stones) are selected for (mammoth to eat). In the group IBC's like hunting together, made up of CBL's, where drivers and throwers are replaced but the behavior retained as specific tasks form lineages as properties of an IBC is selected for by iterations of successful hunts. Behavior is selected for at a group level.

Discussion of Empirical Evidence

One of the earliest and most cited empirical works to include a generational design used confederates in the experiment at the start of the generational chain, and introduced naïve individuals sequentially (Jacobs & Campbell, 1961). Confederates overestimating the movement of visual stimuli and naïve persons entering the group where asked to give their judgment on the movement after the confederates. The method is an adaptation of an earlier experiment on conformity (Asch, 1955). The experiment of Asch used confederates in groups and naïve subjects. Jacobs and Campell included the generational model to study how the intentionally wrong judgment faded from the group's culture in time. This form of imitation behavior can be called a CBL. The overestimate was quite large and a conflict with the learning history of all included individuals is likely: learning how long an inch is. The behavior is extinguished rapidly once the confederates leave the room. In the context of cultural selection as defined, responses imitating the overestimate were not selected for once the confederates left the experiment. Responses which overestimated the movement were not socially reinforced when the source of reinforcement, the confederates, left the experiment. Previous learning history selected for responses in line with the rule "an inch is this far": it is probable this has been socially reinforced in the individuals' history before this experiment. There can be several processes of selection operating on a cultural lineage. Results might have been different if the experimenters had used a behavior with arbitrary properties in the experiment. In a laboratory setting arbitrary behavior that is novel to the participants may "free" the laboratory learning from the "normal" learning history.

One experiment used the same method of confederates overestimating a visual stimulus as Jacobs and Campbell (1961), and added another independent variable by varying the instructions given to the participants (Zucker, 1977). The instructions given had three "institutional strengths": the three different instructions were named personal influence, organizational context and office. In the personal influence instructions, the task was explained and the experiment ran. In the organizational context the participants were told they constituted a two member organization and that replacing individuals is normal in organizations. The office condition built on the organizational context adding to the instructions that the participants were members of a smaller office in a larger organization. The researchers find that the instructions influenced how long the exaggerated response persisted and how resistant the exaggerated response was to change. There was no manipulation in the study apart from the initial confederates, and the instructions. The study utilizes previous knowledge of institutionalization, this can be viewed as behavior already learned by the participants, and the learning history may be very different between individuals. Cultural selection can never be experimented on in a cultural "vacuum". Learned cultural behavior can be evoked and will influence the experiment if elicited. The result supports the theory of cultural selection when viewed as CBL manipulated by different CSS: the instructions altering the function of stimuli in the experiment.

Early work on social evolution was done with a specific focus on leadership (Insko, Gilmore, Drenan, & Lipsitz, 1983; Insko, et al., 1980). In these studies three villages produced different folded paper products: These products were then traded between the groups. Insko et al. (1980) included a fourth fictional group.. The fourth group trade emissary was a confederate. Several selections processes can be identified in this research, the researchers used anthropological theory and looked at different leadership issues that arise within- and between groups. Relevant to this topic are some of the results from the studies.

Both studies comprised nine generations and only the first generation was given proper instructions on how to fold paper products correctly. These instructions are analogous to CSSs. The groups' responses form lineages although the members are exchanged by replacing them in a generation like manner. The most important success criterion for the groups was the production of correctly folded paper products, for trade with other groups, per production cycle. The group members were free to advice, CSS, other members while working on their products. All groups increased production over generations. Responses that had the property of less duration of production time were selected for. These responses were continuously reinforced at the level of the group as the group had more products for trade with other groups in the experiment. The results indicate that reinforcement delivered contingent on group behavior shaped the behavior of the participants: as in IBCs.

Methodology for studying cultural phenomena in the laboratory was developed further for an experiment featuring traditions of choice and traditions of giving and following rules (Baum, Richerson, Efferson, & Paciotti, 2004). The generational structure was used to simulate naturally occurring generations, and the participants worked in groups. This method was called a microsociety design. Group choice between paper cards of two colors, one paid more than the other, was recorded along with rules uttered by the group before making their choices. The cards gave anagram puzzles of equal difficulty. Earnings were manipulated by adding a time-out of different length on one of the colors the group could choose. It was found that the group performance increased over time even though participants were replaced: the rules remained in the group. Rules were informative more often than mythological or coercive, when time-out was at maximum value (3 minutes). The difference in reinforcement between the two colors was then at its maximum. With this method, change in the target response can be tracked through time and the target response can easily be manipulated. The study used several groups, each reinforced with different time-out periods, and no reversal of

reinforcement was made in this study. The task given to the participants, solving anagrams on colored paper was not a variable manipulated. The functional relation between the group choice of color and the corresponding reinforcement schedule was manipulated. In this study a manipulation of IBC's occurred. All participants had to agree on a choice of color, their behavior had to interlock to come in contact with the environmental contingency. The behavior was the same for all participants, speaking "I agree", conformity bias might have influenced the participants (see Efferson, et al., 2008 for an experimental study on conformity bias). The study supports the assumption that IBC's as defined above can be manipulated in the laboratory.

Writers utilizing methodology originally used in the study of natural selection have had a special focus on the difference between social and individual learning (Boyd & Richerson, 1985). The framework developed by Boyd and Richerson *dual inheritance theory* has seen prolific use in experiments (e.g. Henrich & Gil-White, 2001; Kameda & Nakanishi, 2002; Mesoudi, 2008; Toelch, et al., 2009). A distinction between individual and social learning may not be relevant to the definition above as they can be functionally the same. The social environment and the physical environment both supply reinforcement and thus select properties of cultural behavior: this is equally true for properties of an individual's response in ontological selection. Within the framework of the dual inheritance theory the strategy an individual employs is seen in relation to the difficulty of the task. An individual relies on individual learning (reinforcement) or social learning (imitation, modeling and CSS). With increased environmental insecurity the individual relies more on social learning. In one study ,using the framework of Boyd and Richerson framework, planting decisions on virtual farms were manipulated to vary the difficulty of planting decisions (McElreath, et al., 2005). Of the three experiments reported on in the article: one allowed the participants to see the planting decisions of a group. The researchers aimed at testing formal models on evolution of social

learning. They fitted data to different models and identified the best fitting model utilizing model comparison techniques. One model was named conformity: the participants chose as the majority of the group. The conformity model had high explanatory value when the environmental contingency fluctuates and has a high variance. In the context of cultural selection the results indicate that behavior in the form of CBL and IBC might arise due to varying environments. No information was given to the participants in the study specifying the consequences of planting decisions. Only the stimulus-response relation was given. The writers note that the participants show a sharp decline in frequency of accessing social information in the experiment. The models do not take into account frequency of accessing social information. The figure published in the article resembles an extinction burst (Catania, 2007; Cooper, Heron, & Heward, 2007). This is a demonstration that cultural behavior is dependent on its consequences. No preference for behaving culturally can be selected for unless the environmental contingency reinforces such behavior. Laboratory experiments within the framework of cultural selection might give new insight: adding emphasis on the relation to the environment may yield further information on how cultural behavior arises.

