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GRANT INFORMATION

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INTRODUCTION

The Research Network on the Etiology of Tobacco Dependence, better known as the Tobacco Etiology Research Network (TERN), was an experiment in knowledge development by the Robert Wood Johnson Foundation (RWJF). It was the first, and to this point in time, the only "transdisciplinary" research network RWJF has funded.

This report is a case study of both the process and the early scientific and human capital outcomes of the network. In this report the authors describe:

- The processes and mechanisms that make transdisciplinary science different from more traditional scientific approaches to knowledge development.
- The network that was developed to facilitate transdisciplinary science.
- The scientific benefits and substantive findings from a transdisciplinary approach to knowledge development.

BACKGROUND AND ORIGINS

The historical context within which TERN was established is the best place to begin. In the early 1990s, RWJF identified substance abuse as a priority goal area. Within the substance abuse goal area, it identified tobacco for special emphasis because of the huge health and health care costs attributable to tobacco use.

There was scientific evidence that nicotine is the drug in cigarettes that produces dependence (Surgeon General, 1988) and that cigarettes are a very efficient drug-delivery device. Also, it had been shown that close to 80 percent of adult smokers have their first

experience with smoking and nicotine while they are adolescents. The principal motivation behind TERN related to this evidence: The likelihood that improving knowledge about the etiology of tobacco use and dependence might significantly improve prevention, treatment and policy interventions to reduce the consequences of tobacco use; and the possibility that a transdisciplinary research network could produce knowledge significantly different than knowledge produced in more traditional approaches to knowledge development.

In the 1990s the dominant conceptual framework for the etiology of substance use involved a list of known risk and protective factors for use of tobacco, alcohol and marijuana organized under several general categories of risk and protective factors (see Hawkins, Catalano and Miller, 1992). The principal limitations of this list are:

- All factors are given essentially the same weight.
- Almost all of the factors are at the individual level and few are focused on the contexts or environmental conditions within which behavior occurs.
- No explicit attention is given to developmental progression, either in use of the substances or in the growth and changes in the individual and their cognitive, emotional, physical and psychosocial development. Further, mere knowledge of the existence and potential importance of these risk and protective factors had been present for some time. Efforts to prevent or treat tobacco use and dependence using these risk and protective factors have produced at best limited success, particularly among youth.

The reasons for limited success in preventing and treating tobacco use and dependence among youth to that point in time were clear.

- Knowledge about the basic causes, processes and mechanisms by which experimentation with tobacco leads to dependence for some and not for others was rudimentary at best. Prevention of transitions in use of tobacco products requires that a great deal more be learned about these distinguishing and differentiating causes, processes and mechanisms.
- Knowledge of the complex varieties of transitions and behaviors associated with childhood and adolescence also was limited. Initiation of tobacco use and becoming dependent on nicotine do not occur in a vacuum. Rather, these behavioral changes usually occur within dynamic and changing contexts that characterize an important stage of development — adolescence.
- The knowledge base is often built upon a single disciplinary perspective.

RWJF reasoned that a prerequisite for more robust and effective prevention and treatment, particularly among youth, would involve addressing these gaps or deficiencies in the understanding of the etiological causes and natural course of tobacco use and dependence from a transdisciplinary perspective.

The study of the etiology of tobacco use and dependence was still a relatively young field in the early to mid-1990s. RWJF's program staff recognized that tobacco use and dependence were "emergent" phenomena influenced by factors from multiple domains, including biological, intrapersonal, interpersonal and social, contextual and environmental, and cultural. While numerous cross-sectional studies had identified and explored these domains separately, few integrated, multidisciplinary, longitudinal studies had been undertaken,

leaving largely unexplained precisely which variables matter most within each domain, the relative importance and interactions among variables within and across domains, and the various developmental pathways to tobacco use and dependence. Further, a disproportionate number of the existing studies had focused on the causes of the initiation of smoking, largely neglecting the antecedents and contemporaneous correlates of the progression from experimentation to regular use and then to dependence.

The fundamental research questions are:

- What are the differences between those who try tobacco/nicotine (about two-thirds of the population) and those who do not try?

- What are the differences between those who try and go on to become dependent on nicotine (about one-third of those who try) and those who do not become dependent?

- What are the causal pathways to tobacco use and dependence on nicotine?

These questions clearly involve a number of complex interacting factors concerning individuals who are also influenced by the numerous environmental contexts in which they live, work, play and change. Some of these are immediate, such as the family, school, neighborhood, peer contexts; some are more distant, such as societal and state-level policies. As RWJF program staff considered how best to address these questions, it became increasingly clear that they could not be answered through the usual research mechanisms involving separate, single-investigator, single-discipline projects. Rather, establishing the kind of knowledge needed for the development of effective, evidence-based prevention and treatment interventions for tobacco use would require a coherent program of interdisciplinary research capable of integrating perspectives and methods from a wide variety of disciplines.

The magnitude of the consequences of tobacco use and dependence in American society, the evident gaps in understanding of the basic causes, processes and mechanisms underlying tobacco use, and the complexity of the research questions that needed to be addressed, led RWJF program staff to consider a variety of programmatic options.

PROGRAM DESIGN

One option that emerged was the transdisciplinary research network. The John D. and Catherine T. MacArthur Foundation, the Canadian Institute for Advanced Research and other knowledge-development organizations were using this kind of research network as a mechanism to facilitate cross-boundary research on scientific questions underlying complex phenomena such as mental health and illness, tropical diseases and cognitive neuroscience.

These networks served as research institutes without walls, bringing together highly accomplished researchers from a variety of disciplinary traditions to ask questions not otherwise able to be addressed; formulate new, comprehensive, and more integrated conceptual and theoretical frameworks (that in a network focused on tobacco use and dependence might be more effective in explaining it and be of practical value as well); design research capable of capturing a wider range of interacting forces; and develop methods able to handle data from many domains, levels of analysis and time frames.

RWJF staff decided that the research network concept was well suited for the kind of interdisciplinary research needed to examine the complex, multidimensional factors that determine tobacco use. Therefore, in early 1996, they sought and received authorization

from the RWJF Board of Trustees to establish and support a research network on the etiology of tobacco use and dependence, an experiment in funding for RWJF.

RWJF established the Tobacco Etiology Research Network (TERN) to strengthen the capacity to develop breakthrough research by:

- Bringing multiple perspectives, disciplines and methodologies to bear on the problem.
- Providing intellectual and financial support for developing needed new conceptual approaches, methodologies and exploratory studies.
- Attracting additional leading senior-level researchers to work on this relatively immature area.

TERN was to bring leading researchers from a variety of perspectives and disciplines to work collaboratively on a regular basis for a period of eight years. During this time period, members of the group, under the leadership of a chairperson, would:

- Share and meld their diverse perspectives and draw on other colleagues in order to assess the state of knowledge and identify major gaps in the field.
- Develop new integrative conceptual frameworks, approaches and methods.
- Develop a research agenda.
- Design and conduct targeted, multidisciplinary exploratory studies.
- Integrate and disseminate findings.

These members and tasks would serve as the core around which the network would undertake additional capacity-building activities such as training and mentoring young scientists, and conducting targeted workshops, conferences and summer institutes.

When it was established in April 1996, TERN was considered an experimental funding mechanism at RWJF and an experiment in transdisciplinary science, the first integrative research enterprise devoted solely to examining the factors underlying the adoption of an addictive behavior. Fortunately, the creators of TERN at RWJF were able to draw upon the pioneering experience of the MacArthur Foundation. Beginning in the early 1980s, the MacArthur Foundation had used research networks to strengthen knowledge about other complex issues. RWJF program staff was able to capitalize on the lessons learned from the MacArthur experience through Denis Prager, who served as a consultant to RWJF for TERN. Prager had been director of the Health Program at the MacArthur Foundation and had been involved in establishing and overseeing that foundation's research networks for 11 years.

Network Concept

Design and Intent. The research network is a mechanism for bringing diverse perspectives, knowledge, expertise and strategies to bear on complex problems associated with the health, well-being and behavior of individuals and the societies in which they live. The goal is the creation of research that, because it exploits the full range of talent represented by network members, is able to address more significant and complex problems, and to produce knowledge and understanding that is more profound, richer, and, ultimately, more applicable in real-world settings than that conducted by individual investigators.

- Research networks comprise individuals (usually 8–12) selected on the basis of their capacity to contribute to the network's goals, and of their commitment to, and suitability for an intense transdisciplinary collaborative process. While the individuals who comprise the network may represent research teams at their home institutions who participate in carrying out specific experiments, studies and analyses, it is the individuals, themselves, who constitute the network and bear responsibility for bringing their intellectual resources to bear on significant problems.

- The research network is a complement to, not a replacement for individual scholarly pursuits. It is designed to add value to individual scholarship by providing a setting in which the talents of individuals can be mobilized in a collective manner to address scientific issues of common concern, and to conduct a kind of research that would not otherwise be possible, that is, research unlikely to be supported by more traditional research funding mechanisms and organizations.

- The process is one of intellectual collaboration characterized by a level of openness, trust and comfort that facilitates the gradual breaking down of the disciplinary and sub-disciplinary barriers that can impede truly collaborative work.

Research networks are intended to produce:

- Research that represents the intellectual work of the entire group.

- Research that brings the approaches and methods of two or more members of the group to bear on a specific theoretical, applied or methodological problem.

- Changes in the research of individual members as a result of their exposure to the diversity of perspectives and strategies in the group.

- Training of future researchers who, as a result of their association with the network, have a broader perspective and an appreciation for the potential of transdisciplinary work.

Collaborative Process. The collaborative work of a research network represents a range of engagements among the members that include the following:

- The work of the full group in (1) defining the network's substantive focus, priorities and research agenda; (2) establishing a conceptual framework for guiding network research; (3) contributing to the design of specific projects; (4) reviewing project progress and outcomes; and (5) assessing the network's overall productivity.

- Collaboration among two or more network members in (1) theory development; (2) empirical studies; (3) the design of instruments, measures and analytical frameworks; and (4) refinement and development of research methodologies.

- Work by individual network members on specific aspects of their own research with the potential for advancing the work of the network as a whole.

- Commissioned work by non-network scientists who bring specific expertise into the network not adequately represented by network members.

- Working groups comprised of several network members and scientists from outside the network with expertise to focus on a specific substantive area or task.

- Targeted pilot studies conducted by members of the network or scientists from outside the network with special expertise.

NETWORK PLANNING

The first tasks facing those responsible for establishing TERN were selection of an individual to serve as network chair, and recruitment and selection of the members of the network's core group.

The Network Chair

One key to the success of a collaborative research network is the leadership provided by the chair. The chair is first among equals — the designated leader responsible for guiding the work of the network and for making decisions concerning direction and resource allocation. This is primarily a collective enterprise; however, someone has to be in charge and accountable.

Responsibilities. The network chair is responsible for the following.

- Guiding the work of the network so that its research activities are consistent with the goals it was created to pursue.

- Promoting and fostering research that exploits the full range of perspectives, expertise and experience represented by network members.

- Assuring that the collective work of the network adds up to a whole that would not have been possible were the network members working individually.

- Allocating network resources in a manner that maximizes their effective and efficient use.

Criteria for selecting a network chair. Given the centrality of the chair to the success of TERN, RWJF program staff considered a number of highly qualified people. In narrowing their search and, eventually selecting a chair, staff applied the following criteria:

- The capacity to provide overall substantive leadership and direction to a group of strong peers.

- An understanding of group process and of what it takes to mobilize the collective strengths and capacities of a talented group of individuals.

- The ability to oversee the administrative and logistical processes that underlie any complex venture of this kind.

RWJF program staff selected Richard Clayton, Ph.D., professor of sociology and director of he Center for Prevention Research at the University of Kentucky. Clayton was well known to RWJF program staff, having been a leader in research on the etiology of addictive behaviors as well as in the development and testing of interventions for the prevention and cessation of tobacco use. He was known to be committed to interdisciplinary research, to be collaborative and "to be held in high esteem by his colleagues," according to Denis Prager, Ph.D., a consultant to RWJF for TERN and one of this report's authors.

As chair of TERN, Clayton became a key player in the process of selecting the members of the network's core group, and in guiding the network's explorations of possible substantive directions. This planning process was accomplished by members of the TERN planning team that consisted of Clayton as well as Marjorie Gutman, Ph.D., a senior program officer at RWJF; Nancy Kaufman, R.N., M.S., a vice president at RWJF; and Prager. The TERN planning group was responsible for establishing a process for selecting the members of TERN's core group of scientists. Later, Karen Gerlach, Ph.D., became the senior program officer at RWJF involved with TERN.

Setting Up the Network Core Group

The most critical elements in the success of a collaborative research endeavor are the professional and personal attributes of the participants and the degree to which they meld into a collegial, open, productive working collective. The process of identifying individuals who met these criteria was highly intensive in terms of time and energy. It involved identifying a pool of candidates and determining who was best qualified and most appropriate for such a collaborative research venture.

The strategy for identifying appropriate members of TERN involved inviting a rotating group of individuals judged to be potential TERN scientists to planning meetings organized around discussions of critical research issues in tobacco etiology. During the period October 1996 to March 1997, five such planning meetings were held.

Substantive agenda for planning meetings. The first four planning meetings engaged invitees in wide-ranging discussions of the current status of addiction science, key issues in tobacco research specifically and major barriers to progress in understanding the etiology of tobacco dependence. As a means of stimulating productive discussions, Clayton and the other members of the planning team drafted a concept paper listing some of the issues that might constitute TERN's initial research agenda. They distributed this paper to invitees prior to each of the planning meetings.

On the first day of each of the first four planning meetings, participants arrived in the late afternoon for a reception, dinner, introductions and a description of the goals of the planning process and the expectations for the meeting. The second day of the meeting was devoted to discussions of substantive content (morning) and collaborative processes (afternoon).

Questions on substantive content included:

- What other areas (non-tobacco) of research or theory might offer insight into the etiology of tobacco dependence?
- Are there particular methodological approaches that might provide new or enhanced insight into the etiology of tobacco dependence?
- What are the gaps in our knowledge of the etiology of tobacco dependence? What are the key unanswered questions?
- What are the critical factors and influences within adolescence that deserve high priority if tobacco dependence is to be better understood?
- What are the critical factors and influences beyond initiation and before dependence that will allow researchers to understand better the transition from non-user to dependent user?

Questions focused on collaborative processes included:

- How difficult do researchers think it will be to develop a truly interdisciplinary understanding of a phenomenon that involves genetic, biological, psychological, social and interpersonal, economic and cultural elements?

- How much effort should be spent by the research network pouring over existing paradigms versus trying to break with those paradigms?

Process for selection of network core members. These intensive meetings provided an opportunity for the members of the TERN planning team to engage participants in discussions of the topics identified in the draft research agenda as a means of determining who might be effective network members.

In order to assure that all relevant disciplines were represented in the various meetings, individuals were invited from the following areas: (1) psychopharmacology; (2) behavioral genetics; (3) human development and adolescence; (4) neurobiology; (5) societal influences; (6) proximal influences (those factors that are closest to the individual); (7) epidemiology; (8) clinical interventions; (9) longitudinal methods; and (10) ethnography (the study of the contexts in which individuals live including their families, friends and acquaintances, fellow workers, neighborhoods and the cultural influences on their relationships using more qualitative than quantitative research methods).

Individuals invited to the planning meetings were selected on the basis of their strong record of productivity in an area of research central to, or potentially important to, the network's focus on the etiology of tobacco use. All invitees were established scientists known for their contributions to the fields in which they worked. Were RWJF simply designing a program of individual investigator-initiated grants, this would have been sufficient. However, because RWJF was committed to establishing a truly interdisciplinary network focused on understanding the complex phenomena associated with tobacco use and dependence, the principal question was whether an individual was committed to, and capable of, being an important contributor to an enterprise in which collaboration was the *sine qua non*.

Criteria for selection as network core group member. Accordingly, the planning team — with reference to the MacArthur Foundation experience — developed a set of the most important criteria used to select the members of the TERN core group, which are listed below.

- A demonstrated commitment to interdisciplinary collaboration as a critical strategy for overcoming substantive and technical barriers to progress in the field.

- Collegiality, group process skills and a demonstrated capacity to work collaboratively.

- Personal and professional maturity and security, openness to new ideas and approaches and an ability to reach beyond current prevailing paradigms and strategies.

- Willingness to make the requisite commitment of time and energy.

During the planning meetings two other criteria emerged as critical to selection of the core group members. The first was a willingness to move away from one's own data. The second

was an evident curiosity about how other disciplines asked and approached research questions.

In the end, the planning team identified the following individuals as those most suitable and appropriate to form TERN's core group of scientists. These individuals represent the 10 disciplinary perspectives originally identified as central to the TERN mission. More important, all of the scientists on the final list had demonstrated an ability and willingness to think creatively and across disciplines with regard to research on the causes of tobacco use and dependence.

▪ Psychopharmacology	Robert Balster
▪ Cognitive Psychology	Stephen Tiffany
▪ Pharmacology	Jack Henningfield*
▪ Behavior Genetics	Kathleen Merikangas
▪ Adolescent Development	Judith Brook**
▪ Adolescent Development	Ronald Dahl
▪ Neurobiology	Mary Jeanne Kreek***
▪ Neurobiology	George Koob
▪ Societal Influences	Frank Chaloupka****
▪ Proximal Influences	Brian Flay
▪ Epidemiology	Gary Giovino
▪ Clinical Intervention	David Abrams
▪ Clinical Intervention	Saul Shiffman
▪ Longitudinal Methods	Linda Collins
▪ Ethnographic Methods	Mark Nichter
▪ Sociology	Richard Clayton

** Henningfield declined to become a member of the core group, but agreed to serve as a senior adviser to TERN. Nevertheless, Henningfield attended and actively participated in the meetings and activities of the network throughout.*

*** Brook elected not to become a member of the network. Ronald Dahl of the University of Pittsburgh was later invited to represent the study of adolescence and adolescents in the network.*

**** Kreek left the network and was replaced by George Koob of the Scripps Research Institute.*

***** Chaloupka left the network due to the press of other obligations from RWJF activities, he was not replaced.*

These individuals were invited to the fifth and last meeting of the planning process, held March 18–20, 1997. The purpose of the meeting was to assess the degree to which these individuals could function as a collaborative team, using a series of topics to further refine the initial TERN agenda. Those topics included:

- Tobacco/nicotine dependence and similarities and differences with other drugs.
- Individual differences in vulnerability to tobacco dependence.
- Differential rates of use by various population groups.
- Measuring dependence on tobacco among youth.
- Childhood, adolescence and transitions.

