Integrating Behavioral Research Findings with a Liberal Arts Paradigm

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INTEGRATING BEHAVIORAL RESEARCH FINDINGS WITH A
LIBERAL ARTS PARADIGM

A Thesis
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Louisiana State University and
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in

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by
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ABSTRACT

This paper explores the role of behavioral research in understanding the complexity and relevance of creativity. A brief history of the liberal arts and its current application is followed by a discussion of the importance of variability in generating novel and diverse responses, challenging the notion that creativity is solely a product of innate talent. The effects of reinforcement on variability, and how it relates to a complex relationship between reinforcement and the probability of variable responding leads to a discussion of how the combination of previously trained behaviors can lead to creative problem-solving, emphasizing the role of combinatory behavior processes in producing novel and useful performances. Finally, behavioral research findings are related to the liberal arts paradigm in higher education, suggesting that a broad base of knowledge and interdisciplinary approaches are essential for fostering creativity and preparing students for the future. By embracing behavior analytic insights such as generative learning principles, institutions can better equip students with the skills and knowledge needed to thrive in an uncertain and rapidly changing world.
INTEGRATING BEHAVIORAL RESEARCH FINDINGS WITH A LIBERAL ARTS PARADIGM

Since the beginning of the internet, we have witnessed an acceleration in technological progress and the speed of information exchange that has changed how we think of career training and acquiring job-related hard skills. Newly acquired skill sets often become obsolete or irrelevant more quickly than we would like, and this dilemma seems poised to worsen as new AI technologies and automation are likely to take over more jobs in the information economy. This ever-shifting landscape demands creative solutions to novel problems. However, problems are rarely completely novel, or as insurmountable as they may seem or be portrayed. Very often they are novel combinations of familiar factors, or they are composed of new elements, yet their underlying structure is familiar. Higher education purports to prepare students for a lifetime of engaging with problems and improve their ability to do so.

21st Century Problems and A New Approach to Solutions

What do we do when we face an immense challenge that can seem unfamiliar and overwhelming? Many of us would like to think that these are the moments when creative solutions emerge. They seem to dawn on us as if unbidden from some mysterious realm deep inside the complex infinite swirl of the unconscious. For most, this is as good of an explanation as they need. They are happy to regard these moments of transcendent revelation as something supernatural, otherworldly, or so mysterious as to be relegated to the sublime. Although I would have to agree with that assessment of the subjective experience of how these moments feel, I also desire a better understanding of how to bring them about. We have yet to discover a reliable and verified method for sharing the subjective experience of another exactly, and we probably never will, so it may be more pragmatic to address the tangible aspects of creating conditions conducive to creativity.
Creativity research has increased substantially in recent years as its importance to organizations, businesses, and industry has become more explicit. According to a large-scale analysis of almost 100 years of creativity research covering almost 40,000 academic articles the largest topic cluster is “organizational creativity and team creativity,” and it includes research on the factors affecting innovation and creativity in the workplace (Mejia et al., 2021). These trends, as well as an interest from academic communities beyond individual psychology of creativity, have emerged from the creativity literature (Mejia et al., 2021). Studying creativity invites a myriad of challenges related to its seeming ineffability, yet the field of behavior analysis offers insights grounded in the observable relationships between people and their environments. Behavior analysis assumes that the behavior of organisms is lawful, and thus objectively measurable by observing, quantifying, and subjecting to experimentation the relationship between an organism and environment (Skinner, 1966). Through this observation and experimentation, behavior analysts are able to describe the functional relationships that offer causative explanations of human behavior. For this reason, its findings produce useful interventions and tools for changing behavior patterns, including patterns of behavior labelled ‘creative.’

The behavior analytic approach has yielded a literature composed not only of insights into creativity, but also a body of knowledge about the basic processes of behavior that comprise creativity. Defining creativity itself is a complex and difficult proposition. Epstein (1980) claimed that a definition is unnecessary for developing reliable methods to produce interesting and useful new behaviors. In everyday discourse we routinely recognize certain activities, performances, and behaviors as creative. Often these involve artistic pursuits like painting,
filmmaking, and sculpture, yet an expanded perspective should also encompass how organizational problem solving necessitates creative skills (Amabile, 1988).

Along these lines, behavior analytic insights, which offer a practical and beneficial conceptualization of creativity, may be used to develop more effective methods for arranging educational environments. These findings align with and support the broadly realized framework of a Liberal Arts approach to higher education. Although such a framework is evident in small liberal arts colleges and undergraduate degrees in philosophy or art history, it is also the foundation of many bachelor’s degrees from major universities. The liberal arts framework provides a broad base of learning for students and is thought to aid in developing well-rounded individuals with the ability to engage in meaningful pursuits—not merely develop the hard skills of a specific career. This pursuit of humanistic values has lost major ground in recent decades to the demands of an increasingly competitive global market (Heller, 2023).

