

National Institutes of Health
Science of Behavior Change

Annual Meeting of Investigators

Finding Mechanisms of Change in the Laboratory and the Field

Bethesda, Maryland
June 20-21, 2011

MEETING SUMMARY

Revised September 13, 2011

This summary report was prepared by Chandra Keller-Allen, Rose Li and Associates, Inc., under contract to the National Institutes of Health (HHSN263200700991P). The statements, conclusions, and recommendations contained in this document reflect both individual and collective opinions of the meeting participants and are not intended to represent the official position of the National Institutes of Health, or the U.S. Department of Health and Human Services. We gratefully acknowledge review of and comments on a draft of this report provided by B.J. Casey, Jamie Chriqui, Barbara Fredrickson, Scott Halpern, Johannes Haushofer, James Hudziak, Jonathan King, David Laibson, Julie Lumeng, Rose Maria Li, Alison Miller, Megan Moreno, Jenae Neiderhiser, Matthew Nock, Lisa Onken, Henry Saffer, Timothy Strauman, and Lois Tully.

Executive Summary

The National Institutes of Health (NIH) Science of Behavior Change (SOBC) Common Fund program awarded 10 grants in fiscal year 2010 in response to the request for applications (RFA) titled *Science of Behavior Change: Finding Mechanisms of Change in the Laboratory and the Field*.¹ NIH convened the first annual meeting of investigators in Bethesda, MD, on June 20-21, 2011, to update the NIH SOBC Working Group about investigators' progress to date and also to inform future efforts. The meeting began with a keynote presentation by Dr. Matthew Nock that provided general insights about mechanisms of behavior change and why they are important to study, approaches to measuring mechanisms, and approaches to changing behavior by testing individual components and targeting potential mechanisms directly. The latter has the potential to revolutionize the science of behavior change.

Following the keynote presentation, investigator presentations were clustered by approaches for studying mechanisms underlying behavior change—behavioral economics, genetics, social and policy approaches, and emotional self-regulation—and introduced by an invited speaker for each respective grouping. Each cluster of presentations was followed by general discussion among the participants.

Behavioral Economics

Behavioral economics may help explain why people often fail to act in their own best interest. Dr. David Laibson presented examples of how unhealthful behavior choices could be changed using inexpensive, scalable interventions (e.g., defaults or nudges). Evidence suggests that interventions that address self-management are more effective at promoting change than education alone. Dr. Scott Halpern is conducting a randomized controlled trial (RCT) of 2,185 Walgreens employees across the United States to compare the structure of financial incentives in smoking cessation programs. Dr. Johannes Haushofer is examining how delay discounting (gains and losses tomorrow are “worth” less than those today) is mediated by poverty and stress in three settings: the loss of livestock in southern Kenya; an RCT of unconditional cash transfers in western Kenya; and family health insurance intervention versus cash transfer versus control for employees in a stressful working environment in Nairobi.

Genetics

Dr. Jenae Neiderhiser introduced the link between genetics and behavior change by focusing on her own work using family relationships (in twin, sibling, and adoption study designs) and elucidating the roles of genes and environment. Dr. Timothy Strauman is testing a model of risk phenotype for self-regulation failure based on the functioning of the dopaminergic system and anticipates testing a set of micro-interventions targeting that phenotype. Dr. Barbara Fredrickson is investigating how positive emotions alter bodily systems in ways that ultimately reinforce sustained behavior change. She developed the Upward Spiral Model of Lifestyle Change, positing that when a new wellness behavior elicits positive emotions, it increases changes in biological resources, and over time may lead to long-term changes for improved

¹ The RFA can be found at <http://grants.nih.gov/grants/guide/rfa-files/RFA-RM-10-002.html>.

health and well-being. Dr. James Hudziak is identifying the specific genetic and environmental influences on exercise behavior and developing a family-based intervention for children in the transitional ages of 9 to 13 years old in order to maintain their exercise behavior.

Social and Policy Approaches

Dr. Jamie Chriqui noted that policy and environmental changes can have sustained population health and behavioral impacts, but they often require patience. A policy strategy for behavior change requires viewing behavior as being influenced by a much larger social system. Successful policy changes that have influenced public health have targeted, for example, vaccine preventable diseases, maternal and infant health, and tobacco control. Dr. Megan Moreno is examining social media as an opportunity to learn more about adolescent health behaviors and to explore the possibility that social media can be used as a medium for healthful messages. Dr. Henry Saffer is conducting an econometric analysis based on a theoretical neuroeconomic model of cues, arguing that past alcohol consumption may have an important role in modifying the effects of the advertising and price of alcohol.

Emotional Self-Regulation

Research presented by Dr. B.J. Casey demonstrates that individual differences in brain activity can predict behavior change, particularly during sensitive periods of development, and therefore help to identify candidates for targeting interventions. Development, social contexts, and individual differences are important considerations when determining approaches to behavior change. Drs. Alison Miller and Julie Lumeng are examining behaviors and physiology among 1- to 3-year-old toddlers to determine if there are predictors of obesity risk; the results have the potential to inform understanding of self-regulation and obesity prevention efforts. Dr. Kevin Ochsner noted that the inability to cope with stressors could lead to maladaptive forms of regulation that over time can lead to health problems. He is studying emotion regulation strategies that can be used during two points of the appraisal cycle—attentional control and cognitive change—during the developmental periods of childhood and adolescence. Dr. Elizabeth Phelps is investigating whether the tools of affective neuroscience and neuroeconomics can be used to characterize more precisely how and when emotion is incorporated into the value computation as well as to change emotion and choice, with the ultimate goal of better understanding behavior change.

General Discussion

Participants engaged in general discussion throughout the meeting and addressed several topics including: the interaction of psychology and economics; the influence of research on the policy-making process; dissemination of evidence-based interventions; the role of technology; the importance of translational and cross-disciplinary work; cost-effectiveness of behavior change interventions; and the goal of developing a unified science of behavior change. A more detailed description of key themes and highlights from the meeting can be found in the full meeting summary.

Introduction

The National Institutes of Health (NIH) Science of Behavior Change (SOBC) Common Fund program seeks to promote basic research on the initiation and maintenance of behavior change, and the application of such research toward personalization of interventions. By integrating work across disciplines, this effort is intended to lead to an improved understanding of the underlying principles of behavior change. NIH awarded 10 grants in fiscal year 2010 in response to the request for applications (RFA) titled *Science of Behavior Change: Finding Mechanisms of Change in the Laboratory and the Field*. The grantees are scientists undertaking behavior change research from a variety of disciplines—behavioral economics, psychology, neuroscience, neuroeconomics, genetics, pediatrics, and clinical medicine. The projects bridge work done in laboratories and in the field, and are intended to stimulate investigations of basic mechanisms at the social, contextual, behavioral, psychological, neurobiological, or genetic level of analysis.

NIH convened the first annual meeting of investigators in Bethesda, MD, on June 20-21, 2011. The meeting was intended to update the NIH SOBC Working Group about investigators' progress to date and also to inform future efforts. The SOBC Working Group co-chairs, Patricia Grady (Director of the National Institute of Nursing Research [NINR]), Richard Hodes (Director of the National Institute on Aging [NIA]), and Richard Suzman (Director of the Division of Behavioral and Social Research, NIA), welcomed the participants and expressed enthusiasm about the potential to advance the science of behavior change in a cross-disciplinary manner. It is hoped that the various approaches under way to studying mechanisms can inform each other. The following items should be considered as the group moves forward with this research: 1) the extent to which there may be common mechanisms across behaviors that can be the focus of interventions; 2) the ways in which knowledge of mechanisms can be used to identify segments of the population that are amenable to particular behavior change interventions; and 3) how greater understanding of the evolution of self-control and conscientiousness over the life course can inform behavior change efforts. Promoting research to elucidate basic mechanisms and how they operate will allow for the development of more efficient and effective approaches to multiple behavior change. Ultimately, the goal is to inform and develop approaches to behavior change that are cost-effective and amenable to public health and public finance structures.

Following a keynote presentation on mechanisms of change by Matthew Nock (Harvard University), investigator presentations were clustered by approaches to mechanisms—behavioral economics, genetics, social and policy approaches, and emotional self-regulation—and introduced by an invited speaker from that field. Each group of presentations was followed by general discussion among the participants. Multiple NIH Institutes and Centers (ICs) were represented at the meeting, including members of the SOBC Working Group and program officers (see Appendix for the agenda and the list of participants). This report summarizes key themes and highlights from the meeting proceedings.

Keynote Presentation

Offering More Than a Talking Cure: Using Psychological Science to Change the Way We Study and Change Behavior

Matthew K. Nock, PhD, Professor of Psychology, Harvard University

Dr. Nock shared general insights about mechanisms of behavior change and why they are important to study; approaches to measuring mechanisms; and approaches to changing behavior by testing individual components and targeting potential mechanisms directly.

Mechanisms of Change: What, Why, and How?

Dr. Nock identified three overall aims of intervention research: 1) developing interventions and testing efficacy; 2) studying the mechanisms, or processes through which behavior change occurs (i.e., how the intervention works or why people change); and 3) identifying the moderators of change, or the factors that influence the direction or strength of the change as well as identifying predictors of change. According to Dr. Nock, research needs to focus more on determining how interventions actually work.

Dr. Nock proposed three compelling reasons to focus on mechanisms. First, the study of mechanisms can bring parsimony to multiple treatments. Yale University psychology professor Alan Kazdin reviewed more than 550 behavioral interventions used to change child behavior (e.g., emotion regulation, problem solving). Because it is unlikely that these interventions are operating through 550 different mechanisms, identifying common components can lead to a more efficient research program and increase the likelihood of better targeting interventions. Second, a better understanding of mechanisms of behavior change can maximize the potential for clinical change. Current evidence-based treatments have shown modest effects with small impacts that do not necessarily persist. The active ingredients of an intervention and their impact could be amplified if researchers can elucidate what these ingredients may be. Third, the study of mechanisms can help to inform behavior change beyond treatment. For example, a better understanding of mechanisms underlying emotion regulation may inform understanding of the etiology of pathological behavior, which may in turn inform approaches to altering non-pathological behaviors.