One study investigated the effect of different forms of instructions and the effect of these (Schotter & Sopher, 2007). Two types of instructions, CSSs, were studied: written advice and access to a written historical record of the experiment. Advice was found to influence the fostering of convention, or rule following, more than historical record. The participants were allowed advice, historical record viewing or both before making a choice in an Ultimatum game. The participants gave only one response each but the effect was seen across generations. The difficulty of interpreting historical records rose as more and more information became available, this would be a natural setting in any cultural process. In relation to cultural selection and CBL's, the results indicate that advice may have the largest

influence on the behavior of other individuals belonging to the same group: even when other forms of information on the behavioral contingency are available.

Combining the microsociety method of Baum et al. (2004) with the dual inheritance theory, Caldwell & Millen (2008; 2010) studied whether successive improvements occur over generations. Within the framework of Boyd and Richerson this effect is called cumulative cultural evolution (CCE). In one study the participants produced paper airplanes or spaghetti towers (Caldwell & Millen, 2008). The independent variable was the instructions given to the participants. The dependant variable measurement of relevant characteristics of the task: length of flight or height of tower. The participants could communicate freely while in the experimental room. They entered the room in a staggered manner so they could view the constructing of two participants and the products of all participants finished with their task. Participants entering the experimental room later had more models to model from. The experiments included parallel chains of participants and analyzed similarity ratings within and between chains. Improvement over time in the relevant criterion specified in the instructions was found to occur in both tasks. The researchers found that similarity ratings were hard to make, but conclude that chains of participants produce more similar products within chains than between chains. Interrater reliability is not reported in the studies, and would be of interest with a difficult task like similarity assessment. The behavior measured in the participant chains corresponds to the definition of a CBL above. One point of interest is that the response properties height or flight length of finished product is selected for, even though the behavioral lineage consisted of only 10 responses: finished products. In a similar study the task was building spaghetti towers and one more independent variable was introduced, latency in height measurement with a disturbance (Caldwell & Millen, 2010). One set of instructions instructed the participants to build for height only, the other set for height and sturdiness combined. A monetary reward per centimeter was given to the participants and two towers

were available as models for all participants: except the first two participants who had zero and one model respectively. The researchers find evidence of cumulative improvement in height for both dependent variables: measurement of height before and after disturbance. Interestingly the instructions specifying a sturdiness rule did not show significant improvement in measurement after disturbance when compared with the group given no such instructions. Similarity ratings were used to assess the difference in design between towers made by participants given instructions on height and towers made by participants given instruction on height and sturdiness. The researchers find the similarity ratings to be significant: there is no interrater reliability measurements reported. The results suggest selection may favor properties of CBL's in the laboratory, e.g. height and length. Prediction in a behavioral system is pragmatically useful, the researchers shows that behavior in the form of CBL can be predicted in an experiment.

One experiment directly manipulated the IBCs in the laboratory setting (Vichi, Andery, & Glenn, 2009). Participants played a game where tokens were exchanged for monetary reward at the end of the experiment. Tokens were earned by placing bets individually then choosing collectively a row in a matrix. The experimenter then announced the column, where the column and row met there would be either a plus or a minus sign. If a plus sign resulted from the pairing of row and column the experimenter doubled the bets of the participants. If minus the experimenter took half the tokens. The group then distributed their earnings and had to place some of their tokens in a participant's pool. Participants were allowed to talk freely and take notes during the experiment. The distribution of the earnings was the IBC manipulated in the experiment; either unequal or equal distribution was favored. The favored distribution resulted in the experimenter choosing a column, when the participants had chosen a row, yielding a plus sign in the matrix the round following the favored distribution. The independent variable was metacontingencies: either favoring equal

or unequal distribution of earnings. Conditions were reversed when 10 consecutive rounds showed a plus sign in the matrix. The experiment show experimental control over the target response in the form of an IBC. There is no replacement of participants in this study so it gives no further understanding on cultural selection across generations of individuals. The independent variable directly manipulated the IBCs in the experiment: the experiment used the definitions used in this paper for IBC. The results indicate that IBCs may be manipulated in the laboratory using the definitions of IBC and CBL.

Conclusion

Evidence regarding cultural selection as defined is found when analyzing the articles included in this paper; but only one experiment provides evidence of cultural selection as defined. Most experiments are done with theoretical frameworks and with variables that can only be understood in the context of cultural selection by analyzing the methodology of the reports. Behavior in the form of CBL, where behavior is passed on from individual to individual in a generation like manner, has been studied in several experiments. Evidence of selection processes working on properties of a response when behavior is modeled from the previous generation is found. Mostly researchers' use between group designs to study this behavior and most studies employ an S-R type of manipulation using instructions and measuring the effect of these. Only one study is found that shows experimental control.

Cultural behavior in the form of IBC's are found to depend on the environment, supporting the assumption that selection is at work. One study is insufficient to draw conclusions from: There is a clear need for more research to be able to understand cultural phenomena of cultural selection. Cultural phenomenon in the laboratory seems particularly difficult to isolate and measure. Researchers have utilized behaviors in direct conflict with CBL's in the social group the participants were recruited from. Novel responses may be easier to control in the laboratory, an arbitrary relation to previous learning history may indeed be

necessary. Experiments structured around novel behaviors will open for experimental control demonstrating the effect of the selection process. Showing experimental control is dependent on choosing an independent variable that will cause a measurable change: Choosing independent variables is more precise when the dependent variables are chosen on the grounds of their availability for manipulation. The emphasis on control is no less necessary in the study of cultural behavior than operant behavior. When the mechanism of cultural selection can be controlled in the laboratory, opportunities to apply this knowledge on large scale social systems increase. There is a need for further studies on cultures defined as cultural evolution and on cultural selection. But if we wish to get an understanding of causality in cultural evolutionary processes there needs to be a shift towards an approach emphasizing the relation of culture and its environment.

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Cultural Selection: The Effects of Reinforcement on Interlocking Behavioral Contingencies in a Microsociety Design

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Abstract

On the theoretical assumption that cultural selection can be conceptualized as a selection process of *interlocking behavioral contingencies* (IBC) the author conducted an experiment drawing on the theory of radical behaviorism and theoretical work by Sigrid S. Glenn. 20 secondary school pupils aged 18 to 19 years participated in groups of three in a task of choosing color combinations. The experiment was structured as a microsociety design with N=1 design elements. One trial consisted of participants choosing one color each: No talking amongst the group members was permitted. The groups' responses, choice of colors, gave point scores contingent on one response property, the ten combinations of colors. Combinations were arbitrarily arranged in five categories. The categories had different reinforcement values. The participants were replaced in a staggered manner making 18 generations. 30 trials marked the end of a generation. The participant leaving the group gave advice to the participant about to enter the experiment. When the group made 10 consecutive choices in the highest reward category the experimenter changed the contingency from reinforcement delivered contingent on combinations to reinforcement delivered on a VR5 schedule. Results indicate group behavior structured as IBC came under control of the independent variable: reinforcement contingent on color combinations. The author concludes that studies of cultural change may benefit from using the conceptual entity of interlocking behavioral contingencies.

