

## **IMPACTING COMMUNITY SUSTAINABILITY THROUGH BEHAVIOR CHANGE: A RESEARCH FRAMEWORK**

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**ABSTRACT:** The need for “sustainability” has encouraged a variety of disciplines to consider ways to reduce the impact of a given community on the environment around it. Approaches can range from changing the behavior of a few people to completely restructuring the communities in which people live. Interventions in the larger system of a community provide potential for larger levels of change. How to do this has yet to be fully evaluated, especially from the perspective of people's behavior interacting within a community environment. The behavior analysis literature provides many individual level interventions, such as contingency management programs and empirically evaluated “kernels” (Embry & Biglan, 2008) across various populations and behaviors. The current paper argues that these provide a starting point for working with other sciences to change the environment, impact the cultural practices of people in the community, and promote sustainability. An overview of the current literature is provided along with various models for application of these interventions to larger communities.

**KEYWORDS:** sustainability, kernels, large-scale implementation, communities

Recent reports by leading earth and climate scientists (Day, Hall, Yanez-Arancibia, Pimentel, Ibanez-Mart, & Mitsch, 2009; Hansen & Sato, 2011) indicate that global warming is making resources needed for human survival more scarce and climate changes are accelerating. The evidence is clear that sustain-

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ability of habitats fit for humanity, as we now know them, are increasingly threatened by climate changes. These changes are in part driven by human activities. Several sciences have focused research agendas on “sustainability.” The term “sustainability” is increasingly used in the context of creating efficient products, buildings, transportation and cultural practices. The most common definition of sustainability relates to the features of a practice or product that meet the current needs of the population while not hindering the ability of future populations to meet their needs (World Commission on Environment and Development, 1987). Thus, the concept of sustainability goes beyond the lifespan of an individual to include consideration of the needs of successive generations.

Variations in the definition range from continuing current economic growth and consumption within somewhat weak boundaries, to strong limits on growth that halt expansion and conserve resources for future generations (Bond & Morrison-Saunders, 2011). For instance, at the policy level, movement toward the deregulation of industries like mining and oil (Environmental Protection Agency, 2011a, 2011b) provides an example of weak sustainability. Such policies permit these industries to continue production to meet consumer demand for established products instead of focusing on development of different technologies (i.e., wind and solar). Grant (2010, 2011), on the other hand, argues for reinvention of culture to a steady-state economy living within sustainable bounds. This entails much more than shaping consumption towards greener alternatives; he advocates fundamental behavior changes away from consumerism and materialistic lifestyles to resource-light lifestyles focused on leisure, culture, and pursuit of sustainable reinforcers. In a similar approach, Bostow (2011) recommends self-management to establish reinforcement of actions that reduce an individual's carbon footprint as a method to address global warming at a personal level. This paper does not evaluate the merits of those points of contention concerning weak or strong sustainability, as the topic is vast and covered more effectively by those in economics, political science, and environmental sciences.

As is demonstrated by the weak versus strong discussion, sustainability can be studied and interventions applied at a variety of levels, with various targets and with different expected outcomes. The scope of this paper primarily focuses on targeting sustainability at the level of communities with the assumption that the boundaries and definition of a community are fluid. For example, a community can be centered on various boundaries of geography such as a neighborhood, city, country, etc., or it can be centered on similar stated rules and values such as clubs (i.e., Rotary clubs) or temporary communities such as Burning Man (<http://www.burningman.com>). Therefore, this paper takes both the perspective of worms and eagles (Sulzer-Azaroff, 2000) as a means to link individual behavior

change to an issue that requires large-scale outcomes, such as is possible by targeting community sustainability.

### **Sustainability and Other Disciplines**

Physical and structural development and re-development of sustainable cities provides a place for environmentally friendly and community-oriented behaviors to be shaped. Creating cities and communities that are “sustainable” has primarily been approached from the technological and architectural perspective. The U.S. Green Building Council (2011), for example, is a non-profit organization with the mission of promoting energy efficient green buildings. They utilize the LEED (Leadership in Energy and Environmental Design) accreditation program to measure the sustainability of a construction site, materials and resources used to build structures. They evaluate efficient use of water, energy and other green technologies by the building’s occupants, pollution of air by residents, access to the community, and other region-specific measures (U.S. Green Building Council, 2011). The U.S. Green Building Council (2011) promotes sustainable building practices through a voluntary certification program of optimal design. Another organization, the Green Highway Partnership (2010) outlines standards for developing green infrastructure for transportation, specifically in storm water management, recycling and ecosystem protection.