Some methods used in this area of science, such as statistical mediation, are not sufficient for identifying mechanisms of behavior change. Researchers have used regression techniques, path analyses, and structural equation modeling (SEM) in attempts to test if the effect of a treatment on an outcome is mediated by a third variable. Many studies now incorporate this method. However, this type of modeling cannot elucidate the directionality or causality of the relationship. Coined the “Kazdin-Nock Illusion,” investigators often commit an error of logic by assuming that change in a mediator *causes* change in the outcome.² According to Nock, only randomization to condition with pre- and post-treatment measures allows for causal

² Kazdin, A. E. & Nock, M. K. (2003). Delineating mechanisms of change in child and adolescent therapy: Methodological issues and research recommendations. *Journal of Child Psychology & Psychiatry*, 44, 1116-1129.

inferences. Statistical mediation is necessary but insufficient to demonstrate operations of mechanisms of behavior change; in short, correlation does not equal causation.

Dr. Nock recommended criteria for demonstrating mechanisms of behavior change. The three most important criteria include identifying a strong association between the intervention, proposed mediator, and outcome; the use of experimental methods to demonstrate that manipulation of the mediator leads to a change in outcome; and the demonstration of a temporal relationship (i.e., change in the mediator precedes change in the outcome). The case is strengthened if additional criteria are met: specificity of mechanism; a dose-response relationship between mediator and outcome; consistency of findings through replication of effects across studies; and plausibility and coherence with the larger body of science.

There now appears to be agreement among scientists on the importance of understanding mechanisms of change that was not apparent even 10 years ago. However, most intervention studies are designed to test efficacy but not determine mechanisms of change. The use of self-reporting of processes (e.g., problem solving, decision making) in behavioral studies is insufficient for capturing the change process. Few studies include frequent repeated measures of dynamic change processes.

Measuring Mechanisms

Advances in basic research on behavioral and psychological processes are needed to measure and change clinical behaviors more accurately. Some of this influence is evident in history (e.g., the basic research of Pavlov and Skinner influencing Rogers' and Beck's work on talk and behavior therapy), although it appears minimal. New methods for measuring processes important to mechanisms of behavior change, such as tools to measure brain function, are available. There are now many resources to help understand how people are changing, and there are opportunities to update interventions to reflect these advances. However, talk therapy is still largely dependent on self-report.

Dr. Nock provided an example research area from his own work on non-suicidal self-injury (NSSI). The traditional approach to NSSI has been talk therapy (cognitive behavioral therapy [CBT], dialectical behavior therapy, etc.) with a pre-post self-report measure and statistical tests of mediation. Some effects have been found, but there is still not a clear understanding of NSSI behavior and no evidence-based interventions for NSSI. An alternative approach is to study the potential mechanisms for this behavior before attempting behavior change through treatment. This approach includes using findings and methods from basic research to identify processes that may influence behavior (e.g., emotion regulation, distress tolerance/impulse control, interpersonal problem solving, self-injury related cognition) and developing methods for repeated measurement of the potential mechanisms in the natural environment.

Dr. Nock and Dr. Wendy Mendes examined interpersonal processes directly and found that there was higher arousal and poorer distress tolerance among self-injurers. They also found that self-injurers are able to generate the same solutions to social problems as non-self-injurers

but select worse solutions. These findings suggest that self-injurers may hurt themselves to decrease arousal and lack social problem solving and communication skills.³ Drs. Nock and Mendes then assessed changes in these processes repeatedly over the course of treatment using real-time measurement in the natural environment with ecological momentary assessments (EMA). Dr. Nock shared findings from a sample of 30 adolescents over a 2-week EMA sampling period.⁴ There was a great overlap between NSSI thoughts and behaviors and other risky thoughts and behaviors (e.g., alcohol or drug use), and there was an increase in negative affect directly preceding self-injury behavior and a decrease in negative affect after the behavior. Subjects also wore vests that collected physiological behavior data before, during, and after self-injury behavior; the findings are consistent with self-report EMA data that reveal huge increases in arousal prior to self-injury, and a self-soothing effect after it (i.e., activation of the parasympathetic nervous system).

Changing the Way We Change Behavior

Most psychological treatments have many components, and it is important to identify the active ingredients. Each active ingredient may work through different or multiple mechanisms. Approaches to elucidating active ingredients include component analysis through dismantling studies or the testing of individual components using single-case experimental designs. Dismantling studies are time and resource intensive and have not consistently illuminated key components to interventions. It can be more cost-effective to look for treatment effects within people over time than to assign people to treatment or no treatment.

Dr. Nock provided an example of a single-case experimental design on NSSI from his own work. When asked what self-injurers do when they think about self-injury but do not engage in the behavior, they often report exercise. Dr. Nock and colleagues employed an ABABAB single-case design to test exercise as an intervention for self-injury behavior. During the first month of data collection, the subject participated in psychological treatment five times per week and was engaging in self-injury behavior two to three times per week (A). The subject was then assigned to an aerobic program (B) during which the frequency of self-injury decreased substantially. The exercise program was then dropped and the frequency of self-injury increased. This type of design allows for the opportunity to study mechanisms, affect, cognition, and biological change.

There is increasing work in clinical science focused on identifying processes related to a behavior problem and changing these processes directly through training. There have been effects seen for attention training for anxiety, mood, and alcohol; interpretive training for anxiety; cognitive control training for depression; evaluative conditioning; and approach/avoidance training. The future of mechanisms research lies in targeting specific mechanisms for change, rather than employing a large treatment package without knowing exactly what is affecting change.

³ Nock, M. K. & Mendes, W. B. (2008). Physiological arousal, distress tolerance, and social problem-solving deficits among adolescent self-injurers. *Journal of Consulting and Clinical Psychology, 76*, 28-38.

⁴ Nock, M. K., Prinstein, M. J., & Sterba, S. K. (2009). Revealing the form and function of self-injurious thoughts and behaviors: A real-time ecological assessment study among adolescents and young adults. *Journal of Abnormal Psychology, 118*, 816-827.

Understanding mechanisms of change is essential for behavior change efforts; pre- and post-treatment self-report measurements of proposed mechanisms are insufficient to study change processes; measures that can capture processes in the laboratory and in the field are needed; and testing individual intervention components and targeting putative mechanisms may revolutionize the science of behavior change.

General Discussion

There was general discussion about how to target particular interventions. A particular problem behavior might be evident across a population, but there may be subgroups of people for whom different mechanisms are working and therefore would respond to different types of interventions. Large-scale interventions provided at the population level are needed as well as targeted interventions. Interventions that focus on particular mechanisms and processes, rather than specific behaviors, might affect a range of behaviors.

Participants acknowledged that defining “mechanism” could be challenging because of its complexity and the importance of examining multiple levels of analyses (e.g., brain, EMA genetics) over time.

One premise of this NIH Common Fund Program is that a unified science of behavior change might be developed. The notion that the same mechanisms influence multiple processes and behaviors is compelling, yet these literatures are often “siloes” within different disciplines. Participants offered strategies for unifying these efforts, including reorganizing journal structures, finding ways to facilitate interdisciplinary research, and fostering cross-disciplinary collaboration.

Behavioral Economics

Behavioral Economics and Behavior Change

David Laibson, PhD, Robert I. Goldman Professor of Economics, Harvard University

Classical economics assumes that people know what is in their best interest and that they act on that knowledge. Behavioral economics (or psychology and economics) incorporates more nuanced assumptions: people often hold mistaken beliefs and even when they understand what is best, they do not always follow through. Education (i.e., people will change if you just give them the right information) and assistance with self-regulation (e.g., removing the barriers to behavior change) are two key strategies for behavior change. In most cases, education-only interventions do not have a large impact on behavior.

Numerous studies have found support for present-bias—the idea that rewards consumed in the present receive a special premium in the utility function—though the concept remains controversial; the model implies that people have time-inconsistent preferences and points to a possible mechanism underlying self-control problems. For example, when subjects were given the choice of a healthful snack or chocolate for the following week, most chose the healthful

snack. When subjects were given the choice to eat at the time they were afforded the choice, most chose the chocolate.⁵ The pattern that emerges is that people want to have fun right now, but desire to (and understand they should) do the right thing in the future.

Dr. Laibson discussed the discounting model with present bias.⁶ A simplified version of this model assumes that people place a psychological weight of *one* for the utility of immediate events and a psychological weight of *one-half* for the utility of future events. In other words, people receive full utility value from events that occur right now, but only half utility value for events in the future. The consequence of these preferences is procrastination, as demonstrated with exercise and retirement savings (the cost of doing what is good for you today is greater than the cost of doing the same thing tomorrow, so unless there is an urgent reason to act in the present, you will usually choose to act tomorrow). Studies have shown that people are partially aware they have a self-regulation problem and will sometimes choose more restrictive options in order to ensure they make better choices.

Dr. Laibson discussed three types of intervention strategies designed to increase retirement savings behavior among employees: defaults; choice-based regimes requiring active decisions; and simplified enrollment. Studies have shown how these interventions affect participation rates of employees at typical firms compared to standard opt-in programs. Default programs (opt-out) automatically enroll employees in 401(k) plans and result in the greatest participation rate among employees (90 percent participation). Active choice regimes, in which the employee is told they must make a choice and indicate that choice to enroll or not enroll in a 401(k), result in a 70 percent participation rate. Simplified enrollment procedures (checking a box on a postcard) result in a 50 percent participation rate. All of these interventions improve upon the standard opt-in enrollment rate of 40 percent.