Keywords: Interlocking behavioral contingency, metacontingency, experiments, cultural selection, cultural evolution

Cultures are found in endless variety over the world, historical and archaeological findings show that cultures have varied over time and space. Cultural change can be seen as an evolutionary process where some practices are retained and others abandoned (Nelson, 2004). Understanding cultural change has been a matter of finding a replicated cultural entity and explaining how it is transferred from individual to individual in a group. A group is central to the concept of culture: culture is a feature of a group. A group's culture can be defined as learned behavior and its physical products (Glenn, 2003). Cultural behavior is usually seen as a form of behavior only humans are capable of. Some traits only humans exhibit are seen as crucial for cultural behavior: sensitivity to stimuli from other humans, ability to imitate and ability to react to social reinforcement (Baum, 2000, 2005). It is held as a prerequisite that a replicated cultural entity is retained differentially through series of repeated selection for culture to be thought of as an evolutionary process (Dawkins, 1978). The replicated entity has been given many names e.g.: meme (Dawkins, 1978), culturgen (Lumsden & Wilson, 1981), and culturant (Sigrid S. Glenn, personal communication). Most of the terms used for the replicated entity, the culturant a notable exception, can be seen as ideas or bits of information that are retained inside an individual and spread via imitation through a population (Walter, 2007). In this article the term cultural practice is used as a general term: A discussion of the definitions and terms themselves are not within the scope of this article.

Evolutionary cultural change could be seen as a process, only a social group is capable of, promoting phylogenic fitness: a coevolution between genes and culture (Boyd & Richerson, 1985). In the present context cultural change refers to the process of selection working on a population of cultural practices; not the fitness of the group or individual where the cultural practice could be said to be "retained". The cultural practices are differentially replicated on account of their relation to the environment, social and non-social. Selection can

be viewed as a general process; not only affecting the genetic material of an individual and defined as: “Repeated cycles of replication, variation and environmental interaction so structured that environmental interaction cause’s replication to be differential” (Hull, 2001).

Radical behaviorism is the study of how the environment influences behavior and is a contextualist, materialistic approach (Baum, 2005; Delprado & Midgley, 1992; Skinner, 1953, 1969). Behavior is conceptualized using a three term contingency: preceding stimulus, response and reinforcing consequence. As an example: a pedestrian crossing light shows red, a person stops and cars drive by. The environment is the reinforcing consequence and can have two functions. Either increasing the probability of another response given the same stimulus or decreasing the probability: denoted reinforcing the behavioral response or punishing the behavioral response respectively. In the example above the behavior is presumably reinforced, it is more likely to happen again than the alternative (walking given red light). The preceding stimulus (red light) does not elicit a response (stopping) but can increase the likelihood of a response following the stimulus when paired with a consequence: this relation is called stimulus control. Behavior can be seen as dependent on three selections processes: phylogenic (natural selection), ontogenic (selection of behavior of one individual) and cultural (selection of cultural practices) (Skinner, 1984).

Phylogenic selection is the process shaping our species, commonly known as natural selection. Genomes are selected for on the basis of their phenotypic trait by the environment (Dawkins, 1978). The genome is the replicated entity, replication occurs when parents pass on genetic material to their offspring. One major difference between cultural selection and natural selection is the time scale. Change in genetic material due to natural selection generally takes a very long time. The genetic material is not changed within a single lifespan. Behavior of an individual can change within seconds of experiencing an environmental consequence, or having the contingency described as a verbal rule.

Ontological selection refers to an individual's learning history, and the process of selection works on the individual's operant behavior (Skinner, 1984). Operant behavior of an individual is selected for by the environmental consequences: The environmental consequence of the behavior causes a change in the probability of the behavior's future occurrence. Ontological selection is denoted the second level of selection as the species must first have evolved and operant behavior must be an evolved trait of the organism behaving. An operant has measurable properties (e.g. duration, force and latency) that are selected for by the environment. Variation is a property of an operant: any operant exhibits some variation, and the amount of variation in an operant lineage can be controlled by contingent reinforcement (Page & Neuringer, 1985). Selection requires cycles of environmental interaction: the environmental interaction occurs every time properties of the operant behavior are either reinforced or punished.

The third level of selection is the result of several individual's operant behavior; it is less understood and less formalized. The interaction is still a response but this response is not only a part of a single individual's behavioral repertoire, but also a group's behavioral repertoire (Glenn, 1991; Skinner, 1984). Cultural lineages are considered functionally alike to operant lineages, and made up of operant behavior. Cultural selection is the third level of selection, the group must be individuals with operant behavioral repertoires, and operant behavior must first evolve in the individuals' phylogenic history, which in turn is contingent upon evolved characteristics of the species.

Sigrid S. Glenn has developed a theoretical framework for analyzing the third level of selection (Glenn, 1988, 1991, 2003). Cultural practices are described as two concepts, reflecting two possibilities of behaving as a group. The group operates on the environment to produce favorable results. As operant behavior operates on the environment cultural behavior must for the two levels of selection to be regarded functionally the same. The first concept is

culturo-behavioral lineages (CBL). One example is hunting behavior: a father might take his son hunting showing him how to find the prey, the son then imitates the father and is reinforced in doing so by experiencing successful hunts. These are behaviors learned by imitating, modeling or by contingency specifying stimuli (CSS) (Blakely & Schlinger, 1987; Schlinger & Blakely, 1987). CSSs can be regarded as rules or instructions, in the present context CSSs may function as a means of "inheritance". Behaviors that require several individuals interacting as a cohesive whole to make contact with the environmental contingency are described as *interlocking behavioral contingencies* (IBC): these behaviors rely on CSSs. Imagine an extended family group hunting large prey: none of the individuals hunting can take down the prey alone. With a part of the group waiting in a previously agreed upon position the others may drive the animal to the members of the group waiting: the prey may then be taken down. This behavior is reinforced at a group level, and IBCs are viewed as the "highest" form of cultural behavior while CBLs as pre-cultural behavior. The present study seeks to explore the effect of reinforcement on IBCs in an experimental microsociety. Can lineages of cultural behavior, in the form of IBCs, be manipulated by altering the environmental consequences?

Research suggests that cultural practices can be selected upon over generations of participants in experiment (Baum, Richerson, Efferson, & Paciotti, 2004; Caldwell & Millen, 2008, 2010; Insko, Gilmore, Drenan, & Lipsitz, 1983; Insko, et al., 1980; Jacobs & Campbell, 1961; Zucker, 1977). In these studies certain behaviors were favored, either by CSSs given as information before the study commenced or directly by altering the contingencies during the experiment. Participants were in all the studies replaced to mimic generations: group sizes and interval between replacements were different in the studies. Common for all these studies were the emphasis on behavior over generations. Studies have been undertaken on the effect of reinforcement on aggregated behavior of groups. Results indicate behavior may be

susceptible to selection at the third level of behavior (Baum, et al., 2004; Vichi, Andery, & Glenn, 2009).