Researchers in urban planning, engineering, architecture, geography, and other disciplines are engaged in analysis and design of sustainable communities. Research targets include changing infrastructure to promote efficient and environmentally friendly transportation systems (Johnson & White, 2010; Mihyeon Jeon, Amekudzi & Vanegas, 2006; Oswald & McNeil, 2010) and re-development of urban housing (Winston, 2009). A common concern voiced by these researchers (Oswald & McNeil, 2010; Winston, 2009) is the need for measures and indicators to evaluate effective practices that promote sustainable infrastructure. A visitor to New England, for example, may see that the textile mills along the banks of streams that produced textiles during the early years of the American Industrial Revolution have gone through a series of redevelopments. After serving as sites for textile or shoe manufacture, these mills were transformed to manufacture other products (e.g., the jewelry industry in Rhode Island) and more recently transformed again into design studios, software companies, and retail stores. These redevelopments, over a span of 100 plus years, re-used old infrastructure, reduced pollution, and sustained commerce and communities within the geographic boundaries of New England. Note that sustainability can be viewed from multiple perspectives in this example. One can view the populations of these towns as sustaining their lifestyle by adopting new

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types of commerce within the geographic limits of their borders. One can also view the sustainability of the textile industry as it migrates from manufacturing sites in New England, then to the southeast of the USA, and then to Asian factories. What metrics enabled this planned development across generations of citizens? What is missing in other communities that became ghost towns when the initial economic base passed and no replacements developed? For example, Virginia City, Nevada was a boomtown based on mining silver from the Comstock Lode in the late 1800's. At its peak, this town had 30,000 residents. After a few short decades, the silver played out and most residents left. Today, Virginia City is home to about 1,500 residents (5% of the peak population) who live and work in a re-enactment of the heyday as a small-scale tourist attraction. The histories of these places are worthy of study as they reveal how the residents of these communities reinvented themselves within the constraints of their resources or faded into history. A perspective on the sustainability of industries is needed, as well as factors that support survival and/or migration of businesses in communities.

Creating a sustainable system is likely to require iterations of a sustainable process as stepping-stones to some optimal design. If the current configuration is exhausting available resources, this becomes an urgent matter. For example, measuring the extent of a community's reliance on other communities for water, food, electricity, etc. is vital for maintaining a sustainable system and defines the challenge of those communities in terms of their growth and limits. In southern Nevada, for example, Las Vegas consumes more water than can be replenished by nature (Las Vegas Sun, 2011). The only option for sustaining Las Vegas as it currently exists, is to divert water from the Colorado River, which also feeds other communities. Contentious debate is occurring over the needs of farmers, ranchers, and conservationists concerned about the consequences if Las Vegas increases its water consumption. Eventual solutions might range from efforts fitting a weak sustainability approach (e.g., slow the rate of increase in water consumption, increase conservation and allow more expansion) to strong sustainability (e.g., cap consumption, increase conservation and halt expansion). Here too, the boundaries of a community are essential for planning sustainability efforts. How one defines the community (e.g., Las Vegas, southern Nevada, southwestern USA) dictates the range of options from fairly local considerations to regional or larger issues.

Through a series of workshops stemming from the National Institute of Public Health and the Environment in the Netherlands, Bossel (1999) proposed a systems approach to evaluate and measure sustainable development that gives perspective on the problem of unregulated growth. This system's approach

defines several subsystems in a community. The first subsystem is the foundation of communities, including infrastructure like transportation, utilities, schools, recreational facilities, and market places. The second is the social system, which includes cultural diversity, employment options, prevention and treatment of social problems, and other aspects of a quality lifestyle. It includes citizen participation in government and non-governmental organizations that regulate roads, buildings, water, electricity, energy distribution and so on. A system with broad span is the economic system including banks, trading across regions, employment, production and consumption. Finally, there is management of resources and the environment including waste disposal, recycling and building efficiency that define the ecological footprint. Bossel's (1999) subsystems provide indicators of the viability of the community and its leadership that can be used to guide refinements and growth.

Note that a desert city like Las Vegas includes all these subsystems. Together they demand resources from the environment (like water) needed for the city's existence. Households, agriculture, industry, schools, golf courses, casinos, hotels and more must share the available water supplies. Within each of these subsystems are ample interventions and research opportunities around sustainable community development. Ultimately the dwindling water supplies in Lake Mead and the water table will dictate if weak or strong sustainability approaches are required in Las Vegas. Given that climate predictions (Karl, Meillo, & Peterson, 2009) for the southwest of the US are that it will become drier and hotter with increased global warming, one can anticipate that communities like Las Vegas have reached their growth limit. A relevant question is will this community act in time to plan limits to growth or will this occur as a dire emergency? A feature of global warming is increased variability in climate. For a place like Las Vegas, a challenge is to maintain a cushion in the water supply such that sufficient resources are available to carry the community through the inevitable droughts that will occur with increasing frequency and severity.