Employers and employees have aligned goals in terms of health care: improved health and lower costs. Interventions that lower barriers and increase desired behavior can also be applied to health. For example, home delivery of prescription medicines is less costly for consumers and employers, saves time, raises medication adherence, and improves safety. Pilot study results examining an active-choice regime at one company show an increase in enrollment from 100,000 to almost 300,000 and substantial savings to both participating employees and the employer health plan.

In summary, behavioral economics may help explain why people often fail to act in their own best interest. Self-defeating behavior can be changed using inexpensive, scalable interventions (defaults, active choice regime, and simplified participation) shown to be effective with retirement savings behavior. The same concepts are now being applied to health choices. The evidence suggests that interventions that address self-management are more effective than education alone. Education should not be abandoned, but it is important to complement

⁵ Read, D. & van Leeuwen, B. (1998). Predicting hunger: The effects of appetite and delay on choice. *Organizational Behavior and Human Decision Processes*, 76, 189-205.

⁶ Laibson, D. (1997). Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, 112, 443-477.

education with self-regulation interventions because education alone does not have a sufficient impact on behavior.

Comparative Efficacy, Acceptance, and Effectiveness of Health Incentive Structures

Scott D. Halpern, MD, PhD, MBE, Assistant Professor of Medicine and Epidemiology, University of Pennsylvania

Among the 20.6 percent of Americans who smoke, 75 percent of them want to quit. Despite the availability of new pharmaceuticals, anti-smoking policies, and behavior modification programs, only 2 to 3 percent achieve prolonged abstinence annually. Work-based smoking cessation programs are desirable because they have been shown to be more effective than community-based programs, minimize start-up costs by building on existing programs and networks, reduce healthcare costs and absenteeism, and are beneficial for both smoking and non-smoking employees.

Incentives have been tested across a broad array of health-related behaviors, and they have more often than not produced statistically significant improvements in those behaviors. However, in virtually every case, the incentives have been compared against no incentives, rather than against other types of incentives. Additionally, in no case has a study been large enough to discern what types of people are more likely to respond to different types of incentive structures.

The key elements of a financial incentive program include its size, schedule, and structure. Determining the size and schedule of the incentive (i.e., immediacy, frequency, duration) is akin to a dose-finding study. The most effective sizes and schedules differ by specific behavior or product. However, optimal structures of incentives should cut across behaviors because the structure will map to mechanisms of how people respond to incentives.

Dr. Halpern's SOBC grant involves conducting an RCT of 2,185 Walgreens employees across the United States to compare the structure of financial incentives in smoking cessation programs. This study recognizes the need to go beyond simply asking if financial incentives are effective, and asks what types of incentives work and how they can be improved by comparing usual care with four incentive arms with equal expected value. A pilot study is currently ongoing in the Chicago area, and the full RCT will begin in January 2012. The specific aims are to: 1) compare efficacy and effectiveness of four financial incentive structures for improving quit rates as measured by prolonged smoking abstinence for 6 months; 2) compare smokers' acceptance of the four financial incentive structures; and 3) identify individual characteristics that modify incentive structures' efficacy and acceptance.

The four incentives structures being compared include payments based on performance of the individual versus a group (collaborative and competitive) and financial incentives framed as gains versus losses (reward versus loss of deposit). The incentive structures are added to usual care, which in this case is the Quit for Life smoking cessation program that includes free nicotine replacement therapy, access to educational resources, and web-based monitoring of progress. The effectiveness, in addition to parsing out acceptance and efficacy, of incentive

structures needs to be determined in order to understand mechanisms and improve public health simultaneously.

After a baseline assessment to determine eligibility, participants will be randomly assigned to one of five groups (usual care and four incentive structures). The participant can then agree or disagree to participate and remains enrolled in the study even if he or she declines. Using the randomization arm as an instrumental variable to be included in the efficacy analysis allows an unbiased measure of efficacy to be obtained. The randomization arm is an optimal instrumental variable because it has no independent relationship with smoking cessation that is not mediated through the interventions being tested. The study is using an adaptive randomization schedule to increase the proportion of people being offered interventions that prove to be less attractive. At 6 months after a participant's quit date, the incentives will be discontinued and the subjects will be monitored for recidivism over an additional 6 months.

Question and Answer

Dr. Halpern noted that 50 percent of large employers currently use some kind of financial incentives for smoking cessation. If employers are truly motivated to maximize smoking cessation for a particular amount of money they would use an incentive structure that works optimally for their specific population.

Dr. Halpern clarified that the competitive and collaborative intervention groups have the same goal of maximizing employee quit rates but are testing different elements of acceptability and efficacy. In the collaborative aim, employees are linked through social networks to foster cooperation. In contrast, linkages are avoided in the competitive arm; the participants will not know specifically with whom they are competing and will be spread across the country.

Poverty, Stress, and Discounting: A Potential Micro-mechanism for Behavior Change?

Johannes Haushofer, PhD, Research Associate, University of Zurich

Dr. Haushofer's project⁷ is a multidisciplinary effort to understand how discounting is mediated by poverty and stress. Discounting matters because it constrains long-term planning by decreasing the subjective value of future outcomes; is implicated in a variety of disorders (e.g., gambling, alcohol, and nicotine addictions); is a good predictor of achievement; and constrains altruism because it decreases the value of future reciprocation. The study asks whether and how short-sighted temporal preferences arise endogenously.

The working hypothesis supporting this study is that poverty leads to stress, stress leads to short-sighted choices, and short-sighted choices lead to more poverty. There is evidence to support each of these links. Studies have shown that poor people tend to be more stressed and have higher levels of cortisol, and that stress affects behavior. There is emerging evidence that changing discounting behavior has large welfare benefits. However, it is not yet known whether stress causally affects discounting.

⁷ Dr. Ernst Fehr is co-principal investigator for this project but was unable to attend the meeting.

Using the lab-based Trier Social Stress Test, Dr. Haushofer identified two dissociations in the effect of stress on discounting: stress affects present bias discounting, but not impatience; and severe or acute stress increases present bias while moderate or subsiding stress decreases present bias.

The remainder of the grant period will focus on the relationship between poverty and stress; there is no current evidence in the literature for a causal relationship. The project will examine this relationship in three settings: a natural experiment involving the loss of livestock during a severe drought in 2008-2009 in southern Kenya; an RCT of unconditional cash transfers in western Kenya (n=1000 households); and family health insurance intervention versus cash transfer versus control for employees in a stressful working environment in Nairobi (n=1200). Preliminary results in the first study indicate that there is a statistically significant relationship between the proportion of livestock lost during the drought and present cortisol levels (i.e., an increase in poverty as measured by loss of livestock predicts an increase in stress levels).

Question and Answer

Dr. Haushofer indicated that the amount of money for the cash transfers was determined with input from a non-governmental organization, Give Direct.

Dr. Haushofer clarified that the cortisol samples are collected twice, once before and once after the survey; an average diurnal pattern is thus obtained for the group. Other measures include stress and depression questionnaires, optimism scale, locus of control, questions on subjective well-being, and collection of IL6 and TNF alpha in one site.

The participants discussed the prospect of manipulating cortisol levels with medications in the future. There are also opportunities to study symptoms and treatment of depression and anxiety in developing countries, where it is often highly prevalent (e.g., 45 percent of Dr. Haushofer's sample meets clinical criteria for depression).

General Discussion

The general discussion touched on three main themes: the interaction of psychology and economics; for whom nudges toward better self-regulation are most beneficial; and incentivizing processes versus outcomes.

The application of economics to psychological principles involves documenting real-world efficacy, scaling up, and formalizing mechanisms in mathematical models of human behavior. The field of behavioral economics succeeds when it scales up individual lessons learned in lab experiments for real-world implementation and thereby contributes incremental progress in understanding what can be improved upon. Mathematical models that incorporate psychological principles can be compared, combined, integrated, and used to forecast long-run economic dynamics (e.g., how healthcare reform is going to affect the economy over the next several years). The best behavioral economics is translational work from psychology.

Other work on behavioral nudges, not presented here, has shown that the biggest effects are for disadvantaged groups. Disadvantaged groups are less successful at following through on good intentions so interventions that help self-regulation (i.e., behavioral nudges) are expected to have a greater effect on them. In other words, behavioral interventions targeted at improving self-regulation behavior are best able to promote change among those who are least equipped to do it naturally.

It is unclear if the process or the outcome is being incentivized when incentives are part of an intervention to change behavior. The classical economic perspective would advocate for incentivizing outcomes because it is more efficient than incentivizing multiple processes. Ethicists may contend that people are differently equipped to achieve different outcomes and voluntary processes can be incentivized in a just fashion. The question remains when considering whether comparable outcomes would be achieved by incentivizing processes.

Genetics

The Role of Genes and Environment in an Approach to Understanding Behavior Change

Jenae M. Neiderhiser, PhD, Professor of Psychology, The Pennsylvania State University

Dr. Neiderhiser's approach to understanding behavior change focuses on family relationships including how family members facilitate change in one another and elucidating the roles of genes and environment. Much of this work relies on twin, sibling, and adoption study designs including the Twin and Offspring Study in Sweden (TOSS), Nonshared Environment in Adolescent Development (NEAD), and Early Growth Development Study (EGDS).

Mechanisms of parenting behavior can be a framework for examining the gene-environment correlation.⁸ Parenting behavior can be influenced by contextual factors, parental characteristics, and child characteristics. Passive gene-environment correlation is evidenced by parents' genes influencing how they parent. Evocative gene-environment correlation is evidenced by a child's genes influencing parental response to the child. Parent personality is also influenced by social support networks, his or her own psychopathology, and partner relationship, all of which can mediate parenting behavior. These distinctions in gene-environment correlation can be teased apart using twin and adoption study designs.