- Treatment of dependence among youth.

- Identity as a smoker.

In the course of the year, the TERN planning team reviewed approximately 70 individuals; 40 participated in the planning meetings. An additional opportunity to identify potential members of TERN was the RWJF-sponsored Conference on the Science of Preventing Tobacco Use: New Partnerships and Paradigms of Tobacco Prevention Research, held in Sundance, Utah, May 6–9, 1997 (see Grant Results Report on ID# 030055). Designed to stimulate new ways of approaching the problem of preventing tobacco use, the conference provided opportunities for participants to (1) be brought up to date on the state of the art of prevention research; (2) engage in transdisciplinary brainstorming sessions; and (3) interact informally around topics of mutual interest.

Network Infrastructure

With the core group selected and an initial substantive agenda developed, the network was ready to be officially launched. TERN members are listed in Appendix 1. The first meeting of the new network, TERN, occurred in October 1997. However, before that, it was necessary to establish the leadership and administrative infrastructure on which the network would rely for direction and operation.

Leadership responsibilities. Leading and managing a collaborative research network requires a great deal of time and energy on the part of the chairperson. He was responsible for providing the substantive leadership required to create and advance the network's agenda. In addition, he also has to:

- Foster and facilitate collaboration among a disparate group of individuals with varying backgrounds, personalities and approaches to science (thought by some to be akin to herding cats!).

- Create and oversee policies intended to manage the collaborative process and its products.

- Design, convene, facilitate and follow up meetings of the core group and of various network working groups.

- Oversee network administrative and logistical functions.

- Manage the relationship between the network and RWJF.

- Serve as the principal representative of the network to the "outside world."

Chair must be free to devote large amount of time, energy and attention to the network. Implementation of these six responsibilities identified several important lessons with regard to research networks as a funding mechanism for RWJF.

- Providing leadership for such a network is close to a full time job. The chair must be able to quickly extricate himself/herself from other responsibilities in order to devote the time required early in the network's existence.

- It is necessary for RWJF to provide assistance and guidance to the chair during the early stages. Because TERN was the first such network in RWJF's portfolio of grants, no explicit blueprint was available on what to do and when and how to do it.

- At the outset, it is important to create mechanisms to sustain momentum from meeting to meeting.

Importance of strong support staff. TERN's early operations also highlighted the need for strong support staff to administer the operations of the network. RWJF had determined that one key to success of the network was to take care of all the logistics and other aspects of the work of the network so that the core group members could focus their entire energy on the substantial intellectual effort required for success. The lesson learned here is that a network needs a stand-alone administrative structure responsible for:

- Supporting the chair in carrying out his/her leadership duties.

- Organizing all network meetings and conference calls.

- Handling all logistical arrangements at meetings.

- Assuring the smooth flow of information, documents, data and manuscripts among network members.

- Developing and managing the network's budget and administrative expenditures.

- Managing the RWJF grant and interacting with RWJF's assigned financial officer.

- Creating and managing sub grants between the network's host institution and the institutions of core group members.

What is needed is administration and logistics that are competent, efficient and invisible.

In February 1997, TERN hired an individual who had experience as the administrator of a MacArthur network. After a relatively short period of time and because of other commitments, she had to leave this position with TERN. Her former assistant in the MacArthur Network took over the network administrator position. One of the lessons learned from this experience is the difficulty involved when the network administrator and the chair are not in the same location — both administrators were located in Columbus, Ohio.

Another lesson learned is that the chair and the network administrator must be able to communicate almost constantly and work together in a seamless way as a team. Melissa Segress, a staff member in the Center for Prevention Research at the University of Kentucky, became the network administrator in 2000 and provided the kind of administrative support the network needed. Segress and Crystal Caudill, who had responsibility for budget monitoring, worked with Clayton in administering TERN throughout the remainder of the network's life.

Development of the Transdisciplinary Process

As a collaborative enterprise TERN went through the stages of development of an interdisciplinary network articulated by Robert Kahn in *The MacArthur Research Program in Mental Health and Human Development: An Experiment In Scientific Organization,* (April, 1992, MacArthur Foundation Occasional Paper):

Stage 1 — Listening across the interdisciplinary gulf. In this stage, "One is reminded of the stance of astronomers at their radio telescopes, listening for signs of intelligent life elsewhere in the cosmos, more hopeful than optimistic." While talking, discussing, debating and arguing are essential to the success of a network, it is the emergence of a pervasive value on listening that is the hallmark of successful collaboration across disciplinary boundaries.

Stage 2 — Conceptual translation. Here, the "underlying tasks are the development of a common language and the tentative planning of collaborative work," a prerequisite for intellectual collaboration. As the process unfolds and proceeds, network members acquire a kind of multi-disciplinary vocabulary that they hold in common and can use without pausing for definition or further explanation.

Stage 3 – Leading indicators of collaboration. At this stage (1) questions about purpose and mission have largely been worked out; (2) the development of a common language has facilitated communication across disciplinary lines; (3) network members are well acquainted with each other; and (4) there is a high degree of mutual appreciation and tolerance. During this stage, the groundwork is laid for the development of collaborative work.

Stage 4 — Active involvement in joint projects. At this relatively mature stage of development, network members are working together as a whole and as subgroups to (1) design and mount pilot studies; (2) develop more substantial collaborative research projects; (3) develop new methods needed to analyze the resulting data from many domains, levels of analysis and time frames; (4) interpret findings; and (5) publish the results.

One of the lessons learned in TERN is that while these stages are presented as sequential, the tasks in each stage continue throughout the process of becoming more transdisciplinary. For example, listening across the interdisciplinary gulf and conceptual translation may become easier as the group matures and becomes more integrated, but continue to serve important functions throughout the life of a group.

NETWORK IMPLEMENTATION

The first meeting of TERN occurred in October 1997. As an exercise to prepare for the second meeting in January 1998, the core group members were asked to identify the most important research questions for TERN to address. The result was a 17-page, single-spaced list of high priority research questions.

Identifying the Gaps in the Knowledge Base

At the January 1998, meeting the core group members quickly decided that TERN should:

- Be willing to question and challenge all of the assumptions on which the existing science is based.
- Identify the major gaps in the science and focus attention on those issues.
- Conduct research that is innovative and that would not likely be funded under existing funding mechanisms.
- Not be rushed on any of its projects, but rather take the time to explore all of the most important issues from many different perspectives.

With these as guiding principles, the network shelved the 17 pages of research questions and began identifying key constructs that needed special attention — major gaps in the field — and began the sometimes tedious and often stimulating process of listening across the gulfs that often serve as barriers to limit communication across disciplines.

At this meeting, consensus was reached rather quickly on several issues that would largely organize the work of TERN throughout its life. Those issues are listed below and will be described in more detail in subsequent sections of this report.

- **Measuring tobacco use in real time to reflect differences in patterns or trajectories of use.** Tobacco use is a dynamic and unfolding phenomenon and thus must be measured in a dynamic rather than a static fashion. Everyone who uses tobacco has a trajectory of use that can be measured. In order to understand the etiology of tobacco use, the phenomenon must be measured in real time and in ways that differentiate the many patterns or trajectories of use that exist. Tobacco-use trajectories are also necessarily intertwined with trajectories of use of other substances — including alcohol and marijuana, in particular.

- **Conceptualizing and measuring dependence.** Dependence on nicotine is largely responsible for chronic tobacco use and its negative consequences. Discussions and research on dependence have been dominated by the clinical criteria found in the DSM (*Diagnostic and Statistical Manual* of the American Psychiatric Association) and ICD (International Classification of Diseases) taxonomies. The result is conceptualization of dependence as a dichotomy — someone is dependent or not. Rather than being categorical, the members of the TERN core group began with the belief that dependence is more likely continuous — an emergent or evolving phenomenon.

- **Early episodes of use.** Because nicotine is the dependence-producing substance in tobacco, and tobacco use trajectories emerge and take different paths, it is plausible to assume that early episodes of use may be important launching platforms for subsequent trajectories of use. Further, almost all of the research conducted on early exposures to nicotine and early episodes of use had been based on retrospective reports of events that had often happened many years earlier. The network therefore decided to focus on measuring early episodes of use in as close to real time as possible.

- **Stress and emotional responses to stress as pathways to trajectories of use.** At the individual level there are many possible causal pathways to initial use of tobacco, to early episodes of use, and to trajectories of use that may or may not include the emergence of dependence. One category of such pathways can be described as stress and emotional responses to stress. The network decided to focus on this nexus of individual level factors with regard to conceptualization, measurement and empirical research.

- **Contexts and their interaction on individuals in explaining trajectories of tobacco use and dependence.** TERN members reached quick consensus that there had been a dearth of research on contextual influences (e.g., family, school, neighborhood, peer, community, state and federal policies, culture) on tobacco use and that the probable “action” was in the “interaction” of individual-level and contextual-level factors in explaining tobacco use and dependence.

- **Animal to human to animal research.** Network members agreed that TERN had an opportunity to demonstrate decisively the importance of connecting basic science using animals and basic science using humans as participants, and to establish a TERN goal of testing the same hypotheses in both animal and human research.

Strategies to Facilitate Collaboration

With the substantive topics listed above as an initial road map, the network began the hard work identified by Kahn: listening across the interdisciplinary gulf; conceptual translation; early indicators of collaboration; and joint collaborative projects. In addition to establishing rapport and building trust, the TERN meetings were characterized by a great deal of exploration of how important constructs were defined and measured by the disciplines represented in TERN, questioning of the assumptions underlying theories, and the various methodological approaches for studying the etiology of tobacco use and related behavioral patterns. For example:

- Network members experienced in conducting studies in humans wondered, sometimes verbally, how research on rats could be relevant to humans.

- Laboratory-based members wondered how TERN could establish causal relationships using correlational (associational) approaches from population sciences.

- Those who had observed strong behavioral and psychological influences on tobacco use evidenced an appreciation of the biological concomitants of addiction but asked how new knowledge in that area would help improve prevention and treatment interventions.

- Those familiar with the powerful effects of macro-environmental influences such as tobacco industry promotions and advertising, increases in excise taxes, and various governmental policies, wondered if these factors were more powerful than individual-level influences that are closer to the individual and more apparent.

- The ethnographers questioned how the qualitative nuances of individual human behaviors, social interactions and culture could be captured by quantitative analyses of large sample studies. In such studies, participants are asked questions that have a limited number of answers, thus there is a forced choice among the answers listed. Further, the quantitative studies seldom elicit much information about the various environmental contexts in which the individuals live, work, play and change. Thus, these types of studies do not adequately characterize these environmental contexts.

- The methodologists wondered how they were going to devise strategies for dealing with the kinds of qualitative and quantitative data, collected from human and animal participants, implied by the interdisciplinary syntheses being discussed.

A number of strategies were employed to facilitate the work of TERN. These strategies were designed to:

- Promote the development of a group of colleagues respectful and appreciative of each other and of each other's work.

- Provide an intellectual environment conducive to the formulation of an agenda of collaborative research with the potential to significantly advance understanding of the etiology of tobacco use.

- Stimulate and support specific research projects designed to integrate a diversity of substantive and methodological inputs.

- Maximize the productivity of TERN in terms of products useful to the field of tobacco research.

- Expose a group of tobacco-researchers-in-training to a research environment in which interdisciplinary collaboration is the rule not the exception.

- Provide opportunities for outreach to others in the field of tobacco research.

Core group meetings. The principal mechanism for facilitating the work of TERN was meetings of the core group. Eventually, these meetings grew to include the TERN Faculty Scholars — 11 young scientists nominated by core group members from their home institutions. All of the scholars were assistant professors who were deemed open to transdisciplinary work and who might be willing to identify tobacco research as the principal focus of their career (see Reality 3. The value of hands-on experience for training the next generation of transdisciplinary scientists).

Important considerations regarding these meetings included the following:

- **Frequency.** The network had at least three, usually four, core group meetings a year to sustain momentum during a particularly critical period of agenda development or research. Each meeting lasted 2.5 days, generally convening for an optional dinner on the Tuesday evening before day one, Wednesday, and adjourning at noon on Friday. While this represents a significant commitment of time on the part of individuals already fully occupied in other pursuits, it proved to be an important element in both the development and productivity of TERN. Intellectual collaboration does not just happen. Rather, it is the result of a process of continual, intensive interactions among individuals willing and able to bridge their disciplinary perspectives. Despite the demands of such a meeting schedule, attendance remained extremely high throughout. There were ultimately 25 TERN core group meetings.

- **Venue.** Given the degree to which the success of TERN depended on these intensive interactions, meetings were held in environments highly conducive to collegiality, creativity, and productivity, and designed to take advantage of the facilities and the environment in which they were located. One lesson learned by the administrative staff was that working with the same hotel chain provided cost savings and benefits that would not have occurred otherwise.

- **Food.** The value of good food as an incentive for hard work and a force for collegiality can't be over emphasized. Evening meals were held in good restaurants, either associated with the meeting facility or off-site. These meals served as an opportunity for participants to get to know each other as people, not just as scientists, to develop an *esprit de corps*, and, if desired, to discuss scientific issues in an informal atmosphere. In part, the high morale, close friendships, and mutual respect grew out of these opportunities to "let go" and enjoy each other's company. Further, the spouses/significant others and children sometimes came to core group meetings helping to establish friendship groups among members and their families. This also helped family members understand the demands for time away from home required of TERN members.

- **Meeting design.** Each core group meeting was carefully designed to take maximum advantage of the time together and to sustain progress on activities involving the full group as well as subgroups. In the early days of TERN, most of the time was devoted to discussing and further delving into gaps in participants' knowledge of the etiology of tobacco use and exploring collaborative strategies for filling those gaps. As the network matured, more and more time was spent discussing the design of specific research projects and, even later, strategies for analyzing and interpreting the resulting data. Meetings were almost always designed to allow time for various working groups to get together to further their specific tasks (see below). Meetings also provided an opportunity to learn from other leading scientists, sometimes from the tobacco field, or from other areas of research of interest to the network. These guests made presentations of research findings, stimulated active discussion, and led to new ways of thinking about the challenges facing the network by participating in the entire meeting.

Working Group Meetings

TERN organized its activities around specific substantive topics germane to the general themes of the network outlined above. Working group meetings were usually hosted by several members of the core group (including TERN Faculty Scholars) and included scientists from outside TERN whose experience and expertise informed the deliberations.

Much of the work of TERN was carried out through working groups. Such groups took on specific, time-limited tasks related to:

- Preparing reviews of the state of the art of various aspects of tobacco research and publishing them as special issues of journals.
- Developing TERN's research agenda.
- Exploring and developing methodological strategies for data analysis and interpretation.
- Conducting major collaborative research projects.
- Publishing the results of those projects.
- Writing proposals for future funding.

There were more than 100 different scientists from outside the network who provided input into the meetings and/or working group meetings, some on multiple occasions. These scientists played an integral role in the success of TERN.

Electronic Communications

A significant amount of the work of TERN involved e-mail contacts and conference calls. These vehicles, plus Web sites, are a relatively new phenomenon that came to maturity during TERN's life. It is clear that, as these tools are refined and new ones developed, they will play an even greater role in the facilitation of collaborative research endeavors such as TERN.

To illustrate the role of conference calls, during 2002 and the first half of 2003 there were 175 TERN conference calls linking members of the network and working groups on specific tasks. Participants valued the speed with which the notes from these conference calls were given back to the meeting participants — a lesson for others holding regular conference

calls. Minutes of these calls were taken during the call by the network administrator, Melissa Segress, and sent to the participants usually within minutes after the call ended — with action items highlighted for each participant. The active participation of the network chair in almost all of these conference calls provided a critical element of continuity.

Steering Committee's Role

The executive or steering committee formed early in the network consisted of David Abrams, Kathleen Merikangas, Denis Prager, Richard Clayton and the network administrator. It met on a regular basis by conference call, in person at the beginning and end of the day during each core group meeting, and on occasion in the period between core group meetings. A major role of the executive committee was to discuss and organize the agenda for each core meeting and to be attentive during the meetings to substantive and other issues that needed to be addressed.

National Advisory Committee

RWJF program staff appointed four distinguished scientists to constitute a national advisory committee. It consisted of Nancy Adler, Ph.D., (University of California San Francisco), Floyd Bloom, M.D., (Scripps Institute), Thomas Cook, Ph.D., (Northwestern University), and Lee Robins, Ph.D., (Washington University, St. Louis). The committee attended one meeting as a group and all of its members participated in an interactive mid-course assessment of the progress of the network. Cook, one member of the committee, attended and participated in a working group on contextual influences on tobacco use.

Recognizing the Importance of Focus

As noted earlier, the TERN core group decided at its second meeting to focus on a small number of what it believed were very important topics where progress might have the biggest impact and that could serve as leverage for progress in other areas. This decision was based on recognition of several realities.

> **Reality 1. The value of niche-picking.** At the time TERN began its work, a great deal of research in the field was directed toward predicting initiation of tobacco use. Rather than focus on initiation, TERN decided to focus on trajectories of use that begin with initiation. There were also a number of initiatives in the field focused on prevention and cessation among youth and adults. TERN decided not to focus explicitly on either prevention or cessation treatment. Nevertheless, TERN had its collective eyes on the prize of improved prevention, treatment and policies through improved understanding of the etiology of tobacco use and dependence. RWJF, through its *National Center for Tobacco Free Kids* (www.tobaccofreekids.org) (see Grant Results Report on ID#s 035929, 029600, 028989), *Bridging the Gap* (www.impacteen.org), *Substance Abuse Policy Research Program* (see http://www.saprp.org and the National Program Report) and *SmokeLess States: National Tobacco Policy Initiative* (http://smokelessstates.org/), had supported tobacco-control research and advocacy, so network members chose not to focus as much attention on those types of interventions. TERN did devote a substantial part of one meeting to an intensive discussion and exploration of genetics, but decided that, given the complexity of the topic and the state of the art in the science at the time, this was an area of etiologic interest best left to research teams focused specifically on genetics.
>
> **Reality 2. The value of pilot studies.** While RWJF program staff expected TERN to field some major research studies, it turned out that there were a number of developmental pilot research activities that did not require either a great deal of time or funding. Therefore, TERN invested in a number of relatively small pilot studies that

were strategically selected to lay the groundwork for other TERN studies or to address specific research questions the network was not going to directly address, but believed were important. Discussion of data from pilot studies at core group meetings helped maintain scientific momentum. One example is pilot animal studies that focused on identifying patterns of nicotine exposure that led to dependence in rats. Another dealt with the influence of nicotine on functioning of the pre-frontal cortex — the seat of executive decision making in humans — in peri-adolescent rats (i.e., rats between 15 and 42 days of life). Another pilot study involved testing the Nicotine Dependence Symptom Scale (NDSS) in a sample of youth from three ethnically different high schools in San Francisco to make sure the students understood the meaning attached to the items in the scale and that there were no differences in understanding by the ethnic background of the students.