In the present study, the dependent variable was the IBCs of a group of 3 subjects at a time. Properties reinforcing behavior at group level were deliberately arbitrary. For this experiment a task of combining colored cards was chosen. The participants were given 7 seconds to make one combination: the combination made after 7 seconds counted as one response. A point score for the combination was then displayed to the participants: this constituted one instance of an IBC. The participants had three colors to choose from: blue, red and yellow. All 10 possible combinations were grouped in 5 reinforcement categories based on their reinforcement value. The reinforcement value was points awarded for combinations, all combinations gave some reinforcement in the form of points: no combinations ever earned zero points. Participants were told that the one with the highest point score at the end of the experiment would receive a gift card at the local mall. Participants were replaced one at a time to mimic the effect of generations: The effect of generations would further isolate the cultural lineage from the participants' ontogenic lineage emphasizing the group as the learning unit. To limit the social environment of each participant they remained silent for the duration of the experiment. Inference from body language was expected to be negligible. Presumably the participants responded as individuals: but they did not receive reinforcement contingent on individual behavior. The IBC of combining colors in a group of three was the dependent variable, manipulated by changes in the independent variable, the reinforcement value of the different combinations. The assumption, in a selection perspective, was that the independent variable would select for the high value color combinations. Cultural selection occurs when properties of cultural behavior are selected for by repeated cycles of environmental interaction. Properties selected upon were combinations of colors, the environmental interaction a point score displayed to the participants contingent on the color combinations.

Methodological considerations from N=1 designs (Arntzen, 2005) were added to the microsociety design (Baum, et al., 2004) in an effort to exert control of the behavioral lineage. The task was simple, combining colors, to make the participants able to react on a FI 7 seconds reinforcement schedule (Catania, 2007). A control condition was introduced when the participants made combinations in reinforcement Category 5 for 10 consecutive trials. The control condition was administered as a VR5 schedule, every 5th trial on average was reinforced as a Category 5 regardless the color combination. All other combinations were reinforced in the lowest category: The control condition equally reinforced all combinations no preference for combinations should appear. Combinations and points score was collected during the experiment.

To enable transmission of IBCs over generations participants leaving the group gave advice to their immediate successors. This was done in a separate session and recorded on videotape. Research indicate that advice can be more effective in transmitting cultural behavior than having a complete record of the experiment at hand (Schotter & Sopher, 2007). Advice can be regarded as CSS. Giving advice may in this context be seen as behavior in the form of CBL. The advice was given based on group membership; the advice behavior was described in the information sheet as a CSS. The instruction described the following contingency to the advisors: When told to give advice, give good advice and points acquired in the experiment will increase.

The experimental questions this experiment attempts to answer are: Could behavior seen as a lineage of IBCs be controlled experimentally? Would the advice session yield different results when responses were reinforced by the FI 7 second schedule or on a VR5 schedule?

Because of the relative paucity of empirical work on cultural selection as defined here, the variables in this experiment were set up with the theoretical entity of IBC's. The IBC's

recorded were combinations of colors chosen by a group; members of the group were replaced to mimic the effect of generations. Reinforcement was manipulated to control the selection of the responses that were parts of a cultural lineage. Advice sessions were recorded and the advice later coded for interpretation.

Method

Subjects and Setting

20 Norwegian secondary school students were recruited by visiting their classroom and asking for voluntary participation after a short presentation of the procedure for the project. All participants were in their last year of secondary school: all participants were 18-19 years old. The experiment was conducted at the school, Rælingen Videregående Skole, over the course of three hours.

Materials

Information sheets about the experiment and written consent forms were distributed to each participant. Participants drew numbers for the order of entering the experiment. One room was used for the experiment, one for the participants waiting to enter the experiment room, and one for the advice session. In the experiment room there were four desks and four chairs (one for the experimenter and three for participants). Three sets of three colored paper cards (in the colors blue, yellow and red). One laptop was used for scoring and recording responses with an additional screen displaying the score to participants. A countdown clock was displayed. An assistant with a video camera recorded the advice sessions.

Design and Variables

This study combined the Microsociety design and the BAB design. In the experimental condition a FI 7 seconds schedule was administered. Furthermore the

participants responded on a FR1 schedule: every response was reinforced. The reinforcement value was given as points: The participants were told that the one with the highest points score would win a gift card of 500NOK. 10 combinations were available, given three participants, three colors and the participants could choose the same color. Of these ten combinations five categories of reinforcement were created by randomly combining one category and two combinations (app. A). The values in each category was given a range of 10 points, a random score in the range was awarded for the corresponding color combination. The categories were not overlapping: a sequentially larger gap separated them to make it easier for the participants to discriminate. The reinforcement categories were tested in pilots and the reinforcement value of categories used in the experiment were selected based on the results of this testing. The reinforcement was changed to a control condition when the group had made 10 consecutive responses in the highest reward category. In the control condition reinforcement was administered on a VR5 schedule: Reinforcement Category 5 was administered on average every 5th response and reinforcement Category 1 was administered on all other responses. In the experimental room the participants made their choices in groups of three. One participant left and was replaced by a new participant every 30 trials, 30 trials constituting one generation. There were 18 generations in total. Participants leaving gave advice to the participants new to the experiment except for the last generation where no more participants was to enter, this constituted 17 advice session. In the first generation all participants were naïve. When the participants leaving the experiment gave advice, the two remaining members of the group sat with the experimenter. The remaining members were encouraged not to talk about the experiment when deemed necessary.

Dependent variables were combinations of colors formed by the three participants' choices, and advice given to the new participant measured as instances of verbal behavior containing CSSs in each advice session. The main independent variable was the reinforcing

consequence in the IBC. Responses were either followed by reinforcement on a FI 7 seconds schedule with reinforcement value categories, or reinforcement delivered on a VR5 schedule. The advice received also functioned as an independent variable influencing the responses of the individuals given advice.

Procedure

The participants were placed in a waiting room. Participants drew numbers 1-20. The numbers were written on paper notes and drawn from a basket for randomness and denoted the order they were called in to the experimental room. Once the participants had drawn their participant number they were not allowed to trade and exchange numbers. The participants were informed that the one with the highest personal point score would receive a gift card at the local mall Lillestrøm Storsenter, value NOK500. Before entering the experimental room the participants signed a written consent (app. B) and read through the information sheets regarding the experiment (app. C & D).