There are few studies on sustainability of communities, especially ones that include how human behavior is affected (and affects) the physical, engineering and architectural modifications. Codoban and Kennedy (2008) proposed measuring sustainability by using the "metabolism of neighborhoods" as a metric. "Metabolism" included inflow and outflow measures such as average household estimate of resources consumed in the buildings' operations, preparation and consumption of meals and beverages and transportation needs of the residents. Inflows to the neighborhood are the water, food, electricity and fuel, and the outflows are solid waste and wastewater and atmospheric pollutants and greenhouse gases. These metrics depict the effects of behavior upon the

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environment, evaluate the neighborhood's sustainability and indicate where improvements are needed. They do not, however, provide insight about how to change those behaviors.

These other sciences identify important variables at levels of analysis above that of the individual which either negatively or positively impacts the "health" of a community. Collaboration with other approaches provides behavior analysts with potential linkages to important aspects of sustainable communities (Bossel, 1999) such as organizational and community structures that promote efficient use of resources, purchasing and investments, community participation in governance and other actions beyond an individual's personal "green behaviors". Leading scientists in other disciplines like earth science (Thompson, 2009, 2010) and zoology (Wagner, 2009) appeal to behavior analysis as an important contributor to shape the human response to environmental change. They challenge the field to contribute soon to very large-scale interventions while there is time to make a difference.

### **Sustainability and Behavior Analysis**

Behavior scientists are becoming increasingly engaged with climate change and the human activities involved in preventing further environmental damage or restoring damaged eco-systems. Within psychology, social psychology, environmental psychology and behavior analysis, one finds a rich conceptual and empirical base related to the problem (Bostow, 2011; Grant, 2011; Newsome & Alavosius, 2011). Behavior analysis is particularly noteworthy for interventions that making lasting, durable changes across a variety of responses, settings, and populations (Sulzer-Azaroff, Mayer, & Wallace, 2012). Most of the applications of behavior analysis are done in the context of improving socially important behavior within schools, clinics, businesses, and communities. Sustainability from the perspective of human behaviors' impact on the environment and climate change is not emphasized but the approach and literature base provide a sound foundation for research and applications to that problem.

### **Contingency Management**

Recently, there has been a resurgence among behavior analysts in promoting environmentally relevant behavior and community sustainability. Abrahamse, Steg, Vlek, and Rothengatter (2005) reviewed 38 studies of interventions to promote household energy conservation. They report that a combination of antecedent and consequent manipulations was most effective for decreasing energy consumption but also that maintenance of effects is a challenge yet to be

surmounted. A special section of *The Behavior Analyst* (Heward & Chance, 2010) proposed a number of solutions including a database to list environmentally friendly products to guide consumer choice (Layng, 2010), behavior management techniques typically used in treating procrastination to encourage environmentally friendly behavior (Malott, 2010), and various forms of technology to increase green behavior (Pritchard, 2010; Twyman, 2010). Additionally, Nevin (2010) and Neuringer and Oleson (2010) discuss the value of creating social networks encouraging cooperation by members of the community to engage in green behaviors. Nevin (2010) pointed to Martha's Vineyard, Massachusetts, and Samso, Denmark as examples of communities that strive to be self-sufficient by empowering residents to cooperate. Citizens attend local meetings to share ideas about alternative energy products and collectively choose those ideas that support their goals (i.e., install wind farms and decrease energy costs).

Such approaches have merit and perhaps fall toward the weak end of the sustainability continuum, as they seem to accept that high rate consumption of goods and services is a given feature of humans. These efforts re-direct consumption towards smarter choices rather than less overall consumption. These options generally fit within lifestyles supported by a growth economy (Grant, 2011) and may be insufficient to achieve a sustainable planet. Newsome and Alavosius (2011) also note that contingency management programs, while effective, are themselves often not sustainable as the resources to run them are usually finite. As noted by Abrahamse et al. (2005) and Osbaldiston and Schott (2012), the most effective programs involved packages of interventions, such as feedback, monetary incentives, social modeling, etc. Little maintenance data is reported (Abramamse et al., 2005; Osbaldiston & Schott, 2012) in studies to evaluate if the behavior reverted to pre-intervention levels after the interventions ended. These interventions are resource heavy and there is little empirical support that they created lasting change needed for sustainability.