Reality 3. The value of hands-on experience for training the next generation of transdisciplinary scientists. In 1999 RWJF provided a training grant to TERN (ID# 036562). In planning its training activities, TERN decided not to focus on pre-doctoral, doctoral or post-doctoral students, but rather to recruit assistant professors at the beginning of their academic/research career into the tobacco field. The senior scientists in the core group were invited to nominate assistant professors from their home institutions, and a vetting process was implemented. Three decisions made by TERN proved to be critical to the success of what became the TERN Faculty Scholars Program. The first decision was to have the principal mentor for the scholars be someone from a different institution and discipline. The second decision was to fully integrate the scholars into the core group meetings with as little differentiation as possible between senior and less-than-senior scientists. The third decision was to encourage the TERN Faculty Scholars to play key roles in TERN research activities and to take the lead on publications from TERN's research. TERN Faculty Scholars were:

- Craig R. Colder, Ph.D. (SUNY at Buffalo)
- Lisa C. Dierker, Ph.D. (Wesleyan University)
- Eric C. Donny, Ph.D. (Johns Hopkins University, now University of Pittsburgh)
- Lorah Dorn, Ph.D. (University of Pittsburgh, now Cincinnati Children's Hospital Medical Center)
- Thomas Eissenberg, Ph.D. (Virginia Commonwealth University)
- Brian P. Flaherty, Ph.D. (Pennsylvania State University, now University of Washington)
- Lan Liang, Ph.D. (University of Illinois at Chicago)
- Mimi Nichter, Ph.D. (University of Arizona)
- Elizabeth E. Richardson, Ph.D. (Brown University)
- William Shadel, Ph.D. (University of Pittsburgh)
- Laura Stroud, Ph.D. (Brown University)

See Appendix 1 for more information.

RESULTS OF TERN STUDIES

Every transdisciplinary research network will be necessarily unique because of differences in mission, the individuals who comprise the network, and the processes and mechanisms through which the work is accomplished. However, on the basis of the TERN experience, it is clear that two essential elements of a network are:

- The integration of conceptual approaches from the disciplines represented by the network members into a clear conceptual framework that is a creative synthesis and expansion of the existing conceptual approaches.

- The development, testing and expansion of state-of-the-art of methodologies that begin to uncover new understandings of the phenomena that constitute the foci of the network's activities.

Greater conceptual clarity, methodological rigor and the unique combination of them are at the heart of a transdisciplinary research network, the *raison d'etre* for its existence. In the TERN experiment, virtually all of the discussions, debates, listening and learning that occurred were about conceptual and methodological issues. These constitute the glue, the adhesive that tie scientists to each other in a collective and collaborative experience. The value of the focus on conceptual and methodological innovation will become clear in the sections that follow.

Early Work on Trajectories of Use

When TERN began its work, most studies measured tobacco use with standard and somewhat static measures that included:

- Ever use —usually defined as having reported use of 100 or more cigarettes lifetime.

- Use in the past year or 12 months.

- Current use — defined most often as any use during the past month or 30 days.

While adequate on some level, these measures fail to reflect the dynamic evolving experience with tobacco and nicotine, the changes in patterns of use that occur over time, and the multiple and complex causal pathways to tobacco use that may or may not include the emergence of dependence. As Collins and Graham (2002) note in a TERN-sponsored publication, the field connects tobacco use at time one and tobacco use at time two measured as "current" use, and implicitly assumes that the reported use at these two time points, connected in a straight line, reflect the patterns of use and change over the entire intervening period, usually a year.

When TERN began its work, the construct of trajectories was just emerging in the fields of juvenile delinquency and criminology and alcohol research to describe patterns of behavior. In these fields, trajectories were being used to describe patterns from data collected at multiple times from the same individuals, but with the behavior characterized in rather gross terms and covering a somewhat broad period of time. Methodological improvements were needed to make the measurement of trajectories more scientifically informative. Another advantage of focusing on trajectories was that laboratory animal studies of the acquisition of nicotine self-administration were easily able to measure individual differences in trajectories and relate them to predictor variables.

Early papers. To begin its work on trajectories TERN sponsored a session in 1998 at the Society for Research on Child Development. Two of the TERN-supported papers were subsequently published in *Health Psychology* (see Colder et al. 2001; Novak and Clayton 2001). These are two of the earliest papers published in the tobacco field focusing on trajectories.

In a TERN-sponsored paper, Mayhew, Flay and Mott (2000) questioned whether progression in smoking occurs in incremental, categorical stages and noted that individual change may

take place continuously over time. From this perspective, variations in smoking behavior over the early phases of smoking can be captured by individual growth curves that allow for the assessment of individual change represented in a variety of trajectories. Moreover, these trajectories may be grouped into clusters of change curves that share cluster-specific predictors. The TERN-sponsored paper by Colder and his colleagues (2001), for example, identified five distinct patterns of change in adolescent smoking across four years of a longitudinal study. These included rapid escalators who were characterized by early escalation of smoking (beginning at age 13) with a rapid increase to heavy levels of smoking. Others showed later onset of smoking (age 15) and escalated to low or moderate levels of smoking. They also identified groups of stable light smokers (one to two cigarettes per month) and stable puffers (smoked only a few puffs a month). The stable puffer group was the largest of all the trajectory groups (25 percent of the smokers). Other researchers have identified similar groupings of smokers on the basis of change in their smoking behavior over time.

The Chicago beeper study. One of the first collaborations to emerge out of TERN involved a grant from the National Cancer Institute (NCI) to Brian Flay, Robin Mermelstein and Don Hedeger from the University of Illinois Chicago and Saul Shiffman from the University of Pittsburgh. TERN supplemented the NCI grant that involved screening a large sample of middle and high school youth and their parents to get to a total of 559 adolescents. These 559 youth were grouped after baseline into those who were vulnerable or at risk for trying cigarettes, those who had tried but were not regular users, and those who had experimented but were not yet regular smokers.

The youth in the sample were studied at baseline and every six months using traditional methods of data collection. One week out of every six months, these youth were provided with a personal digital assistant (PDA). They provided data up to five times a day triggered by random beeps of the PDA. They also provided event-precipitated data if they smoked a cigarette or if they were offered a cigarette and refused. In addition to questions about smoking patterns, these youth were asked where they were, whom they were with, and questions about their mood states.

Data from this study were presented at a TERN-sponsored plenary at the Society for Research on Nicotine and Tobacco, a TERN-sponsored plenary at the Society for Behavioral Medicine, and at a TERN-sponsored meeting of the New York Academy of Sciences. The Chicago beeper study was able to address several of the priority issues identified by TERN: (1) measurement of trajectories of tobacco use; (2) measurement of tobacco use in real time; (3) measurement of dependence in youth; and (4) the relationship of stress and emotional response to stress to tobacco use.

There is evidence that many adult chronic smokers smoke primarily to reduce the effects of withdrawal that occur throughout the day, therefore smoking to avoid negative emotional and physical states. Similarly, Mermelstein and her colleagues found that a large proportion of youth experience positive emotional states when they smoke. It is hypothesized that, for these adolescent smokers, the behavior occurs primarily in emotionally positive contexts (with their friends) and that smoking is perceived by these youth to be serving positive functions (i.e., they are trying on identities, smoking is seen as helping them fit into groups, smoking is occurring in conjunction with other mostly positive social experiences).

The Major TERN Study: The UpTERN Study — A Model of Transdisciplinary Research on Trajectories of Use

The major transdisciplinary research study conducted by TERN was carried out among college students. Steve Tiffany (University of Utah, formerly of Purdue University) was the

principal investigator and provided project leadership along with his colleagues at Purdue (Chris Agnew, Department of Psychological Sciences and Nancy Maylath, Purdue Student Health Services). The study required a huge effort at Purdue that included Tiffany, Agnew, Maylath and the UpTERN steering committee, as well as a number of graduate and undergraduate students. TERN funded all aspects of this unique study.

This was an omnibus study covering virtually all of the substantive topics identified by TERN in its second meeting in January 1998. This section describes the study itself and some of the findings with regard to trajectories.

As will be described later, there was also a major ethnographic component to the UpTERN study that involved Mark Nichter, Mimi Nichter, Elizabeth Richardson and Asli Carkoglu, a doctoral student in family studies at Purdue, who was later supported by TERN for a one-year post-doctoral study in anthropology at the University of Arizona. Carkoglu is now an assistant professor in Turkey.

Primary purpose. A primary purpose of the UpTERN study was to examine trajectories of tobacco, alcohol and marijuana use as well as the emergence of dependence, and the various pathways to use.

Study site: Purdue University. Purdue University was chosen principally for logistical reasons. Out of 6,560 students entering as freshmen in the fall of 2002, 4,560 students completed a screener survey when they attended the "day-on-campus" in the summer of 2002. Of these, there were 2,001 freshmen students who had had some exposure to cigarettes, all the way from a puff to consumption of many cigarettes. All 2,001 were approached about participating in the UpTERN study; 912 chose to complete a comprehensive baseline questionnaire.

Characteristics of participants. As the data in Table 1 confirm, all 912 of the participants in the UpTERN study had been exposed to nicotine through cigarettes, although there was a wide range of exposure from one puff to less than one cigarette to 500 or more cigarettes; 45 percent of the participants reported smoking in the 30 days before providing these data at the day-on-campus in the summer before their freshman year. Shortly after they arrived on campus these 912 participants completed a comprehensive baseline questionnaire.

Table 1. Characteristics of 912 Enrolled Participants in UpTERN Study

Female Male	46.4% 57.6%	414 498
Lifetime Cigarettes at Screener/Summer Before Freshman Year		
500 or more	12.5%	114
100-499	13.4%	123
26-99	14.9%	136
16-25	10.5%	93
6-15	14.5%	133
2-5	21.0%	192

1	7.5%	69
1 puff < 1 cigarette	5.7%	52

Smoked in past 30 days		
Yes	45.3%	413
No	54.7%	499

It should be noted here that our goal was not to generalize incidence or smoking prevalence to college students or even to students at Purdue University. Our goal instead was to better understand tobacco and other substance use trajectories in close to real time.

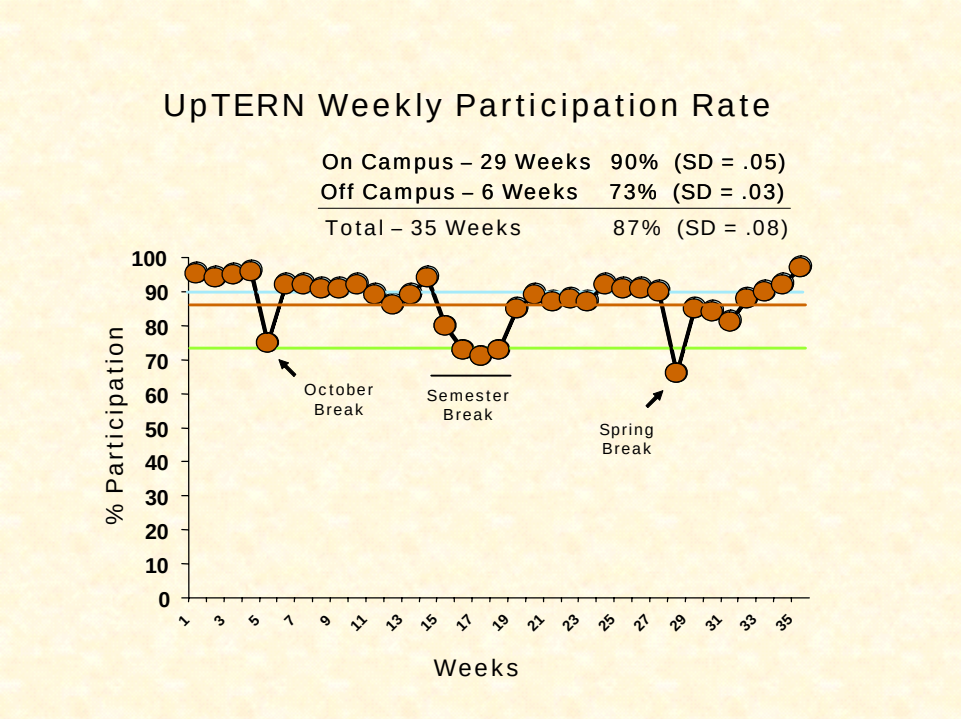
Principal substantive foci. The baseline and virtually all other data were collected on the Web. The next chart shows the kinds of data that were collected each week. The 912 students were to provide daily use of cigarette, alcohol and marijuana for the "previous" week by logging on every Sunday night for 35 weeks, with data covering 245 days. In addition, as Chart 1 shows, there were certain types of questions that were asked once a month.

Chart 1. Types of Data Collected and the Periodicity of Data Collected in the UpTERN Study

Asked Every Week	Daily reports of (1) cigarette use, (2) alcohol use, (3) marijuana use and (4) cigarette combined with alcohol use; detailed questions about smoking, stress, emotional responses to stress, depression, smoking initiation and dependence measured primarily by the Nicotine Dependence Symptom Scale.
Week 1	Weekly items plus physical activity
Week 2	Weekly items plus romantic relationships and friendships
Week 3	Weekly items plus sleep habits and body image
Week 4	Weekly items plus stressful events

Response Rates. In order to adequately characterize trajectories of substance use covering 35 weeks and 245 days, it is necessary to have a high response rate. The Web-driven data collection strategy proved to be ideal. As shown in Chart 2, the overall response rate for the 35 weeks was 87 percent, 90 percent during the weeks on campus, 73 percent during the time off campus. This data collection was not only unique given the size of the sample, but very successful as these data show.

Chart 2: UpTERN Weekly Participation Rates



Trajectories of use. Now, what about the trajectories? The next series of charts show what the trajectories for tobacco use look like monthly, weekly and then daily. It is important to note that these are the first data on daily use over an extended period of time for any sample, particularly young adults in college.

The findings were somewhat surprising in several ways.

- The average number of cigarettes consumed per day was considerably lower than expected. While TERN researchers recognize that the sample is of college students and their use levels may be generally lower than their non-college counterparts, the average number of cigarettes per day across the whole sample was quite low given that a criterion for inclusion in the sample was some prior exposure to tobacco.

- The general expectation in the field is that tobacco use goes up over time. In this sample, the overall trajectory trended downward over the year. This was again not expected.

- The shape or architecture of the trajectory for the entire sample was somewhat surprising. While it is difficult to "visually" detect the patterns with this many points of data, such data allow questions that can not be addressed with the traditional design — a baseline and one or more follow-up data collection periods six, 12, or more months later. For example, the last chart in this series shows data for the first 22 weeks, the first semester and the beginning of the second semester for this sample. With data like these, for example, one could ask: What is the highest Thursday of the first semester for smoking? The answer would be Halloween. Another question is: What happens to smoking during final exam week? As expected, it goes up. The traditional explanation is that students smoke more during exam weeks because of

nicotine's stimulant effects and because nicotine helps one "track" and thus blocks out peripheral sights and sounds. On closer examination of these data, an alternative hypothesis emerged. Perhaps smoking goes up during final exam week because students may finish their exams early and start partying before going home for the holiday break. Preliminary and partial support for this hypothesis can be seen in the lowest smoking day of the fall semester — Christmas Day — when the freshman student is home with his or her parents. The highest day of the fall semester occurs one week later as part of the New Years celebration. Chart 7 shows trajectories of alcohol use and Chart 8 trajectories of marijuana use.