Three participants with the lowest participant numbers were called in to the experimental room forming the first generation. The participants remained seated throughout the experiment and the colored paper cards were already in place by the participants' desks. Every desk occupied by a participant thus had three paper cards with the colors blue, red and yellow. Once the experimenter gave the participants permission to start, they had seven seconds to complete a three piece combination. The time was given by a countdown clock on the experimenter's desk. One paper card was placed in front of every participant making a combination of three, one trial of the experiment. No talking was permitted during the whole session in the experimental room. The experimenter requested a card from any members of the group that failed at choosing a color at the end of seven second period. A score was then given and the experimenter registered the score and the combination. The point score for each combination was displayed to all participants via a computer display on the experimenter's

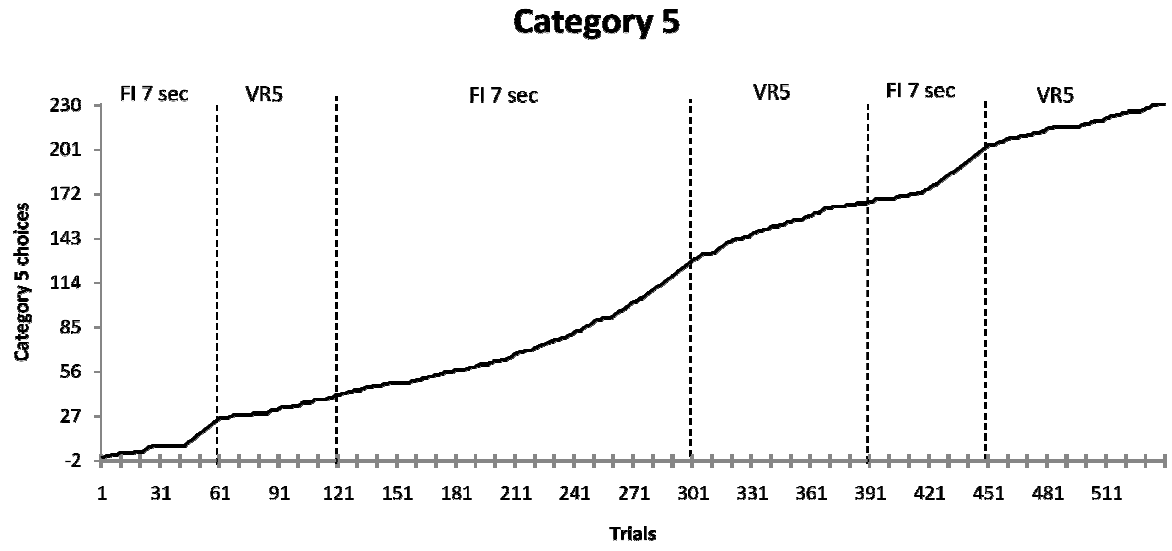
desk. When 10 consecutive combinations from Category 5 of the reinforcement categories were given by the group, the conditions were altered. For a period of 60 to 90 combinations the control condition was administered. The control condition was terminated when the experimenter judged the combinations delivered by the participants to occur with near equal probability. After 30 trials of the experiment the participant with the lowest participant number was asked to leave the room by the experimenter and a research assistant followed the participant to the advice room. In this room the research assistant activated the video camera, and then the participant leaving was allowed to give advice to the participant about to enter the experimental room for a total of 60 seconds. The research assistant called the participant about to enter the experiment room into the advice room before this. Debriefing was done after all participants had been through the experimental procedure with all the participants gathered.

Results

The cumulative record of Category 5 responses, seen as a behavioral lineage, shows an increase in frequency when submitted to the experimental condition (FI 7 seconds). In Figure 1 the cumulative record is shown, the participants made ten consecutive Category 5 choices in the second generation of the experimental condition. The first period of control condition started at trial 61 and lasted for 60 trials. The second period under the experimental condition was considerably longer lasting 180 trials before the participants made 10 consecutive Category 5 responses. The longer period of the experimental condition was followed by a longer period of the control condition, 90 trials. The third period of the experimental condition lasted for 60 trials and was followed by a period under the control condition run until the experiment ended. The cumulative record shows that in the three periods when the participants experienced the control condition (VR5 schedule), there was a decrease in frequency of Category five combinations made by participants.

Figure 1.

Cumulative Record of Category 5 choices.



Calculating percentages of responses per category over all conditions shows that responding in Category 5 under experimental condition increased throughout the experiment. Responses in Category 3 have the least percentage of the responses. This distribution of responses is not seen in the control condition. A decline in the percentage of responses in Category 1 and 2 can be seen in the experimental condition over the three periods. In the periods of the control condition the declining pattern is not seen. The percentage of responses in the Category 1 and 2 is most similar in the 1st and 3rd period of control condition. These periods were both preceded by 60 trials of the experimental condition as oppose to the 2nd period of the control condition which was preceded by 120 trials. The maximal percentage of Category 5 responses in the control condition occurred in the second period.

Table 1.

Percentages of Responses in Categories under all Conditions.

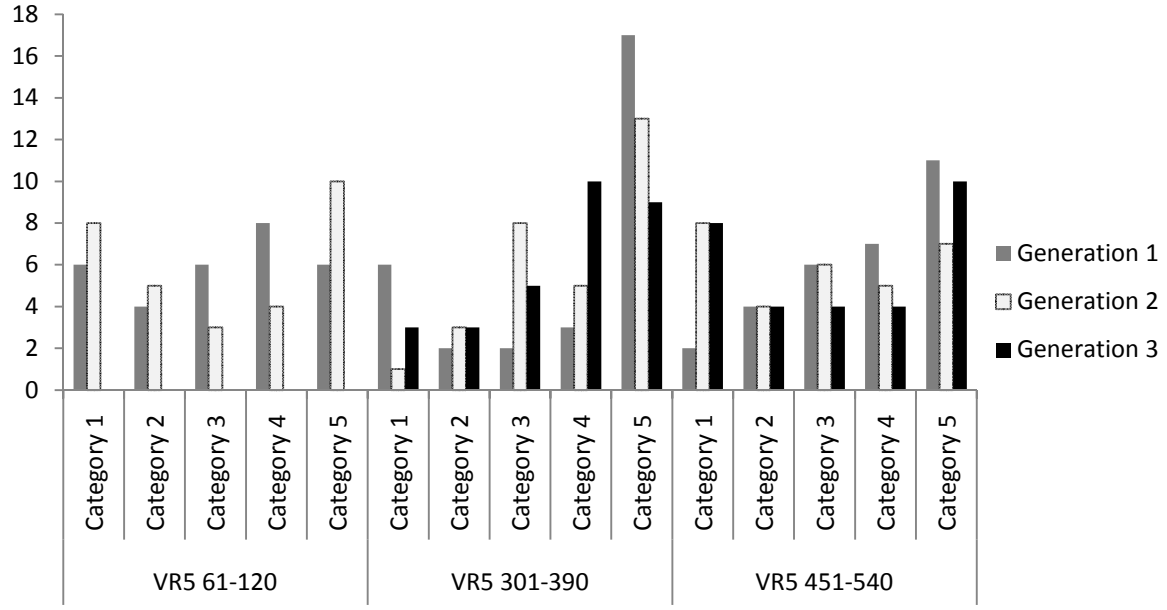
	Trial	**Category 5**	**Category 4**	**Category 3**	**Category 2**	**Category 1**
FI 7 sec	1-60	41,67 %	21,67 %	6,67 %	11,67 %	18,33 %
VR5	61-120	26,67 %	20,00 %	15,00 %	15,00 %	23,33 %
FI 7 sec	121-300	48,33 %	20,56 %	4,44 %	13,89 %	12,78 %
VR5	301-390	43,33 %	20,00 %	16,67 %	8,89 %	11,11 %
FI 7 sec	391-450	60,00 %	21,67 %	1,67 %	8,33 %	8,33 %
VR5	451-540	31,11 %	17,78 %	17,78 %	13,33 %	20,00 %

Note. The reinforcing condition is seen on the far left. The corresponding trial numbers denote when the different schedules were introduced in the experiment. The timeline goes from top to bottom.