### **Larger Units and Kernels**

More than contingency management of individual behavior toward adoption of greener lifestyles will be needed to promote a sustainable community. Systems-wide change will necessarily involve an evaluation of larger social units to have a substantial impact (Biglan, Glasglow & Singer, 1990; Embry & Biglan, 2008; Sulzer-Azaroff, 2000). Additionally, Fawcett, Mathews and Fletcher (1980) argue that behavioral interventions, especially those being implemented in a community, need to be contextually appropriate and "effective, inexpensive, decentralized, flexible, sustainable, simple and compatible" (p. 508). The

challenge is to create behavior change with large groups of people, evaluate generalization across communities and maintain progress over time.

**Sustainable community research models.** Creating support systems that interlock contingency management elements could be an option to sustained operation at a level needed to affect community wellbeing. Hayes, Barlow and Nelson-Gray (1999) provide a model for systematic development of empirically validated treatments at the individual level that can then be applied to larger units, such as communities. Azrin (1977) described much the same process of programmatic research and provided numerous examples of effective learning-based treatments for problem behaviors developed via this progression from small-scale studies through clinical trials. Azrin (1977) based his interventions on principles of behavior, in particular reinforcement, but found the need to engineer solutions to fit particular populations, settings, and problems. He referred to these various applications of reinforcement as “emergent principles” discovered during search for treatments that reliably produced effective outcomes. Hayes et al.’s (1999) model similarly outlines a research agenda that involves: functional assessment and treatment innovation; time series evaluation; tinkered program evaluation; efficacy testing and program evaluation; and training and dissemination research. Below is a brief outline of each level of the Hayes et al. (1999) model to demonstrate a potential research framework around behavior change to promote sustainable communities.

Hayes et al.’s (1999) model involves a progression of research starting with functional analysis and treatment innovation at the level of the individual. Using single subject or time series study, an intervention is systematically evaluated within a relatively small sample of subjects. Promising results from this initial evaluation lead to a process of tinkered program evaluation, involving slight modifications made to the intervention. Replication and systematic modification of the intervention in other environments and with other participants allows for further technical precision and evaluation of the generalization of the intervention.

Recently, components of this process have led to the development of “kernels” (Embry & Biglan, 2008). Kernels are empirically validated interventions that show a reliable effect during experimental analysis on at least one specific behavior. The kernel is a fundamental unit; therefore removing any component of the kernel would make it ineffective. Understanding these fundamental units of behavioral influence help create empirically validated interventions, aid in dissemination and provide a scheme to understand the essential components in packaged interventions (Embry & Biglan, 2008). Kernels appear similar to Azrin’s (1977) emergent principles in that they describe elements important for the effective delivery of a given intervention in treating a



problem. According to Embry and Biglan (2008), kernels can be organized around four primary behavior analytic processes. The first process is to consequence behavior to increase or decrease the future probability of a behavior. The second manipulates antecedent stimuli to occasion specific behaviors, so that a history of consequences in the presence of stimuli establishes those stimuli as signals for future behavior. The third process involves changing verbal behavior as this alters the effects of contingencies. Finally, the last process involves kernels that affect the biological function of the person (for example progressive muscle relaxation).

The *Journal of Applied Behavior Analysis (JABA)*, as the primary journal for reporting research on applied interventions is an optimal place to look for effective kernels for changing the behavior of people in the community. Table 1 provides a preliminary account of valuable kernels in *JABA* that change behaviors related to promotion of a healthy and sustainable community. Other journals (e.g., *Journal of Organizational Behavior Management*, *Journal of Applied Psychology*, etc.) also offer effective solutions. Kernels could be further elaborated by examination of other journals and with various definitions of what could constitute “community” interventions. At this point, there are numerous kernels with ample research support, such as public posting of graphic feedback (for both increasing and decreasing behaviors) as well as various types of auditory, written and visual prompts to change behavior. Additionally, the table illustrates various dependent variables already targeted, such as safety belt use, recycling, work safety practices, energy and water conservation, community participation and cooperation among others that are directly relevant to the health of a community.

When interventions have gone through the tinkered program evaluation and kernels can be identified, it is then possible to evaluate them in full-scale implementation with a larger population, such as an organization or community. Many interventions that behavior analysts have thoroughly researched provide effective ways to change behaviors and promote community sustainability. This provides a starting point for more systematic applications to organize and structure support systems that could have large impacts on behaviors shown to be important in promoting a “healthy” community. Behavioral applications to occupational safety have reached this level of refinement. The safety interventions offered by behavioral consultants can be viewed as tested packages that include combinations of a few kernels, such as goal setting, feedback, behavioral coaching and reinforcement. After an intervention has been shown effective at the large scale, research then turns to the best ways to train people in implementation and evaluate effective methods for disseminating the intervention to populations