Dr. Neiderhiser analyzed data from both NEAD (child-based design) and TOSS (parent-based design) together to better understand the gene-environment interaction. NEAD children vary in genetic relationships: identical and fraternal twins, full and half siblings, and unrelated siblings. The TOSS sample consists of parents who are identical or fraternal twins and their children. Data analyses indicate that both parents' genes (passive gene-environment correlation) and the child's genes (evocative gene-environment correlation) influence parenting. A difference emerges between fathers and mothers in negative parenting behaviors; for fathers, both passive and evocative gene-environment correlations are evident. However, negativity among

⁸ Belsky, J. (1984). The determinants of parenting: A process model. *Child Development*, 55, 83-96.

mothers is primarily influenced by evocative gene-environment correlation. In other words, mothers' negative parenting behavior is more influenced by the child's genes and how the child's personality provokes a response from the mother. This is a key distinction because it informs behavior change attempts to be targeted toward changing a mother's response to a child rather than changing a mother's personality characteristics.

The Extended Children of Twins (ECoT) model combines parent- and child-based designs to enable examination within the same sample, rather than comparing across samples. Data analyses from ECoT indicate that children elicited parenting behaviors (evocative gene-environment correlation) and that there are differential patterns of findings for mothers and fathers.⁹ There was no evidence of direct environmental effects (i.e., adolescent internalizing problems elicited maternal over-involvement rather than maternal over-involvement influencing adolescent internalizing problems). A second study with ECoT data found that externalizing problems in children evoke more criticism from mothers.¹⁰ However, there was a direct environmental influence for fathers: fathers' criticism of children influenced children's externalizing problems. These findings suggest that in both analysis and treatment, differences among family members need to be considered.

Studies using adoption designs allow for the removal of parents' genes from the rearing environment equation to further clarify gene-environment interplay. Findings indicate that genetic influences do not have a direct effect on infants' early risk behaviors for anxiety, attentional control appears to be a mechanism through which genetic influences are moderated by environmental factors, and individual and modifiable characteristics are the route through which risk is translated to behavioral outcome. Genetic factors influence the impact of the environment on development. Behavior change will only happen if the individual is sensitive to the environmental manipulations. Another study using adoption design examined the influence of parent depression on toddler adjustment and found that there is a direct effect of adoptive parent depressive symptoms on child functioning at 27 months (environment) and an indirect effect of birth mother depressive symptoms.¹¹ Depression has an effect on the child, both through genes and the environment.

⁹ Narusyte, J., Neiderhiser, J. M., D'Onofrio, B. M., Reiss, D., Spotts, E. L., Ganiban, J. et al. (2008). Testing different types of genotype-environment correlation: An extended children-of-twins model. *Developmental Psychology, 44*, 1591-1603.

¹⁰ Narusyte, J., Neiderhiser, J. M., Andershed, A. K., D'Onofrio, B. M., Reiss, D., Spotts, E. L., et al. (2011). Parental criticism and externalizing behavior problem in adolescents: The role of environment and genotype-environment correlation. *Journal of Abnormal Psychology, 120*, 365-376.

¹¹ Pemberton, C. K., Neiderhiser, J. M., Leve, L. D., Natsuaki, M. N., Shaw, D. S., Reiss, D. et al. (2010). Influence of parental depressive symptoms on adopted toddler behaviors: An emerging developmental cascade of genetic and environmental effects. *Development and Psychopathology, 22*, 803-818.

Self-Regulation Failure: Identifying and Modifying a Risk Phenotype

Timothy J. Strauman, PhD, Professor of Psychology, Duke University

Dr. Strauman's project¹² is designed to test a model of a risk phenotype of self-regulation failure and then test a set of micro-interventions targeting that phenotype. The term self-regulation is used to denote processes by which people identify and pursue goals and evaluate progress. Many behavioral and medical disorders involve failures in self-regulation of goal pursuit.

Three potential mechanisms for self-regulatory dysfunction have been identified in the literature. Regulatory focus theory from social psychology posits that individual differences in regulatory focus are predictors of responses to goal pursuit success/failure feedback. Parallel work in cognitive neuroscience has examined the role of the orbital prefrontal cortex in goal representation and pursuit. The third source is from behavioral genetics: specifically, the heritable variability in the COMT gene, which regulates synaptic dopamine concentrations in the prefrontal cortex, is a predictor of individual differences in affect regulation.

Dr. Strauman and his colleagues predict that the three-way combination of dominant promotion orientation, COMT Met/Met genotype, and chronic promotion goal pursuit failure represents a risk phenotype for self-regulation failure. Such individuals will be at risk for failing to disengage from goal pursuit, intense dysphoric affect, diminished sensitivity to reward cues, and loss of approach motivation. These hypotheses will be tested with rapid idiographic goal priming with success and failure feedback among college students and adolescents. It is expected that promotion goal priming will be associated with greater left orbital prefrontal cortex activation and prevention goal priming will be associated with greater right orbital prefrontal cortex activation. A three-way interaction of promotion strength, COMT genotype, and success/failure feedback is predicted to identify risk phenotype in the goal priming task.

Findings to date on the goal priming task include: 1) rapid priming of idiographic promotion goals is associated with left orbital prefrontal cortex activation, as predicted; and, 2) when compared to college students, adolescents do not display activation in other regions associated with the self in response to promotion goal priming. Next steps include a proof-of-concept analysis for the hypothesized risk phenotype and using the findings for the basis for testing micro-interventions to alter dysfunctional responses to failure feedback within the phenotype.

The connection between the present study and behavior change is the idea that micro-interventions can be targeted to the self-regulation difficulties of individuals identified with this particular risk phenotype. A previous study of the differential efficacy of a self-regulation focused therapy for depression compared to standard CBT demonstrated a difference in response between subjects with and without identified self-regulation problems. This provides support for the idea that particular interventions can be better matched with individuals when there is evidence of a mechanism of action at play. Novel strategies for behavioral intervention

¹² Dr. Ahmad R. Hariri is co-principal investigator for this project but was unable to attend the meeting.

for individuals with the risk phenotype being explored in the current study include efforts to reduce promotion engagement strength in response to failure feedback and disrupting promotion fit in response to failure feedback.

Question and Answer

This study involves planning for a three-way interaction *a priori*, which is challenging. The behavioral data suggest what they are likely to find, but what is lacking is genotype variability. Dr. Strauman is also looking at DAT1 effects. Sufficient recruitment will be necessary to allow for a fair test of these hypotheses given that some of these effects are small.

Drs. Hariri and Strauman also will be able to look at structural magnetic resonance imaging (MRI) information (e.g., cortical thickness) against the genetic markers, although the study includes no hypotheses about structural relationships so that aspect is exploratory. The subjects are being drawn from a much larger 5-year study, so the team will have access to a broad range of data.

Dr. Strauman noted that the psychological importance of naturally occurring variability in the COMT gene is supported in the animal literature and in a growing number of human studies if one looks broadly at goal processing tasks and information processing generally.

Affective and Genomic Mediators of Sustained Behavior Change

Barbara L. Fredrickson, PhD, Kenan Distinguished Professor of Psychology, University of North Carolina, Chapel Hill

The overarching aim of this project is to investigate how positive emotions alter bodily systems in ways that ultimately reinforce sustained behavior change. This aim has been inspired by existing data from Dr. Fredrickson's Positive Emotions and Psychophysiology (PEP) Lab, the work of Dr. Steve Cole (collaborator) in social genomics, and the cytokine theory of depression.

Research from the PEP Lab has found that loving-kindness meditation raises trait positive affect, and those who experienced an early boost in positive emotions from the intervention were four and a half times more likely to have continued the meditation practice 15 months later.¹³ Vagal tone predicts high positive emotions yield as a result of loving-kindness meditation practice. People who have this baseline parasympathetic marker are better able to use meditation technique for good outcome. Also, learning this meditation technique increases vagal tone. Other work suggests that mental health status predicts positive emotions yield of wellness behaviors (e.g., learning something new, helping other people, engaging in social interaction). People identified as flourishers (as opposed to non-flourishers or depressed individuals) receive a bigger boost from positive activities.

¹³ Cohn, M. A. & Fredrickson, B. L. (2010). In search of durable positive psychology interventions: Predictors and consequences of long-term positive behavior change. *The Journal of Positive Psychology, 5*, 355-366.

Dr. Cole's work using a bioinformatics approach to social genomics also served as an impetus for this project. Dr. Cole looked at more than 22,000 genes in lonely people versus socially integrated people and found roughly 200 genes that were differentially expressed in chronically lonely people. This bioinformatics approach helps elucidate what is happening between environment, emotions, and genetics and how they affect health and behavior.

The cytokine theory of depression also informed the present study. The theory posits that high inflammation produces survival promoting sickness behaviors (e.g., reduced positive affect and emotion, increased negative affect, and social withdrawal) and the effects are reciprocal. Relatedly, anti-inflammatory processes may regulate wellness behaviors (e.g., activity, curiosity, social engagement). It is possible that when internal biological systems register health and opportunity (as opposed to illness and threat), the wellness behaviors may become increasingly rewarding through amplifications of their positive emotion yield.

Dr. Fredrickson developed the Upward Spiral Model of Lifestyle Change that posits that in cases where a new wellness behavior elicits positive emotions, it increases changes in biological resources (e.g., vagal tone, oxytocin, blood pressure), and over time may lead to longer term changes for improved health and well-being. The specific aims of this study are to: 1) identify peripheral biological resources and genetic polymorphisms that moderate the link between wellness behaviors and their positive emotion yield; 2) identify the biological signaling pathways that mediate the proposed association between increases in positive emotions and changes in inflammation-related gene expression; and 3) investigate the pathways through which increases in positive emotions influence changes in inflammation-related gene expression, sustained wellness behavior, and associated health outcomes.