Chart 3: Cigarettes per Day Averaged Over Each Month

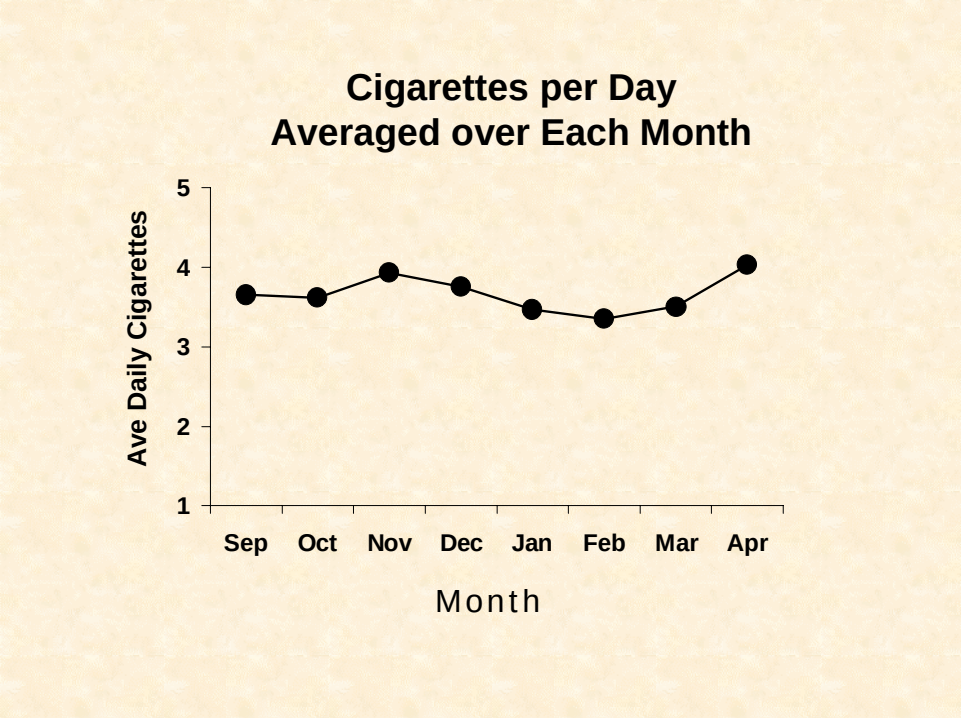


Chart 4: Cigarettes per Day Averaged Over Each Week

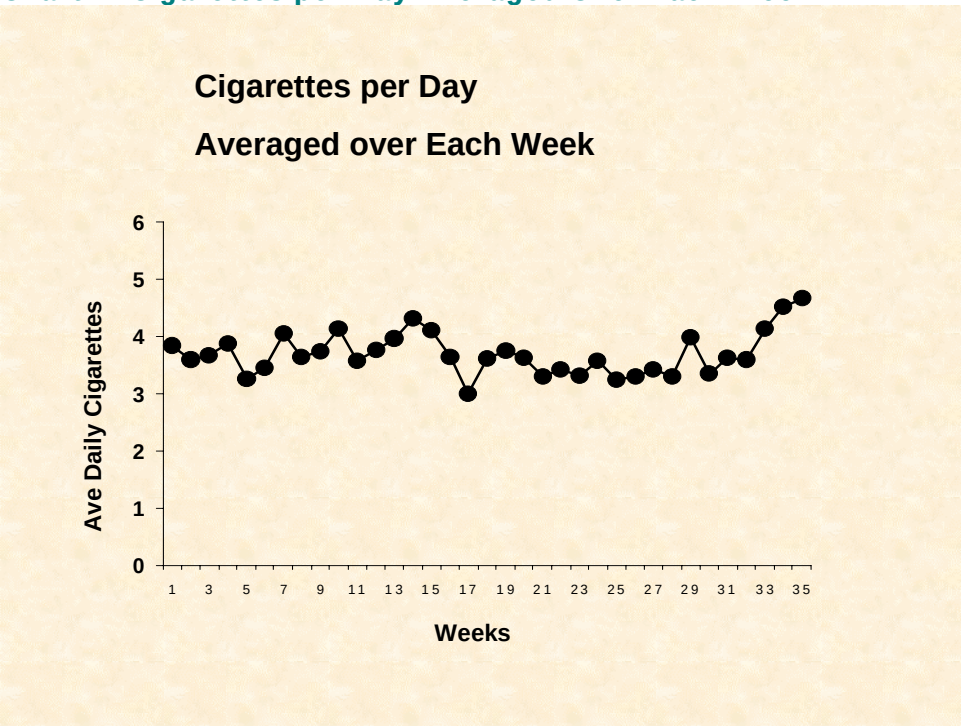


Chart 5: Cigarettes: Average Daily Number

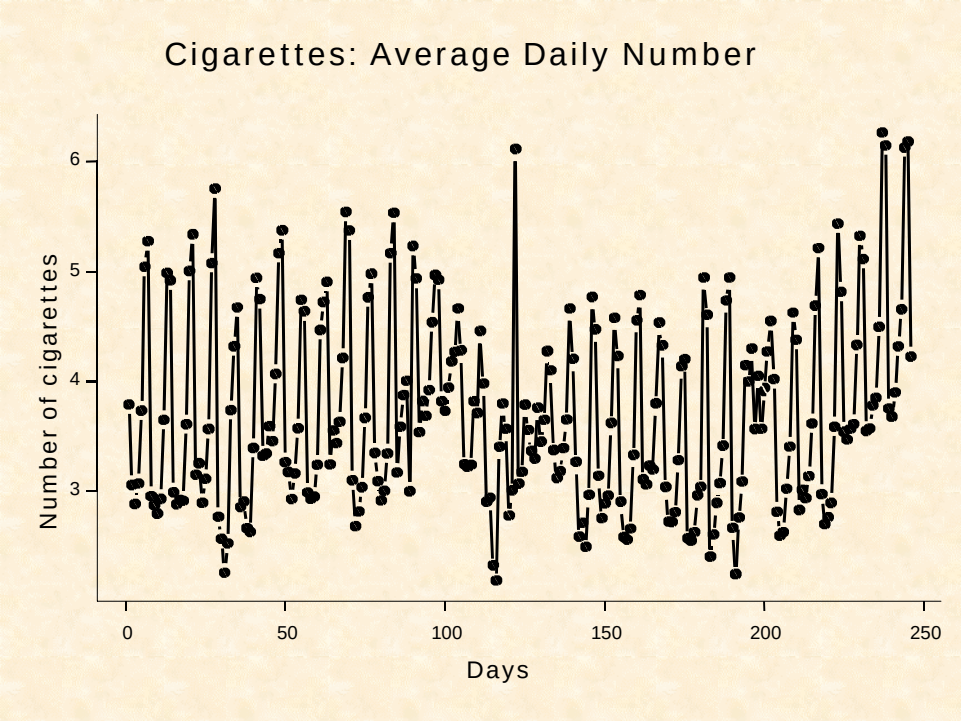


Chart 6: Mean Number of Daily Cigarettes

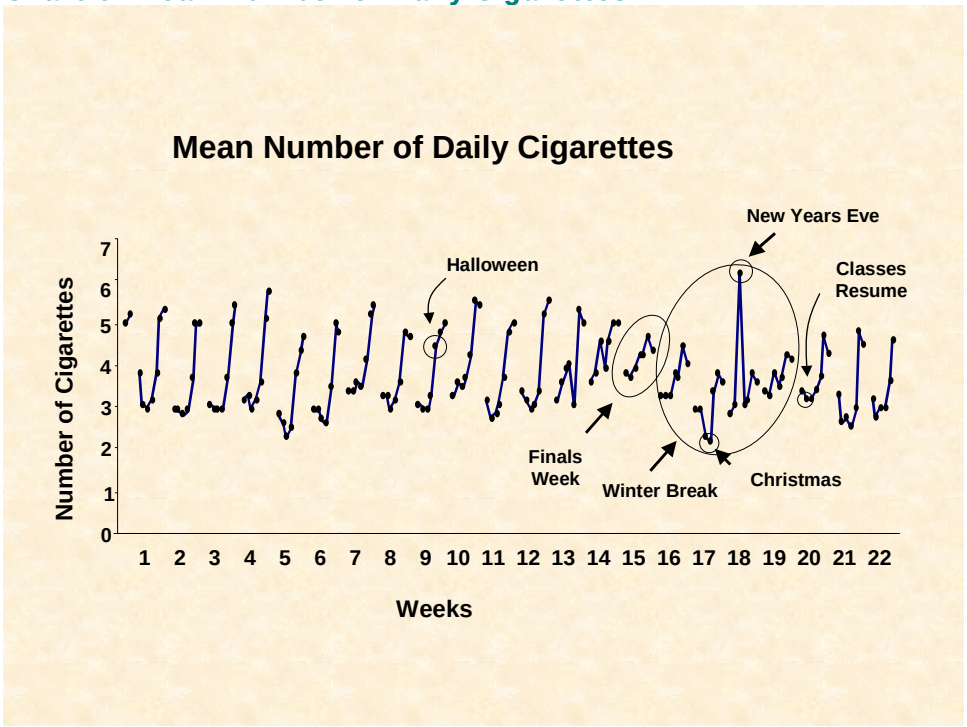
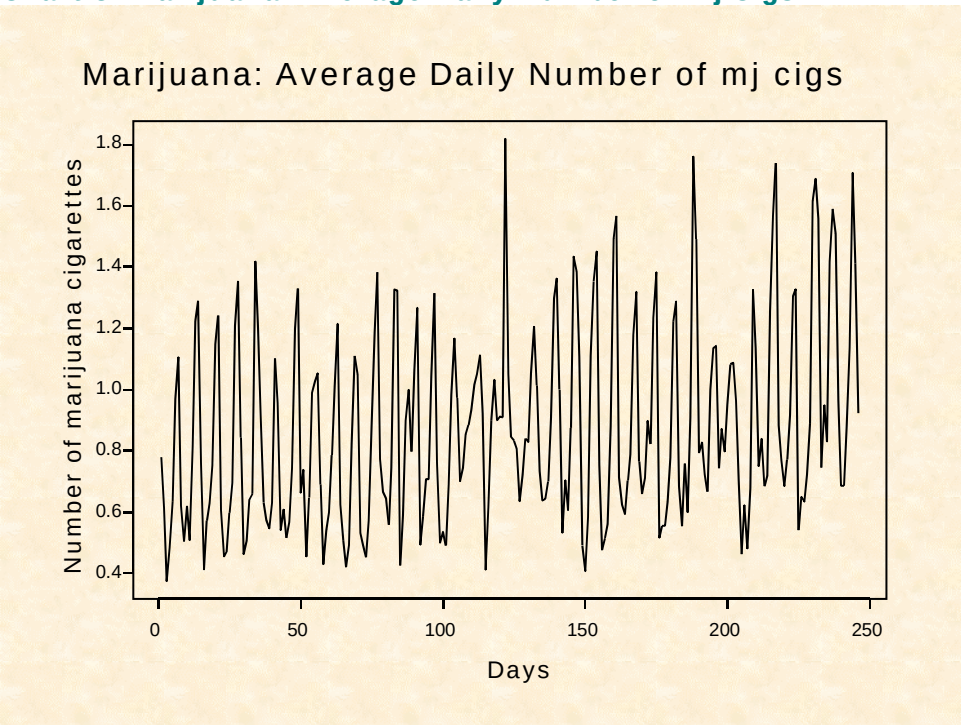


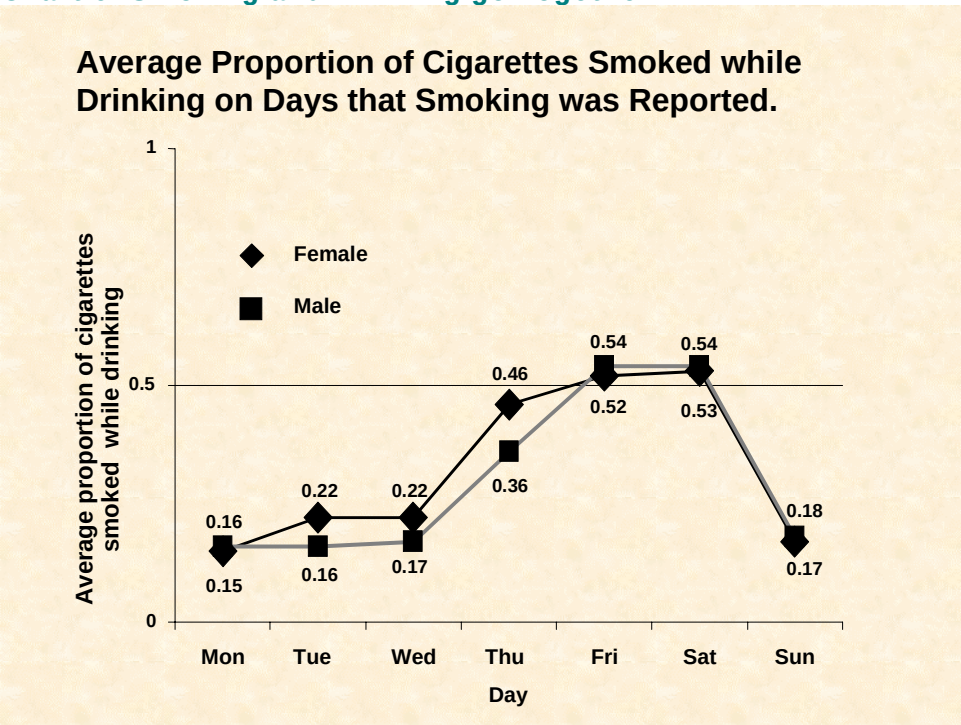
Chart 7: Alcohol: Average Daily Number of Drinks

Chart 8: Marijuana: Average Daily Number of mj Cigs



The close connection between smoking and drinking. The hypothesis about smoking and partying — translated as drinking — can be seen in Chart 9. This chart shows two very important things. First, smoking and drinking are fairly low on Sunday, Monday, Tuesday and Wednesday. They go up on Thursday and then peak on Friday and Saturday. So, one question might be: is Thursday a weekday, a weekend day, or a special transition day between the week and the weekend? The second finding from this chart is that more than 50 percent of the smoking episodes on Friday and Saturday occur simultaneously with drinking, and the pattern seems to be similar for males and females. In fact, these data suggest that smoking and drinking are so closely intertwined, at least for this sample, that it may be unwise to study one separate from the other.

Chart 9. Smoking and Drinking go Together



Understanding trajectories. The uniqueness of the data on trajectories collected in the UpTERN study constitutes a landmark in the study of substance use. Data like this simply did not exist prior to this study. These data provide considerable opportunities to expand the knowledge base and help push the proverbial envelope on methodological and statistical issues. There are at present a somewhat limited number of approaches to understanding these trajectories, some with rather strange sounding names like time-series analysis and growth mixture modeling. Suffice it to say that TERN members are using the very latest statistical approaches to understanding the trajectories detected in the UpTERN data.

At present there are several papers under review that have utilized the trajectory data on tobacco use. Dierker et al. (2005a, 2005b) have used a time-series approach using single variables and multiple variables to examine the trajectories that exist in this sample. It is important to recognize that everyone has a trajectory so Dierker and her colleagues in TERN are examining the characteristics of all the trajectories that appear. Using this approach, Dierker and her colleagues are attempting to specify how and where on trajectories of use dependence is reached. This requires the identification of the point at which dependence seems reasonably certain on common measures, such as the number of cigarettes consumed per day. In another paper, also methodological in nature, Colder and his colleagues (Colder et al. 2005) have used a different approach to understanding trajectories; it involves identifying all of the existing trajectories and grouping them according to their shape and structure and other characteristics of the individuals exhibiting them.

Using even state-of-the-art statistical techniques to analyze these very unusual data has been difficult because the techniques themselves are as complicated and complex as the data on trajectories from 245 days. The attempt to understand trajectories of tobacco use and dependence and the discussions and presentations about this that have occurred in TERN highlight an extremely important feature and benefit of transdisciplinary research networks — the critical value of research and statistical methodology.

There are some disciplines where these state-of-the-art statistical techniques have never been used, but perhaps could be. There are some disciplines where use of these techniques is becoming more widespread. Most researchers, however, are not yet comfortable with either the theory underlying them or the sophisticated knowledge required to implement them. All of the network members participated in the discussions about these analyses and were able to ask probing questions and receive answers about the strengths and limitations of these techniques and how they are different from, and perhaps better than, existing techniques for understanding trajectories.

Traditionally, progress in science has occurred primarily within disciplines where there are strong incentives to do things just like all other "fill-in-the-blank" scientists. This "silo" type thinking and working has served fields well. However, there are simultaneous methodological and statistical innovations occurring in all scientific disciplines that may be relevant and useful to scientists in another field. Unfortunately, the scientific community does not have enough effective mechanisms for diffusion of these innovations. What happened in TERN with regard to understanding trajectories — involving scientists from many disciplines struggling to understand trajectories of tobacco use using sophisticated methodological and statistical approaches — is certainly one mechanism of diffusion that has promise for building transdisciplinary knowledge.

Continuing work on the UpTERN study. RWJF program staff expected the network to think out of the proverbial box, to try to move the scientific envelope into areas that may be risky but could become a catalyst for new and innovative thinking. One of the most profound benefits of a transdisciplinary research network is the natural emphasis on cutting-edge statistical analytic techniques. An example concerns missing data. When data are collected from humans, in some cases those individuals fail to answer some of the questions included in the questionnaire (usually a small number of individuals and questions in any one study). The problem is: when data are missing, what does one do with the remaining answers? A traditional approach has been to delete that individual from the analysis that includes the question(s) for which they did not provide answers. This is, of course, not the optimal choice for a researcher that wants to include all individuals who participated in the study.

During several core group meetings, presentations were made on various ways to handle missing data. One of the world's leading experts on missing data was approached to help TERN with this issue. His response was that the missing data experts were just now tackling how to handle missing data with less than 10 data collection points. The mere thought of dealing with 245 days of data for which missing data might be relevant was not even on the radar screen of those working on approaches and the creation of algorithms to handle missing data.

Because the UpTERN data were collected largely on the Web, missing data problems were minimized. However, the data set is not completely free of missing data problems. TERN members will continue to experiment with ways to handle missing data when the research design involves such a large number of data elements. This is another methodological issue where the value of a transdisciplinary approach is clear.

Over the next several years there will be a number of other seminal papers on trajectories emerging from the UpTERN study. It also should be noted that the sample group has now been followed into their sophomore year — adding to the value of this unique sample and study.

Because of the uniqueness of the TERN data on trajectories, and as part of the commitment of TERN to be inclusive, TERN convened a working group of leading experts on analysis of such data to discuss state-of-the-art statistical approaches to trajectory data and to seek input from the experts specifically on how to analyze data from the UpTERN study.

Acquisition and Early Episodes of Use — Animal to Human to Animal Research

At the second meeting of TERN the members made a commitment to understand early episodes of use among humans and, because so many disciplines were represented, to use early episodes of use as a substantive focus to link animal to human to animal research. In a TERN-sponsored paper in a special issue of *Drug and Alcohol Dependence,* Eissenberg and Balster (2000) thoroughly reviewed the existing literature on early episodes of use and found that virtually all attempts to capture the phenomenon involved retrospective recall, sometimes requiring the participants to remember back a number of years to their initial use of tobacco/nicotine. They further found that there were few published studies of "acquisition" of nicotine use among animals. Most studies of nicotine only included animals that would reliably self-administer the drug. Those animals that failed to reliably self-administer nicotine were almost always eliminated from the studies and little was known about the sources of individual differences.

Acquisition of nicotine/tobacco use. This doesn't mean that the data on individual differences in acquisition were thrown away. They existed but had never been considered that interesting in spite of the fact that the total sample — those that acquired and those that did not — are probably most similar to humans where some never try, some try but do not continue, others continue but do not become dependent, and some become dependent on tobacco/nicotine.

TERN took two approaches with regard to the animal data: The first involved identifying laboratories that had the data deemed suitable to understanding acquisition. The principal investigators of these studies were then approached to see if they would share their data with TERN. Four of these senior scientists were invited to a TERN meeting and asked to make presentations on their work. These scientists were Burt Sharp from the University of Memphis, Tony Caggiula from the University of Pittsburgh, Mohamed Shoaib, from the University of London, and George Koob from the Scripps Institute (at that time, Koob was not a member of TERN). The second approach involved TERN providing funding (at a later date) for the purchase of 12 compartments for Koob's laboratory at Scripps Institute that would be devoted to studying nicotine acquisition. Koob and his colleagues also received a grant from the Tobacco Related Disease Research Programs in California for the actual conduct of the studies (see O'Dell et al. 2004).

Then, TERN's acquisitions working group conducted a study of individual differences in trajectories of acquisition that is, as best the authors can tell, the first such study conducted on nicotine acquisition. The results were presented in the President's Plenary Session at the Society for Behavioral Medicine by Eric Donny and his colleagues in 2003 (see Donny et al. 2004; Lanza et al. 2004).