In American higher education the predominant framework of undergraduate degree programs has been based on the classical liberal arts model (Godwin & Altbach, 2016). Principle goals of this model are to teach a broad base of knowledge in multiple areas from science, mathematics, reading, writing, and art, while developing broader skills of communication, analysis, and critical thinking (Godwin & Altbach, 2016). It has been more comprehensively implemented at small, private liberal arts colleges, but the general approach is still in use at many larger universities as well. Yet there is currently a large-scale shift in the priorities of many universities. As career preparation and job skills have become a primary reason for a college degree, the classical values of being a well-rounded citizen and life-long learner have faded into the background (Baker & Baldwin, 2015). Increasingly, institutions are expanding Science,
Technology, Engineering, and Math (STEM) programs and disinvesting from the humanities, which have witnessed a rapid decline in enrollments for their majors (Heller, 2023).

The aim of this paper is to synthesize the research findings from behavioral science on how various skills and behaviors are merged and modified in processes that relate to, or are subsumed by, creativity with the liberal arts framework at the heart of American higher education. These behavioral research findings will be introduced and explained, and their insights will be integrated into the liberal arts framework. This should provide a basis for how the liberal arts approach to higher education may be validated and updated to maximize its effectiveness for future students.

The Liberal Arts

**Origins of the Liberal Arts**

The modern liberal arts education is derived from the Medieval concept of the *artes liberalis*, or the seven liberal arts appropriate for “free men.” Artes liberalis stood in contrast to the artes mechanicae or arte illberalis, which focused on the practical trades such as blacksmithing, farming, sea navigation, military service, and medicine (Roche, 2010). There were originally seven liberal arts: grammar, logic, rhetoric, astronomy, music, geometry, and arithmetic (Roche, 2010). They were seen as the culmination of human progress and represented more than the mere advancement of technology, physical goods, or commerce. They were the skills one required to convey the profundity of the human experience beyond the ability to merely barter and trade. This ability to effectively communicate in dialectic exchange has been passed down through the ages as a skill of broad and immense value.
The Liberal Arts Today

Today’s American universities tend to organize their undergraduate curricula along the lines of a Liberal Arts framework, derived from the idea of inculcating a broad base of knowledge to prepare students for thinking across disciplinary boundaries. At their foundations these approaches to education at the undergraduate level all seek to build students’ knowledge and skills in a similar fashion. That is, with an emphasis on communication skills and critical thinking. These organizing frameworks implicitly acknowledge that higher order synthesis, integration, and combination of various spheres of knowledge is only possible when the pupil has encountered and mastered these areas first. The liberal arts framework is most evident in the general education requirements for most undergraduate degrees. Regardless of major, most undergraduate students are required to take courses in the humanities, science, math, and art. There is typically an amount of flexibility for students to decide what specific subjects within those disciplines they wish to learn, as well as the more open-ended electives that may be taken in almost any area. This required breadth of knowledge is fundamental to the tenet of liberal education to educate the “whole person” (Godwin & Altbach, 2016). This approach has been successful throughout its history because it prepares graduates for a lifetime of learning, rather than focusing on the end of formal education as the end of knowledge acquisition.

The pressures of global economic competition and rapid technological advancement are pushing higher education institutions to embrace a focus on career preparedness in STEM fields. This may come at the expense of higher order critical thinking and synthesis skills if these liberal arts domains are not more explicitly acknowledged and integrated into undergraduate curricula. The National Science Foundation’s (NSF) Directorate of Education and Human Resources (EHR) released a Visioning Report in 2020 with three priorities. The second priority was to
“build an ethical workforce with future-proofing skills.” Within this priority, they acknowledge the need for creativity and complex problem-solving skills to prepare individuals for the changing needs of the workforce (p 18). Future-proof skills are those technical, social, and cognitive abilities that are less susceptible to automation and remain valuable across various industries and employment opportunities. These skills remain useful over the course of one’s life, because they are soft skills involved in flexibility and adaptation. Steve Jobs was hailed for his creativity and innovation as he achieved success in the tech sector, but his early life involved many different paths to knowledge. No one imagined that an ideal CEO for the turn of the 21st century would be the one who had studied Zen Buddhism, electronics manufacturing, psychedelics, the humanities, technology, poetry, music, and design (Isaacson, 2011). Jobs’ collection of seemingly disparate skills and knowledge were an important part of not only being future proof during a time when technological advancement accelerated at an exponential rate, but they also contributed to his ability to create the future.