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Table 1. *Overview of Kernels in Behavioral Community Research in JABA.*

Kernel	Description	Behavior Affected	References
<b>Kernels altering consequences of behavior</b>			
<i>Kernels increasing frequency of behavior</i>			
Peer-to-peer praise: notes, compliments	A note from a peer that is given publicly (written or said aloud) or given individually.	Safe driving; safety belt use; reuse dinnerware	Austin et al. (2006); Clayton and Helms (2009); Geller et al. (1985); Manuel et al. (2004)
Public posting (graphing of feedback) of a targeted behavior	Results or products of activities that are posted publicly. Data can be of individual behavior or group behavior.	Drivers yielding to pedestrians; contribution to senior center; sunscreen; reuse dinnerware	Van Houten et al. (1985); Jackson and Mathews (1995); Lombard et al. (1991); Manuel et al. (2004)
Principal lottery	Financial or symbolic rewards given for positive behavior.	Sunscreen; safety belt use; recycling; active safety systems; child immunizations	Lombard et al. (1991); Sowers-Hoag et al. (1987); Witmer and Geller (1976); Geller et al. (1982); Alavosius et al. (2000); Yokley and Glenwick (1984)
Team competition/Group contingencies	Groups compete on a task or performance and reinforcers given contingent upon group performance instead of individual performance.	Safety belt use; recycling; energy conservation	Hagenzieker (1991); Keller (1991); Slavin et al. (1981)
Reinforcement for top performer	Money or social recognition of an	Cooperative behavior	Altus et al. (1991)

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	individual person relative to other members over a given time span.		
Private feedback	Include graphs, written feedback or auditory feedback given individually.	Glove use; safety belt use in cartoons; removing home hazards; safety behaviors; recycling	Babcock et al. (1992); Mathews and Dix (1992); Tertinger et al. (1984); Alavosius and Sulzer-Azaroff (1986, 1990); Luke and Alavosius (2011); Jacobs et al. (1984); Keller (1991)
Incentives	Money, reduced cost or additional time with reinforcing task.	Community participation; litter removal; carpooling; designated driver; recreation membership; obtaining dental work for children	Bunck and Iwata (1978); Chapman and Risley (1974); Jacobs et al. (1982); Kazbour and Bailey (2010); Pierce and Risley (1974); Reiss et al. (1976); Bacon-Prue et al. (1980)
<hr/> <i>Kernels decreasing the frequency of behavior</i>			
Taxes on consumptive behaviors	Percentage of purchase is added to purchase price.	Water consumption	Agras et al. (1980)
Response cost	Removal of a previously available stimulus such as time or services contingent upon noncompliant behavior.	Violation of community recreation rules; refusing sanitation packaging	Pierce and Risley (1974); Stokes and Fawcett (1977)
Law enforcement	Fine or ticket given	Safety belt use;	Hagenzieker (1991);

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fine or citation	contingent on noncompliant behavior.	highway speeding; drivers yielding to pedestrians; cigarette sales to minors	Van Houten and Nau (1981); Van Houten and Malenfant (2004); Van Houten et al. (1985); Lavelle et al. (1992); Jason et al. (1996)
Incentives for low rate behavior	Money or some other reward contingent upon low rates of behavior.	Gasoline consumption; electricity consumption	Foxx and Hake (1977); Hayes and Cone (1977)
Principal lottery for low rate behaviors	Financial or symbolic rewards given randomly for low rates of behavior.	Mileage	Foxx and Shaeffer (1981)
Private, specific feedback	Graphs, written feedback or auditory feedback given individually.	Energy/electricity consumption; police vehicle accidents	Hayes and Cone (1981); Hayes and Cone (1977) Palmer et al. (1977); Larson et al. (1980); Winett et al. (1979)
Public posting (graphing of feedback) of a targeted behavior	Results or products of activities that are posted publicly. Data can be of individual behavior or group behavior.	Highway speeding; elevator use	Van Houten and Nau (1981); Van Houten et al. (1980); Randarsson and Bjorginsson (1991); Van Houten and Nau (1983); Van Houten et al. (1981)

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### **Kernels affecting behaviors primarily via antecedents**