The experimental- and control conditions were administered three times each. In trials 61-120, 300-390 and 450-540 the participants responded in the control condition. Figure 2 displays a count of responses per category in all these periods. When viewed as generations the count shows there is a tendency for more variation the longer the control condition period lasts. In the second period of the control condition the participants started off with a considerable bias towards choosing Category 5 responses, by the third generation this bias had evened out with the other categories.

Figure 2.

Categories chosen under the VR5 Schedule per Generation.



Note. The first period of VR5 consisted of two generations, each generation consisted of 30 trials making the first period of VR5 last for 60 trials. The two latter periods lasted three generations, 90 trials.

Counting the responses in all categories of the periods under control condition and comparing the first and second period there can be seen nearly twice as many Category 5 responses in the second period than the first, see Table 2. Only the responses from the two first generations of the second period of the control condition were used for the comparison, an equal total number of responses were compared. Comparing the last generation in the second and third period of the control condition make for a comparison of two generations where no member had direct experience with the experimental condition, all three participants were introduced to the experiment during the control condition. The total count of responses shows a higher number of responses in Category 4 and 5 in the second period of control condition than the third. The third period of control condition notably showed a large number of Category 1 responses.

Table 2.

Comparison of Periods of the VR5 Reinforcement Schedule.

	Trial			
	61-120	**301-360**	**361-390**	**511-540**
Category 5	16	30	9	9
Category 4	12	8	9	4
Category 3	9	10	5	4
Category 2	9	5	3	4
Category 1	14	7	3	8

Note. Scores from two first generations of the first- and second instance of the VR5 schedule are compared in the two columns to the left, a higher number of responses in Category 5 is seen in the latter. To the right the last generations in the second- and third periods under the VR5 schedule are compared.

The advice sessions were recorded and five raters with experience in behavioral theory were recruited. The raters were given information on how to score specifying “rules” observed in the advice sessions (app E), instructions previously given to the participants and an overview of the reinforcement categories with points values. The scores reflected the number of rules given forth in one session. Rules needed to specify a contingency of the experiment to be scored. Results from the advice sessions were inconclusive (point-by-point agreement ratio 0, 4).

Discussion & Conclusion

The results indicate that the dependent variable, color combinations made by the group, came under the control of the independent variable, reinforcement delivered contingent on the color combinations. This is indicated as the frequency of Category 5 combination choices, highest reinforcement value, increases under the experimental condition as seen in Figure 1. When the control condition is administered the frequency of Category 5 choices decline, this indicates experimental control of the target response. The effect of the experimental condition increases as more trials are run. This can be seen as an increase in percentages of choices in the two categories yielding the highest reinforcement value, see Table 1. The percentage increase of combinations in Categories 4 and 5 in the periods of experimental condition indicates the combinations are selected for as a cultural lineage. The periods of experimental condition were separated by periods of control condition. Results suggest the behavior learned in the experimental condition stay in the cultural lineage: In the last period of the experimental condition over 80% of the combinations were of the two highest reinforcement value categories.

The length of the periods of experimental condition resulted in a different shape of the curve in the three periods of the control condition, see Figure 1. The first period of control condition was introduced after two generations (60 trials). The curve rapidly levels out

indicating only a weak preference for choosing Category 5 combinations had been learned by the groups. The second period of the control condition was administered after a considerably longer exposure to the experimental condition. Considerably more trials in the control condition were needed before the frequency of Category 5 choices declined. In the behavioral lineage there was a tendency to respond on the experimental condition for a longer time when exposure to the experimental condition was prolonged. This is natural when measuring one subject's responses: in this experiment the effect can be seen even when participants were replaced in a staggered manner. Only the cultural lineage can be said to have been under a longer time of exposure to the experimental condition. Exposure to the experimental condition was the same for participants compared in Table 2. The tendency to respond according to the experimental condition was present even when no participants had direct experience with the experimental condition. As seen in Figure 2 a comparison of the periods of the control condition indicates that a longer exposure to the experimental condition resulted in a stronger preference for choosing Category 4 and 5 in the control condition. This supports the assumption of a cultural lineage with a tendency to respond according to the experimental condition. Participants' choices were not only made on account of their private learning history of discrimination in the experiment: the learning history of the behavioral lineage consisting behavior in the form of IBCs affected their choices.

The advice session may have influenced the choices of the participants and they may have generated rules on their own during the natural time out: when advice was given by the leaving member. The advice session did not yield any results for comparison due to difficulties in creating a reliable way of interpreting the data. The inter-rater reliability (0, 4 point-by-point agreement) was very low for the advice measurement. Examination of the recorded advice sessions revealed that one of the advising participants gave advice opposite the experience in the experiment, and two gave advice in conflict with contingencies

described in the information sheet. The reason for this may be a lack of clarity in the instructions, or the participants may have given advice as received even if contrary to the instructions. The contribution of rules made by the social group versus rules made by the participant alone cannot be assessed in this study. During the advice sessions the participants remaining in the group sat with the experimenter, they may have created functional rules for themselves in private that outperformed the rules acquired through the advice session, the question on the nature of “inheritance” in behavioral chains remains for further studies. The rules may be easier to access by creating a written record of rule giving.

In Table 1 the percentages of choices made by category can be seen, in the experimental condition Category 3 was chosen considerably less than the other categories. One reason for this might be the category only had combinations made of the same color (e.g. red-red-red): as the categories were paired with combinations at random this was not a deliberate manipulation. The category may have been easier to discriminate than others due to topographical difference.

During the experiment two irregularities occurred. Due to an error in programming, the reinforcement of one of the combinations in the control condition gave points in the range of 260-2700 instead of 260-270. The error occurred in four trials. This did not affect the responding of the participants in any other way than other instances when combinations in the control condition gave the score in the highest value range. The combination the participants made were more likely to repeat itself the trial following the high yield. The second irregularity happened as the program did not display the new score on the display to the participants after they had completed a combination. This occurred in four trials spread out through the experiment. The participants were shown the score from the previous combination. It was not uncommon for the same score to appear twice in a row and the errors

occurred with large intervals between them in the experiment: It is unlikely this affected the participants.