The notion of future-proof skills has only emerged in the relatively recent past as the speed of technological change has caused more rapid skill obsolescence. The concern over obsolescence coupled with the fact that the American higher education system has increasingly focused on job-preparation, has led to an idea that higher education is somehow failing to equip students for future employment. Yet, this is only true if one believes that the penultimate goal of post-secondary education is to prepare graduates for a specific job. The traditional view of the liberal arts, and higher education, institutions is that engagement with the humanities, as well as sciences, provides a sound foundation for developing higher order skills that are broadly useful across contexts and careers. Thus, students who stay engaged with the humanities and develop critical thinking and analytic skills are likely to be better prepared to adapt in a world of
changing environment-behavior relations (World Economic Forum, 2020). The current trend in higher education is a focus on those areas that are perceived as being the most likely to produce groundbreaking technological advancements, lead to higher paying careers, and be competitive in global economic competition. Yet all of those ends require means that are being systematically neglected from the curriculum of higher education institutions. The aggressive focus on STEM at the national level is manifesting as a loss of funding for other crucial areas, like the humanities (Gleason, 2020) and thus narrowing the scope of what is meant to be a broad and liberal education. The liberal arts model aims to prepare responsible citizens capable of working in interdisciplinary and intercultural contexts, and its method of educating the whole person has been recognized around the world (Mou, 2020). At the cultural level, if American universities continue to disinvest from a broad engagement with the human experience, they should expect to see a commensurate stagnation in the output of life changing technologies, history making discoveries, and quality of life improving advancements, because all of these outcomes rely on the combination of a diversity of knowledge.

Moreover, no one knows what that diverse set of skills and knowledge needs to be composed of in the beginning. Success or failure in critical problem-solving moments may illuminate specific shortcomings and lead to further expansion of knowledge, but as a foundation, one that is broad, and includes a wide range of knowledge, should provide better chances for success across various contexts.

**Behavioral Research**

There are a number of ways in which one could apply research findings to support the liberal arts approach to higher education. The scientific literature on learning, education, and psychology are broad and deep, but one area of practical value is behavior analysis. The research
in this area utilizes methodologies that produce highly effective behavior changing interventions. A key aspect of the behavior analytic approach to behavioral research is collecting data at the individual level repeatedly over time, meaning data are not aggregated across multiple participants. Rather, these findings contain the moment-to-moment observations of individuals, their behavior patterns, and deliberate changes in the social and physical environment that influence those patterns. The benefit to this approach is a focus on the observable and manipulable elements of an organism’s environment. Changing an individual often seems difficult, but changing their environment may be much easier. Then the effects of the environment on the individual can be realized.

Creativity has been approached by behavior analysts from a pragmatic perspective and shares some key features with problem solving. Behavioral research on creativity and problem solving regularly demonstrates the involvement of multiple component skills and behaviors (Kubina et al., 2006; Williams, 2021). In behavior analytic research, creativity has been conceptualized as specific patterns of responding to complex situations with novel and useful combinations of behaviors. Behavior analysts approach creativity as a class of behaviors, rather than a descriptive quality. Creative behaviors are treated as operants, or functional relations, that are composed of an antecedent event or circumstance, a response (behavior), and a consequence (reinforcement, extinction, or punishment) that changes the probability of the behavior occurring (increase or decrease).

The study of operant creativity has emerged from a variety of experiments examining disparate activities and behaviors. Glover and Gary (1976) delivered contingent reinforcement to fourth and fifth grade students during a game in which they were asked to provide as many novel uses for an object as they could. The children’s responses were analyzed along four dimensions
of creativity as defined by Torrance (1966) including fluency (the number of ideas), flexibility (the variety of ideas), elaboration (the filling out of an idea), and originality (the uncommonness of an idea). Over the course of the experiment each of these dimensions of creative responding was used as the basis for contingent reinforcement during separate phases. In each experimental phase, the dimension of creativity being reinforced showed significant increases, and in the subsequent phase when reinforcement was no longer delivered, those dimensions decreased to baseline levels. The most dramatic effect occurred during the elaboration phase, where the participants responses increased substantially in length and developed multiple steps. Originality was witnessed to be the least responsive to contingent reinforcement with only a slight increase. Taken altogether their results show strong support for the ability to develop creativity through contingent reinforcement procedures.

Similarly, Goetz and Baer (1973) utilized descriptive praise as reinforcement for novel forms of block building by preschoolers. In their experiment they began with a baseline phase in which no contingent reinforcement was delivered and the children built structures with the blocks. In the next phase, reinforcement in the form of descriptive praise was delivered contingent on building novel structures with the blocks. Then during a reversal phase, reinforcement was made contingent on building repetitive forms previously seen during baseline. In the final phase descriptive praise was again delivered contingent on building a diversity of structures. Their results show a distinct pattern where the diversity of forms produced by children increased during the phases of contingent reinforcement for novelty and decreased during the phase of contingent reinforcement for repeating previously constructed forms. Their results demonstrated support that direct reinforcement can be used to increase novel, or “creative” performances.
More recently Bradley and Johnson (2021) used a quasi-experimental case study to demonstrate proof-of-concept for how training and reinforcing the requisite skills to build and use a compass to find magnetic north may lead to their spontaneous combination in a later problem solving test condition. In their study they separately trained participants to magnetize a needle, float a needle on the surface tension of water, and knowledge about the magnetic poles of the earth. In the final test condition, participants were asked to build a device that consistently identified geographic North. Participants who were taught all the requisite skills and knowledge successfully built functional compasses during the test, while those who received a combination of some requisite skills and distractor skills, did not.