The sample consisted of 106 Sprague-Dawley rats (a type of rat often used in laboratory research). These rats were trained to lever press for food and implanted with jugular catheters. They self-administered 20 to 90 micrograms/kilogram of nicotine one hour a day through an IV catheter. Each infusion was paired with a visual stimulus. The schedule of reinforcement utilized "fixed-ratio" responding. On days 1–5 the rats received an injection in response to pressing a lever in their compartment. On days 6–8 it took two times as many presses to receive the nicotine as on days 1–5. On days 9–20, it took five times the number of presses to receive the same dose that was received on days 1–5. Several of the aspects of

the study design would be expected to minimize individual differences in trajectories of self-administration, yet large differences were found.

The results were clear. There were a number of patterns (i.e., trajectories) of nicotine acquisition exhibited by these rats. There was greater heterogeneity (more spread) of pattern at the lower dose 20 mcg/kg, greater homogeneity (less spread) of pattern of acquisition the stronger the dose 90 mcg/kg.

Chart 10. Acquisition Patterns Regardless of Dose

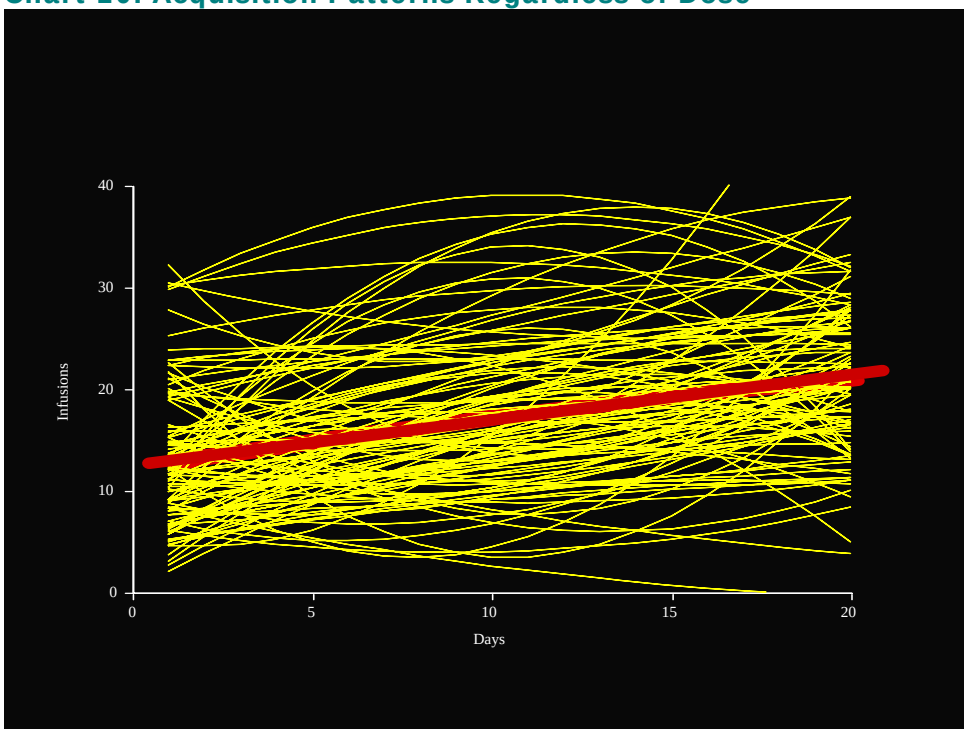


Chart 10 shows this heterogeneity in the nicotine acquisition patterns in these rats. A question arises about how similar these patterns are to those found in humans engaged in nicotine acquisition. Mermelstein and her colleagues presented a slide on patterns and trajectories from adolescents in the Chicago beeper study in the same plenary session at the Society for Behavioral Medicine meetings. Neither Donny nor Mermelstein had seen each other's slides before the session. It would have been impossible from the two slides to determine whether the data were from humans or rats. Mermelstein and Donny were surprised to see the similarities across species and encouraged that it may be possible to credibly test the same hypotheses across species and achieve the TERN goal of animal-to-human-to-animal research.

Using a statistical technique employed primarily by social scientists (hierarchical linear modeling), it was possible to identify several determinants of these individual differences in trajectories. A particularly interesting and important finding was that the dose of nicotine animals received with each injection only altered the overall number of injections, but not the trajectories. It might have been expected that higher doses per injection (corresponding to amount of nicotine per puff in humans), might have hastened acquisition, but it did not. The counterpart in humans would be that dependence for those smoking low-nicotine cigarettes would develop as rapidly as for those smoking high-nicotine cigarettes as even early users adjust their smoking patterns to select nicotine exposure.

This study also had both biological and behavioral outcome measures. Of significance is that the level of behavioral dependence measured as the amount of work animals would perform to obtain nicotine injections a month after they acquired nicotine self-administration could be predicted by individual differences noted within the first few days of their acquisition of self-administration. This finding reinforced the network's decision to focus on early use episodes.

The critical role of methodology in transdisciplinarity. One of the most important lessons learned in TERN is the critical role that methodology plays in the creation of transdisciplinarity among the members and in the emergence of transdisciplinary science. In the process of examining the trajectories and patterns of acquisition the TERN acquisitions working group applied growth curve modeling, an approach with origins in the social and behavioral sciences, to analyze the data from rats. This led to two papers that appeared in *Drug and Alcohol Dependence* (see Donny et al. 2004; Lanza et al. 2004). The members of TERN are convinced that, if this statistical technique were to become commonly used in basic animal and human laboratory research, it would constitute a paradigmatic shift in basic science, offering tools to explore individual differences.

Additional pilot studies among peri-adolescent animals. Adolescence is a period (actually a series of periods) that is of critical importance with regard to acquisition of tobacco/nicotine use in humans. There is no perfect analog to adolescence in rats. However, peri-adolescent rats, those who are between day 15 and 42 of life, are considered to be a proxy for human adolescence. The identification of major individual differences in the rat studies led to TERN support of two important but modestly funded pilot studies. The first study was conducted by Ann Kelley, Charles Landry and their graduate student, Terri Schrochet. Kelley had been a member of the BAAD working group in TERN, more formally known as the Biobehavioral Aspects of Adolescent Development.

Kelley and her colleagues examined nicotine reactivity in C-fos gene expression in the frontal cortex — the seat of executive decision-making — in peri-adolescent rats compared to adult rats. They found that peri-adolescent rats were much more reactive to nicotine than adult rats, and that this effect was especially prominent in the frontal cortex. This work led to a federal grant to Schrochet and her involvement, with Kelley, in the TERN-organized and sponsored meeting (also sponsored by RWJF, the National Cancer Institute, the National Institute on Drug Abuse, the National Institute of Child Health and Human Development, and the National Institute of Mental Health) held at the New York Academy of Sciences on Adolescent Brain Development in September 2003 (see Dahl and Spear 2004).

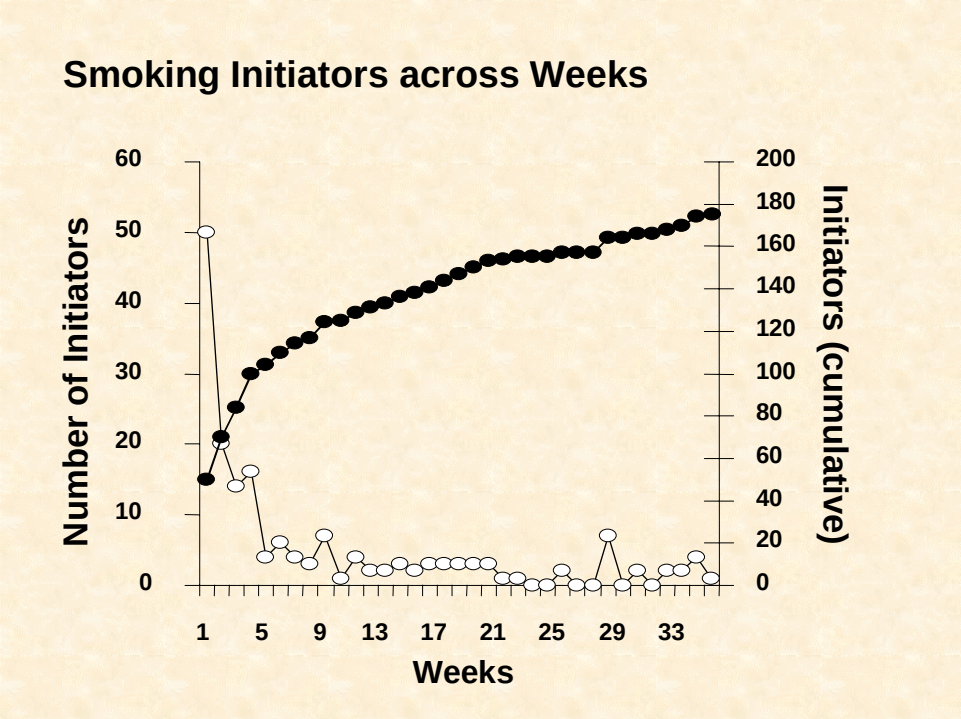
Cheryl Kirstein, a former student of Linda Spear, another "outside" member of the BAAD working group, and Spear conducted experiments to see if changes in the environment affected nicotine's effects on peri-adolescent compared to adult rat brains. Their research suggests that the environment plus nicotine may synergistically affect continued use of nicotine in peri-adolescent rats, and by extrapolation, in human adolescents, although that extrapolation is offered very cautiously. Kirstein played a key role in organizing the poster sessions of the TERN-sponsored New York Academy of Sciences meeting.

Early episodes of use among humans. The commitment to study and understand acquisition and early episodes of use was also manifest in the UpTERN study. The first time a participant in the UpTERN sample reported starting cigarette use they were asked a series of questions about their reactions to the first, second, third, fourth and fifth cigarettes. Altogether, there were close to 170 students from whom such data emerged. Chart 11 shows those participants. This was the first time early episodes of use in "close to real time" had ever been examined. Another important feature of this study was the incorporation of interview data to complement the Web-based quantitative data.

The data from these early episodes of use are now being analyzed by the TERN acquisitions working group and have served as the basis for a R21 grant application from the National Institute on Drug Abuse. The principal investigator of that grant is Michelle Acosta, now at Columbia University, who was formerly a post-doctoral student of Tom Eissenberg (a TERN Faculty Scholar) and Bob Balster (a member of the core group) at Virginia Commonwealth University and who worked on their TERN research. There are several important findings emerging from the analyses of these data. These early use episodes occur almost exclusively in social situations — with a large majority occurring among students who were drinking alcohol, often in large amounts. In light of the significant co-use of alcohol, the effects of nicotine in these early episodes require reinterpretation. None of the earlier studies focused on this issue.

This and ongoing work on this part of the UpTERN data set is designed to shed new light on what TERN initially decided was a major gap in the existing knowledge base. It is possible that early use episodes provide important clues about the architecture of trajectories of use and dependence.

Chart 11. Smoking Initiators Across Weeks



Conceptualization and Measurement of Dependence

When scientists from different disciplines engage in a collective and collaborative process of becoming more transdisciplinary, there are several key ingredients that can be used to determine if progress toward transdisciplinarity occurred.

- **In-depth and lengthy discussions of how salient concepts/constructs are defined.** In TERN it was not unusual to hear someone say: "So, that is the way your discipline defines X." The response might be: "We agree on most elements of the definition, but we would add/subtract/amplify the definition as follows." This is part

of the conceptual translation process outlined by Kahn and discussed earlier in this report.

- **A willingness to be open to new ways of thinking about an important concept/construct and mutual agreement to be constructive rather than defensive.** The rapport, trust and intellectual excitement about learning across disciplines helped the numerous and sometimes intense discussions the group had about dependence.

Dependence is perhaps the most important concept/construct in the drug abuse field. With reference to nicotine and tobacco, TERN noted several interesting facts:

- Although chronic tobacco use was identified in the 1964 Surgeon General's report as the most obvious cause of the morbidity and mortality attributable to dependence on nicotine, the Surgeon General's report on nicotine addiction was not published until 1988, a hiatus of almost a quarter of a century.

- Although nicotine dependence likely exists on multiple dimensions, the prevailing gold standard diagnostic tool from a clinical perspective (i.e., DSM [*Diagnostic and Statistical Manual*]) simply adds up symptoms and, if a patient has four or more of these symptoms, they are considered dependent.

- The scale most widely used to measure dependence, the Fagerstrom Test of Nicotine Dependence, was not designed to measure dependence and is not multidimensional.

- Tobacco researchers have approached the definition and measurement of nicotine dependence among youth often by ratcheting down measures designed to assess dependence among adult chronic users of tobacco.

During the early stages of TERN, the network decided that a fresh examination of nicotine dependence was needed — an examination that attempted to review what is known, identify the major gaps in the knowledge base, and attempt to fill those gaps with clear transdisciplinary thinking.

Special supplemental issue: tobacco, nicotine and youth. The etiology of tobacco use and nicotine dependence does not exist in an intellectual vacuum or an academic silo. Rather, it is located under the broad umbrella of substance abuse (i.e., drug and alcohol abuse and dependence). It is clear from the experience in TERN that scientific progress in any field requires an in-depth exploration of the conceptual and methodological underpinnings of the current knowledge base. Recognizing this, and following extended and intensive discussions, TERN established a working group on dependence and commissioned a number of papers that were published in a supplemental issue of *Drug and Alcohol Dependence* (2000) on "Tobacco, Nicotine, and Youth." This journal is the official journal of the College on Problems of Drug Dependence (CPDD) (formerly the Committee on Problems of Drug Dependence, CPDD has been in existence since 1929; it serves as an interface among governmental, industrial and academic communities in the United States; it also functions as a collaborating center of the World Health Organization).

The supplement included a paper on the conceptual foundations of dependence (Shadel et al. 2000), a paper on extant attempts to measure dependence among youth and an essay on whether adolescents using tobacco were addicted (Colby et al. 2000a, 2000b), a paper by Eissenberg and Balster (2000) on early episodes of use, and a paper by Mayhew, Flay and Mott (2000) on stages of tobacco use. See Appendix 2. These papers are cited in the field

and laid out the conceptual orientation of TERN to understanding the etiology of tobacco use and dependence by focusing on the meaning and measurement of transitions, stages and trajectories of tobacco use and dependence, and by focusing attention on the potential importance of early episodes of use and how individuals become tobacco users.

This led to an extended period of intensive discussion and debate within the network as its members attempted to develop an integrative conceptual framework or model of the etiology of tobacco use and dependence. One of the hallmarks of a transdisciplinary research network is conceptual translation and the amalgamation and synthesis of theoretical streams from various disciplines into an organizing model for its work. This process and period of TERN was at times very frustrating for all involved, yet intellectually stimulating. This exercise and the activities involved highlighted the complexity of the phenomena being examined and the value of attempting to become more transdisciplinary. On a number of occasions, members of the core group referred to this process and period as conceptual (dis)integration.

Special supplemental issue on theory. One product that emerged from the intellectual challenges of this period in the network's history was a commitment to more thoroughly examine the streams of theories about dependence within the broader drug abuse/substance abuse field. The three streams of theories selected were (1) negative reinforcement, (2) positive reinforcement and positive incentive, and (3) social learning — each containing a number of more explicit theories within the stream.

Three papers were commissioned and eventually published in a special issue of *Addiction* in 2004. The authors were:

- Thomas Eissenberg, a TERN Faculty Scholar from Virginia Commonwealth University
- Stephen Glautier from Southampton University in Great Britain
- Thomas Brandon, Thaddeus Herzog and Jennifer Irvin from the University of South Florida and Chad Gwaltney from the University of Pittsburgh

Stephen Tiffany, Cynthia Conklin (a former student of Stephen Tiffany and a post-doctoral student at the University of Pittsburgh), Saul Shiffman and Richard Clayton wrote a paper that attempted to synthesize the three theoretical streams. Tiffany, Shiffman and Conklin edited the issue.

Several aspects of this activity highlight TERN's approach to its work:

- The authors of the papers in this volume were more junior than senior in the field.
- TERN recruited senior scientists, many of who were responsible for the theories covered in each paper, to serve as consultants to the authors of the papers.
- The authors were invited to attend a TERN meeting, brief the network on their thinking, and participate in discussions about the theories.
- TERN established a process by which TERN members reviewed various drafts of the papers before they were submitted to the journal for publication.

An animal model of withdrawal: a pilot study. From some disciplinary perspectives, a critical element of dependence is confirmed withdrawal. Failing to find published research that documented withdrawal from nicotine in an animal model, TERN funded a pilot study

conducted by Patrick Beardsley and Bob Balster at Virginia Commonwealth University. The results of this TERN-sponsored pilot study confirmed the empirical existence of withdrawal from nicotine in the sample of rats. Papers are being prepared for publication from this study.

Methodology: Essential for Transdisciplinary Research Networks

Research design, measurement and statistical analysis are central to scientists in all disciplines. If there is one common language in science, it is the various aspects of methodology. While there is considerable heterogeneity in the conceptual and substantive approaches to studying important phenomena, there is more homogeneity with regard to methodology. Methodology was clearly one of the most important cohesive elements in TERN.

Because discussions of methodology were integrated into virtually every aspect of TERN, this report highlights some of the more significant indices of methodology in the work of TERN.

Methodological innovations in the UpTERN study. First, the scientists in TERN looked to see if growth curve modeling, a statistical technique that has it origins in the social and behavioral sciences, could be applied to data from animals. The prevailing opinion was that the results from such analyses would be more robust than those obtained when a more traditional technique such as analysis of variance is used. This proved to be the case when growth curve modeling was applied to the acquisitions data (see Donny et al. 2004; Lanza et al. 2004). Thus, one of the benefits of a transdisciplinary research network is the increased likelihood of adoption of statistical analytic innovations by disciplines that would not be aware of these techniques were it not for the cross-disciplinary discussions.

Second, almost every design feature of the UpTERN study shows the types of innovation that emerge from a transdisciplinary research network. This includes the use of Web technology to collect data from a large sample over an extended period, 35 weeks and 245 days of data. It includes the use of quantitative data collected via the Web to identify specific individuals for more intensive qualitative data collection to enhance knowledge of various issues such as early use episodes, party smoking, and potential gender differences in smoking patterns and motivations.