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Non-verbal transitional cues	Visual, kinesthetic and/or auditory non-verbal cues to change behavior in	Purchase returnable bottles; designated driver; recycling; reuse of dinnerware;	Geller et al. (1973); Kazbour and Bailey (2010); Ludwig et al. (1998); Manuel
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	a patterned way with praise or occasional rewards.	use of condoms; adherence to traffic lights; reduction of jaywalking	et al. (2004); Honnen and Kleinke (1990); Jason et al. (1985); Jason and Liotta (1982)
Boundary cues and railings	Lines or other cues that indicate where behavior is acceptable or desired.	Recycling; motorist and pedestrian conflict	Brothers et al. (1994); Jacobs et al. (1984); Huybers et al. (2004)
Peer modeling	Video or in-person model engaging in the targeted behavior.	Sunscreen use; dormitory noise	Lombard et al. (1991); Meyers et al. (1976)
Auditory verbal prompt	Auditory verbal prompt given to indicate desired and/or undesired response.	Safety belt use; community participation; litter removal; bike helmet use; shopping cart child seat belt use	Austin et al. (1998); Bunck and Iwata (1978); Chapman and Risley (1974); Engerman et al. (1997); Van Houten et al. (2007); Barker et al. (2004); Bunck and Iwata (1978)
Written and/or visual prompt	Written and/or visual prompt given to indicate desired and/or undesired response.	Safety belt use; recycling; community participation; donations; use of condoms; safe driving behaviors; drivers yielding to pedestrians and stop signs; motorist and pedestrian conflict; contributions to senior center; carpooling; energy/electricity	Rogers et al. (1988); Austin et al. (2006); Brothers et al. (1994); Bunck and Iwata (1978); Clayton and Helms (2006); Clayton et al. (2009); Cox et al. (2005); Farrimond and Leland (2006); Geller et al. (1985); Gras et al. (2003); Honnen and Kleinke (1990);

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		conservation; reuse dinnerware; graffiti; refusing packing; illegal parking in spaces for physically disabled; obtaining dental care	Van Houten and Retting (2001); Van Houten and Malenfant (2004); Van Houten et al. (1985); Huybers et al. (2004); Jackson and Matthews (1995); Jacobs et al. (1982); Luyben (1980); Manuel et al. (2004); Mueller et al. (2000); Palmer et al. (1977); Altus et al. (1991); Stokes and Fawcett (1977); Williams et al. (1989); Cope and Allred (1991); Austin et al. (1993); Hayes and Cone (1977); Reiss et al. (1976)
Training	Usually including task analysis, instructions, feedback and demonstrations of appropriate and/or inappropriate behavior. Includes behavior skills training.	Glove use; installing house weatherization; home safety skills for children; removing home hazards; child abduction prevention; safety belt use	Babcock et al. (1992); Pavlovich and Greene (1984); Peterson (1984); Tertinger et al. (1984); Johnson et al. (2005); Johnson et al. (2006); Sowers-Hoag et al. (1987)
<b>Kernels affecting behaviors primarily via relational frames</b>			
Public commitment	Individuals sign or pledge to engage in behavior.	Sunscreen	Lombard et al. (1991)
Media association with immediate	Media (TV, videos, radio) showing	Water consumption;	Agras et al. (1980); Clayton and Helms

negative social outcomes	behavior resulting in social rejection, escape from social rejection or negative consequences.	safety belt use	(2009)
Media – informational prompt	Media (TV, video, radio) providing information or rules about appropriate and/or inappropriate behaviors.	Recycling; self protection; environmental political action	Jacobs et al. (1984); Poche et al. (1988); Schroeder et al. (2004)

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*Note.* Table format based on Embry and Biglan (2008).

who could benefit from it. Behavioral safety interventions are well codified, widely accepted, and now developed and managed by a range of personnel from Ph.D.-level consultants to front-line managers with little formal training in behavior analysis. This research model (Azrin, 1977; Hayes et al., 1999) and the concept of kernels (Embry & Biglan, 2008) provide a systematic way to develop readily applicable methods to change the behavior of many people in communities in ways that enhance sustainability.

Alavosius, Adams, Ahern and Follick (2000) describe a community-level intervention to manage occupational safety in Rhode Island, USA by organizing multiple kernels across a large segment of the Rhode Island workforce. The primary purpose was to sustain commerce threatened by a crisis in availability of workers' compensation coverage. This required community leaders, business owners, and government members to assess how insurance companies' refusal to provide workers' compensation coverage to Rhode Island employers would curtail community businesses. Analysis indicated that alternative forms of insurance could replace conventional models if legislation was changed to permit such arrangements. The solution entailed a cooperative model in which legislation changed to permit many business owners to pool resources and self-insure. This model included organization of social and financial contingencies to support delivery of safety and case management services (Alavosius, Getting, Dagen, Newsome, & Hopkins, 2009). This was set in motion by a vivid crisis in the community—the economy was threatened with potential collapse. The solution was a community endeavor in that the beneficiaries were hundreds of separate employers across multiple sectors of the Rhode Island economy that collectively employed tens of thousands of workers. The agents managing the intervention assembled efforts across multiple sub-systems (Bossel, 1999) of the Rhode Island

economy (business owners, trade group leaders, health-care providers, etc.). The solution required management of various levels of analysis (changing individual behavior through kernels from the level of the shop floor up through influencing legislative change allowing more competition in the insurance trade) to interlock behavioral contingencies, evaluate and refine program elements, control work-related injuries and illnesses, manage quality care for injured workers and sustain business operations. This provides an example of how multi-layered models and interventions that inform how practices focused around sustainability might similarly be managed within work environments and perhaps communities.