Laboratory tests are being conducted to address the first aim using two kinds of guided meditation, loving-kindness meditation (with positive emotions) and mindfulness meditation (neutral emotions), as the targeted wellness behavior. Baseline measures, pre- and post-meditation blood draws, blood pressure, vagal tone, C-reactive protein, and oxytocin are being collected.

The second part of the project will be a large field test of the entire model that looks for changes in gene expression. The same measures will be applied to the subjects in the lab, and then they will engage in a 12-week period of daily reporting of emotions and behavior. Subjects will be randomly assigned to one of the two types of meditation workshops and will be brought back to the lab after the 12 weeks of reporting and then again 12 months later. The goal is to predict who will show the biggest changes to wellness behaviors and to the extent there is change, and see if the change is mediated by effects on gene expression that predict long-term behavior change.

Question and Answer

Dr. Fredrickson clarified that they will begin by looking specifically at the 209 genes across replications Dr. Cole has found to show changes with stress and loneliness, but they will have the capacity to look across all 22,000 genes to see if there is a different set of processing genes that are more responsive to positive emotions. Once more is known about transcription factors,

the team can return to the blood samples and test hypotheses iteratively. Dr. Fredrickson is interested in how positive emotions can be used to change behavior non-consciously.

In response to a question about identifying individuals who will respond to a particular intervention, Dr. Fredrickson noted that one goal is to triage. Genotyping people in the future may not be necessary. If self-reported affect during the first week of the intervention is the best predictor of wellness behaviors 15 months later, then individuals can self-predict, and it would be a low-cost intervention to inform people of that.

Determinants of Adolescent Exercise Behavior: Towards a Family Evidence-Based Intervention

James Hudziak, MD, Professor of Psychiatry, Medicine and Pediatrics, University of Vermont

Dr. Hudziak argued that families would benefit if the field of child psychiatry shifted its emphasis to developing strategies for good emotional health for all people (i.e., pursue health promotion more globally) from the typical approach of focusing treatment on very ill individuals, for whom treatment is least effective. He explained the model of support offered by the Vermont Family Based Approach to demonstrate this type of desired effort. The model includes a tiered level of support for three categories of families: well group (no evidence of emotional/behavioral problems), at-risk group (evidence of emotional/behavioral problems among parents), and ill group (evidence of emotional/behavioral problems among children). All families receive support from a family wellness coach using evidence-based programs collected in a tool kit (e.g., nutrition, exercise and healthful activities, physical and mental health, and effective parenting programs). In addition to the family wellness coach, families in the at-risk group receive evidence-based psychotherapeutic interventions delivered from the family perspective. Families in the ill group receive psychotherapeutic and psychopharmacologic interventions from a family-based psychiatrist.

Dr. Hudziak's study focuses on one component of the health promotion programs offered through the family wellness coach to all families—the sports and exercise program. Dr. Hudziak's team aims to identify the specific genetic and environmental influences on exercise behavior and develop a family-based intervention to see children through the transitional ages of 9 to 13 years old so that they maintain their exercise (i.e., promote a shift from exercise ability to exercise availability).

The specific aims of the study are to: 1) determine the causes of individual differences in voluntary exercise behavior from childhood to young adulthood (using the Netherlands Twin Registry); 2) test the hypothesis that individual differences in exercise ability and the psychological response to exercise are the major factors underlying heritability of adolescent exercise behavior in the laboratory; and 3) investigate the feasibility and short- and long-term effects of a family-based interactive voice response (IVR) system intervention protocol targeting exercise behavior change in young adolescents.

Several findings have emerged from pilot analyses addressing the first aim. Early participation in exercise behavior in young children, although doubtless influenced by genetics (better

athletes may already get more pleasure than those who struggle), is primarily driven by environmental factors. Ongoing analyses will look at the relationships between psychopathology measures, substance use measures, and body mass index (BMI) on exercise behavior in multivariate models. By age 13, and in association with a number of societal factors (e.g., only gifted athletes continue to exercise regularly after age 13), participation in exercise becomes primarily due to genetic factors in this environment.

The second aim will test the association between exercise ability and current exercise behavior and establish a gene-exercise interaction using a laboratory protocol with twins. The laboratory protocol also will establish the heritability of the acute psychological responses during and after a standardized exercise protocol, test the association between the acute psychosocial response to exercise, and establish the contribution of genetic factors to this association. This portion of the study will begin in October 2011 in Amsterdam.

The goal for the third aim is to design and test a family-based IVR intervention to change exercise behavior in young adolescents. The treatment group will consist of children aged 9 to 13 years old who do not exercise on a daily basis with the behavior change goal of 30-minute daily exercise over a 6-week intervention period. IVR intervention technology has been shown to be highly successful in the field of psychiatry and has been used previously in exercise intervention. In addition to IVR, methods will include an iPhone application, texting reminders, and the use of Twitter to encourage competition between groups and schools. A pilot study of 25 girls and 25 boys will evaluate the enrollment process and inform modifications of the study to ensure adequate participation levels (e.g., determining if it is better to enroll parents or children).

Question and Answer

In response to a question about gene correlations for athletic ability over time to determine if the same genes are at work at different ages, Dr. Hudziak noted that it is possible to look at exercise behavior using a molecular genetics approach, but it is less sophisticated than a behavioral genetic approach that is more mathematically based. It is known that genes turn on and off, but it is unclear if there are new genetic factors at age 13 that were not present before. Dr. Hudziak is working with a doctoral student who will focus on this issue.

General Discussion

Participants discussed the value of learning about multiple small genetic pathways to behavior mechanisms versus finding one large explanatory single nucleotide polymorphism (SNP) or gene. The remainder of the discussion focused on clarification of Dr. Fredrickson's study.

A decade ago there was much optimism that a single SNP or gene would have significant explanatory power. It is now becoming clear in the genetics literature that there are many small effects that operate through multiple SNPs. In thinking about an intervention as an environmental effect that will interact through gene and epigenetics to change behavior, it is likely that there also will be a lot of small effects through multiple SNPs.

Some argued that there may be collections of hundreds of small effects but through parsimony of multiple studies, there can be greater understanding of the mechanisms of self-regulation and emotions. There is a lot of potential in the aggregation of small effects, and it is an opportunity rather than a limitation. In addition, pathway clusters can be examined with extremely large samples. Bioinformatics now allows for new techniques computationally that make these analyses more realistic.

Dr. Fredrickson explained that because so little is known about overall positive emotions, her study is grounded in the literature from negative psychology and depression, which is why they are choosing to focus on inflammation (cytokine theory of depression) and oxytocin at this point. Other than the strong work that has been done in depression, there was very little guidance on where to start.

Dr. Fredrickson noted that previous studies have demonstrated that mindfulness meditation gives people the skills to downgrade negative emotions, but does not boost positive emotions. Loving-kindness meditation provides participants with the skills to generate positive emotions. One hypothesis of the study is that individual differences predict the type of meditation that will work best for the individual. Understanding how interventions actually work is critical and has the potential to revolutionize how talk therapy is applied.

Dr. Fredrickson further described the cohort that will be used for her study: healthy, working, mid-life adults aged 35 to 65 years old in the healthy and ordinarily stressed population. She is not selecting for disease nor using it as an exclusionary factor. All chronic illnesses and medication will be included and measured. Participants in the lab will be asked if they are healthy that day, and vitals will be obtained to document possible inflammation due to infections. Volunteers have been primarily white females, and it has been a challenge to obtain a diverse sample.

Social and Policy Approaches

The Role of Policy and the Environment in Influencing Behavior Change: Examples from Chronic Disease and Public Health

Jamie F. Chriqui, PhD, MHS, Senior Research Scientist, University of Illinois at Chicago

Policy strategies can benefit all people exposed to the strategy by providing opportunities and support for developing more healthful behaviors rather than focusing on changing individual problem behaviors.¹⁴ Population-based policies may alter behaviors (e.g., availability of bike lanes may increase biking to work) or social norms (e.g., seeing physically active neighbors may lead to greater acceptance of physical activity). A key finding in this area of research is that policy interventions can have a sustained population-level impact on health, particularly in

¹⁴ Brownson, R. C., Kelly, C. M., Eyster, A. A., Carnoske, C., Grost, L., Handy, S. L. et al. (2008). Environmental and policy approaches for promoting physical activity in the United States: A research agenda. *Journal of Physical Activity and Health*, 5, 488-503.

efforts to prevent chronic diseases and related risk factors such as heart disease and stroke, smoking, alcohol abuse, obesity, and physical inactivity.

Examples of successful policy changes that have influenced public health include vaccine preventable diseases (pneumococcal conjugate and rotavirus), maternal and infant health (folic acid), and tobacco control through taxes, smoke-free air laws, and comprehensive tobacco control programs. There is a clear inverse relationship between cigarette prices and cigarette sales over several decades. Price in particular has had the most sustained impact on tobacco use. Young people tend to be more price-sensitive and tend to discount the future more heavily than adults; young smokers are less addicted than adult smokers. However, peer influences are much more important for youth, indirectly accounting for one-third of the overall impact of price on youth.¹⁵ Smoke-free air laws have taken time to implement, and most started small and over time have expanded to complete bans in many places. The combination of increasing price, restricting exposure, and restricting access has had a sustained impact on smoking prevalence in the United States.