In the studies examined thus far, the interest in observable and measurable behaviors and influential factors has been productive in the investigation of creativity. Thus, a behavior analytic approach may be a useful way to analyze how students interact with aspects of the educational environment on an individual level. Such insights may reveal effective strategies to facilitate creativity in higher education.

Behavior analytic research on aspects of creativity is beneficial to draw on for another reason as well. The world is increasingly mediated through technological devices, information exchange, and global interconnectedness. Some of the most impactful technological shifts in our culture over the past several decades have involved the internet and its integration into more and more aspects of our everyday lives. As these technological shifts have advanced to their current iterations as proprietary platforms of social and informational engagement, they have used principles of behavior change to more effectively capture users’ attention and shape their behavior (Vaidhyanathan, 2018, pp 38-43). A deeper understanding of behavior change principles may enable higher education institutions and instructors to harness their power for
more effective teaching strategies as well as enlightening students to their existence and myriad uses in the world.

Defining creativity is a difficult task. Any definition will likely be limited by its domain or context. Creativity is a natural category that is complex and multifaceted, and as such resists universal definitions or clear-cut boundaries. Yet, many behavioral and non-behavioral researchers alike use working definitions of creativity characterized by “useful novelty” (Epstein, 1980; Epstein, 1986; Marr 2003; Kubina et al., 2006; Stein, 1974; Amabile, 1988). In other words, the products of behaviors that are novel and of value to a situation or community. This working definition bears an obvious resemblance to problem solving and the two concepts overlap substantially. The research findings in this section generally conform to this conceptualization of creativity, and this provides a basis for operationally defining novel, useful behaviors and some of their controlling variables.

For example, if a person walks up to a door, turns the knob, and pulls to open it because this response has previously opened doors for them to pass through, but this door does not open, they face a problem. If they continue to emit the same response of turning the knob and pulling to no avail, their behavior does not encounter the previously established reinforcer of access to what lies beyond the door. But if they begin to try different responses like pushing the door, knocking, going around to the back entrance, calling the building manager, or affixing a message to a cat asking a person inside to open the door, one of these behaviors may contact reinforcement. In regards to problem solving, Skinner (1953) described the necessity of emitting a large number of responses when the highly likely response cannot be emitted. This view of problem solving, which relates to the current discussion of creativity, was that it involved behaviors that manipulated the environment to allow the response to occur (Skinner, 1953).
Thus, in the example of the door, it is the many various behaviors one may emit in the attempt to gain access that are necessary to solve the problem. It may take many responses, combined in various forms to succeed. In terms of creativity, the criterion for what is labelled creative in this situation will change depending on who is asked to judge, yet it is likely that only a response that is novel would earn such a label.

In other instances, variability does not contact reinforcement. Much of the educational experience in America involves following the strict prescriptions of curriculum. A multiple-choice test represents a list of problems, each with only one correct solution, and one opportunity to provide it. When a student is told to learn a list of facts for later testing, variability of responding is not rewarded, in fact in these instances it is likely punished. Yet in the academic experience, this isn’t necessarily a negative outcome. Many discrete facts and bits of information pertaining to a domain need to be reliably reproduced on command (i.e., memorization), so that they are available on such tests. All of that information is also important because knowing it sets the occasion for combining it appropriately in a situation.

Variations in behavior are a necessary part of creativity (Campbell, 1960; Neuringer, 2003), and understanding how to influence them will aid in the training of students in creative problem solving. The selectionist perspective of behavior is dependent on variations in behavior just as natural selection is dependent on variation in genes (Skinner, 1981). This variety of behaviors may be beneficial if an individual encounters a situation in which their initial response in a novel situation is unsuccessful (i.e., does not contact reinforcement).

Similar to the evolution of species over many generations, behavior change is a process of variation and selection (Skinner, 1981). Many different behaviors are exhibited by an individual (variation), and the consequences of some of those behaviors increase or decrease
their occurrence over time (selection). The selectionist perspective was one of B.F. Skinner’s major contributions to the science of human behavior and offers a useful way to think about how behaviors change over time. Humans exhibit an enormous range of behaviors in seemingly endless combinations. Creative problem solving is a skill that is a highly valued outcome of higher education. So, what insights on the influences of variability in problem-solving behaviors can be learned from behavior analytic research?