**Accreditation for alignment with community values.** An extension of Hayes et al. (1999) and Azrin (1977)'s models to promote sustained interventions is through accreditation of organizations and communities that demonstrate the use of kernels to improve the sustainability of the community. Community sustainability may build upon an existing base of empirically tested interventions and use existing distribution channels to affect large populations through existent organizations. Beito, Gordon and Tabarrok (2002) point to the power of organizations and private groups, such as homeowners associations, in pushing local government policy to improve the community as a bottom-up approach to change. These subpopulations impact the larger culture and community if they manipulate contingencies that shape the community in general.

Numerous organizations accredit product safety and processes with environmental impact (Cradle to Cradle, n.d.), building environmental impact (U.S. Green Building Council, 2011), and consumer choice via real estate agent knowledge and skills about the benefits of green homes (Earth Advantage Institute, 2010), among others. Accreditation allows for an independent outside organization to objectively evaluate a business on several key indicators with the additional benefit of increased marketability of the business. This approach is employed within behavior analysis by the Cambridge Center for Behavioral Studies (CCBS, 2010). The CCBS accredits safety programs in organizations that demonstrate effective and sustained behavior-based safety systems. Criteria for accreditation include data-based behavior management programs (which often rely on kernels) that provide evidence of sustained outcomes (incidence rates below industry benchmarks). In most cases, workers and managers within the organization, without the aid of behavioral safety consultants, developed accredited interventions. Capable employees read the literature and extracted solutions to apply in their organizations. In some cases, interventions were generalized to their home environments, further promoting safety in that community. A similar approach is under development to accredit companies for green practices. This accreditation would evaluate whether there is innovative



behavior occurring within the organization to continually improve and implement sustainable practices that benefit the organization and reduce negative externalities that harm the community. Accreditation standards should focus on decreasing adverse impacts by the company on the community, and even giving back to the community in line with the Cradle to Cradle approach (McDonough & Braungart, 2002). Accreditation and re-accreditation allow for continual development and reevaluation of kernels in various combinations to shape innovations. Managers of exemplary organizations can link their organizations with private groups, cities, etc., to share effective and efficient empirically developed practices. Using accreditation standards to interlock efforts by organizations and communities promotes application of tested behavioral solutions to change behaviors at a large scale.

Accreditation of organizations' green practices could alter how those organizations present themselves to their consumers. By seeking and recognizing increasingly networked green practices, independent advocacy organizations, like the CCBS, can change perceptions of what constitutes responsible practices within organizations. Biglan (2009) calls for advocacy organizations to act as counter weight against profit-driven corporations with the goal of reducing their negative externalities. Third-party review of green practices and associated outcomes can educate consumers about unseen consequences of purchasing products from corporations that harm the environment and put market pressure on organizational leaders to adopt sustainable practices. Although this provides a useful framework for targeting larger groups of people, it is worth noting that this would likely fall closer to a weak sustainability approach that only slows growth as opposed to making substantial changes in lifestyle.

### **Community Sustainability Research Framework**

This paper demonstrates that there is a significant base of research in behavior analysis for changing behavior within the context of a community. The development of sustainable communities was initially envisioned as an area that behavior analysts could contribute to (Skinner, 1948/1976). The global economic downturn, skyrocketing national debts, increasing recognition of the implications of global warming, and proliferation of social media to educate the public are among the drivers of change building within our communities. We find optimism in the potential for behavioral sciences to collaborate with other sciences to reinvent communities and create sustainable communities.

Other fields, i.e., engineering and architecture, evaluate important indicators relevant to their subject matter and then build the environment to impact these indicators and develop sustainable communities. As has been stated, behavioral

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and psychological interventions approach this process as well. For example, Abrahamse et al. (2005) report on methods to improve household's energy conservation and describe the limited, but promising, effects of both antecedent and consequent manipulations in changing green behaviors. Indicators of actual environmental impact would enhance evaluation of these interventions and support their institutionalization within government and business structures. Collaboration among disciplines can detect important outcomes and measure leading behavioral indicators. For instance, it is not within the scope of behavior analysis to measure regional kilowatts per hour and it is not for the engineer to study how a person's learning history interacts within his/her home environment. Combined they draw a path between the person's behavior within their home environment and the kilowatts of energy being used within a region to develop potential kernels that sustain cultural practices. These then are organized within the structures (organizations, policies, etc.) that sustain their operation.