By altering the reinforcing condition as an independent variable in the experiment a change in the dependent variable could be demonstrated. When the conditions were reversed the dependent variable changed towards more variation although the responses were not completely random. When compared to everyday life we can say the group learned to know its environment and when the environment changed the group tried to work out new ways to succeed. There are many ways to conceptualize cultural change and cultural replicators. By using the methodology and concepts from behavior analysis cultural change can be measured in a functional materialistic manner. Arbitrariness emphasizes the selection process instigated by the experiment, as oppose to measuring a variable that is found in daily life. If an experiment builds on skills found in daily life; the measurement is less valid. In the context of cultural selection, there are considerable difficulties in assuring the participants are equals in skill proficiency. The cultural selection process is easier to study the less experience the participants have with the experimental task: The behavior studied should be novel and properties arbitrary. The results from this study build on the growing knowledge of cultural selection within behavioral science, as well as work done in various fields often drawing on other disciplinary approaches. One of the most prominent theories on cultural change the *dual inheritance theory* utilize the concept cumulative cultural evolution (CCE) (Boyd & Richerson, 1985). In the view of CEE: performance, in a given task measured, improves through generations due to social learning: specifically the ability and opportunity to imitate. Cultural knowledge is said to accumulate over generations. The results presented here indicate the dual inheritance theory can aid behavioral theory as a prediction on how cultural practices evolve. Studies showing experimental control are required for evidence on the specific mechanisms causing the improvement in performance.

Empirical evidence on cultural change should be sought employing a materialistic functional framework, as that of radical behaviorism. From the viewpoint of radical behaviorism the concept of cultural knowledge or a cultural idea that spread from one individual to the next is seen as an abstraction (Baum, 2000). The idea can only be inferred from observed behavior and falls short of explaining the behavior it is inferred from (Hayes & Brownstein, 1986). Cultural change is thus a measure of the behavioral change of individuals in a group: The cause of behavioral change can be found in the environment. This environment may be both social, the group is the source of behavioral change in the individuals; and non-social, the physical environment is the source of behavioral change in the individuals on account of affiliation with the group.

The findings indicate that if indeed one looks for cultural replicators and seeks evidence of universal Darwinism, there is no need to look beyond the material world when specifying variables. This has functional implications. Cultural behavior structured as IBC's can be controlled in the experimental setting even when all the participants are replaced. Furthermore all collaborative efforts can be conceptualized as IBC's. The theoretical notion of behavioral lineages belonging to a social group may lend itself to further scientific studies by utilizing methodology similar to the one used in this study. Further studies should seek explanations of how rules are transmitted from generation to generation and seek other explanations: such as the effect of rules generated by individuals in private. How the cultural lineages are split up and new behaviors created may also lend itself to scientific study if we accrue more information on the phenomena of cultural evolution. There is a clear need to shed light on many issues regarding cultural evolution, research yielding precise results and showing experimental control of cultural change is needed. This study emphasizes the relation between the environment and the behavior in question, cultural behavior of humans.

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Appendix A

Reinforcement Value of Categories

Table A1.

Reinforcement Value of Categories.

Category 1	Blue	Blue	Red	or	Red	Blue	Blue	or	Blue	Red	Blue
1-10											
	Blue	Yellow	Red	or	Red	Blue	Yellow	or	Yellow	Red	Blue
Category 2	Yellow	Red	Red	or	Red	Red	Yellow	or	Red	Yellow	Red
50-60											
	Blue	Blue	Blue								
Category 3	Red	Red	Red								
110-120											
	Yellow	Yellow	Yellow								
Category 4	Blue	Blue	Yellow	or	Yellow	Blue	Blue	or	Blue	Yellow	Blue
180-190											
	Yellow	Yellow	Red	or	Red	Yellow	Yellow	or	Yellow	Red	Yellow
Category 5	Blue	Yellow	Yellow	or	Yellow	Yellow	Blue	or	Yellow	Blue	Yellow
260-270											
	Blue	Red	Red	or	Red	Red	Blue	or	Red	Blue	Red

Appendix B

Written Consent/Informert Samtykke

(EN) Written Consent

You will now participate in a research that relates to how groups collaborate. The research is formed as a choice of colors in groups of three. The purpose of the research is to find out how groups make choices and how these choices evolve over time. Data from your choices are coded and cannot be linked to single individuals. Data from the research will not be transferred to a third party nor used in any other way not specified herein. The experiment will be conducted at Rælingen videregående skole. The duration of the whole experiment will be two and a half hours. Your time in the experimental room is limited to 15 to 20 minutes, some waiting will have to be expected for most participants.

The research is divided into two sessions. You will give advice to a new participant entering the group after you have been in the experiment. This advice session will be videotaped with sound so the researcher may analyze the advice session afterwards. The videotape will be erased after this analyzes is concluded.

There will be no result ready from the research today. The results will be presented in my master thesis written at Akershus University College. The research report will be ready by fall 2010 and will be forwarded to you if u requests it by mailing me at:

eivindhaukaas@hotmail.com

Participation in this research is voluntary, you may withdraw from the experiment at any time.

I have read the information above and consent to participate in this study.

……

(name and date)

(N) Informert samtykke

Du skal nå delta i et forsøk som omhandler hvordan grupper samarbeider. Forsøket består av at du velger farger i en gruppe bestående av tre deltagere. Hensikten med forsøket er å finne ut av hvordan grupper foretar valg og hvordan disse valgene utvikler seg over tid. Data fra forsøksrommet er anonymisert og kan ikke knyttes til enkeltpersoner. Disse dataene vil ikke bli overført til andre databaser eller brukt i andre anledninger.
Forsøket vil foregå på Rælingen videregående skole. Det vil ta omkring to og en halv time. Du vil tilbringe omkring 15 til 20 minutter inne i selve forsøksrommet men må beregne en del venting.
Forsøket er delt i to. Du skal gi råd til en ny deltager etter som kommer inn i gruppen etter du har vært inne i forsøksrommet. Denne rådgivingen vil bli videofilmet med lyd for at forsøkslederen skal kunne analysere rådgivingen i etterkant. Opptaket vil bli slettet etter at analysen er foretatt.
Det vil ikke være klart noe resultat fra forsøket i dag. Resultatene vil bli redegjort for i min masteroppgave skrevet ved Høgskolen i Akershus. Oppgaven vil være ferdig høsten 2010. Resultatene fra forsøket sendes deg om du kontakter meg etter oppgaven er ferdig på mail:

eivindhaukaas@hotmail.com.

Deltagelse i forsøket er frivillig og du kan når som helst trekke deg fra forsøket.

Jeg har gjort meg kjent med informasjonen og samtykker til å delta på forsøket.

……

(navn og dato)

Appendix C

Information Sheet given to Participants 1-3

(EN)

You will now play a game with two other participants the purpose of the game is to collaborate. The group will combine three colors giving a point score on a computer screen. U will participate in different group compositions, the average of the point scores you participate in receiving will make up your personal point score. The one with the highest average score wins a gift card at Lillestrøm Torv (local mall) of 500 NOK (approx. 80 USD).

After some time one member of the group will be escorted out of the room, and another participant enters the room. The experiment starts again when three participants are present. After leaving you will be given the opportunity to advice the next participant about to enter the room, your successor in the game. Half of advised participant' score will be added to your score, good advice give more points.

- You choose one color each round: it can be a new one or the same as last round.
- The color you choose is laid on the table so your choice is readily understood by all.
- You may change your choice on account of what the others choose but you must choose before the countdown clock reaches zero.