Behavior analysts have investigated variability as a dimension of behavior that is measurable and controllable. Pigeons, porpoises, children, and young adults have all been the subject of experiments that successfully increased the variability of their behaviors (Neuringer, 2003). The crucial experiment in operant variability was conducted by Page and Neuringer (1985). It involved pigeons pecking two response keys (L and R) for food reinforcers. These subjects were required to peck the two keys in sequences of 8 pecks that differed from the last 50 sequences to receive the reinforcer. This is what is known as a lag schedule. So, if a subject pecked a sequence of LLRRLLRR, the reinforcer was only delivered if that sequence differed from the previous 50 sequences. During the experimental phase in which reinforcement was contingent on emitting novel sequences, the subjects’ response sequences quickly became highly variable. When the reinforcement demands changed to be noncontingent on their variability but delivered at the same frequency and pattern as the previous phase, the subjects’ response variability decreased dramatically and remained low. The researchers then reversed phases back to the experimental condition with contingent reinforcement, and responding again reached high levels of variability. Finally, a noncontingent phase was implemented again, and the variability of responding decreased again. The reversal design of the experiment from contingent to noncontingent reinforcement, and the subjects’ pattern of responding that changed as a result,
strongly suggests that variability is an aspect of behavior that is sensitive to contingent consequences. The results of the study also show that it is possible to generate very high levels of variability with such contingencies. When the subjects’ sequences were compared with a random number generator used to simulate sequences, results showed that nearing the end of each experimental phase when variability was highest, the variability of the subjects responding was nearly as random as the simulation. Because of the effective experimental reversal design and the strength of their results, this was the first experiment to demonstrate such clear and strong results of operant variability.

The results supporting the operant nature of variability have been confirmed by later experiments as well (Machado, 1989, 1992, 1997). Using a different participant population, Galizio et al. (2020) studied the effects of using a lag schedule to promote variable play in children with autism spectrum disorder (ASD). One of the characteristic criteria for diagnosing individuals with ASD is the display of restricted and repetitive behaviors (American Psychiatric Association [APA], 2013). In this experiment, participants received contingent reinforcement for meeting variability criteria in their play behaviors. Their results demonstrated again that behavioral variability can be increased with contingent reinforcement, even in individuals with ASD who previously displayed very repetitive patterns.

Another aspect of variability contributes to its complexity and relevance to creativity. Cherot et al. (1996) compared the effects of reinforcing variability with the effects of reinforcing repetition. What they found across both rats and pigeons were two simultaneous effects of reinforcement on variability. Reinforcement contingent on variable responses increased the overall level of variability, but as individual reinforcers were approached in time, the probability of variable responding decreased. In other words, when a reinforcer was contingent on a
sequence of different responses leading up to it, the later responses in the sequence were more likely to be repetitive than the earlier ones. This complex effect may have implications for how variability contributes to creativity. If proximity to a reinforcer reduces the probability of variable responding, but rewarding a variety of responses increases the likelihood of variation overall, an educational environment designed to produce creativity may require a responsive system of reinforcers. At the very least it would require instructors interested in training creativity to be keenly aware of how they are reacting to students’ response patterns over time. For instance, an instructor who is using reinforcement to increase variability in responses during a problem solving exercise should consider an intermittent reinforcement schedule to mitigate the anticipation of rewards. They may also benefit from recording data about variability so they are not mislead by small patterns of repetition immediately preceding the reinforcer. This also suggests that observation and recording of data related to students’ response patterns should go beyond the usual percent correct scores of assignments, quizzes, and exams.

Emitting many different behaviors in the face of a challenging problem produces a large group of potential solutions. The particular circumstances of the problem itself will determine the most useful solutions, but sometimes the solution may require a combination of several responses. Epstein and colleagues (1984, 1985) succeeded in training multiple component behaviors in pigeons, and then presenting them with a challenge that required a combination of those behaviors. The pigeons were trained using contingent reinforcement in separate sessions to push a box to different points, to stand on the box, and to peck a small fake banana. Each component behavior was trained through a process called shaping, wherein reinforcement is delivered for successive approximations of the terminal behavior. So to start, reinforcement may be given for any move toward the box. When the pigeon is consistently moving toward the box
reinforcement will then only be given for touching the box. Finally, when this pattern of behavior is consistent, reinforcement may only be given when the pigeon actually pushes the box in the right direction.

After each of the component behaviors was successfully shaped the pigeon was placed in a chamber with the same banana affixed to the ceiling and a box present. In the culmination of the experiment the pigeon, in this new context, successfully pushed the box under the banana, climbed the box, and pecked the banana. Importantly, this sequence of the behaviors was untrained and occurred spontaneously when the pigeon was placed in the final test chamber for the first time. It suggests that the spontaneous interconnection of repertoires is a natural result of when those repertoires have been previously acquired, and new contingencies necessitate their occurrence together to contact reinforcement. Epstein’s initial experiment was a replication of a much older experiment by Kohler (1925) in which chimpanzees who solved a similar problem were said to show ‘insight.’ Epstein’s findings suggest that rather than requiring a construct such as insight, creative problem solving in non-human’s may be explained by non-mentalistic aspects of behavior. The spontaneous combination of established behaviors happens frequently and as a result of the contingency requirements of a new situation to produce reinforcers.