The number of kernels applicable to community interventions indicates that behavior analysis has much to contribute to the development of sustainable communities in collaboration with other areas, such as urban planning. This paper has focused on shaping sustainable communities primarily by targeting pro-environmental behaviors. There are other behaviors that can impact the sustainability of a community such as active community involvement, collaboration with others, and adopting healthy and safe behaviors. Table 1 provides examples of numerous kernels that have impacted other behaviors vital for a long lasting and healthy community. Descriptive assessments have revealed potential measures and behaviors that can indicate more or less "sustainable" cities. For instance, various public press articles report rankings of the "most sustainable cities" (Sustainable.org, 2011; SustainableCircles Corporation, 2010). Sustainability indicators reported in the public press translate into dependent variables across three populations. One population consists of people who develop and implement contingencies within the community, such as policy makers, people in redevelopment agencies, government officials, and people in advocacy organizations. Kernels at this level include arranging contingencies to encourage novel behaviors or innovation, policy changes, or collaboration with people in other organizations, university, or community members. Interventions might change the behavior of the policy makers towards creating community-level contingencies like incentives, taxes, fees, and other monetary arrangements that alter citizens' behavior. Information campaigns to educate citizens and disseminate knowledge of empirically validated interventions affect the larger public (Biglan et al., 1990) and shift cultural practices. The Occupy Wall Street

campaign is a current example of citizens organizing to voice dissatisfaction with prevailing practices and influence policy makers to govern differently.

The second population is employees in public and private sector organizations that impact the community in which they operate and affect the economic sustainability of the community. For instance, retail organizations like grocery stores support our appetites for consumption. Their choices of what to sell directly affect our consumption behavior. They also actively support local non-profit organizations like schools and athletic teams and can be agents for social influence. As mentioned in the benefits of accreditation, organizations can encourage employees to recycle, conserve energy and water and reduce the organization's impact on the environment and/or decrease negative externalities that harm the community. Organizations retain jobs locally or send them offshore and have a negative or positive impact on the employment rate in the community which then has cascading effects on various other resources and behaviors of community members.

Finally, interventions can directly target the residents of the community. Dependent variables related to sustainability include everyday behaviors such as participation of community members in government (Altus, Welsh & Miller, 1991), buying from local businesses or pro-environmental organizations (Layng, 2010), collaborating with other members of the community (Alavosius et al., 2009), development of innovative ideas that benefit the community and bringing those ideas to people who can implement these ideas. Table 1 provides examples of community behaviors that have already been targeted such as increasing recycling, increasing energy conservation, decreasing gasoline consumption, increasing public ridership or increasing the use of bikes and walking as a means of transportation. Interventions targeting the health and safety practices of the community members, for instance, increasing exercise, increasing healthy eating, as well as personal safety behaviors such as using sun screen or wearing safety belts all align with this agenda and offer an established starting point.

Many behaviors can be targeted and analyzed for their impact on various indicators important in sustainable communities. These behaviors might be categorized in broad classes such as those involved in social influence (education of self and others, advocacy, political action), habitual conservation (car pooling, recycling, composting), support of green companies (purchase of efficient products and services), and interventions organized to support their adoption. With a combination of outcomes measures, such as aggregate resources consumed and pounds recycled, and behavioral measures as indicated by management of kernels, organizations and communities might be accredited and celebrate improvements.

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The acceleration of global warming may reveal the behavioral changes described above as falling short of those needed to achieve sustainability of current lifestyles and communities most at risk. Grant (2011) provides a compelling case for solutions under a strong sustainability agenda. Perhaps the greatest value of using behavioral kernels and existing community organizational models to reduce the accelerating consumption and environmental damage is to buy more time to prepare populations to implement practices along the lines of strong sustainability. There is practicality for organizations and communities to work with existing elements (kernels and organizations such as the CCBS) to alter production and supply chains towards greener innovations. Changing behaviors of community members to create a slowing effect on climate change is a partial solution that is actionable now. Conducting this within a research agenda (i.e., Azrin, 1977; Hayes et al., 1999) can contribute to our understanding of how to organize contingency networks within the current infrastructure. The accumulated knowledge within behavioral science and the implicit knowledge in our culture's organizational base, such as the small towns of New England, may be what are best available for greater cultural reinvention as populations accept the challenge to act.

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