Third, because the UpTERN study contains so many data points, it provides opportunities to test the limits of existing analytic techniques. This was most clear when TERN approached experts in missing data algorithms for advice on how to deal with missing data. When the experts discovered that we had data covering 245 days, they informed TERN that current work was focused on how to deal with missing data from less than 10 data collection points. In analyzing the UpTERN data, the scientists in TERN discovered that it is more difficult to model trajectories the more data points available for analysis.

Fourth, the network organized two working groups (independent variables and dependent variables) in developing the data-collection instruments for the UpTERN study. These two groups were comprised of representatives from a variety of disciplines and exemplified the value of a transdisciplinary approach. For example, the working group on independent variables was co-led by Bob Balster, a psychopharmacologist who had minimal experience in constructing questionnaires, particularly on independent variables, and Lisa Dierker, a TERN Faculty Scholar with considerable experience in such efforts. This group explored a large number of scales and measures and devised a creative way of obtaining data on a number of important sociological and psychological constructs.

Fifth, as part of its emphasis on methodology, TERN convened a small conference on trajectories and how to analyze them. The participants included some of the world's most prominent statistical experts on analyzing trajectories. On several occasions, TERN assembled a small group of experts to discuss ecological momentary assessment (EMA) approaches to data collection and their relevance for advancing knowledge of pathways to trajectories of tobacco use. In studies using an EMA approach, such as the Chicago beeper study mentioned earlier, the participants are contacted randomly multiple times a day and queried about where they are, what they are doing, who is with them, and other behavioral and psychosocial patterns. This is done via a personal digital assistant. These small scale working group conferences proved invaluable to TERN in its deliberations about how to conceptualize and measure tobacco use.

Special supplemental issue on measurement and methodology. As noted, innovations in methodology are at the heart of any transdisciplinary research activity. In 2002 TERN published a supplemental issue of *Drug and Alcohol Dependence* on "Measurement and Design Issues in Tobacco and Drug Use Research." The editors of that volume were Linda Collins (a member of the TERN core group), Brian Flaherty (a TERN Faculty Scholar from Penn State) and Suzanne Colby from Brown University. See Appendix 2. The editor of the journal tells us that these papers are among the most cited and downloaded papers in the journal in recent years and have led to a significant increase in submissions of papers utilizing the advanced methodologies described in this special issue.

- One was a paper by Flaherty on focused on reliability (i.e., does a measure applied multiple times produce the same configuration of responses?).

- It also included an analysis by Abigail Panter and Bryce Reeve that is the first paper published on item response theory models specifically focused on tobacco. Item response theory is an approach designed to ensure that the responses to multiple items in a questionnaire are measuring the same thing.

- Another paper authored by David MacKinnon and two of his graduate students (Marcia Tarborga and Antonio Morgan-Lopez) dealt with mediation analysis. For example, one might hypothesize that social class influences the likelihood that an individual will smoke and that the higher the social class, the lower the smoking rate. However, there may be a variable that "mediates" this relationship, (i.e., that "filters" the influence of social class). One example might be an individual's own attitudes toward smoking or perceptions of the harm of smoking that could alter the likelihood that an individual will become a smoker, regardless of social class.

- Linda Collins wrote a paper on adaptive sampling (sometimes called snowball sampling, in which a researcher starts with one individual in a network of individuals and eventually, in interviewing subsequent individuals, finds him or herself referred back to the person with whom the study started) with a prominent statistician (Steven Thompson) who had never published on substance abuse. While adaptive sampling is often perceived as a less rigorous methodology, Collins and Thompson identified aspects of this approach that demonstrate its rigor.

- Collins also wrote a paper with John Graham on an issue that will become increasingly important — the effects of periodicity of data collection on analytic strategies. For example, what should researchers do when one aspect of their study involves a baseline questionnaire and follow-ups conducted one year apart, but other times in between, the participants are asked to provide other data? This is seen most clearly in the Chicago beeper study when the participants completed a baseline questionnaire

and follow-ups every six months after that. However, for one week out of every six months they were given a PDA and asked to provide data five times a day when they were randomly beeped.

- Another paper in this volume involved a comprehensive description of how qualitative approaches can be used to tailor quantitative measurement strategies regarding dependence in youth. This paper by Mark Nichter, Mimi Nichter, Pamela Thompson, Saul Shiffman and Anna-Barbara Moscicki built on TERN involvement and investment in a project funded by the California Tobacco Related Disease Research Program (TRDRP). It involved examining tobacco use in three ethnically different high schools in the San Francisco Bay area to determine if the questions designed to measure nicotine dependence among these adolescents needed to be worded differently for youth from different ethnic groups. The answer was no.

Stress/Affect (the Emotional Response to Stress) and Trajectories of Tobacco Use

Over the entire course of TERN there was a strong interest in stress/affect (the emotional responses to stress) as major pathways to trajectories of tobacco use and dependence. The network dealt with this interest in several ways.

- TERN commissioned a comprehensive review paper by Bob McMahon and Jenny Antony (one of his doctoral students) on psychopathology and tobacco use following up on McMahon's paper at a 1998 National Institutes of Health conference on nicotine addiction sponsored jointly by the National Institute on Drug Abuse (NIDA) and the National Cancer Institute (NCI).

- TERN funded a pilot study on acoustic startle conducted at Yale by Elsa Daurighe, a post-doctoral student of Kathleen Merikangas, a core group member. When individuals hear an unexpected "startling" sound there are large individual differences in their response and response time. It has been hypothesized that such acoustic startle responses are a marker or potential predictor of who will or will not become dependent on nicotine and other substances. This pilot study was designed to use a human model similar to an animal model to see if acoustic startle could be a biological marker for nicotine use and dependence.

- TERN commissioned a paper by three young scientists who had never worked together. These were Jon Kassel (University of Illinois at Chicago), Laura Stroud (Brown University and a TERN Faculty Scholar), and Carol Paronis (an animal researcher at Harvard University). They were brought to two separate TERN meetings to help get the paper organized and to hear from TERN members who were reviewing various drafts of the paper. The paper was presented at a TERN-sponsored plenary at the Society for Research on Nicotine and Tobacco (SRNT) meetings and eventually published in *Psychological Bulletin* (2003) — one of the leading journals in psychology. See Appendix 2.

- TERN worked with Ron Kessler (Harvard University School of Public Health) and Merikangas, who were responsible for the second National Co-Morbidity Study (a nationwide survey for which the principal funding agency is the National Institute of Mental Health). TERN helped create the items used in this important study to measure tobacco use and dependence among adolescents.

- Throughout the course of TERN there was an active psychopathology working group that is currently analyzing data from the UpTERN study to examine issues such as the

relationship between depression, anxiety sensitivity, stress, conduct disorder, and personality and trajectories of tobacco, alcohol and marijuana use.

- A number of TERN-sponsored papers were published that were not included in special issues (see Appendix 2).

Contextual Influences on Tobacco Use Trajectories

From the second meeting and throughout TERN, its members were impressed by the overwhelming emphasis in the field on individual-level risk/protective factors to the exclusion of the influence of contextual and environmental-level variables on tobacco use and dependence. TERN therefore developed a working group of contextual factors.

TERN working group on contextual factors. The TERN working group on contextual factors identified the contexts members believed might be most influential on tobacco use trajectories and commissioned a series of papers to be written primarily by younger scholars. After they had prepared an outline of their paper, this group was invited to a working group meeting so that they could get to know one another and have a better sense of what TERN expected. Thomas Cook, one of the national advisory committee members, was able to attend and participate in this meeting.

Subsequently, when more robust drafts of the papers had been written and reviewed by TERN members, the entire working group was invited to attend a full TERN meeting and to get additional feedback on their papers. There were two papers on the family as a context (Avenevoli and Merikangas, Darling and Cumsille), one on peer context (Kobus), one on neighborhood and community context (Wilcox), one on the media (Wakefield), one on economic context (Liang) and one on political economy (Pollack and Jacobson). Separate papers that serve as commentaries on methodological and conceptual aspects of contextual issues were written by Mark Nichter, Frank Chaloupka and Cook. This volume was edited by Brian Flay and Dick Clayton and published as a special supplemental issue of *Addiction* in 2004. It is the first attempt to focus exclusively on contextual issues regarding tobacco use trajectories ever published. See Appendix 2.

Contextual factors in the UpTERN study. TERN has been involved in several efforts to extend knowledge of contextual factors as they affect tobacco use trajectories and in interaction with individual level factors. For example, in the UpTERN study, extensive data were collected on where students were living on campus. In addition, extensive calendar data were collected for “all” campus events occurring during the 2002 academic year at Purdue when TERN was studying the freshman class. These data will be incorporated into subsequent papers from the UpTERN study.

OpTERN: contextual factors and tobacco use in the military. Data on TERN’s most extensive examination of the influence of contextual factors on tobacco use trajectories were collected in November 2004 and March 2005. TERN is collaborating with a research team from the Research Triangle Institute (RTI) of Research Triangle Park, N.C., on a study being conducted among sailors at the Great Lakes Naval Training Center in Waukeegan, Ill., where all people joining the Navy must complete the nine weeks of basic training. Recruits are prohibited from smoking during basic training. Recruits can begin to smoke upon graduation from basic training when they officially become sailors. About one-half of those who undergo basic training at Great Lakes stay on for advanced training in one of the 17 specialty schools (gunner’s mate, radar technician, etc.), during which time they can smoke. These schools last different periods of time, all have dormitory space allocated for their students, and all of their students go to class in the same facilities. Therefore, these advanced training schools constitute a unique environmental context.

TERN is interested in the re-acquisition (return to smoking) and acquisition (first time smoking) among sailors in these 17 schools following the forced abstinence of basic training (a policy intervention). The question is: Are there differences across contexts (schools) in how long it takes for someone who previously smoked to re-acquire tobacco use across schools, and how soon acquisition occurs among those who did not smoke prior to basic training. Because all the students are roughly the same age, all have the same schedules and same benefits, and because there is considerably more diversity by race/ethnicity among sailors (only 60 percent are white, non-Hispanic) than among college students at Purdue, this setting was ideal for TERN to study contextual influences. The data from the 3,400 sailors who participated in this study are being analyzed and have been used in a briefing to Navy officials at the end of July 2005 and at a conference sponsored by the Navy in August 2005.

There are several findings of interest from the preliminary analyses.

- First, the forced abstinence of basic military training does not seem to reduce smoking or smokeless tobacco use. The sailors were classified by whether they smoked/used smokeless tobacco in the month before entering basic training and whether they had started smoking/using smokeless tobacco again, or for the first time, since the end of basic training.

    - It is clear that there are a number of sailors who started using tobacco *after* basic training (No Yes row). Some 9 percent of males and 6 percent of females report not smoking in the 30 days before entering basic training but have smoked since the end of basic training. The percentages for smokeless tobacco are 5 and 1 percent.

    - Only 3 percent of males and 4 percent of females are in the Yes No row indicating that they have quit smoking, or at least have not re-acquired smoking since the end of basic training.

    - The fact that 36 percent of males and 29 percent of females re-acquired smoking (Yes Yes row) after the forced abstinence of basic training reflects the strength of the dependence on nicotine. A similar conclusion can be reached for smokeless tobacco.

Smoking/Smokeless Tobacco Use in 30 days before basic Training	Smoking/Smokeless Tobacco Use Since the end of basic training	Smoking Males	Smoking Females	Smokeless Tobacco Males	Smokeless Tobacco Females
No	No	52%	62%	78%	96%
No	Yes	9%	6%	5%	1%
Yes	No	3%	4%	2%	1%
Yes	Yes	36%	29%	14%	2%

- A second question from the Navy study was how quickly after the end of basic training sailors either started smoking again or began smoking for the first time. In fact, 63 percent of those who have smoked since the end of basic training did so in the first week, 76 percent in the first two weeks.

- The third question from the Navy study involves the influence of context on smoking — in this case, the barracks in which they reside. Among the 12 barracks examined, the percentage of sailors who smoked before basic and since the end of basic ranged from 28 percent in one barracks to 43 percent in another. The percentage of sailors who reported they had smoked since the end of basic training but did not smoke in the 30 days prior to basic ranged from 5 percent in one barracks to 16 percent in another.

- It is clear that smoking is very prevalent in this group of sailors with the total prevalence ranging from a low of 36 percent in one barracks to 51 percent in another.

TERN is exploring various intervention and policy options with the Navy based on this research. Similar studies are being conducted in the Air Force and Army. Data are not yet available from the other two services.

In addition, TERN's partners at the Research Triangle Institute had received funding from the Department of Defense to study alcohol use among recruits in the Navy, Air Force and Army. TERN has access to data collected on tobacco use from Air Force personnel who are in technical training (same as the Navy's advanced training). The data for this study were collected in the early summer of 2005 at four bases. The Air Force differs from the Navy in that smoking is prohibited during both basic and technical training. The data from this study will be analyzed and papers written from the data in the fall of 2005.

In addition, researchers at the Research Triangle Institute and TERN applied for and received a grant from the U.S. Army Command for Health Promotion and Preventive Medicine (CHPPM) to study soldiers in their advanced individual training (AIT) at four different bases. In the Army a solider can begin to use tobacco during their 21st week in the Army, somewhere beyond basic training but before completion of AIT. These data will be collected in the late summer and early fall of 2005.

Altogether, TERN expects to have data on approximately 10,000 to 12,000 sailors, airmen and women, and soldiers during their advanced training and to follow them at 12 months after they leave advanced training and are working in their permanently assigned units. These data will provide TERN with an opportunity to examine the influence of environmental contextual factors on smoking acquisition and re-acquisition under three policy interventions that differ in terms of how long smoking is prohibited.

Conferences

In order to meet the mandates set for it by RWJF, TERN organized and sponsored a number of events at professional meetings. This included special sessions at the Society for Research on Child Development, the Society for Research on Nicotine and Tobacco, and the Society for Behavioral Medicine.

In addition, TERN organized a conference titled "Addictions 2000, Prevention of Substance Use Problems: Directions for the Next Millennium." This meeting included a number of the leading prevention researchers from the United States and several from other countries. The papers from that meeting were published as a special issue of *Addictive Behaviors: An International Journal,* Volume 25, No. 6, November/December 2000.

The most ambitious of TERN's conference activities was a special September 2003 meeting of the New York Academy of Sciences held in New York City. The meeting grew out of a TERN working group on behavioral aspects of adolescent development (BAAD), co-chaired by Bob Balster and Ron Dahl that included Ann Kelley from the University of Wisconsin, Linda

Spear from the State University of New York at Binghamton, and Judy Cameron from the Oregon Health Sciences Center and the University of Pittsburgh, as well as several other TERN members. The New York Academy of Sciences meeting involved financial support from the National Cancer Institute, the National Institute on Drug Abuse, the National Institute of Child Health and Human Development, National Institute of Mental Health, the Robert Wood Johnson Foundation and TERN. The proceedings of the meeting, entitled "Adolescent Brain Development: Vulnerabilities and Opportunities," later was published as Volume 1021 of the New York Academy of Sciences, and edited by Ron Dahl and Linda Spear (2004).

The organizing committee identified several criteria for measuring the success of this conference:

- **Attendance.** A total of 300 individual registered and attended the meeting, the maximum that could be accommodated in the conference facility. The facility was full for all the sessions in spite of the fact that a hurricane was occurring on the east coast at the time of the meeting.

- **The number of hits on the conference Web site.** There were 40,000 hits in the span of several months. This number surprised and pleased the New York Academy of Sciences partners because this conference was the first for which they used the Web site as a communication device.

- **The feedback received from federal funding partners.** TERN sponsored a small de-briefing meeting in Washington attended by representatives from the federal agencies that had provided funding. The response was consistently positive with unanimous agreement that the format for the meeting (brief presentation to orient the session followed by a presentation from a scientist who studies animals and a scientist who studies humans, followed by a brief presentation by an integrator) was not only interesting but very stimulating. It is often said that the nicest form of compliment is imitation. At a pre-conference workshop on translational science at the July 2005 annual conference of the College on the Problems of Drug Dependence, the organizers explicitly acknowledged that the format and structure as well as the inspiration for the workshop came from TERN's New York Academy of Sciences meeting on adolescent brain development.

- **The quality of the presentations**. As noted, each session involved a presentation by someone studying animals and someone studying humans, as well as an organizer and a discussant. There was uniform agreement among the federal funding partners for the meeting about the breadth, depth and comprehensiveness of the presentations. Feedback from senior and junior scientists concerning the poster sessions, which were organized primarily for graduate students to share their findings, were uniformly positive. Graduate students working with the members of the organizing committee for the meeting took the lead and organized the poster sessions, half of which reported findings from animal studies, half from studies of humans — with posters representing different approaches and different species purposefully and strategically located side by side at the poster session.

Finally, in his presidential address for the Society for Behavioral Medicine in 2003, David Abrams specifically acknowledged the influence of TERN in his thinking about transdisciplinary research. A plenary theme lecture by Stephen Tiffany at the 2004 meeting of the Society for Research on Nicotine and Tobacco Research was based almost entirely on the work of TERN.

THE IMPACTS OF TERN

There are a number of ways of assessing the impact of a collaborative enterprise such as TERN. There is the usual measure of scientific productivity — publications in peer-reviewed journals (see Appendix 2 and the Bibliography). It is quite likely that, through the special journal issues produced by the network and the large number of publications that will continue to emanate from its research, TERN will be judged a success by this traditional measure.

However, there are many other measures of success that, for an endeavor like TERN, are equally or perhaps even more important than publications over the long-term. They include:

- New integrative ways of thinking about tobacco etiology, use and dependence, as captured in creative theories, constructs and research designs.
- New methods for collecting, handling, analyzing and interpreting data resulting from the kind of research pursued by TERN.
- Changes in how participants in the network think about, approach and conduct research.
- The recruitment to tobacco research of established investigators from other fields.
- The training of a cadre of future researchers knowledgeable about the state of the art of tobacco research and committed to the collaborative ethos.
- Advancement of the field of tobacco research by TERN participants through their publications, presentations, training of students and fellows, service on peer-review panels and journal review boards, and receipt of other funding for their work (see Appendix 3).

At this time, perhaps the best way to assess the degree to which TERN has been successful as measured by these broader indicators is to ask the senior investigators who comprise the core group, and the TERN Faculty Scholars what they think. The following sections summarize what the authors found when they asked participants in TERN the following questions:

- How has TERN influenced how you think about and approach research questions?
- What have been the most significant benefits of the collaborative process for you professionally and personally?
- What are TERN's most significant contributions to the field of tobacco research?
- What do you believe are TERN's most significant impacts on the next generation of tobacco researchers?
- What do you believe are TERN's greatest strengths?