Contingency adduction is a similar behavioral concept used to describe how novel performances composed of previously shaped behaviors form spontaneously to meet the needs of new contingency requirements (Andronis et al., 1997). Importantly, these combinations of behaviors are not an act of selection by the organism but rather the product of the new circumstances and their requirements to contact reinforcement. For example, if a child is separately trained to draw pencil lines that mimic an object, trace pencil lines with pen, and color within pen lines of a picture and is then presented with a situation in which only the combination
of these skills will be rewarded, it is highly probable that the child will now sketch, ink, and color a picture of the object. If the new combination of responses is reinforced, this first reinforcement is the moment of adduction. This arrangement of consequences to require a combination of previously learned behaviors is the cause of such novel, useful performances.

The deliberate process of training component skills and providing opportunities for combination (adduction) is the basis of generative models of instruction. Direct Instruction (Engelmann, 1969; Slocum & Rolf, 2021), The Morningside Model of Generative Instruction (Johnson and Layng, 1992), and Headsprout Early Reading (Layng et al., 2004) are instructional models that structure curriculum and delivery based on the previously discussed aspects of combinatory behavior processes. In these approaches to teaching, complex academic tasks and knowledge are broken down into component skills and units. These component skills are then taught to a level of mastery called fluency, that is characterized by being able to perform the task accurately and rapidly even after long periods without practice (Binder, 1987; Haughton, 1972). This degree of automaticity in skills means that they are available in new contexts, under different contingencies, to be combined with similarly fluent skills. The child who has learned to create colorful pictures and write descriptive sentences fluently may readily combine these skills to make picture books about their daily life.

Johnson and Layng (1992) thoroughly explicates the Morningside Model of Generative Instruction (MMGI), in which the scientific methods of behavior analysis are directly applied to the teaching of students. The instructional processes involved in this model include: Establishing (accuracy training), Remembering (fluency building), Enduring (endurance building), and Applying (new environments, more complex skills). These processes are steps that can overlap or run concurrently, but the terminal goal of true mastery is the product of the steps. Students’
skills and knowledge are assessed with *precision placement testing* (Johnson, 1992) that covers a range of academic skills broken down into *units*. Each unit is further divided into a series of *steps* composed of simpler, component skills. These steps are composed of *slices* that correspond to items on the precision placement test. Each slice is taught in small, highly interactive, instructional episodes where students respond to the instruction, on signal, and at a high frequency rate. This rhythmic back and forth between instructor and students is designed to encourage accurate and rapid responding beyond typical classroom requirements where a student who accurately answers only a few questions may be deemed to “know” the information. In this way the most basic elements of more complex skills are built, piece by piece. For example, in order to build fluency in oral reading, one must be able to pronounce words and sounds quickly, and to write compositions, one must be able to write letters, words, and sentences.

The instructional design continues building simpler, component skills to fluency in this way, across a variety of areas. As students progress to more advanced, *composite* skills they are periodically tested on previously trained skills to ensure their endurance. The goal of mastery requires that students can apply those skills in various contexts. So students who demonstrate fluent, accurate responding after periods of no practice are challenged to apply the same skills in new environments to ensure that they effectively generalize across contexts. This might look like a student engaging in a public oral debate with an instructor after having demonstrated their ability to identify logical fallacies in long texts.

This pattern of train, test, and retest after a period without practice happens repeatedly and allows for different subject matters to be pursued concurrently. An important aspect of this instructional method is that all of these data generated by student activities are collected in cumulative records, allowing instructors to engage with individual students responsively. Instead
of students needing to feel worried about falling behind when they are not acquiring new skills as quickly as others, they are able to be moved between various groups of students with similar skill levels to pursue fluency in the skill. This means that student groupings are based on skill levels in multiple domains and change frequently, rather than the division of traditional grade levels based on the structure of curriculum.

To transfer the insights of this model of instruction and its process of building relations between component and composite skills to the university setting, consider the skill requirements of a senior thesis. A student acquires certain skills to fluency in various classes such as writing skills acquired in English composition, knowledge of psychological phenomena and processes acquired in Psychology coursework, statistical analysis skills acquired in experimental statistics courses, and data collection and analysis skills acquired in discipline-specific lab coursework. Then they are presented with the requirement to combine these skills in a thesis project of their choosing. Considering the research on adduction examined above, it is likely that only a thesis subject that requires an interdisciplinary approach will necessitate all of the example skills mentioned, but even a relatively narrow subject will require a student to apply skills learned in one academic discipline or context to a new discipline or context. This ability to successfully apply skills learned in one area to a different area, relates to the behavior process of generalization.