Much of the work to date on policy and environmental change has been guided by socio-ecological theory that posits a reciprocal relationship between behaviors and the social environment. There are five spheres of influence in the Socio-Ecological Model: intrapersonal factors, interpersonal groups and processes, institutional factors, community factors, and public policy. While informative conceptually, concerns have been raised about ecologically based studies that examine the impact of policies on groups rather than on individuals. Such correlations cannot be substituted for analyses of the effects of interventions on individuals. This risk of fallacy with ecological models has led many in public health toward systems theory. A systems perspective recognizes multiple influences in the real world, the interconnectedness and interplay between various sub-systems, and the need for a cross-disciplinary approach.

In summary, policy and environmental changes can have sustained population health and behavioral impacts, but they often require patience. A policy strategy for behavior change requires viewing behavior as being influenced by a much larger social system.

Using Media to Explore Mechanisms of Behavior Change Among College Students

Megan A. Moreno, MD, MEd, MPH, Assistant Professor of Pediatrics, University of Wisconsin-Madison

Social media provides an opportunity to learn more about adolescent health behaviors and to explore the possibility that social media can be used as a medium for healthful messages. More than 90 percent of college students use Facebook, and they frequently reference and display alcohol and substance abuse through social media. In a previous R21 study funded by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), Dr. Moreno found that display of intoxication or problem drinking references on Facebook was positively associated with self-

¹⁵ Chaloupka, F. J. (2003). Contextual factors and youth tobacco use: Policy linkages. *Addiction*, 98, 147-149.

reported problem drinking behaviors through clinical screening. Facebook might present new opportunities for investigation, screening, and prevention.

The specific aims of Dr. Moreno's current study are to: 1) test the predictive validity of displayed references to alcohol, drugs, and tobacco displayed on Facebook profiles for identifying substance use intention, use, and misuse; 2) test a provisional model of Facebook as a mediator of behavior change; and 3) investigate methods by which Facebook can be used as an intervention tool among college students (e.g., via Resident Advisors).

The first aim will be accomplished through monthly Facebook profile evaluations and bi-yearly interviews, scheduled in concert with changes in behavior detected on Facebook, to assess substance use attitudes, intentions, and behaviors. Displayed references incorporate a definition of "display" from the Media Practice Model: engagement in a behavior; consideration of engagement in a behavior; or bragging/boasting about a behavior. Facebook provides a perfect platform for young people to either display who they are or who they want to be. Content on Facebook profiles with references to drinking alcohol in the past, present, or future or a picture showing the profile owner drinking from a clearly labeled alcoholic beverage container will be coded for alcohol use. Displayed references must be specific in order to be coded as "alcohol use" (e.g., references to "partying" or pictures with red Solo cups do not count). Displayed references to being drunk, wasted, or hung over will be coded as intoxication. Coding for problem drinking references was developed in accordance with the CRAFFT (car, relax, alone, forget, friends, trouble) Screening Test and includes references to drinking alone, drinking and driving, forgetting/blacking out, getting into trouble, or getting arrested. Pilot data using 300 public Facebook profiles of 18-year-olds have revealed 76 percent have substance use references (73 percent alcohol, 9 percent tobacco, 18 percent drugs).

The second aim involves developing and testing a Facebook influence model that draws from peer effects models, media effects models, and stages of behavior change. The model begins with social transmission of information and peer communication through Facebook and the user's level of investment in Facebook leading to substance use attitudes, intentions, and use. The third aim is an exploratory effort that will develop and test interventions to promote healthful behaviors using Facebook.

Question and Answer

Dr. Moreno acknowledged that using two forms of self-report, the Facebook profile analysis and interviews, could result in higher correlations. However, the longitudinal nature and use of the timeline follow-back method for all substance use will hopefully allow for obtaining current state information in a systematic manner with less recall bias.

Dr. Moreno clarified that the Facebook profile analyses will be accomplished by "friending" the participants in the study, thereby giving the researchers access to their profiles. No participant has declined enrollment in the study because of this requirement.

A second state university sample will be used to test for differences and examine the possibility of a particular culture of drinking at the University of Wisconsin-Madison.

The Neuroeconomics of Cues and Alcohol Control Policy

Henry Saffer, PhD, Research Associate, National Bureau of Economic Research

Prior economic studies of alcohol advertising have measured an average population effect of advertising with mixed results. Industry has used these weak or mixed effects findings to resist change in policies on advertising. Dr. Saffer's work in this econometric study is based on a theoretical neuroeconomic model of cues that argues that past alcohol consumption may have an important role in modifying the effects of the advertising and price of alcohol. Cues refer to alcohol advertising on television and in retail outlets. A key underlying construct in this model is that the effect of an addictive substance on the forecast of hedonic pleasure, rather than on hedonic pleasure itself, holds the key to understanding the role of cues on alcohol consumption.

Two key neurological processes also provide the basis for developing the empirical model: 1) the rational mechanism develops causal models of the world and reasons out the implications of different choices, but needs time and effort to reason and make a choice; 2) the hedonic forecasting mechanism (HFM) is fast and efficient at learning simple action-reward correlations, but it can only learn about a limited range of near-term consequences. For non-addictive goods, the HFM learns through feedback from the post-consumption experience only. Addictive goods short-circuit this process, and the HFM in this case learns from the consumption itself as well as from the post-consumption experience.

Experiments of cues and rewards have demonstrated that the HFM forecasts a hedonic response proportional to past consumption rather than proportional to the level of the cue. Therefore, the same cue will produce a greater response in heavy consumers than is produced in light consumers. Cognitive control is required to exert conscious effort to rely on the rational mechanism rather than the HFM; however, it becomes more difficult to exercise cognitive control as exposure to cues increases. Also, individuals differ in their ability to exercise cognitive control because of genetics, stress, and other reasons; these variations help explain why some individuals become heavy drinkers and some do not.

The theory will be used to construct a model that will be tested with 100,000 observations. Heavy drinkers are predicted to be more responsive to advertising (policies restricting advertising are targeted at heavy drinkers) and less responsive to price (price and excise tax policies are targeted at light and moderate drinkers). There is empirical evidence that heavy drinkers have lower price elasticity than moderate or light drinkers.

Data for testing this model come from the Young Adult Children of the National Longitudinal Survey of Youth 1979 and the National Longitudinal Survey of Youth 1997. A weighted average of past consumption variable—addictive stock—will be created for each case. Data on television advertising, alcohol prices, state alcohol taxes, and density of alcohol retail outlets have been collected for the corresponding time periods.

General Discussion

The general discussion touched on three main themes: the challenge of understanding and unifying multiple levels of analysis of mechanisms; several aspects of policy interventions; and the challenges of using research to influence policy.

Mechanisms of behavior change can be analyzed on multiple levels (e.g., genetic, individual behavior, population). It is difficult to know how to reconcile individual mechanisms with the complex ecological context. Some participants noted that the strength of the SOBC initiative is that there are multiple projects occurring simultaneously on these various levels and they can inform each other. It is possible that greater understanding of biological mechanisms can promote understanding of individual differences and efficacy of treatment (i.e., why interventions do not work for everyone). Related to this notion of complexity is the tension between population-level policies and small-scale interventions targeting individuals with specific problem behaviors. The mechanisms by which each type of intervention is operating may be different and will require different types of investigations. In some cases, comparisons of the approaches might be warranted.

Policy-level interventions are not effective in all areas of behavior change. Social acceptability, cost-effectiveness, and political feasibility are factors to consider. There may be situations where a policy intervention would produce the desired results but would not be socially acceptable (e.g., outlaw smoking, a complete restructuring of the food industry to prevent obesity) or cost-effective.

Multiple interests influence the policy-making process, and research is often undervalued. Industry, advocacy groups, and myriad political factors all impact political decision making. Often research does not provide clear answers, or it takes a long time to amass adequate evidence, which is incongruent with making policy within specific time frames. This reality is made more challenging by the limitations of research on the effects of policies. Policy interventions are not easily amenable to RCTs, yet other types of research are not given as much weight in the decision-making process. It can also be difficult to find funding for policy research.

Emotional Self-Regulation

Emotion Regulation and Self Control

B.J. Casey, PhD, Professor of Developmental Psychobiology, Weill Cornell Medical College

MRI enables visualization and measurement of deep, primitive brain regions involved in desire and emotions. Individual differences in brain activity can predict behavior change and therefore help to identify candidates for targeting interventions. There are also sensitive periods of brain development between childhood and adulthood in which the impact of behavior change can be maximized (e.g., the subcortical areas develop before the prefrontal areas). Key areas of study include development, social and psychological contexts, and individual differences.

Development

Age-specific changes in regional brain development can impact behavioral choices. There are dramatic developmental changes in the prefrontal and subcortical regions during adolescence that point to optimal windows of impact. The hallmark of behavioral development is a gain in the ability to suppress an inappropriate action in favor of an appropriate one (impulse control) understanding that there are individual differences and the influence of context. There is a linear relationship (albeit with a high degree of individual differences) between age and performance development of impulse control. Likewise, prefrontal activity during correct performance of an impulse control task shows a linear association with age.

Nonlinear changes are observed when withholding a response to alluring social cues (e.g., happy faces) in adolescents relative to children and adults. Adolescents make more commission errors to positive cues than neutral ones, and they show enhanced activity in the ventral striatum to positive social cues. A similar inverted U pattern is observed in response to negative cues across development. Specifically, adolescents show greater amygdala activity in response to cues that signal threat than do children or adults. There is an inverse association of subcortical limbic and ventromedial prefrontal activity, two areas of the brain tightly coupled with behavioral performance (i.e., subject is much slower to respond to negative cues relative to neutral or happy cues). Notably, repeated threat stimuli result in either habituation or exacerbation of the response. Interventions for emotion regulation should take into consideration not only the existence of a heightened sensitivity to negative cues, but also how quickly and easily the person can regain control and fine-tune his or her own behaviors. This ability is what is associated with emotion dysregulation and overall ratings of anxiety.