The next two sections summarize the feedback received in response to these questions. The first section attempts to capture the perspectives of all participants in the network — core group members and TERN Faculty Scholars. The second section contains responses from

TERN Faculty Scholars only concerning questions related to the impacts on them, personally and professionally — and thus on the next generation of tobacco researchers. The statements are quotes, some of which have been slightly edited for clarity and brevity.

Impacts on TERN Participants

Conceptualizing research questions. Participation in TERN seems to have had a profound impact on how network members think about and approach research questions. Here is what they said.

- "This one of the few opportunities I have had to consider a public health problem in a manner that spans micro to macro, genetics to political economics. This was an opportunity for me to truly experience transdisciplinary research by being exposed to colleagues who were not only bright but who were capable of thinking out of the box."

- "I am much more apt to think in terms of processes at multiple levels. Having been trained as a psychologist I was very centered on the individual before. Now I see what a narrow perspective that is."

- "I tend to approach questions much more broadly, or to be more open to broader considerations. I have a better appreciation for qualitative approaches to research, and to animal research as well. The qualitative approach has made me much more sensitive to questions of measurement and to language."

- "There has been a transformation in my scientific approach to thinking about individual differences through the use of multivariate methods (simultaneous consideration of individual differences using multiple variables). Through exposure to some of the leaders in the study of risk factors that relate to individual vulnerability, I have come to see great benefits in applying this approach to even basic biological and behavioral phenomena. The initial demonstrations of this are the two papers applying growth curve models to animal studies of the acquisition of nicotine self-administration. I have a related study in progress for cocaine self-administration. I am not aware of ANY other studies of the application of modern multivariate methods to the study of laboratory-collected data in the area of addiction research. I believe this approach will ultimately identify entirely new categories of controlling variables amenable to in-depth laboratory study."

- "I am much more inclined to think of the etiology of tobacco use in my research questions than I used to be — I see now that frequently I was too fixated on where smokers are, and had not considered the path they had followed to get there."

- "Prior to TERN I conceptualized etiology in terms of general substance use, and didn't consider that etiology may be different across substances in adolescence. My participation with TERN has led me to conceptualize cigarette use as an outcome that is unique from other substance use (e.g., alcohol use). In fact, my most recent research suggests that attitudes operate quite differently for tobacco and alcohol use in childhood and adolescence."

- "Working with qualitative researchers has given me a greater appreciation for the limitations of quantitative analysis of survey data. I have always been somewhat suspicious of questionnaire measures, and consequently, my research program has moved toward using experimental manipulations as a measurement tool (i.e., instead of just asking individuals in studies to answer a multiple choice question, I have

chosen to manipulate their smoking behavior in the laboratory to avoid the limitations of questionnaire data). I now have an appreciation for how qualitative research can inform quantitative analysis of survey data. Qualitative data add a richness and texture to what individuals imply by simply checking a choice on a multiple choice question on a questionnaire. My better understanding of qualitative or in-depth interviewing and observational data would not have occurred were it not for the TERN experience."

- "TERN has given me amazing freedom and flexibility to think outside of my areas of training (i.e. development and epidemiology). I used to have very shallow ideas about dependence, thinking about measuring it only one way. I am now energized by what I might be able to contribute to thinking within developmental epidemiology, by integrating the methodologies with which I am most familiar with evidence from the biological sciences on craving, withdrawal, tolerance, etc. The outcome that I had become so complacent about has now become a major interest to me."

- "More and more I am thinking in terms of natural experiments that can take what has been done in the lab and bring it into the real world."

- "I have stretched my brain and can now think along with colleagues in several other fields in ways I could never do before, making for cross field communication that stimulates me to think of new research questions."

Most Significant Professional and Personal Benefits (Core Group Member Responses Only)

Participation in TERN has benefited core group members in a number of ways, both professionally and personally. Examples are listed below.

- "TERN kept me in tobacco research. It became clear to me during TERN just how important anthropology was to the next generation of tobacco research. I was motivated to do anything I could to draw anthropologists into tobacco research — an area my discipline has been reluctant to enter because it is dominated by psychologists."

- "Professionally I now have a great network of colleagues with whom to exchange ideas. There is no one in this network that I would not like to spend more time with professionally or personally."

- "Learning about Ecological Momentary Analysis [EMA is a technique to collect data in closer to real time with electronic technologies] and other intensive longitudinal data collection methods convinced me of their importance. On the basis of my TERN experience, I instituted a program of research on this topic in my center, and it is still going on."

- "It was very stimulating to have a chance to sit, think, discuss. We do so much running around in academia, we don't have a chance to chew on issues that much. That seemed luxurious to me, like the intellectual equivalent of going to a spa. Just the exercise was good for me."

- "I was not a substance abuse researcher prior to joining TERN. I now consider it to be one of my primary interests. My involvement in TERN led directly to my co-writing a Fast Track-related grant [Fast-Track is a long-term prevention trial] to the National Institute on Drug Abuse [subsequently funded]. I am also pondering ways in which I

can tie my interest in child psychopathology and tobacco use to my interests in intervention."

- "I am so appreciative of the opportunity to have been involved in this network — it has been one of the most rewarding personal and professional experiences in my life. Professionally, I greatly increased my knowledge about tobacco and its effects, learned a tremendous amount about transdisciplinary approaches to this problem, and learned that you can 'teach an old dog new tricks'.... Personally, through TERN, I have been able to strengthen existing friendships and establish many new ones."

- "In learning how to talk the talk and walk the walk in areas of research in which I had no prior credibility at all (e.g. survey research, epidemiology, multivariate methods, anthropology), I feel I have been able to convince (or fool?) many colleagues that I know something about research in these areas. I certainly feel I can read it with a better understanding. This increased credibility in broad new areas of science has been particularly valuable to me in two of my ongoing roles, director of a multidisciplinary institute for drug and alcohol studies and editor of a leading multidisciplinary journal in addictions research."

- "TERN has given me a model for transdisciplinary research in tobacco use. Based on this, I worked with leaders in my university and in the Virginia General Assembly to add a strong research component to the expenditure of Master Settlement Agreement funds in Virginia. I was able to attract funding for the establishment of a multidisciplinary state-wide 'institute without walls,' modeled very much on TERN, that has now been funded for three years in a total amount of over $5 million."

TERN'S Contributions to the Field of Tobacco Research

Participants in TERN believe that the network has made a number of contributions to the field of tobacco. This can be seen in the comments below.

- "TERN has drawn attention to: (1) the emergence and multidimensionality of dependence and transitions as possible points of intervention leverage; (2) the equifinality and multifinality [i.e., one factor leading to multiple outcomes and multiple factors leading to the same outcome] of tobacco use trajectories; (3) the importance of co–substance use in youth tobacco trajectories; (4) the importance of low-level tobacco use in college populations; and (5) changing tobacco-use norms among youth."

- "The collection of review articles and research articles published by TERN alerts disciplines to [the work of] other disciplines and connects them — and frames issues from many perspectives simultaneously. The 'special issues' published by the network provide a great handle on the literature and give important direction to the field."

- "Bringing so many people together and getting them to think about tobacco, demonstrating what a transdisciplinary group can do, and proving that more detailed and integrated levels of analysis can be accomplished within the context of a longitudinal design, all push the field significantly forward, raising the bar, so to speak, for future efforts to understand the complexities of tobacco use."

- "Demonstrating the practicality and utility of conducting large-scale Web-based studies to measure daily behavior, and how smaller experiments that emerge from a larger project (e.g., UpTERN), can inform and enrich our understanding of a large survey study."

- "Although not yet fully realized, TERN demonstrated how qualitative and quantitative data can be used together to inform questions of interest. I hope that ethnography will be seen as an important component of tobacco research, which was not the case seven years ago."

- "Conceptually, TERN characterized the challenge posed by the diverse factors involved in the trajectory of tobacco use from initiation to cessation and again, sadly, to relapse. Empirically, TERN developed a research agenda to make substantial progress in this area."

- "TERN provided evidence for the feasibility of intensive assessment of large numbers of non-clinical research subjects. It filled the gap between national surveys (large but thin) and work that can be done by a single researcher (small and rich). In many ways the current UpTERN data as well as that which will be collected in outgrowths of UpTERN represent the right combination of relatively large and thoroughly rich that the field was in need of."

- "TERN's major contributions will turn out to be conceptual. While there are substantive scientific findings that have been and will come from TERN-supported work, these will be overshadowed by the more difficult-to-measure change in approach to questions of tobacco dependence. For example: (1) the scientific support and leadership that TERN has given to the application of advanced multivariate methodologies (i.e., simultaneous consideration of the influence of multiple variables on specific outcomes of interest to the researcher) to more basic research areas, including lab-based research, will prove to be a watershed in addiction research. It is the type of ground-breaking high-risk, high-payoff new direction in research that would have been impossible to accomplish under a typical NIH model of research support; and (2) bringing more microscopic focus to some of the key events in the ontogeny (development and course) of youth smoking. By measuring behavior carefully, in real time, with daily (or even use episode) data collection, we have generated an amazing database of detailed knowledge about the natural topography of these critical behaviors."

- "TERN has demonstrated the need for more micro-level analysis as well as longitudinal studies. Through UpTERN, we have set the field on an entirely new track to bring a level of scientific focus on the actual behavior emerging in real time that is critical for us to study. In many ways, this is the reverse of the methodological contribution TERN has made to laboratory-based research. In this case, we have brought the mentality of a lab scientist to the study of human behavior in its natural environment. I believe this will be an important legacy."

- "I believe (but am not certain yet) that the focus on early use episodes will have a large payoff in terms of focusing attention on this area of research that had not been looked at very well before. I believe (and know) that some of the TERN review papers are already influencing the field. I know this because, in my journal editing role, I see many submissions coming to the journal that cite some of these reviews."

TERN'S Impact on the Next Generation of Tobacco Researchers (Core Group Member Responses Only)

One of TERN's goals was to expose highly promising junior faculty to transdisciplinary research concepts, methods and practices. The hope was that this would not only sustain

their interest in studying the etiology of tobacco use, but also provide them with the perspectives and skills needed to do so in a richer and more meaningful way. Here is what core group members said about the degree to which the network was successful in attaining this goal:

- "Our junior colleagues will now think of the process of dependence as starting early and taking time and will be more likely to be critical of reductionistic explanations for why some people become dependent faster than others."

- "As a result of their participation in TERN, the Faculty Scholars think in a truly transdisciplinary way. As they are just starting their careers, they will have many years to make an impact. In addition to their own research, they will influence their peers and the future work of their own trainees. In fact, many of our junior colleagues are already training students and post-docs in the 'ways and means' of TERN. Over the long term, this will be TERN's greatest impact. It's indirect, but it's real."

- "The TERN Faculty Scholars Program has been an incredible opportunity to guide and direct the next generation of tobacco researchers, several of whom have the capacity to be leaders in the field. This has been accomplished through identifying key questions that are now being pursued as thesis projects, postdoctoral projects and grant applications — and through getting a critical mass of up-and-coming scientists committed to these pathways."

TERN's Greatest Strengths

Participants in TERN delineated a number of characteristics that they judge to be significant strengths of TERN. Among these are the following:

- "The collegial scientific culture combined with the scientific acumen of the TERN members."

- "The diversity of skills and opinions against a background of mutual respect, even admiration."

- "Flexibility, mutual respect, sheer thinking capacity."

- "An intellectual environment that encouraged collaboration to the exclusion of competing for self-advancement."

- "TERN has been a model of true scientific collaboration. I have never experienced an organization that begins to embody the open and collegial nature of this group. I credit a lot of that to Dick Clayton, whose unique leadership skills have been a perfect match for the challenge of building a culture of scientific collegiality and shared purpose. Support of TERN from RWJF staff in the critical formative years and the help of our consultant have also been invaluable."

- "Well, it is somewhat tautological, but the people in TERN are TERN's greatest strength. The selection process was paramount. [TERN participants] are people with strong opinions, but they are (nearly) always civil. If this basic level of courtesy were not maintained (and believed to be important by all members), then TERN probably would have been quite different. Having time and money didn't hurt either."

- "The TERN Faculty Scholars. Getting younger people involved to be guided by senior scholars was a great idea and really increased our productivity. The general attitude toward more junior people by the bulk of TERN members is a great strength of TERN. If that attitude had not been present, most of the TERN products probably wouldn't have seen the light of day. The senior members are all busy and they probably would not have had the time to do the writing themselves."

- "The theoretical discussions where we realized what we needed to know, and organized ourselves to find out about it."

- "Built-in time at the beginning to learn each others' 'language' and approaches. I was inspired by the early TERN meetings where the conversation was sometimes overly lofty, never getting bogged down in whether we should ask five or six questions in the weekly questionnaires."

- "Nice places/hotels/food/stipends. These fostered a sense of commitment and belonging to something special."

- "Strong central leadership by a chair (Dick) with an unmatched ability to integrate volumes of information into a coherent overarching plan, and great skill in keeping network members focused on the goals that emerge from the plan. An 'outside' consultant (Denis) to provide important feedback and steady the course as needed."

- "Long-term commitment that enabled TERN to grow and thrive. Think of making a one-month commitment to a garden or farm. That is like a one-year grant. A three-year grant is like a four-month commitment to the garden and you can get one decent crop and harvest with a bit of luck. Commitment of several years to a garden or farm is what TERN gave us. This commitment was matched by ongoing nurturing by the Foundation, including its willingness to commit Denis [Prager] to provide such invaluable guidance along the way, and an outstanding advisory board to provide key points of guidance, reality and the contingency of oversight."

- "Lack of fear about thinking beyond what is possible through a federal grant mechanism. No significant internal competition. Regular meetings that allowed us to work together over time. And the opportunity to actually do research together — I think that UpTERN will be our biggest legacy."

Impacts on TERN Faculty Scholars

The responses of the TERN Faculty Scholars have largely been integrated into the responses above. However, on the issues of professional and personal benefits and impacts on the next generation of tobacco researchers, it seemed best for the Faculty Scholars' perspectives to be captured separately.

Most significant professional and personal benefits. Participation in TERN has benefited TERN Faculty Scholars in a number of ways, both professionally and personally. This is reflected below in their own words.

- "TERN has been fantastic for my career. I've been promoted unbelievably by the network. I've made connections with people and had opportunities I could not have dreamed of before TERN. The number of people I can approach as mentors/advisers increased some 15 or 16 times (and they didn't get to ask for changes in my dissertation!)."

- "My current long-term career plan focuses on learning enough about the process of dependence that I can conduct useful substantive work, in addition to developing snazzy methodology. I don't think I would have considered such a thing before TERN. Professionally, I have benefited most from the exposure to different perspectives related to questions of etiology. Personally, I found the work (in large part because of the people) energizing and reassuring (about the field as a whole). This provides momentum to continuing to pursue the questions raised in TERN even after TERN comes to an end."

- "First, involvement with TERN got me writing two major review papers that broadened my knowledge and also helped me gain some visibility in the nicotine/tobacco field. Second, TERN involvement, and particularly interactions and encouragement from TERN colleagues, helped me maintain my focus on potential reduced-exposure products, which led to a five-year NCI grant. Third, I realized by watching senior TERN colleagues that international collaborations can be fun, exciting, and valuable (career-wise), and so jumped eagerly into an opportunity to do some research in the Middle East. Fourth, watching Dick's [Clayton] leadership style has been very instructional for me, and I have tried to incorporate it into my interactions in my home department (where I have been nominated for graduate program director) and in my international collaboration (where, ironically, I am seen as the 'diplomat' of the team!)."

- "I've learned that high level theoretical discussions can be important and fun, and that friendship enhances the scientific process."

- "It has increased my stature as a researcher and mentor. One of my students recently received a National Research Service Award to study subtypes of childhood aggression as a correlate of tobacco and alcohol use, and I believe my involvement with TERN made me more credible as a mentor and promising researcher."

- "I have always been interested in using animal models to inform my conceptualization of addiction. My involvement with TERN has spurred me to pursue this in a more systematic fashion. I am actively collaborating with other researchers at my university to develop paradigms that bridge animal and human models of addiction. To date this work has a yielded a small internal grant to support this effort, and a conference presentation."

- "I have begun collaborations with several researchers who provide an excellent complement to my research background and skills. Consequently, I view these collaborations as having a synergistic, rather than additive, effect on improving the quality of the research that I produce."

- "Conversations with TERN colleagues about adolescent brain development, and then the conference supported by TERN had a significant impact on my conceptualization of adolescent substance use. I have been critical of how explicit decision-making models have been applied to adolescent risk behavior for some time, and my collaboration with TERN has lead me to reformulate my thoughts into a coherent area of research on implicit substance-use related cognitions. I currently have a grant under review on this topic."

- "*Past*: My link to TERN core group members made all the difference in getting my K01 award [a research award mechanism designed to facilitate the career of new scientists] funded through NIDA, setting in motion other funding opportunities.

Because of the K01, I was attractive to a medical research foundation that awarded me a major grant. *Current*: TERN is providing me with access to unique and rich data that will allow me to make significant contributions to the literature in ways that I could never have done. Although there is a great deal of public access data, the UpTERN and OpTERN studies represent depth and richness related to smoking phenomenology that will never be captured in a nationally representative sample. *Future*: I feel as though I have collaborative avenues that will serve me well for the rest of my career. When writing a grant, I have a wealth of brilliant consultants and co-investigators to turn to. Most importantly, I feel confident that we can engage in truly collaborative work, rather than in name only (a not so uncommon phenomenon for individuals listed as consultants on grants)."

- "As a TERN scholar, the network provided me with an opportunity to interact with some of the best-known tobacco scholars in the country. Although this was initially quite intimidating, over the years, I gained insights into the group process and what I, as an anthropologist, could bring to the table. As a fieldworker, I particularly liked working on a project with my UpTERN colleagues. This gave us the chance to put our ideas into action and to bridge the gap between qualitative and quantitative methods. My level of understanding about tobacco has grown exponentially, and the studies I would undertake now as a tobacco researcher would be far more sophisticated as a result of interacting with the TERN group. On a more practical level, my association with TERN over the years has meant that much of my research over the last five years has focused on issues of tobacco use. A tangible result: I got tenure!"

- "The cross fertilization of thought about tobacco was inspirational. As TERN winds down, I feel that I have a network of people from diverse disciplines to write with about tobacco. This could never have been established by meeting people at conferences. TERN allowed me to figure out how people think; the meeting process provided me with insights into members' expertise."