In addition to increasing variability through operant techniques and training component skills that may be combined to form composite performances in new contexts, behavior analysts have also investigated the process of generalization of behaviors and responses. The process by which a trained skill in one context transfers to a different context, or a different set of stimuli, is known as generalization. In generalization, a particular, trained behavior occurs under different,
non-trained circumstances (Stokes and Baer, 1977). Many aspects of the circumstances can change, such as the setting, stimulus, contingencies, behaviors, or time. Importantly, generalization is said to have occurred when a person behaves similarly in a different untrained situation. Generalization can occur in either the stimulus or the response. In stimulus generalization responses are only reinforced in the presence of one stimulus, but may also occur in the presence of similar but different stimuli. Response generalization occurs when, given a similar training history, similar but different responses are evoked by the same stimulus that was paired with reinforcement during training (Johnston, 1979). So if a student is taught how to compose an argumentative essay in an English composition course, and then composes an argumentative essay in a history course their composition skill can be said to have generalized across settings. Or if that student was trained to write expositional essays, but then produced an untrained argumentative essay they have displayed response generalization.

An early review of the applied behavior analytic literature on generalization by Stokes and Baer (1977) has been followed by decades of research on how to most effectively promote generalization through the use of specific techniques. One technique that Stokes and Baer refer to as train sufficient exemplars has been implemented in the form of multiple exemplar training (MET).

In MET critical and non-critical features of the sample stimulus used in training are identified so that the non-critical features can then be systematically varied during training. When combined with reinforcement for correct responding this procedure can create a relationship between the critical features and the reinforcement so that non-critical features can change but correct responding still occurs and the ability to generalize is promoted. For example to train a child to identify a car you may start with a picture of a car, but to ensure that they are
able to identify an entire class of objects known as “car” it will be necessary to train them using pictures of cars in various colors, shapes, brands, sizes, settings, and artistic forms. If one wishes for them to understand the category of “car” as not being limited to only pictures, then incorporating actual cars, line drawings of cars, toy cars, and other car related stimuli will improve the probability they will do so. MET procedures have been implemented by researchers to produce generalization of a variety of skills such as imitation (Garcia et al., 1971), conversation (Garcia-Albea, et al., 2014), vocational skills (Horner & McDonald, 1982), sharing (Marzullo-Kerth et al., 2011), and helping (Reeve et al., 2007).

Song et al. 2021 used MET procedures to clarify the relationship between features of stimuli and reinforcement in the generalization process. Two groups of participants received MET with stimuli whose noncritical features had either a high correlation or low correlation with reinforcement. Three made up words (zop, vek, and dax) were used as targets and visual stimuli consisting of block arrow outlines served as exemplars. The arrows were characterized by three stimulus features: rotation, color, and quantity of dots located inside the shape. Rotation was the critical feature, so all the arrows of each respective class were oriented similarly. For example all of the arrows associated with zop were displayed at a 45 degree rotation regardless of what color or amount of dots were present. The experimenters then trained participants to associate a particular orientation of the arrow with its correct word (i.e., zop for 45 degree orientation). However they programmed the training so that the high correlation group received exemplars whose noncritical features (color and amount of dots) were very frequently the same. Their results showed that the participants in the low correlation group (only the critical feature was highly correlated with reinforcement during training) displayed a more rapid acquisition of the matching response being trained and less variability in their responding. This suggests that their
training was more effective and efficient when the noncritical features of their training stimuli were evenly varied.

From the extensive literature on MET and generalization it is apparent that whatever skills one wishes to train in students, it will be necessary to have procedures in place that effectively train those skills to be applied in novel circumstances. By effectively training component skills and knowledge with sufficient exemplars, and in various settings or contexts, the ability of students to apply these skills in novel situations is likely to be greatly enhanced. This insight contributes to the pattern of literature reviewed in this paper that suggests behavior analytic research on basic behavioral processes and learning support the overall approach of a liberal arts education. By training broadly across various disciplines, and deeply in areas of core interest to particular majors, students’ ability to creatively combine the various components of their education is maximized. Furthermore, since the exact component skills and knowledge of future, novel problems cannot be perfectly anticipated, the liberal arts orientation toward lifelong learning and educating the whole person should be conducive to students’ continued success in life as they perpetually investigate and master new domains.

Finally, the selectionist perspective of behavior analysis enables insights at three levels: phylogeny (genetic variation and selection through evolution of a species), ontogenetic (behavioral variation and selection over the lifetime of an individual), and cultural (individuals contribute to a group-level collection of knowledge, and the group selects the most useful knowledge and practices to retain). Selection at a cultural level is salient to the matter at hand, because as the goals, values, and incentives of the group change, so does its criterion for selection of individual performances it considers desirable. If the environment-behavior relations at the group level are defined by commerce, profit, competition, and accumulation of wealth, the
group’s criterion for selection of desirable behaviors will be shaped by these forces. The value of behaviors unrelated to these factors will likely decrease, and they will diminish in proportion.

**How Behavioral Research Findings Support the Liberal Arts Paradigm**

By applying a selectionist perspective to the issue of creativity, behavior analysts have identified effective strategies that facilitate the teaching of creative behaviors like problem solving. These insights have been usefully applied to learning environments to great effect, and may also provide empirical support for the enduring rationale of a liberal arts approach to higher education. What some describe as *genius* or *brilliance* may be more usefully explained as an unobservable interconnection of behaviors previously trained to fluency that culminate in a complex performance that is highly valued by an interested community defined by their involvement with the problem, medium, or related spheres of knowledge. There are always outliers who seem to have unexplainable natural capacities for acquiring highly complex behavioral repertoires with very little training, but as the research above has demonstrated, there are effective strategies for achieving substantial improvements of skills in most people.