Social Context

Emotionally charged contexts may lead to emotional brain regions “hijacking” prefrontal control circuitry, leading to poor behavioral choices. More risky decisions and crashes occur in adolescent driving behavior when a peer is present than when the driver is alone, and this greater peer influence among adolescents is seen in the ventral striatum based on work by Larry Steinberg. The presence of a peer increases adolescent risk-taking by enhancing activity in the brain’s reward circuitry. In addition, stress can dampen prefrontal function and the ability to shift attention to something other than the stressor. Attention regulation methods may not be as effective for someone under chronic stress relative to those with low stress.

Individual Differences

Variation across individuals (e.g., impulsivity, sensation seeking, emotional reactivity) impacts choice behavior. Cross-sectional and longitudinal data from delay of gratification tests over the course of 40 years of research provide an opportunity to look at behavior as well as neural correlates. Social peer cues rather than marshmallows are used for adults in capturing delay of gratification behavior. Low delayers have difficulty suppressing responses to hot (alluring), but not cold (neutral) cues. No real differences emerge between high and low delayers with cold tasks, but for some people, hot stimuli are much harder to suppress. The prefrontal cortex is involved in impulse control, but the area that differentiates the groups the most is the ventral striatum that is activated during the happy go/no go trials. The ventral striatum is sensitive to social positive cues, and its activity is enhanced in low delayers.

In conclusion, the behavioral and imaging studies of emotion regulation and self-control provide evidence for significant individual and developmental differences in these abilities and the potential for change in these abilities by social and psychological contexts. Development, social contexts, and individual differences can lead to imbalances between control and emotional systems, yielding suboptimal choice behavior. These are important considerations when determining approaches to behavior change.

Self-Regulation as a Biological Mechanism for Excess Weight Gain in Toddlers

Alison L. Miller, PhD, Research Assistant Professor of Developmental Psychology

Julie C. Lumeng, MD, Assistant Professor of Pediatrics

University of Michigan, Ann Arbor

Disparities in obesity appear in early childhood. Forty percent of low-income children are overweight by the age of 36 months old, and there is an increase in overweight prevalence around 24 months. Living in a high-stress poverty environment during early development may contribute to poor physiological self-regulation, which also may increase the propensity for weight gain. The goal of this project is to examine behaviors and physiology among toddlers aged 1 to 3 years old to determine if there are predictors of obesity risk.

Toddlers are at an interesting stage developmentally for studying self-regulation. Toddlers can do some things on their own but are not highly capable of resolving conflicts independently. They may require a lot of mentoring from a parent or caregiver to learn and practice self-regulation skills. Physiological aspects do not always track behavior in toddlers, and this may change through the course of development. It is possible that food and eating can serve as a self-regulation strategy. Comfort foods are calming and reduce emotional and physiological arousal. Emotional eating and stress physiology are associated with weight gain in adults.

The groundwork for this project came from a Challenge Grant study of cortisol levels in 380 preschool children aged 3 to 5 years old. Children in the study who are overweight had flattened cortisol in the morning, where it should be high in the morning and lower during the day. The data from this study are currently being analyzed.

The conceptual model for Dr. Miller and Dr. Lumeng's SOBC study includes aspects of child self-regulation: food-related self-regulation, non-food-related self-regulation, and biological self-regulation. Together, the child self-regulation leads to eating behavior and diet and then weight status. The study aims to: 1) examine relative contributions of food-/non-food-related self-regulation and salivary cortisol/alpha amylase to preference for comfort food, emotional eating, and weight status, and to determine if these associations differ across ages 21, 27, and 33 months; 2) examine biobehavioral markers of self-regulation at 21 months as related to change in weight status between 21 and 33 months, mediated by preference for comfort foods and emotional eating; and 3) identify trajectories of development of behavioral self-regulation and determine if trajectories are associated with preference for comfort foods, emotional eating behavior, and weight status at 33 months, independent of physiological markers of self-regulation at baseline.

The study will include 250 toddlers at 21, 27, and 33 months of age. Measures will include observations of emotional/behavioral self-regulation, physiological stress indicators (cortisol, alpha-amylase), observed eating behavior assessment, parent-reported dietary preference assessment, parent-reported child eating behavior, child weight and height/length, and demographics and covariates (e.g., maternal BMI). Saliva will be collected for cortisol and alpha-amylase assays (diurnal pattern) on three separate weekdays through home visits (child collected three times per day, mother in the morning only). The self-regulation protocol includes food contexts (e.g., snack delay, delay of gratification) and non-food contexts (e.g., gift delay, no-touch toy). Observational data will be coded for self-regulation behaviors (negative/positive affect, attentional focus, time waiting, task success, self-regulation state); eating behavior (negative/positive affect, attentional focus, rate of eating, enthusiasm for comfort foods); and other behavior such as parent-child interaction quality during free play.

This study has the potential to inform understanding of self-regulation at this early developmental stage. Eating behavior is a model for understanding the role of self-regulation in health outcomes very early in the life span. Health disparities in many areas are related to poor self-regulation skills. It is possible that the results could provide new directions for obesity prevention efforts. Dr. Miller noted that if possible, long-term follow-up with this sample would be informative and enhance the ability to identify predictive power.

Question and Answer

The toddlers in the study will be in a variety of care arrangements (e.g., at home, day care, Early Head Start), and these arrangements are being noted and tracked. However, Drs. Lumeng and Miller are not collecting all nutrition information in all care arrangements because of the complexity.

Emotion regulation could be at play at the other end of the spectrum; diet restriction and eating disorders also have emotion regulation properties. However, there is little report of diet restriction behavior among toddlers. It is possible that there are similar mechanisms at work in babies and toddlers with failure to thrive, but that is not the focus of this project.

The Development of Emotion Regulation Mechanisms Impacting Health

Kevin Ochsner, Associate Professor of Psychology, Columbia University

The inability to cope with stressors can lead to maladaptive forms of regulation (e.g., emotional eating, smoking, risky behavior) that over time can lead to health problems. The goal is to regulate emotional responses to avoid maladaptive responses. Emotions are generated when a stimulus (internal thoughts or external events) is presented in context. Attention is then drawn to the stimulus or its attribute and the person decides if it is positive or negative. This process involves the amygdala and ventral striatum; the amygdala seems to be important for threatening stimuli, and the ventral striatum is important for encoding rewarding and enforcing positive stimuli. This appraisal process generates changes in experience, behavior, and physiology (the response), and the cycle repeats over time.

Emotion regulation strategies can be employed at different points in the cycle: 1) selection (avoid the stimulus); 2) situation modification (make the situation better); 3) attentional control (shift focus away from stimulus); 4) cognitive change (reappraise the meaning of the stimulus); and 5) response modulation (suppress or enhance behavior or expression in response to the stimulus). The default and reduced barrier strategies Dr. Laibson presented earlier in the meeting are examples of structuring the external world in ways that avoid or improve the stimuli; when the default is the desired behavior, there is no need for effortful control of behavior. Response modulation can be problematic and lead to maladaptive behavior in the long term. Dr. Ochsner's study focuses on emotion regulation strategies involving attentional control and cognitive change.

The current study is based on evidence that early appearing regulatory abilities predict adult outcomes. Walter Mischel's work on the delay of gratification task, which models temporal discounting, has shown that delay times measured in childhood predict changes in social/cognitive coping measures, SAT scores, and BMI in adolescence as well as drug use, features of mental disorder, and divorce in adulthood, all while controlling for child health and social environment and individual differences in capacity for regulation. Regulation strategies that increase ability to delay gratification are attentional control (ability to shift focus away from the treat) and cognitive reappraisal (pretend the treat is something else). Research has shown how these strategies work in adults, but the relationship between the strategies, especially as they develop from a young age or how they predict health outcomes in adolescents, is unclear.

The specific aims of Dr. Ochsner's study are to: 1) chart the developmental trajectory of emotion regulatory mechanisms that support behavior change through childhood and adolescence and 2) relate the behavioral, physiological, and neural measures collected under the first aim to measures of health and health behaviors, including BMI and substance abuse. The study will use a cross lag design: ages 6 to 18 years old for Time 1 and ages 9 to 21 years old for Time 2. Behavior measures will include delay of gratification health-related data (e.g., BMI, substance use, anxiety, depression). Brain imaging will be completed with functional magnetic resonance imaging (fMRI) assessments of attentional control and reactivity and reappraisal and structural MRI of gray and white matter.

The investigators hypothesize that reactivity systems mature early and regulation systems mature later. There is evidence that during adolescence there is continuing structural development in the brain. It may be possible to identify signatures of reactivity and regulation that predict vulnerability to maladaptive health outcomes for individuals across development.

Separate pilot studies were conducted for behavior and fMRI. Seventy subjects aged 10 to 22 years old participated in the reappraisal paradigm. They were provided images that were neutral or negative, social or non-social. In one trial, subjects were told to imagine themselves within the picture and feeling emotions. In a second trial, subjects were told to imagine themselves far away from the picture and in the role of a reporter. Findings indicate that subjects' ability to regulate increases with age when subjects imagined themselves far away. The ability to down-regulate negative affect is weaker in non-social versus social stimuli. The

fMRI pilot study of 20 subjects shows that amygdala reactivity stays constant across age, while prefrontal systems are activated as a person ages. Amygdala modulation does change over age and is entirely dependent on social versus non-social stimuli.

Mechanisms research can occur on multiple levels of analysis including person level (traits, symptoms, disorders); social/cognitive/affective performance (behavioral measures of emotion generation, regulation); information processes (affect generative and cognitive regulatory processes); neural systems (cortical and subcortical systems); and cellular and genetic assays (neurotransmitter and receptor levels, alleles). Dr. Ochsner's study includes aspects of three of these levels: social/cognitive/affective performance, information processes, and neural systems. The frontier of mechanisms research is to link all five levels of analysis.