TERN's impact on the next generation of tobacco researchers. Listed below is what TERN Faculty Scholars said about the degree to which the network was successful both in providing an environment in which they would sustain their interest in studying the etiology of tobacco use and in providing them with the perspectives and skills needed to do so in a richer and more meaningful way.

- "TERN has created tobacco researchers. I was interested in substance use and abuse, but was not paying much attention to smoking when I became involved in TERN. In epidemiology there seems to be smoking research and then other substance use research. TERN has set a valuable example in how to bring these areas together."

- "The training I received in TERN will have long-term impacts as I train graduate students and post-doctoral fellows."

- "As a result of TERN's conceptual development and research: (1) there will be long-lasting effects for the field of tobacco research from the use of multiple dependence measures, such as those used in UpTERN, which will provide valuable information about the measurement of dependence; (2) tobacco researchers will focus more on co-substance use, rather than looking at tobacco as an isolated behavior; (3) researchers may focus more on issues of gender and developmental age; and (4) researchers will increasingly recognize the limitations of cross-sectional research and

the need for longitudinal designs which cover youth through high school or across the four years of college."

LESSONS LEARNED

- TERN was always thought of as an experiment in collaborative science. The purpose of experiments is to learn — and, those involved have learned a great deal from TERN. Some lessons are listed below. However, first, the authors thought it best, again, to let the participants define lessons learned from their perspectives. So, the authors asked them: "Based on your TERN experience, what recommendations would you make to someone contemplating the establishment of a transdisciplinary network in another field?"

Advice for Someone or Some Organization Contemplating a Transdisciplinary Research Network

Network members were asked: what would you tell someone who came to you for advice about setting up a TERN-like network.

1. **"It takes at least five to seven years to make this work; have a facilitator; do not push an agenda too soon; make decision-making transparent."**

2. **"Only do it if there will be sufficient time for people to learn to speak to one another, and then be able to speak together about the problem at hand."**

3. **"Pick your players carefully.** It is not all about expertise. Equally as important is generosity of time and talent, passion for the work and the area, and willingness to have your ideas challenged."

4. **"Only include people who are both cordial and knowledgeable.** There are a lot of good scientists that might make good collaborators, but I am only likely to develop a fruitful and long-lasting collaboration with people I like and trust."

5. **"Facilitate friendships. Meet frequently.** Three or four times a year seemed to help establish the necessary relationships and keep the work on the front burner."

6. **"Be absolutely clear about the responsibilities that members are accepting when they join the network."**

7. **"Strong collegial leadership is required.** The person leading it will need to learn to simultaneously keep the group on track, but also let [its members] explore."

8. **"Good leadership and staff support are key.** I have no idea how leaders such as Clayton and administrators such as Segress at the University of Kentucky can be identified in advance, but they are critical elements. In this case it worked. I could easily imagine networks that might fail due to less inspired leadership and capable administration."

9. **"Include junior faculty.** They are the folks who are probably most able to change their thinking and who have the time to pursue new ideas/collaborations even after the network ends. I also think the attention to personal relationships is essential."

10. **"Focus on the ideal 'theoretical framework' even though, in the back of your head, you may think that it may not be obtainable.** The process of trying to attain that framework may be the greatest achievement."

11. **"Do everything that TERN did AND provide a viable mechanism for continuing at least some areas of work beyond what should already be a long-range commitment.** Commit major effort to 10 years with the potential for at least some follow-up for another 10 years."

12. **"I am a convert to the value of research networks.** During the first few years when all we did was talk, I had some misgivings. I now realize that most of this 'just talk' was important to do. I was an especially slow learner and profited from a certain amount of repetition. Thus, I am convinced that a successful research network needs all of 10 years to realize its potential."

CONCLUSIONS

On the basis of the material presented here, there is justification for asserting that TERN was a successful mechanism for knowledge development and as a funding mechanism for RWJF. In many ways it is a prototype for transdisciplinary research networks and for the development of transdisciplinarity. This is significant because transdisciplinarity is increasing cited as the goal in federal funding mechanisms. Therefore, RWJF was at the forefront of this movement toward an emphasis on transdisciplinarity and can point to TERN as an example of how to do transdisciplinary science, noting its many strengths and — on the basis of this report — some of the limitations and pitfalls of this approach. The authors believe the investment made by RWJF in this network provided a good return. Listed below are some conclusions for consideration by potential funders of transdiciplinary research networks.

- **The role of staff from the funder in the initiation of the network and ongoing monitoring of its maturation and operations is crucial.** Especially in the beginning, collaborative enterprises tend to regress to the mean of business as usual — parallel play rather than collective scholarship. As representatives of the funder with its resources on the line, it is incumbent on staff from the funder to make sure that the network remains true to its mission and collaborative principles. It is also incumbent on staff from the funder to provide the chair and the network members the time and especially the latitude to develop the rapport, trust and group culture necessary for doing their work.

- **It takes time to establish a network and develop its collaborative processes.** If a funder is not in a position to make a long-term commitment to such a venture, it should not attempt it.

- **Networks need continual fine-tuning.** Each network is a distinctive entity and, as such, must continually refine its leadership, management and administrative functions, fine tune its collaborative strategies and make necessary changes in membership along the way.

- **Network leadership is a full-time job.** The funder's staff must be clear about the time and other commitments required of the chair in order for the network to succeed. It is also critical for the chair to understand the importance of maintaining momentum. Perhaps nothing is more important. For this reason, it is essential that meetings be scheduled at least a year in advance. It is equally important that the network members commit to participating in *every* meeting and to make network

membership such an important part of their work that nothing interferes with their participation in each meeting.

- **A well-organized and efficient network administrator, located in the same venue as the chair, is absolutely required for the network to succeed.** This person, and other support staff provide the logistical support that make it possible for the members to attend meetings and participate in network activities between meetings without ever having to think about the logistics or other things needed to make their work successful. The funding agency should make this crystal clear to the chair. The administrator is the network's flywheel, providing administration and logistical support that is effective, efficient and invisible.

- **A transdisciplinary network offers an excellent opportunity to recruit both senior and less than senior researchers into a substantive field.** The experience with the TERN Faculty Scholars could not have been better or more productive. It was fortuitous that the TERN Faculty Scholars were brought into the network after the senior scientists had had an opportunity to develop trust, rapport and a culture of collaboration. Based on the TERN experience, the authors would recommend a lag between establishment of the network and the beginning of a training initiative. The other things they would recommend, based on their experience, are: (1) thorough integration of the trainees into the group process, and (2) an emphasis on encouraging the trainees to take the lead on research and publication efforts.

- **Ambience matters.** Senior-level researchers are accustomed to attending meetings in less than quality accommodations. The resources devoted to high-quality venues for meetings, food and the evening meals, and to building social ties among members and cohesion in the group are worth every penny expended.

- **Stipends help.** Senior-level researchers are accustomed to receiving very modest honorariums for their participation in scientific activities. A somewhat more than modest honorarium signals that the funder values the contributions of the individuals involved and the time they are committing to the enterprise. Acceptance of the honoraria signals that the network members understand their commitments and intend to live up to them.

All of the discussion above leads to a simple conclusion: the transdisciplinary research network experiment by the Robert Wood Johnson Foundation seems to have worked. It achieved all of the goals set forth by RWJF and had achievements in areas RWJF program staff could not have imagined at its beginning.

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APPENDIX 1: TERN Members

DISCLAIMER="false"

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APPENDIX 2: Special Journal Issues and Supplements Featuring TERN Articles

DISCLAIMER="false"

"Tobacco, Nicotine and Youth." *Drug and Alcohol Dependence* (Volume 59, Supplement 1, May 2000). Clayton RR, Merikangas KR and Abrams DB (eds).

- Clayton RR, Merikangas KR and Abrams DB. "Introduction to Tobacco, Nicotine, and Youth; The Tobacco Etiology Research Network," S1-S4.
- Shadel WG, Shiffman S, Niaura R, Nichter M and Abrams DB. "Current Models of Nicotine Dependence: What Is Known and What Is Needed to Advance Understanding of Tobacco Etiology Among Youth," S9-S22.
- Colby SM, Tiffany ST, Shiffman S and Niaura RS. "Measuring Nicotine Dependence Among Youth: A Review of Available Approaches and Instruments," S23-S39.
- Eissenberg T and Balster RL. "Initial Tobacco Use Episodes in Children and Adolescents: Current Knowledge, Future Directions," S41-S60.
- Mayhew KP, Flay BR and Mott JA. "States in the Development of Adolescent Smoking," S61-S81.
- Colby SM, Tiffany ST, Shiffman S and Niaura RS. "Are Adolescent Smokers Dependent on Nicotine? A Review of the Evidence," S83-S95.

"Prevention of Substance Use Problems: Directions for the Next Millennium." *Addictive Behaviors: An International Journal Special Issue* (Volume 25, Number 6, November/December 2000). Merikangas KR and Clayton RR (eds).

- Merikangas KR and Clayton RR. "Introduction to the Special Issue of Addictive Behaviors," 805.
- Merikangas K and Avenevoli S. "Implications of Genetic Epidemiology for the Prevention of Substance Use Disorders," 807-820.
- Flay B. "Approaches to Substance Use Prevention Utilizing School Curriculum Plus Social Environment Change," 861-885.

"Measurement and Design Issues in Tobacco and Drug Use Research." *Drug and Alcohol Dependence* (Volume 68, Supplement 1, November 2002). Collins LM, Flaherty BP and Colby SM (eds).

- Collins LM, Flaherty BP and Colby SM. "Measurement and Design Issues in Tobacco and Drug Research," S1-S2.
- Clayton RR. "Introduction to the Supplemental Issue on Measurement and Design Issues in Tobacco and Drug Research," S3-S5.
- Flaherty B. "Assessing Reliability of Substance Use Measures With Latent Class Analysis," S7-S20.

- Panter AT and Reeve BB. “Assessing Tobacco Beliefs Among Youth Using Item Response Theory Models,” S21-S39.
  Note: These authors were recruited to write this paper for the TERN special issue. This is the first time that item response theory has been used in the tobacco field.

- Nichter M, Nichter M, Thompson PJ, Shiffman S and Moscicki A-B. “Using Qualitative Research to Inform Survey Development on Nicotine Dependence Among Adolescents,” S41-S56.
  Note: This paper resulted from a TERN supplement to an ongoing study sponsored by the TRDRP in California.

- Thompson SK and Collins LM. “Adaptive Sampling in Research on Risk-Related Behaviors,” S57-S67.
  Note: Thompson is a distinguished statistician. This is the first paper he has ever published dealing with tobacco research.

- MacKinnon T, Taborga MP and Morgan-Lopez AA. “Mediation Designs for Tobacco Prevention Research,” S69-S83.
  Note: MacKinnon is a distinguished scientist in the prevention field and was recruited specifically to write this paper. He brought into the writing two of his other colleagues.

- Collins LM and Graham JW. “The Effect of the Timing and Spacing of Observations in Longitudinal Studies of Tobacco and Other Drug Use: Temporal Design Considerations,” S85-S96.

“Contexts and Adolescent Tobacco Use Trajectories.” *Addiction*, (Volume 98, Supplement 1, May 2003), Flay BR and Clayton RR (eds).

- Flay BR and Clayton RR. “Introduction: Contexts and Adolescent Tobacco Use Trajectories,” iii-iv.

- Avenevoli S and Merikangas KR. “Familial Influences on Adolescent Smoking,” 1-20.

- Darling N and Cumsille P. “Theory, Measurement, and Methods in the Study of Family Influences on Adolescent Smoking,” 21-36.

- Kobus K. “Peers and Adolescent Smoking,” 37-56.

- Wilcox P. “An Ecological Approach to Understanding Youth Smoking Trajectories: Problems and Prospects,” 57-78.

- Wakefield M, Flay B, Nichter M and Giovino G. “Role of the Media in Influencing Trajectories of Youth Smoking,” 79-104.

- Liang L, Chaloupka F, Nichter M and Clayton RR. “Prices, Policies, and Youth Smoking,” 105-122.

- Pollack H and Jacobson PD. “Political Economy of Youth Smoking Regulation,” 123-138.

- Nichter M. “Smoking: What Does Culture Have to Do With It?” 139-146.

- Chaloupka F. “Contextual Factors and Youth Tobacco Use: Policy Linkages,” 147-150.

- Cook TD. “The Case for Studying Multiple Contexts Simultaneously,” 151-155.

“Theoretical Contributions to Assessing the Emergence of Nicotine Dependence.” *Addiction,* (Volume 99, Supplement 1, June 2004), Tiffany ST, Shiffman S and Conklin C (eds).

- Conklin C, Clayton RR, Tiffany ST and Shiffman S. “Introduction to Concepts and Measurement of the Emergence of Tobacco Dependence,” 1-4.

- Eissenberg T. “Measuring the Emergence of Tobacco Dependence: The Contribution of Negative Reinforcement Models,” 5-29.

- Glautier S. “Measures and Models of Nicotine Dependence: Positive Reinforcement,” 30-50.

- Brandon TH, Herzog TA, Irvin JE and Gwaltney CJ. “Cognitive and Social Learning Models of Drug Dependence: Implications for the Assessment of Tobacco Dependence in Adolescents,” 51-77.

- Tiffany ST, Conklin CA, Shiffman S and Clayton RR. “What Can Dependence Theories Tell Us About Assessing the Emergence of Tobacco Dependence?” 78-86.

APPENDIX 3: Grants Received by TERN Members

DISCLAIMER="false"

Abrams D, principal investigator (PI), Transdisciplinary cancer control research training grant (R25T). This grant is providing support for the work of Scott Novak, as a research assistant professor at Brown University. TERN supported Novak's post-doctoral work at Harvard University School of Public Health and his work with Ron Kessler, Ph.D., on the National Comorbidity Study.

Balster RL, co-PI (Roy Pickins, co-PI), "Virginia Youth Tobacco Project," grant from the Virginia Tobacco Settlement Foundation, funded February 1, 2002 through June 30, 2004, $4,250,000. Refunded for 2004-05.

Clayton RR, PI, funding for the New York Academy of Sciences meeting sponsored by TERN and RWJ, $50,000.

Clayton RR, co-PI (Robert Bray, PI), "Tobacco Initiation and Cessation Among New Soldiers," grant PR023063, Department of the Army, TERN component, $452,000 over four years.
Note: This was a joint response to a request for applications from the U.S. Army that involves a collaboration between the Research Triangle Institute and TERN.

Colder CR, co-PI (Larry Hawk, PI), "The Effects of Nicotine on Reward Conditioning: Initial Tests of a Model of the Maintenance of Smoking Dependence," SUNY Buffalo, $50,000.

Dahl RE, PI, conference grant on New York Academy of Sciences' Meeting on Adolescent Brain Development: Vulnerabilities and Opportunities, grant R13 DA0166888 from the National Institute on Drug Abuse, July 1, 2004 through June 30, 2004, $25,000.

Dahl RE, PI, "Interdisciplinary Research: Behavioral/Emotional Health," grant T32 HD049354 from the National Institute on Child Health and Human Development, May 1, 2005 through April 30, 2010, $962,475.

Dorn L, PI, "Smoking and Metabolic Complications in Adolescent Girls," R01 grant (a regular research grant) submitted to NIDA, Priority Score (27th percentile), $3,088,548.

Koob GF, PI, "Nicotine Self-Administration in an Animal Model," grant from the Tobacco Related Disease Research Program, 2003, Cycle XII, $663,933.

Richardson EL, PI, adding an intensive, motivational enhancing cognitive-behavioral intervention to brief intervention plus nicotine replacement therapy (NRT) will enhance the achievement and maintenance of smoking cessation in a sample of young adults, ages 18–25 years. This pilot study is funded through the Brown-Harvard-Yale Transdisciplinary Tobacco Use Research Centers Grant (TTURC), Nicotine Dependence: Risk and Recovery Over Generations, with funding from NCI, NIDA and RWJF (ID# 042672).

Stroud L, PI, K-23 (a grant mechanism designed to foster the career of clinician scientists) Mentored Patient-Oriented Research Career Development Award (K23 MH65443-01), "HPA Reactivity, Puberty, & Sex Differences in Depression," National Institute of Mental Health, NIH.

Stroud L, PI, identifying a biobehavioral marker for vulnerability to nicotine dependence in adolescents. This pilot study is funded through the Brown-Harvard-Yale Transdisciplinary

Tobacco Use Research Centers Grant (TTURC), Nicotine Dependence: Risk and Recovery Over Generations, with funding from NCI, NIDA and RWJ F (ID# 042672).

Note: David Abrams wrote a letter to Stephen Schroeder, M.D., former president of RWJF, indicating that TERN played a major role in the funding of the Brown-Harvard-Yale TTURC. While this recognition is deeply appreciated, it would not be appropriate for TERN to take credit for the contributions of all of the outstanding scientists at these three institutions who wrote the applications that constitute this TTURC.

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(TERN authors in bold)

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Note: This book was supported in part by TERN and thus, indirectly can be viewed as a TERN publication according to Abrams.

Dahl RE and Spear LP. *Adolescent Brain Development: Vulnerabilities and Opportunities.* Annals of the New York Academy of Sciences, 1021, 2004.

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Note: This is a special issue developed, organized and published with the help of the entire TERN group. See Appendix 2 for the list of articles.

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Note: This is a special issue developed, organized and published with the help of the entire TERN group. It is important to note that TERN recruited an outstanding young scientist at Brown (Colby) to be an editor and that Flaherty is a doctoral student at Penn State in statistics and was employed by TERN. See Appendix 2 for the list of articles.

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Dierker L, Avenevoli S, Stolar M and **Merikangas K.** "Smoking and Depression: An Examination of Mechanisms of Comorbidity." A*merican Journal of Psychiatry,* 159(6): 947–953, 2002.

Dierker L, Avenevoli S, Goldberg A and Glantz M. "Defining Homogeneous Subgroups at Risk for Experimental and Regular Smoking: Findings From a Nationally Representative Sample of Adolescents." Unpublished.

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Note: This paper resulted from TERN identifying three young scientists who did not know each other and persuading them to develop a paper under guidance from TERN. This paper led to a special plenary at a meeting of the Society for Research on Nicotine and Tobacco, several meetings of the authors with the entire TERN group, input from the entire TERN group, and ultimately acceptance of this publication in one of the world's leading journals in psychology.

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Note: Novak was a doctoral student of Dick Clayton's and participated in TERN.

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