The system of institutions that make up higher education in America may be usefully analyzed through a group-level selectionist lens. As we have seen these institutions shaped by the influences of free market capitalism, technological advancement, and a neoliberalist push for less governmental regulations, we have watched them change their criterion for selection of behavior towards those ends. STEM has become the mantra of an increasing number of universities in America, and domains not valuable in the service of career preparation have generally been left to languish.

The inherent value of a broad base of knowledge is derided as a luxury of the rich or impractical for survival. Yet, this singular focus on economic viability suffers from the myopia
of greed. It fails to acknowledge that profound advancements in any area are the product of a myriad of influences from many spheres of knowledge. Cultural stagnation, like depression, is a problem created by stereotypic patterns of behavior and an inability to shift perspectives. Those alternate perspectives can only exist through the early introduction to and maintenance of a broad range of knowledge.

If stakeholders in the higher education arena wish to adequately prepare students for an uncertain future they may greatly benefit from a deeper understanding of behavior analytic tools and insights. Carson (2022) articulates a vision of how to rethink the Bachelor of the Arts degree to better prepare students for the uniquely precarious world they face. Several elements of his proposition provide an opportunity for synthesis with behavioral education approaches.

First, abandoning traditional rubrics and learning outcomes may be successfully accomplished by focusing more on generative learning principles including training to fluency and providing continuous opportunities for generative outcomes. Courses and milestone projects whose expressed purpose is the combination of knowledge and skills from multiple domains may provide such opportunities. Furthermore, the organization of undergraduate degree programs could be modified to accommodate students’ interests in big picture problems and contemporary issues that could be used to guide their course selection across disciplines. Some prestigious universities already require such integrative projects of their undergraduates, like Princeton’s Senior Thesis (Princeton University, 2023).

Second, Carson calls for undergraduate education to become transdisciplinary. This is a far stretch from its current disciplinary orientation, and the distinction between interdisciplinary and transdisciplinary modalities is fuzzy. yet both prescribe an approach to learning that begins with engaging problems of the time and drawing on all available domains of knowledge. This
would reiterate giving a degree of self-determination to undergraduates to choose broad areas of interest that can guide their degrees in more personalized ways. This self-directed course selection already exists in the form of electives within degree plans, but by integrating interdisciplinary and transdisciplinary approaches at the university level logistical hinderances can be analyzed and resolved towards these ends. This may also be effectively accomplished by more efficient training in the component skills and knowledge that lead to creative solutions.

Lastly, making higher education a narrative learning experience would encourage students to connect their life experiences to their education, making for a more personal and intimate experience of learning about the world. This could include teaching students fundamentals in science via self-experimentation. Behaviorist principles can be used by individuals as a form of self-management (Wallace & Pear, 1977; Hickman and Geller, 2005). Self-observation, collecting data, experimentally manipulating variables affecting ones’ own behavior, measuring and analyzing the effects may all contribute to changing how students understand, and talk about, the causes of their behavior. Synthesizing the humanistic, narrative approach to self-understanding with behavior analytic methodologies would represent an operationalization of the interdisciplinary ethos. This may provide an occasion for interconnection of repertoires that include personal narrative and academic knowledge in ways never before realized at the university scale.

In summation, if we are to effectively redesign, or otherwise modify, current undergraduate education to better prepare students for their place in an uncertain and rapidly changing world, the insights from behavioral sciences on creativity can provide the evidence-based foundation for such an endeavor. As the behavior analytic research examined above has shown, creative problem solving requires a wide range of component skills and knowledge.
Moreover, it is exceedingly difficult to know which component skills will be required by novel circumstances one has yet to encounter. So, by training students in a diversity of skills and knowledge and cultivating their ability to move between domains, their ability to effectively adapt to new situations throughout a lifetime will be enhanced, thus ensuring they are future-proof regardless of specific career choices. The success of Steve Jobs to innovate paradigm changing products and systems during a time of rapid technological advancement may be due in large part to his diverse repertoires outside of the obvious industry specific skills that pertain to computing. His creative ideas for products like the iPod, that changed how the world consumed music, would not have been possible without his particular life history and a combined interest in the humanities as well as technology. The future is just as uncertain now, but that is a reason to expand our notions of what skills and knowledge will be necessary for success, not narrow it. If Carson’s (2022) claim proves correct, and undergraduate degrees that train students for specific careers become obsolete in the near future, those institutions that have structured their curriculum around generative learning principles and behavioral education stand the best chance of effectively training creative students capable of adaptability and success.
REFERENCES


https://admission.princeton.edu/academics/senior-thesis


**VITA**

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