Question and Answer

Another major change that occurs during adolescence is puberty and alterations in hormones. It is possible that these changes somehow interact with the brain development discussed. Dr. Ochsner's study does not collect hormonal assays, but does collect data on pubertal stage. Dr. Ochsner also clarified that they will have structural and resting state MRI scans as well, but not necessarily for every child.

Emotions and Choice: Mechanisms of Behavior Change

Elizabeth A. Phelps, PhD, Silver Professor of Psychology and Neural Science, New York University

Dr. Phelps' study focuses on emotion and decision making. Current findings from affective neuroscience are demonstrating that conceptualizing emotions and reasoned decision making as competing processes is not accurate. Emotion has a modulatory role in cognition and in the value computation. It is possible that emotion has a modulatory role in decision making as well. This study is investigating whether the tools of affective neuroscience and neuroeconomics can be used to characterize more precisely how and when emotion is incorporated into the value computation as well as to change emotion and choice.

Emotion involves several components: subjective feelings, bodily response, expression, and tendency to action.¹⁶ Dr. Phelps will focus primarily on bodily response because it can be measured and it does not rely on self-report or interventions. Arousal will not be related to all aspects of decision in the same way. Three decisions will be examined: loss aversion, risk sensitivity, and temporal discounting rate. The specific aims of this study, for which both the behavioral outcomes and their underlying neural representation will be investigated, are to: 1) investigate the link between variability in loss aversion, risk sensitivity, and temporal discounting and physiological arousal response to choice options or outcomes; 2) examine the impact of altering arousal on these decision variables (emotion regulation and pharmacological manipulation); and 3) explore the impact of stress on the decision variables and the effectiveness of the techniques used to alter arousal.

¹⁶ Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, 44, 695-729.

There is a lot of individual variation in loss aversion coefficients, and subjects are more aroused to loss relative to gains. When a regulation strategy is introduced (i.e., think like a trader assembling a portfolio, and this is just one choice of many) the cognitive strategy decreases loss aversion for most participants, regardless of their previous loss aversion. Together, these findings suggest that arousal responses to outcomes are closely related to participants' choices and that perspective taking in the context of decision making has similar behavioral and physiological effects as emotion regulation in more traditional contexts.

In examining the neural mechanisms underlying the behavioral effects, the left amygdala was the only correlate. The amygdala is known to be involved in mediating the effect of emotional arousal across a variety of contexts, including in attention and in memory; the fact that amygdala activity to outcomes parallels the previously observed arousal responses to outcomes is not surprising, and serves as further evidence that behavioral loss aversion as observed in choices may simply reflect arousal-related responses to outcomes. The dorsolateral prefrontal cortex shows a baseline increase in activity when cued to "regulate" ("try to think of something calming in nature") versus when cued to "attend" ("try to focus on your natural feelings and react normally").

Next steps for this study focus on manipulation of loss aversion and will include investigation of the influence of a beta-adrenergic blocker on loss aversion and risk sensitivity (propranolol impacts amygdala; nadolol does not pass blood-brain barrier); the relationship between arousal and discount rate; and how stress impacts these decision variables and the success of regulation. Pilot data show that the introduction of shock (i.e., a threat condition) leads to a decrease in sensitivity and decrease in loss aversion.

Question and Answer

Dr. Phelps is not specifically looking for gender differences in this study, and none has been found in previous studies. However, if gender differences emerge in the findings, the team plans to double the sample. Dr. Phelps noted that other regulation strategies could have different effects, and at this point the investigation is neutral in terms of the type of effects that are expected. This study focuses on economic decision making because it is the best available tool to distinguish risk from loss. This approach is a starting point and will be related to psychopathology. At this point, it is unclear if the regulation strategies introduced in the lab setting will or can have a sustained impact on behavior change. In another study on fear, techniques practiced during CBT are emerging in new learning 2 weeks later; however, the long-term impact is still unclear.

General Discussion

Dissemination of Evidence-Based Interventions

Participants discussed the challenges of disseminating evidence-based CBT interventions in ways that allow for greater access to effective treatments for the broader population. The current system allows for training in proprietary interventions to be limited to a small number of providers (e.g., no new therapists in the United States are being trained in trauma-based

CBT), and/or the costs of obtaining interventions are prohibitive to many providers. Unfortunately, there are multiple barriers to adopting proprietary interventions seamlessly within widespread service delivery systems. Evidence-based interventions do not necessarily have to be delivered through the healthcare system; schools and community organizations could be points of delivery as well.

Technology

Participants discussed technology-based strategies for affecting behavior change among the broader public. One suggestion was to use video game technology to incorporate reappraisal tasks. Advantages of the approach would be cost-effectiveness and likely efficacy. However, several participants expressed strong concern against promoting additional screen time and the unknown deleterious effects such video games could have on children and adolescents during vulnerable periods of development. It was noted that the video game industry is currently conducting one of the largest uncontrolled experiments in the United States, and, therefore, regardless of thoughts on the appropriateness for their use as interventions, the effects should be examined.

The role of social media in understanding or intervening in behavior also should be further investigated. It is possible that social networking sites (e.g., Dr. Moreno's study), text messages, or IVR strategies (e.g., Dr. Hudziak's study) will have a prominent role to play in behavior change at the population level.

Translational and Cross-Disciplinary Work

Participants noted the critical importance of basic research on mechanisms leading to intervention development and testing in larger populations; this connection in research is underdeveloped.¹⁷ Mechanisms research is occurring across multiple levels of analysis and across several disciplines. The value of these multiple studies will be to test measures across studies. The motivation of the OppNet Basic Research on Self-Regulation RFA¹⁸ was to have different disciplines all measuring self-regulation at different levels of analysis, examine how they map onto one another, and learn how they manifest differently throughout the life course. It may be beneficial for the SOBC grantees and the grantees from the OppNet self-regulation RFA to have opportunities for discussion and collaboration in the future in order to move the field forward in service of healthcare reform.

Cost-Effectiveness

Participants had varied opinions on the role of cost-effectiveness as a criterion for behavior change interventions. Changing behavior is inherently expensive, and the notion of cost-effectiveness may be naive. However, many noted that cost-effectiveness takes into account the relative cost of interventions as well as the broadness of the impact and is absolutely critical to consider when obtaining research funding or when attempting to influence policy. One of

¹⁷ There is currently a Program Announcement soliciting applications on developing interventions based on basic behavioral mechanisms work from the Office of Behavioral and Social Sciences Research (OBSSR) at NIH, which can be found at <http://grants.nih.gov/grants/guide/pa-files/PA-11-063.html>.

¹⁸ RFA-AG-11-010 can be found at <http://grants.nih.gov/grants/guide/rfa-files/RFA-AG-11-010.html>.

the primary arguments for the SOBC initiative is that by identifying common mechanisms, more efficient, and therefore cost-effective, interventions can be developed to address multiple behaviors. Additionally, screening for problems is only relevant and cost-effective when there is an evidence-based treatment available for the identified problem.

Participants discussed the possibility of discovering revenue-generating strategies for inducing behavior change (i.e., tobacco taxes). There are many barriers, politically and within industry, to taxation of unhealthful foods. Preliminary findings from work being done at Yale and the University of Southern California on this topic suggest that beverages may be easier to target than food and when the taxes are framed as funding childhood obesity prevention, they are more palatable. However, it will be years before research can provide adequate answers on this issue. Another strategy would be to incentivize consumers to eat healthful foods, and it is possible that effectiveness research could be done to compare the two strategies.

Next Steps

The co-chairs of the SOBC Working Group challenged the presenters to reflect on the meeting and move forward to address critical questions about behavior change work. The focus needs to be on uncovering mechanisms that can produce interventions that affect public health in a cost-effective way. The SOBC initiative needs to be able to estimate a timeline for answering basic questions, developing effective interventions based on the mechanistic knowledge, conducting comparative effectiveness research, and impacting public health broadly.

- 3:15 p.m. BREAK**
- 3:45 p.m. SOCIAL AND POLICY APPROACHES** *NIH Facilitator: Frank Perna, NCI*
Introduction Jamie Chriqui
- 4:05 *Using Media to Explore Mechanisms of Behavior Change* Megan Moreno
Among College Students
- 4:30 *The Neuroeconomics of Cues and Alcohol Control Policy* Henry Saffer
- 4:55 Open Discussion
- 5:15 p.m. ADJOURN**
- 6:30 p.m. NETWORKING DINNER (cash bar available prior to dinner)**
Shangri-La Restaurant, 7345 Wisconsin Avenue, Bethesda, MD
<http://www.shangrilaus.com/> Tel: 301-656-4444

June 21 (Tuesday)

- 9:00 a.m. INTRODUCTION** Patricia Grady, Richard Hodes, Richard Suzman
- 9:15 a.m. EMOTIONAL SELF-REGULATION** *NIH Facilitator: Lisa Onken, NIDA*
Introduction B.J. Casey
- 9:35 *Self-Regulation as a Biological Mechanism for* Julie Lumeng and Alison Miller
Excess Weight Gain in Toddlers
- 10:00 *The Development of Emotion Regulation Mechanisms* Kevin Ochsner
Impacting Health
- 10:25 *Emotions and Choice: Mechanisms of Behavior Change* Elizabeth Phelps
- 10:50 Open Discussion
- 11:20 a.m. GENERAL DISCUSSION**
- 11:50 p.m. MEETING WRAP UP** Jonathan King, NIA
- 12:05 p.m. ADJOURN**

National Institutes of Health
SCIENCE OF BEHAVIOR CHANGE
ANNUAL MEETING OF INVESTIGATORS
Finding Mechanisms of Change in the Laboratory and the Field
NIH Natcher Conference Center, Delegate Room D
June 20-21, 2011

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