Please do not talk or give any signs to your fellow group members during the game.

(N)

Du skal nå spille et spill med to andre, formålet er å samarbeide. Gruppen skal kombinere tre farger som gir poeng på en dataskjerm. Du deltar i forskjellige gruppesammensettinger, gjennomsnittet av poengene du bidrar til blir din poengsum. Den med høyest gjennomsnittlig poengsum vinner et gavekort som kan brukes på Lillestrøm Torv, verdi 500 NOK.

Etter en viss tid vil en av deltagerne bli fulgt ut av forsøksrommet. Forsøket starter igjen når en annen deltager kommer inn. Når du har forlater forsøksrommet vil du få muligheten til å gi råd til den neste som skal inn, din etterfølger i spillet. Halvparten av poengsummen denne etterfølgeren oppnår legges til de poengene du har oppnådd, å gi gode råd gir deg mer poeng.

- Du velger en farge hver runde, det kan være en ny eller samme som forrige runde.
- Den fargen du velger legges på bordet slik at alle deltagerne kan se ditt valg.
- Du kan endre ditt valg på bakgrunn av hva de andre velger, innen stoppeklokken kommer til null.

Det er ikke lov å snakke eller gi andre tegn til de andre deltagerne, forsøkslederen vil da be om stillhet.

Appendix D

Information Sheet given to Participants 4-20.

(EN)

Before you enter the experiment you will receive advice from a participant that has been through the experiment. You will now play a game with two other participants the purpose of the game is to collaborate. The group will combine three colors giving a point score on a computer screen. U will participate in different group compositions, the average of the point scores you participate in receiving will make up your personal point score. The one with the highest average score wins a gift card at Lillestrøm Torv (local mall) of 500 NOK (approx. 80 USD).

After some time one member of the group will be escorted out of the room, and another participant enters the room. The experiment starts again when three participants are present. After leaving you will be given the opportunity to advice the next participant about to enter the room, your successor in the game. Half of advised participant' score will be added to your score, good advice give more points.

- You choose one color each round: it can be a new one or the same as last round.
- The color you choose is laid on the table so your choice is readily understood by all.
- You may change your choice on account of what the others choose but you must choose before the countdown clock reaches zero.

Please do not talk or give any signs to your fellow group members during the game.

(N)

Før du kommer inn i forsøksrommet vil du få råd av en deltager som nettopp er ferdig med forsøket. Du skal nå spille et spill med to andre, formålet er å samarbeide. Gruppen skal kombinere tre farger som gir poeng på en dataskjerm. Du deltar i forskjellige gruppesammensettinger, gjennomsnittet av poengene du bidrar til blir din poengsum. Den med høyest gjennomsnittlig poengsum vinner et gavekort som kan brukes på Lillestrøm Torv, verdi 500 NOK.

Etter en viss tid vil en av deltagerne bli fulgt ut av forsøksrommet. Forsøket starter igjen når en annen deltager kommer inn. Når du har forlater forsøksrommet vil du få muligheten til å gi råd til den neste som skal inn, din etterfølger i spillet. Halvparten av poengsummen denne etterfølgeren oppnår legges til de poengene du har oppnådd, å gi gode råd gir deg mer poeng.

- Du velger en farge hver runde, det kan være en ny eller samme som forrige runde.
- Den fargen du velger legges på bordet slik at alle deltagerne kan se ditt valg.
- Du kan endre ditt valg på bakgrunn av hva de andre velger, innen stoppeklokken kommer til null.

Det er ikke lov å snakke eller gi andre tegn til de andre deltagerne, forsøkslederen vil da be om stillhet.

Appendix E

Information and Scorecard for Raters of Advice Sessions

(EN)

Only specifying rules should be scored:

Rules that give information on the real contingencies in the experiment are defined as specifying rules. Only these are to be scored at specifying rules, other utterances and rules are regarded as irrelevant.

- The points are given on a scale from 1 -270, the best point score is the interval 260-270. Rules that describe the scale or the top score are specifying rules. NB! Error in the program used led to four trials with errors of Category 5 combinations: the combinations gave values between 260-2700.
- Rules that describe combinations as **better than** others are specifying rules. Combinations are ranked by categories, Category 5 is the best category. See appendix.
- Rules that describe accurate point score and the combination yielding this score are specifying rules. E.g. blue-blue-red gives 6 points is a specifying rule as the points given to this combination is in the interval 1-10.
- Sequence or position in relation to the other participants (e.g. blue has to be in the middle, the participants on the right has to put down his card first) are irrelevant rules, it does not matter which color is laid first. Information on color combination that give information on the real contingency in the experiment is still regarded as specifying rules. E.g. blue has to be first, then another blue and then yellow then the point score is great (the order is irrelevant but the combination and reference to great points are regarded as specifying).

- The conditions are not altered between trials a group makes, rules about varying the choices are regarded as irrelevant rules. Holding the same combination after a good combination is a specifying rule. Changing after a "bad" combination is also a specifying rule as it is bad the next round also.

Figure E1.

Scorecard given to Raters

Advice 1					
Specifying					

Note. The original scorecard had one table for each advice session. Only one is included for simplicity.

(N)

Kun spesifiserende regler scores:

Regler som sier noe om de reelle betingelsene i forsøket defineres som regel spesifiserende. Kun disse skal scores som spesifiserende regler, andre ytringer og regler regnes som irrelevante.

- Skalaen for poeng er fra 1-270, den beste poengscoren er intervallet 260-270. Regler som beskriver skalaen eller topp poengscore er spesifiserende regler. NB! Feil i oppsett førte til fire trials med en feil i kategori 5 kombinasjoner, de gav verdier mellom 260-2700.
- Regler som beskriver kombinasjoner som **bedre enn** andre er spesifiserende regler. Kombinasjonene rangeres etter kategorier, kategori 5 er best. Se vedlegg.
- Regler som beskriver en nøyaktig poengsum og kombinasjon er spesifiserende. For eksempel "blå-blå-rød gir 6 poeng" er en spesifiserende regel da poengene blir gitt

tilfeldig mellom 1 og 10 for denne kombinasjonen. Deltageren kan med andre ord ha opplevd denne summen i forsøket.

- Rekkefølge og posisjon i forhold til andre deltagere (f. eks: blå må være i midten, høyre legger først) er irrelevante regler, det er samme hvilken farge som er først på bordet. Informasjon om fargekombinasjoner som gir reell informasjon om betingelsene i forsøket er fortsatt spesifiserende regler. F. eks blå må være først og så en blå til og gul til slutt det gir bra poeng (rekkefølgen er irrelevant, men kombinasjon og score er beskrevet stemmer med de reelle betingelsene).
- Betingelsene i forsøket endres ikke i mellom valgene en gruppe tar, å variere er en irrelevant regel. Holde samme etter "god" score er spesifiserende regel. Samme kombinasjon gir samme forsterkning neste runde. Ikke å holde samme etter en "dårlig" kombinasjon er og spesifiserende da den like dårlig neste runde.